CONTROL VALVE SOURCEBOOK

REFINING

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EMERSON™
Process Management

Emerson Process Management gratefully acknowledges the contribution made to this book by **Key Control, Inc.** and the contributions made by Emerson Process Management employees:

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Refinery Control Valves

Introduction

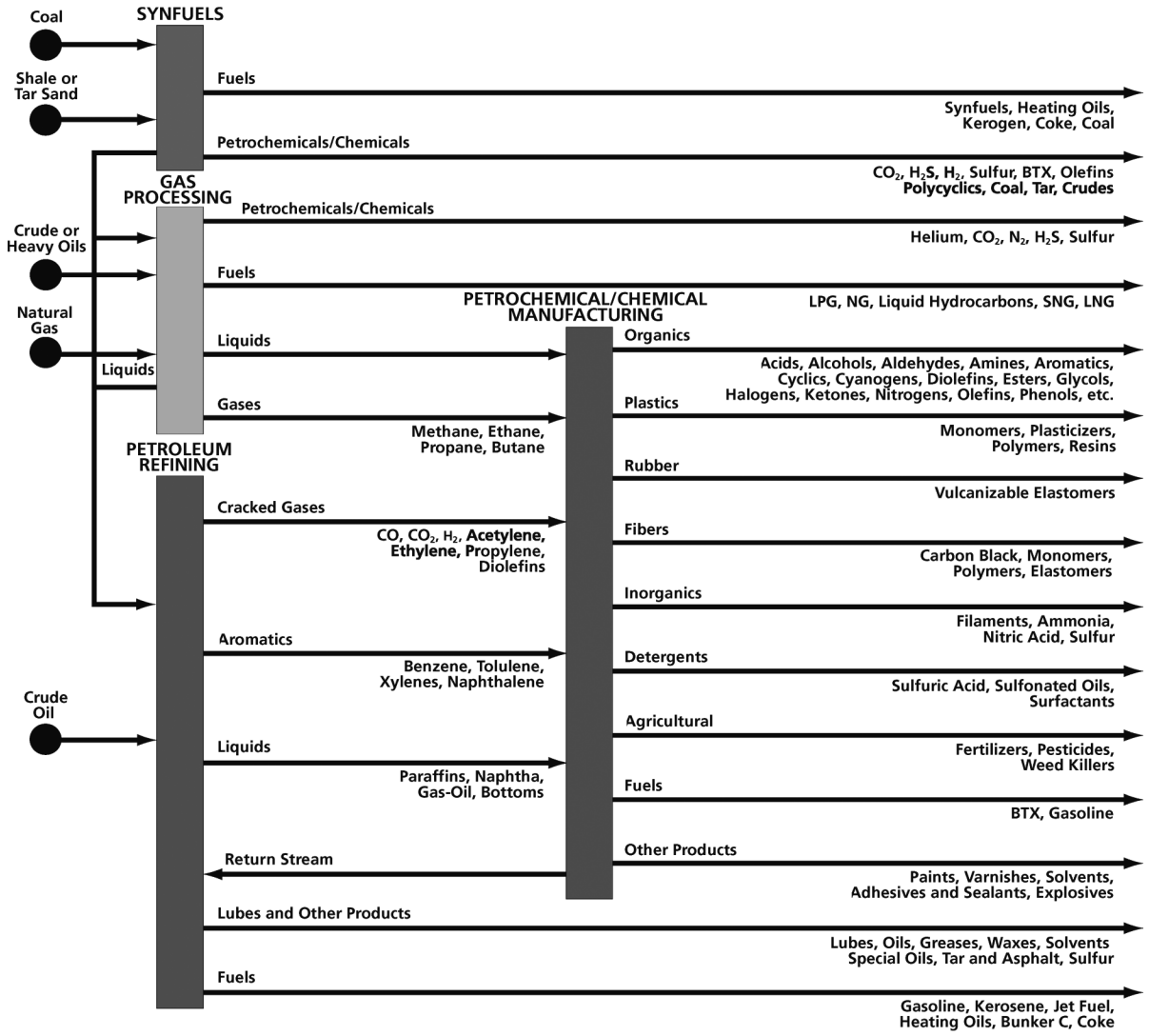
The petroleum refining industry is an industry that is most vital to our modern global economy. Almost constantly, you are in close contact with products that once were distilled through columns like those shown above. Some of these materials and products are so important that their rapidly fluctuating market values are reported every day on television, radio, Internet, and newspapers.

The products go through many phases from crude oil and other raw materials to the final products you use every day. On the following page is a chart showing the raw materials, some of the intermediate petroleum product phases, and some of the final products that reach you as a consumer. Many of the products on the next page are further processed and become part of too many items to mention.

The products are all processed and made ready for the market in refineries. Efficient operation of refineries has a tremendous impact on profit, final consumer price, and wise use of limited resources. Efficient refinery operation depends on well-planned and well-executed control strategies, responsive control systems, and tough, reliable control valves.

This sourcebook is a primer on the use of control valves in many refining processes. It is intended to help you:

- Understand the types of refining processes,
- Learn where control valves are typically located within the process,
- Identify the operational problems that might be caused by poor valve performance,
- Identify Fisher valves that are commonly used for the applications in a refinery.



Product Streams in the Refining Industry
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A standard format is used to present the information on each refining process. The information provided is:

- Other commonly-used names for the described process
- The basis (feed rate) for the example process
- A short description of the process
- A list and description of each important process valve in the unit
- A functional drawing of the process
- Typical process conditions
- Names of Fisher valves that can be considered for each process
- Potential process impacts and special considerations for each valve

Other Names

It is not possible to make an all-inclusive list of commonly-used process names. Many refineries have developed specific process names based on local preference or the preferences of the licensor or designer that developed the process.

Process Descriptions

Many processing units within a refinery contain furnaces and distillation columns, which makes these pieces of equipment and their operation fairly universal. The valve requirements for these units are presented in Chapters 1 and 2, respectively, and are not repeated in the chapters that follow.

Chapters 3 through 14 discuss refining processes, with the valve information presented in each chapter applying directly to the specific process being described.

Valve Selection

The information presented in this sourcebook is intended to assist in understanding the control valve requirements of general refining processes.

Since every refinery is different in its unit makeup and the technologies it utilizes, the control valve requirements and recommendations presented by this sourcebook should be considered as general guidelines.

The information in this sourcebook is intended to assist with understanding general refining process requirements and general control valve considerations.

Under no circumstances should this information alone be used to select a control valve without ensuring that the proper valve construction is identified for the application and process conditions.

All valve considerations should be reviewed with your Fisher sales office or representative as part of any valve selection or specification activity.

Control Valves

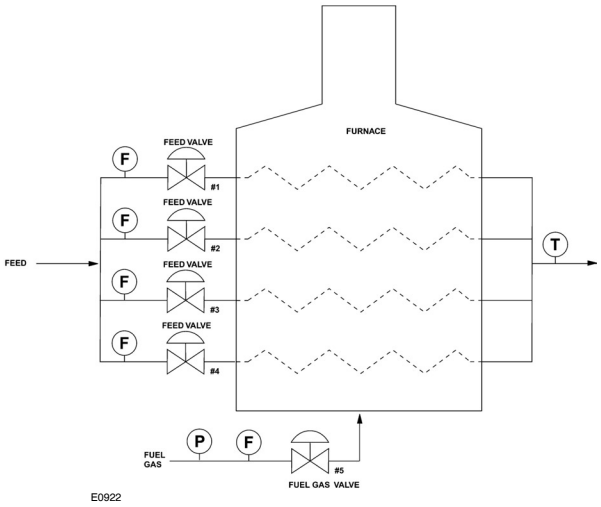
W8119

*Typical Control Valve (**easy-e**® Valve)*

Valves described within a chapter are labeled and numbered corresponding to the identification used in the process flow chart for that chapter. The order in which they are discussed is from left-to-right and top-to-bottom.

If a valve is controlling feed, intermediate or final product streams, the U.S. dollar value of that stream (as recorded at the time of sourcebook publication) and typical feed rate are provided. The valve function also is described, and a specification section gives added information on process conditions, names of Fisher valves that can be considered, process impact of the valve and any special considerations.

Process Drawing



Typical Process Drawing

The process drawing within each chapter shows major equipment items, their typical placement within the processing system and process flow direction. Utilities, pumps and most heat exchangers are not shown. Valves are numbered in sequence from left-to-right and top-to-bottom.

Problem Valves

Often there are references to valve-caused problems or difficulties. The litany of problems includes valve stickiness caused by excessive friction (called “stiction”), excessive play in valve-to-actuator linkages (typically in rotary valves) that causes deadband, excessive valve stem packing leakage, and valve materials that are incompatible with the flowing medium. Any one or a combination of these difficulties can affect process quality and throughput, with a resulting negative impact on refinery profitability.

Many of these problems can be avoided or minimized through proper valve selection. Consideration should be given to valve style and size, actuator capabilities, analog vs. digital instrumentation, materials of construction and the like. Although not being all-inclusive, the information that this sourcebook provides should facilitate the valve selection process.

Abbreviations

BBL	Barrels
BPD	Barrels per day
CCR	Continuous catalytic reformer
DIB	Deisobutanizer
FCC	Fluid catalytic cracker
Gal	Gallons
GPM	Gallons per minute
HCO	Heavy cycle oil
HDS	Hydrodesulfizer
HVGO	Heavy vacuum gas oil
LCO	Light cycle oil
LVGO	Light vacuum gas oil
LPG	Liquified petroleum gas
MBPD	Thousand barrels per day
MCF	Thousand cubic feet
MCFD	Thousand cubic feet per day
MMCF	Million cubic feet
MMCFD	Million cubic feet per day
MGPY	Thousand gallons per year
MLB	Thousand pounds
MLBD	Thousand pounds per day
SRU	Sulfur recovery unit
SWS	Sour water stripper

Chapter 1

Furnace

Other Names

Heater, cracking furnace, steam cracker, steam re-former, reboiler heater

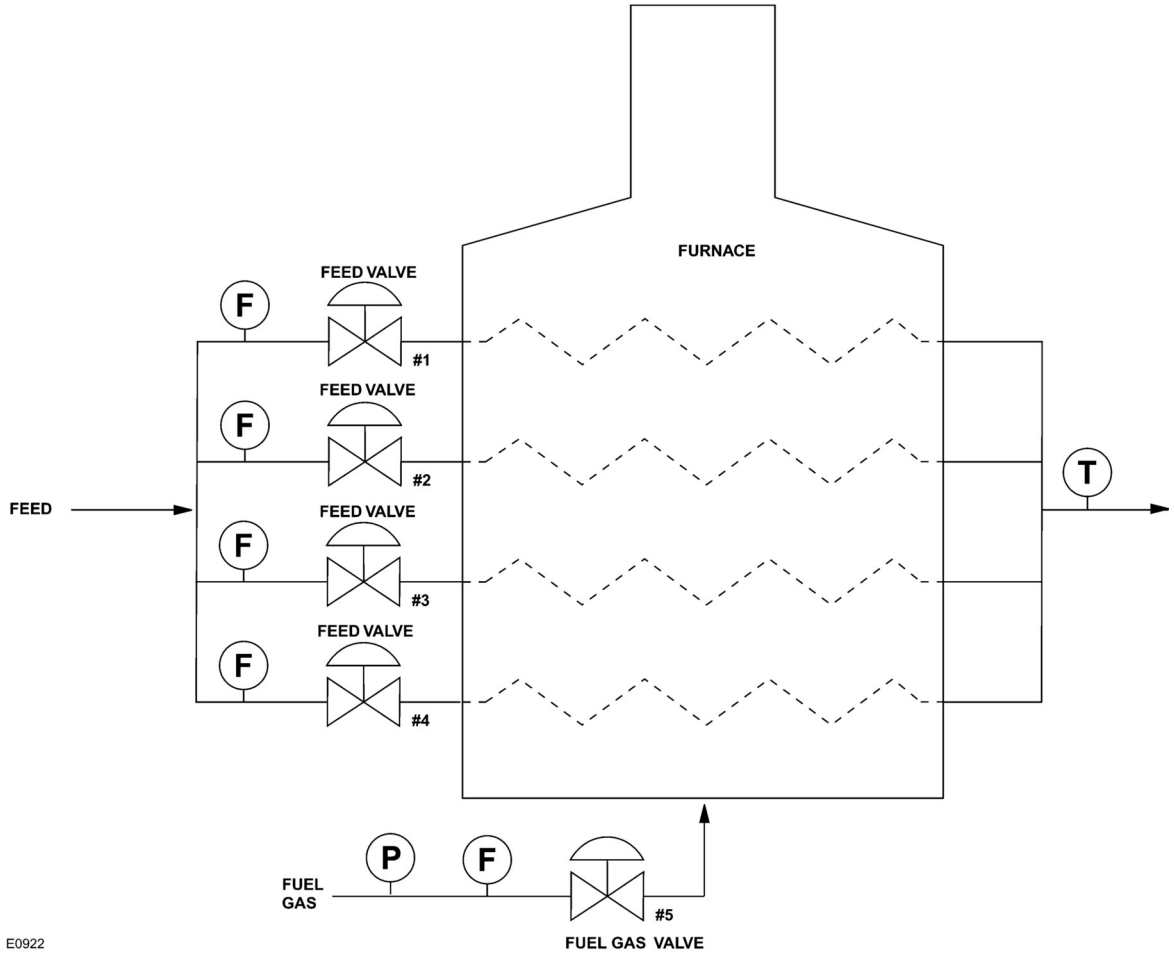
Description

Furnaces are used to heat process feed material. Heat is created by burning fuel in burners on the floor and/or walls of the furnace. There are many different types of fuel that can be used by a furnace, such as natural gas, liquified petroleum gas (LPG), refinery waste gas and fuel oil.

The process feed stream to a furnace is usually broken into multiple tube passes to improve heat transfer. The most common configurations are two- and four-pass furnaces. The passes are recombined into a single effluent stream after they exit the furnace.

The outlet temperature of a furnace is normally dictated by the requirements of a downstream process, usually a reactor or distillation column. Adjusting the amount of fuel burned controls the outlet temperature.

In some cases, the furnace will provide enough heat to crack the feed stream thermally from large hydrocarbon molecules to smaller molecules. In these cases, the outlet temperature is used to control the amount of cracked components in the effluent stream.



Typical Furnace

Control Valves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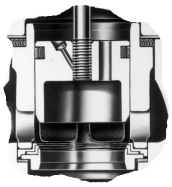
W3962

***easy-e®** Valve*

Feed Valve Function (#1, #2, #3, #4)

Feed valves are usually set up as flow-control loops. They are configured to fail open so that a valve failure will protect the furnace radiant section tubes. If a radiant tube loses flow or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences, as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke buildup. If a flow valve is alternately provided too much and then too little flow, the temperature will also swing and will usually lead to excessive coke buildup. This will shorten the furnace cycle time between decoking procedures, which will normally require the process unit downstream to shutdown.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Feed Valve Specification (#1, #2, #3, #4)

Process Media

Media	Pressure Range	Temperature Range
Heavier gas oil Naphtha	Dependent on process design	

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED

Process Impact

- Control is critical to maintaining integrity of internal furnace tubes, such as preventing coke lay-down.

- Valve performance is critical to overall reliability of furnace.

- Critical to furnace safety; process fluid flow is required at all times through the tubes while the furnace is firing.

Special Considerations

- Sour feed stocks might require NACE trim materials

Fuel Gas Valve Function (#5)

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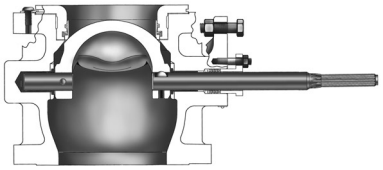
***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

Depending on the furnace service and configuration this valve will normally be part of a loop that controls either the fuel flow or pressure. These valves are specified as fail closed so that a control loop failure will not allow excessive fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. Although many fuel valves have bypass circuits, refinery operations personnel are usually reluctant to run a furnace on bypass for any significant time because of safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the set point of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides control performance that is inferior to a cascade configuration. It is extremely susceptible to any valve dead band such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there will often be a pressure control valve upstream of the fuel valve. This valve will also fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, Refinery operations personnel will be more willing to run a fuel valve in bypass as they still have a way to quickly shut off the fuel in an emergency.

Fuel Gas Valve Specification (#5)

Process Media

Media	Pressure Range	Temperature Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature.
- Performance is critical to reducing energy costs associated with furnace.

Special Considerations

- Potential for acidic fouling gases (for example, H_2S, HCL)

Chapter 2

Distillation Column

Other Names

Tower, stripper, stabilizer, splitter, demethanizer, deethanizer, depropanizer, debutanizer, DIB (deisobutanizer) tower, precut tower

Description

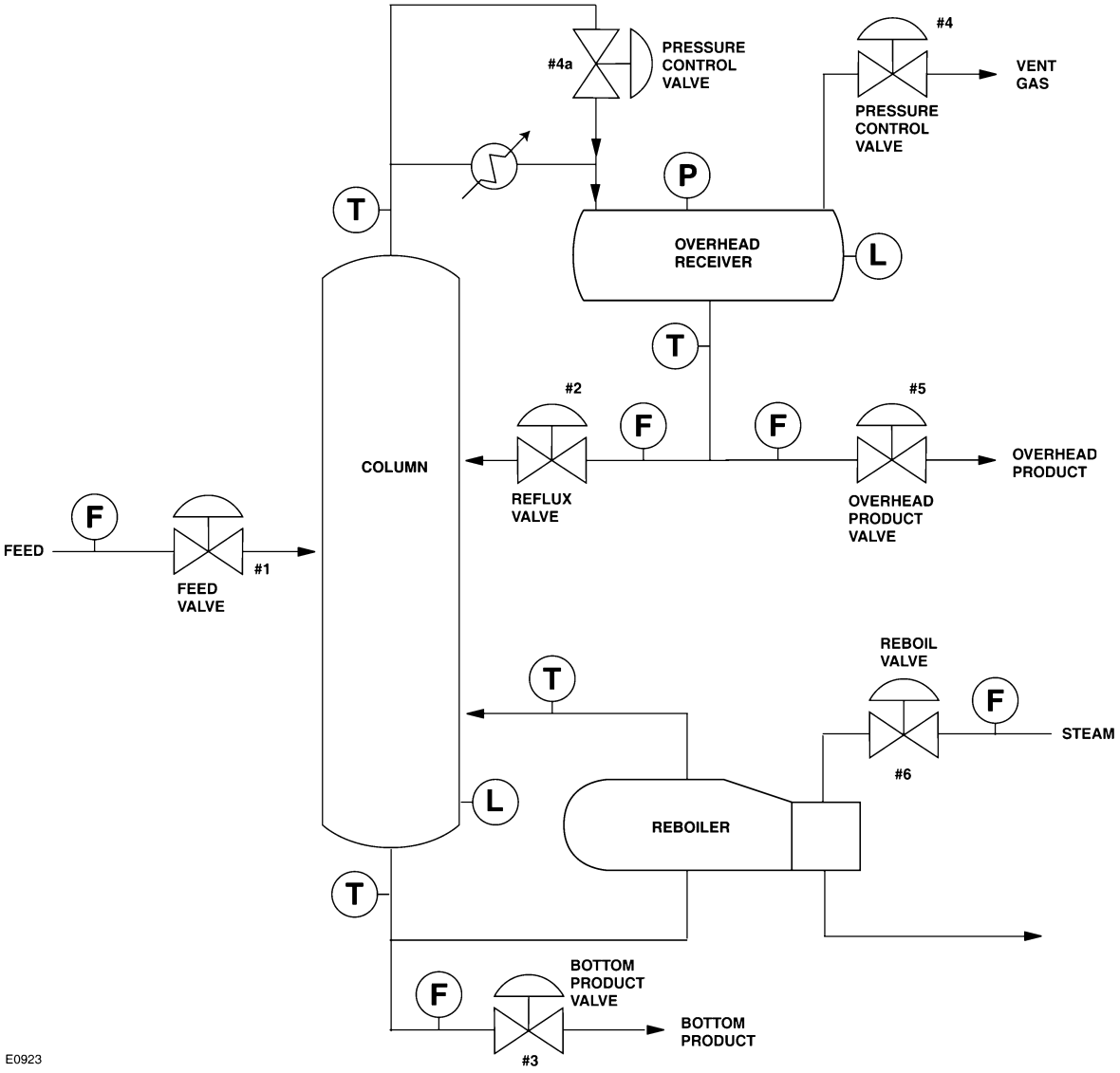
Distillation columns are a basic building block for every refinery. The objective for any distillation column is to separate a feed stream into light-component and heavy-component product streams.

The distillation process relies on the relative volatility between the components that make up the feed stream. The high-volatility (lighter) components will boil at a lower temperature than will the low-volatility (heavier) components. Therefore, when heat is added to the column through a bottom reboiler, the lighter materials are vaporized and rise to the top of the column. The overhead vapors are cooled until they condense and become a liquid again.

The efficiency of the distillation depends on the amount of contact between the vapor rising and the liquid falling down through a column. Therefore,

some of the overhead liquid product is sent back (refluxed) to the top of the column. Increasing the reflux will improve the purity of the overhead product. However, it also requires more heat from the reboiler to re-vaporize the lighter components in the reflux stream. The operation of a distillation column is a balancing act between product purity and energy use.

If the amount of vapor and liquid traveling through the column (often referred to as “traffic”) becomes too great, the column can ”flood.” Too much reflux flow or too much reboil heat resulting in too much vapor, (or both) can cause flooding. When flooding occurs, the efficiency of the distillation column is dramatically reduced, with corresponding drops in product purities.



Typical Distillation Column

Control Valves

Feed Valve Function (#1)

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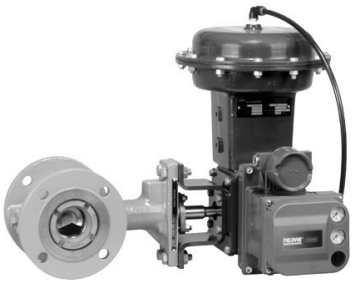
***easy-e®** Valve*



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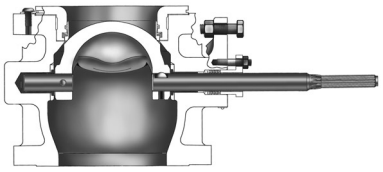

W7435

***Vee-Ball®** Valve*

Feed valves are usually set up as flow or level control loops. An upstream unit or process often controls the valve.

Unstable feed flow will make the distillation column difficult to control. A problem valve will often cause the feed flow to oscillate. As a result, the column will alternate between too little and too much reboil heat. Depending on the size and number of trays in the column, the effect of a swing in the feed will take anywhere from several minutes to more than an hour to reach the ends of the column. Sometimes, the reboil and reflux controls will amplify the swings. The final result is that meeting product purity targets becomes more difficult. Refinery operations personnel will normally respond by over-purifying the products, wasting energy to compensate for the problematic feed control valve.

Feed Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Primarily reactor effluent	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line sizes 4 inches and smaller)	Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line sizes 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Minimal impact to process

Special Considerations

- Flashing might be present depending on the process variables.

Reflux Valve Function (#2)

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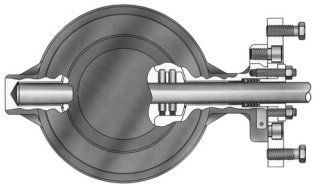
***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*



W6234

***edisc®** Valve*

The reflux valve is typically either a flow or column temperature-control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and eventually will flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate, and the column will be difficult to control.

Reflux Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc®** valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

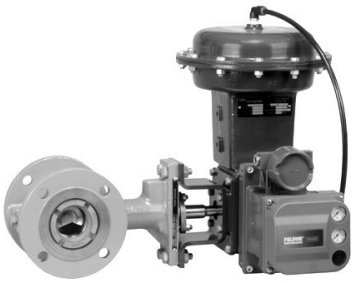
Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

Special Considerations

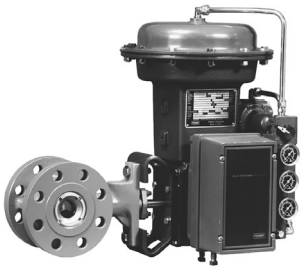
- Typically none

Bottom Product Valve Function (#3)



W8192

***Vee-Ball®** Valve*



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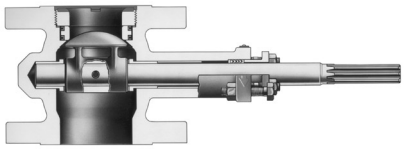

W5793

***eplug®** Valve*

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Bottom Product Valve Specification (#3)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

Special Considerations

- Could encounter higher viscosity materials, sludge and process media with entrained particles
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves.

Pressure Control Valve Function (#4, #4a)

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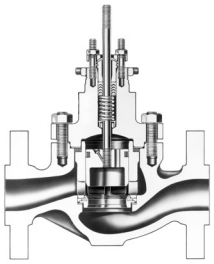

W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

The pressure control valves are used to control the column pressure. Higher column pressures will yield better product purities, but require more energy to operate. Normal operating procedure is to minimize the pressure to lower energy costs while maintaining product specifications. There is a low limit because lower pressures reduce the amount of vapor/liquid traffic the column can handle and can make it more likely to flood.

The simplest way to control pressures is to continuously vent gas from the system (valve #4). This sizing of this valve is critical. If the valve is too large, a small valve movement will cause a large pressure swing. If the valve is too small, the pressure response will be very sluggish. It is likely that a valve that is too small will operate from completely closed to completely open. In either scenario, oscillating column pressure and difficult column control result. A sticking pressure control valve presents the same problem. A sticking valve is a common concern on vent gas service because the valve packing is normally tight to prevent fugitive emissions.

Many distillation columns also use what is known as a “hot vapor bypass” valve (#4a) to control pressure. In these instances, some of the hot overhead vapors are bypassed around the overhead condenser heat exchanger. The amount of bypass will control the pressure. This eliminates the constant venting of process gas, which usually goes to a low-value refinery waste fuel gas system. Unfortunately, the pressure response on a hot vapor bypass valve is normally very sluggish due to slow process response time. Like the vent gas valve, this valve is a concern for fugitive emissions, and the packing is likely to be tight. A sticking valve causes wide, slow oscillations in column pressure, and product purities likewise swing widely and slowly. The response of refinery operations personnel is usually to over-purify.

A majority of columns with hot-vapor bypass valves also utilize a vent gas valve. In these cases, a single pressure control loop manipulates both valves. At lower pressures, the hot vapor bypass valve is used. As the pressure rises, there is a transition point where the hot vapor bypass valve closes fully and the vent gas valve starts to open.

At high pressures, the vent gas valve controls the pressure. This configuration often leads to pressure control problems, as the hot vapor bypass and vent gas valves have different control characteristics. Also, it is unlikely that one valve will close precisely at the same time the other valve opens. If the column is constantly making a transition between using the hot vapor bypass and vent gas valves, the pressure will normally oscillate. This is a tuning rather than a valve problem, but it should be kept in mind for column design or valve resizing.

Pressure Control Valve Specification (#4, #4a)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300

Process Impact

- Controls the back pressure to the distillation column and is very important in controlling the stability of the tower. Many columns use tray temperature to control overhead composition, thus stable pressure is required to ensure that temperature changes reflect composition changes not pressure changes.

Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

- Consider using special materials on valve #4 to address acid gas environment.

Overhead Product Valve Function (#5)

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***easy-e®** Valve*

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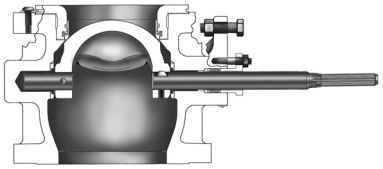


W7435

***Vee-Ball®** Valve*

The overhead product valve is typically used to control the level in the overhead receiver. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Overhead Product Valve Specification (#5)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

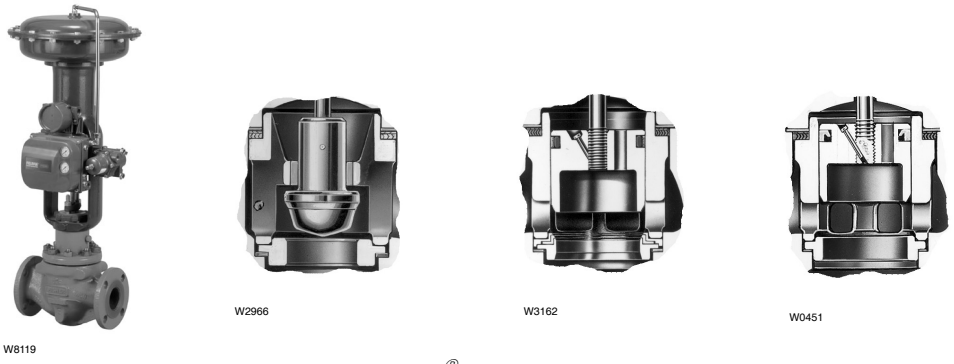
Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

Reboil Valve Function (#6)



easy-e*® *Valve

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. The service is very clean, and fugitive emissions are not a concern. Steam valves are usually very reliable. However, a problematic valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher-temperature process streams are used to provide heat for lower-temperature processes. In these cases, the reboil valve will foul more easily and might create fugitive emission concerns.

Reboil Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

- Consideration of materials for steam application

Chapter 3

Gas Plant

Other Names

Light ends unit, sat. (saturated) gas plant

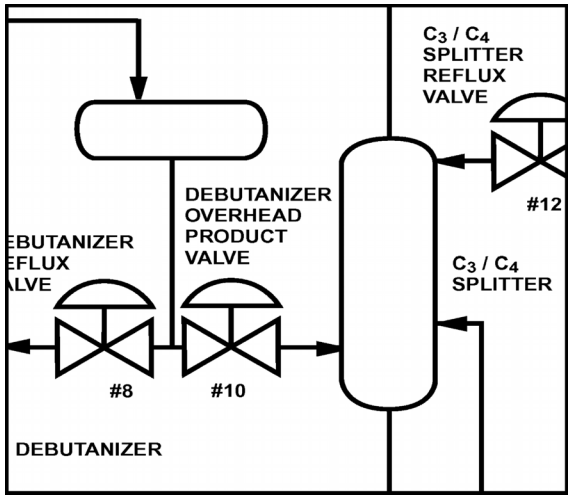
Description

Most reactive processes in a refinery create light end material in addition to the desired products (gasoline, kerosene, diesel, and so on). These light ends include hydrogen, methane, ethylene, ethane, propylene, propane, and various butanes and butenes. Light ends are usually a low-value process stream, and are often used as fuel gas for process heaters. However, if enough light-end materials are produced, there is economic incentive to separate the light ends into component streams. The exact product streams will depend on refinery needs as well as any potential external marketing opportunities.

Some cracking units produce enough light ends that a gas plant is built specifically as part of the unit. (Delayed cokers and fluid catalytic crackers are units that usually have an integral gas plant.) In other cases, gas plants are built to handle the combined light ends of several process units.

Almost all valves in a light-ends gas plant are a possible source of fugitive emissions. Therefore, it is very likely that the valve packing will be kept very tight. This can lead to excessive control valve dead band. Packing selection might play a critical role in valve performance for this type of service.

The example used for this section is a typical FCC gas plant. The light ends that come from the FCC fractionator overhead are separated by this plant into

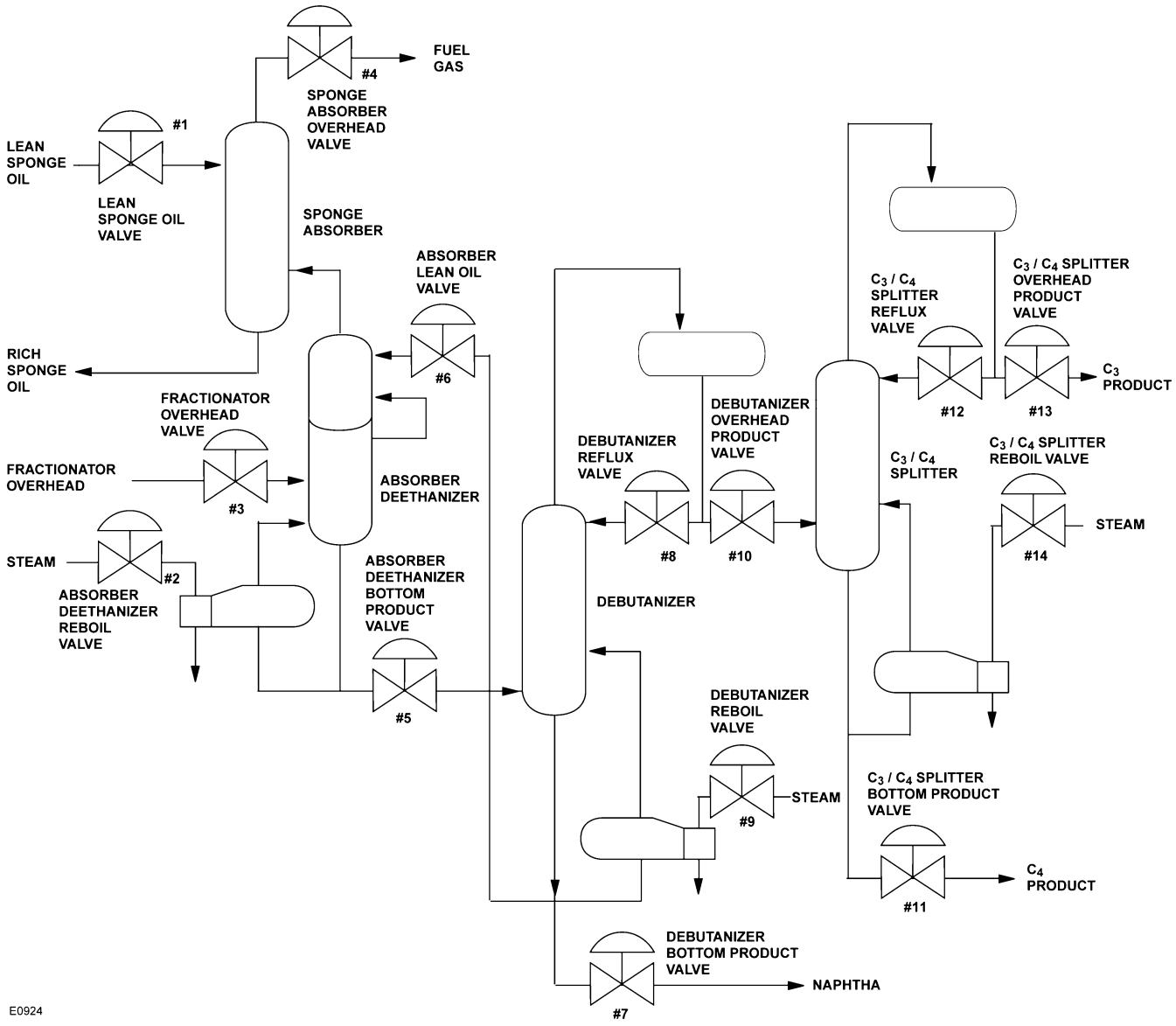


fuel gas (hydrogen, methane, and ethane), C_3 (propylene and propane), C_4 (butenes and butanes), and naphtha.

As fractionator overheads enter an absorber/ deethanizer, hydrocarbons lighter than C_3 leave as overheads to the sponge absorber. The sponge absorber uses heavy oil to reclaim any C_3 that comes overhead from the deethanizer. The remaining gas is sent to the refinery fuel gas system. The C_3 and heavier components leave as bottoms to the debutanizer.

In the debutanizer, C_3 and C_4 are separated from light naphtha. The C_3 and C_4 leave as overheads to the C_3/C_4 Splitter. The naphtha leaves as bottoms to either blending or a downstream processing unit.

The C_3/C_4 splitter separates the debutanizer overheads into an overhead C_3 stream and a bottom C_4 stream.



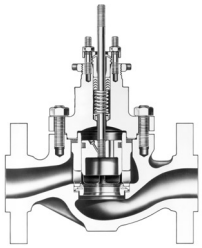
Typical Gas Plant

Control Valves

Lean Sponge Oil Valve Function (#1)

W8119

***easy-e®** Valve*



W3162

W8192

***Vee-Ball®** Valve*

This valve controls the flow of lean, heavy naphtha from the FCC (fluid catalytic cracker) fractionator to the sponge oil tower, which absorbs any leftover C_3 and heavier materials from the absorber/deethanizer overheads. The rich sponge oil is returned to the fractionator. The consequences of bad valve performance are that higher value, heavier components might escape to the lower value fuel gas system.

Lean Sponge Oil Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Lean, heavy naphtha from the FCC fractionator to sponge oil tower	Dependent on process design	Dependent on process media

Valve Types

Heavy-duty,general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

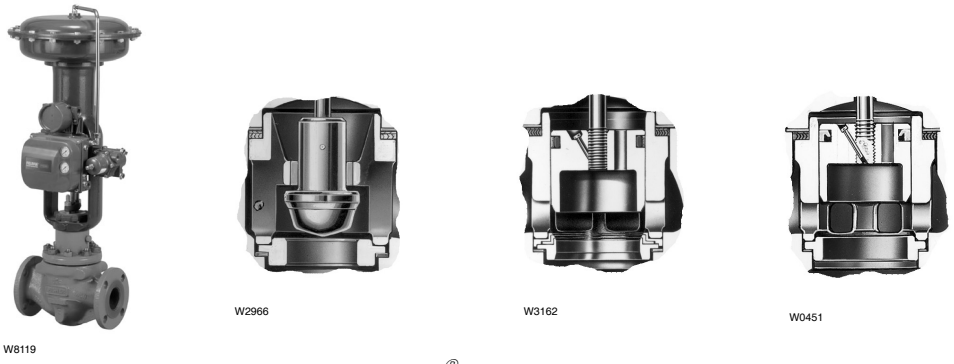
Process Impact

- Poor valve control can allow higher value, heavier components to escape to the lower value fuel gas system.

Special Considerations

- None

Absorber/Deethanizer Reboil Valve Function (#2)



***easy-e®** Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. Steam valves are usually very reliable. The service is very clean, and fugitive emissions are not a concern. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher-temperature process streams are used to provide heat for lower temperature processes. In these cases, the reboil valve will foul more easily and might be a concern for fugitive emissions.

Absorber/Deethanizer Reboil Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process, typically 10.3 bar (150 psig) saturated steam	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor though the column affects column efficiency.

Special Considerations

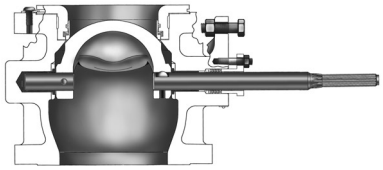
- Consideration of materials for steam application

Fractionator Overhead Valve Function (#3)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

This is the feed valve to the absorber/deethanizer. However, it also is the fractionator overhead product valve. The flow through this valve will normally be set to control the fractionator overhead receiver level. Therefore, any control problems with the fractionator overheads will ripple through the gas plant.

Feed valves are usually set up as flow or level control loops. An upstream unit or process often controls the valve.

Unstable feed flow will make the distillation column difficult to control. A problem valve will often cause the feed flow to oscillate. As a result, the column will alternate between too little and too much reboil heat. Depending on the size and number of trays in the column the effect of a swing in the feed will take anywhere from several minutes to more than an hour to reach the ends of the column. Sometimes, the reboil and reflux controls will amplify the swings. The final result is that meeting product purity targets becomes more difficult. Operations will normally respond by over-purifying the products, wasting energy to compensate for the bad feed control valve.

Fractionator Overhead Valve Specification (#3)

Process Media

Media	Pressure Range	Temperature Range
Primarily reactor effluent	Typically less than 34.5 bar (500 psig)	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

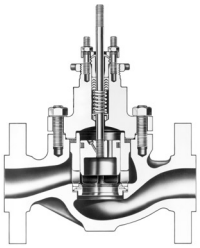
- Control problems with this valve will produce a ripple effect through the rest of the gas plant.

Special Considerations

- None

Sponge Absorber Overhead Valve Function (#4)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

This valve serves as the pressure controller for the gas plant. Because it is setting the pressure for the entire gas plant, it is important that this valve perform well. This is a minor stream in terms of flow (less than 1 MBPD) and has a value equal to that of fuel gas.

It also is possible that the debutanizer or the C_3/C_4 splitter will have a pressure control valve as well.

The pressure control valve is used to control the column pressure. Higher column pressures will yield better product purities, but require more energy to operate. Normal operating procedure is to minimize the pressure to lower energy costs while maintaining product specifications. There is a low limit because lower pressures reduce the amount of vapor/liquid traffic the column can handle and make it more likely to flood.

The simplest way to control pressures is to continuously vent gas from the system. The sizing of the vent valve is critical. If the valve is too large, a small valve movement will cause a large pressure swing. If the valve is too small, the pressure response will be very sluggish. It is likely that an undersized valve will operate from completely closed to completely open. In either scenario, an oscillating column pressure and difficult column control are the result. A sticking pressure control valve will present the same problem. A sticking valve is a common concern on vent gas valves because the valve packing will normally be tight to prevent fugitive emissions.

Many distillation columns also use what is known as a “hot vapor bypass” valve to control pressure. In this case, some of the hot overhead vapors are bypassed around the overhead condenser heat exchanger. The amount of bypass will control the pressure. This eliminates the constant venting of process gas, which usually goes to a low value refinery waste fuel gas system. Unfortunately, the pressure response on a hot vapor bypass valve is normally very sluggish due to slow process response time. Like the vent gas valve, this valve is a concern for fugitive emissions, and the packing is likely to be tight. A sticking valve will cause wide, slow oscillations in column pressure. The product purities will likewise swing widely and slowly. The response of refinery operations personnel will usually be to over-purify.

A majority of columns with a hot vapor bypass valve will use it in combination with a vent gas valve. In these cases, a single pressure control loop will manipulate both valves. At lower pressures, the hot vapor bypass valve is used. As the pressure rises, there will be a transition point where the hot vapor bypass valve closes fully and the vent gas valve starts to open. At high pressures, the vent gas valve controls the pressure. This configuration often leads to pressure control problems, as the hot vapor bypass and vent gas valves will have different control characteristics. Also, it is unlikely that one valve will close precisely at the moment the other valve opens. If the column constantly transitions between using the hot vapor bypass and vent gas valves, the pressure will normally oscillate. This is a tuning rather than a valve problem, but it should be kept in mind for column design or valve resizing.

Sponge Absorber Overhead Valve Specification (#4)

Process Media

Media	Pressure Range	Temperature Range
Distillate light-end hydrocarbon liquid and noncondensible gas	Dependent on process design	Less than 93°C (200°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300

Process Impact

- Controls the back pressure to the distillation column

Special Considerations

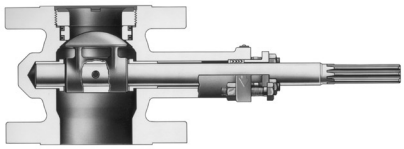
- Packing on these valves is important to reduce fugitive emissions.
- Consider using special materials for the sponge absorber overhead valve if there is an acid gas environment.

Absorber/Deethanizer Bottom Product Valve Function (#5)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Absorber/Deethanizer Bottom Product Valve Specification (#5)

Process Media

Media	Pressure Range	Temperature Range
Light-end, lower boiling point hydrocarbon	Dependent on process design	Less than 343°C (650°F)

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged	CV500
		More rugged construction	V500

Process Impact

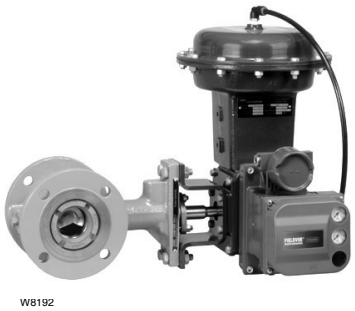
- Dependent on downstream destination.

Special Considerations

- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials
- Low-flow, clean fluids or small line size applications could use globe valves

Absorber Lean Oil Valve Function (#6)

***easy-e®** Valve*



***Vee-Ball®** Valve*

***eplug®** Valve*

Some of the debutanizer bottoms is returned as lean oil to the absorber/deethanizer to absorb heavier components out of the deethanizer overhead stream. If the lean oil valve has problems, such as sticking, then some of the C_3 and heavier material might be lost to the lower value fuel gas system. However, the performance of the deethanizer should still be stable.

Absorber Lean Oil Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Light-end, lower boiling point hydrocarbon	Dependent on process design	Less than 343°C (650°F)

Valve Types

High-capacity, ~~high-rangeability~~ V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged	CV500
		More rugged construction	V500
Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

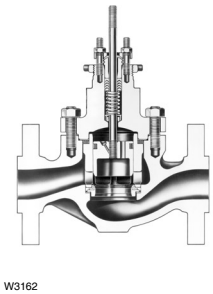
Process Impact

- Dependent on downstream destination

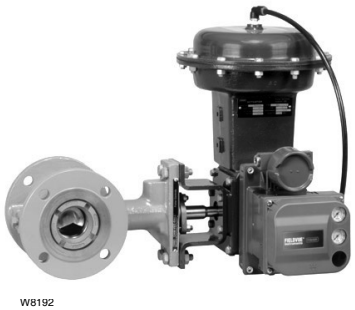
Special Considerations

- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Debutanizer Bottom Product Valve Function (#7)


W3162

***easy-e®** Valve*


W8192

***Vee-Ball®** Valve*


W5791

***eplug®** Valve*

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Debutanizer Bottom Product Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Heavier, higher boiling boiling point hydrocarbon (typically naphtha)	Dependent on process design	Less than 343°C (650°F)

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged	CV500
		More rugged construction	V500
Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- Dependent on downstream destination.

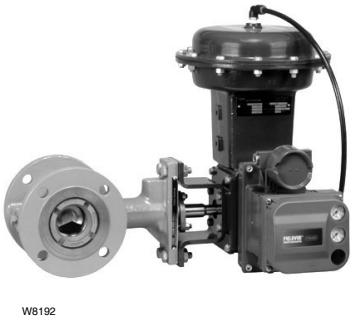
Special Considerations

- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Debutanizer Reflux Valve Function (#8)

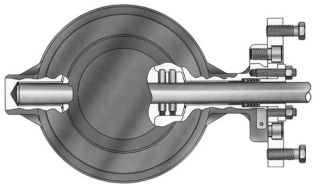
W2777

Design EW Valve



W8192

Vee-Ball*® *Valve



W6234

edisc*® *Valve

The reflux valve is typically either a flow or column temperature-control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and eventually will flood the tower .

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate, and the column will be difficult to control.

Debutanizer Reflux Valve Specification (#8)

Process Media

Media	Pressure Range	Temperature Range
Column light-end gases and liquids	Dependent on distillation process	Less than 93°C (200°F)

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Balanced with graphite cage-plug seal	ED
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

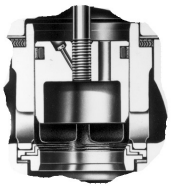
Special Considerations

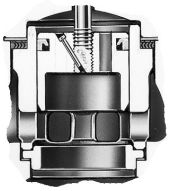
- Typically none

Debutanizer Reboil Valve Function (#9)


W8119


W2966


W3162


W0451

easy-e® *Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. Steam valves are usually very reliable. The service is very clean, and fugitive emissions are not a concern. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher-temperature process streams are used to provide heat for lower temperature processes. In these cases, the reboil valve will foul more easily and might have fugitive emission concerns.

Debutanizer Reboil Valve Specification (#9)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process, typically 10.3 bar (150 psig) saturated steam	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency.

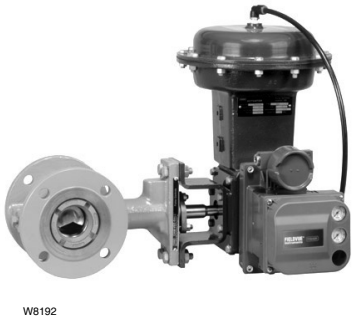
Special Considerations

- Consideration of materials for steam application

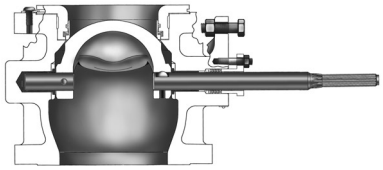
Debutanizer Overhead Product Valve Function (#10)

W8119

***easy-e®** Valve*



W8192



W7435

***Vee-Ball®** Valve*

The overhead product valve is typically used to control the level in the overhead receiver. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Debutanizer Overhead Product Valve Specification (#10)

Media	Pressure Range	Temperature Range
Distilled light-end liquids	Dependent on process design	Less than 93°C (200°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

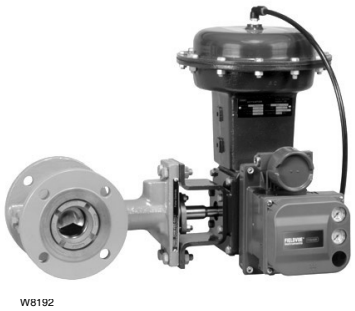
- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

C_3/C_4 Splitter Bottom Product Valve Function (#11)

***easy-e®** Valve*



***Vee-Ball®** Valve*

***eplug®** Valve*

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

C3/C4 Splitter Bottom Product Valve Specification (#11)

Process Media

Media	Pressure Range	Temperature Range
Heavier, higher boiling boiling point hydrocarbon	Dependent on process design	Less than 343°C (650°F)

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500
Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

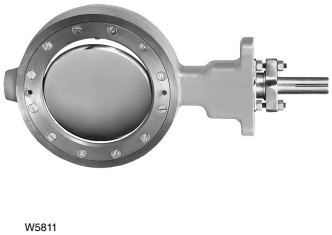
Process Impact

- Dependent on downstream destination

Special Considerations

- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

C_3/C_4 Splitter Reflux Valve Function (#12)


W5811

POSI-SEAL® *Valve*


W8192

Vee-Ball® *Valve*


W8299

edisc® *Valve*

The reflux valve is typically either a flow or column temperature control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and eventually will flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate and the column will be difficult to control.

C3/C4 Splitter Reflux Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Column light-end gases and liquids	Dependent on distillation process	Less than 93°C (200°F)

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Balanced with graphite cage-plug seal	ED
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

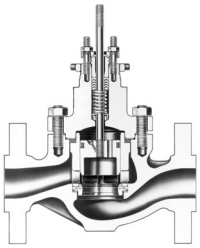
- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

Special Considerations

- Typically none

C_3/C_4 Splitter Overhead Product Valve Function (#13)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

The overhead product valve is typically used to control the level in the overhead receiver. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

C3/C4 Splitter Overhead Product Valve Specification (#13)

Process Media

Media	Pressure Range	Temperature Range
Distilled light-end liquids	Dependent on process design	Less than 93°C (200°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

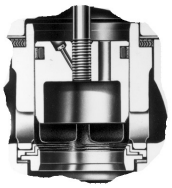
Special Considerations

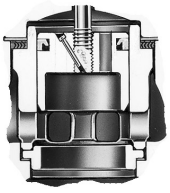
- None

C_3/C_4 Splitter Reboil Valve Function (#14)


W8119


W2966


W3162


W0451

easy-e® *Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. The service is very clean, and fugitive emissions are not a concern. Steam valves are usually very reliable. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher temperature process streams are used to provide heat for lower temperature processes. In these cases, the reboil valve will foul more easily and might have fugitive emissions concerns.

C3/C4 Splitter Reboil Valve Specification (#14)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process, typically 10.3 bar (150 psig) saturated steam	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency.

Special Considerations

- Consideration of materials for steam application

Chapter 4

Crude Distillation

Other Names

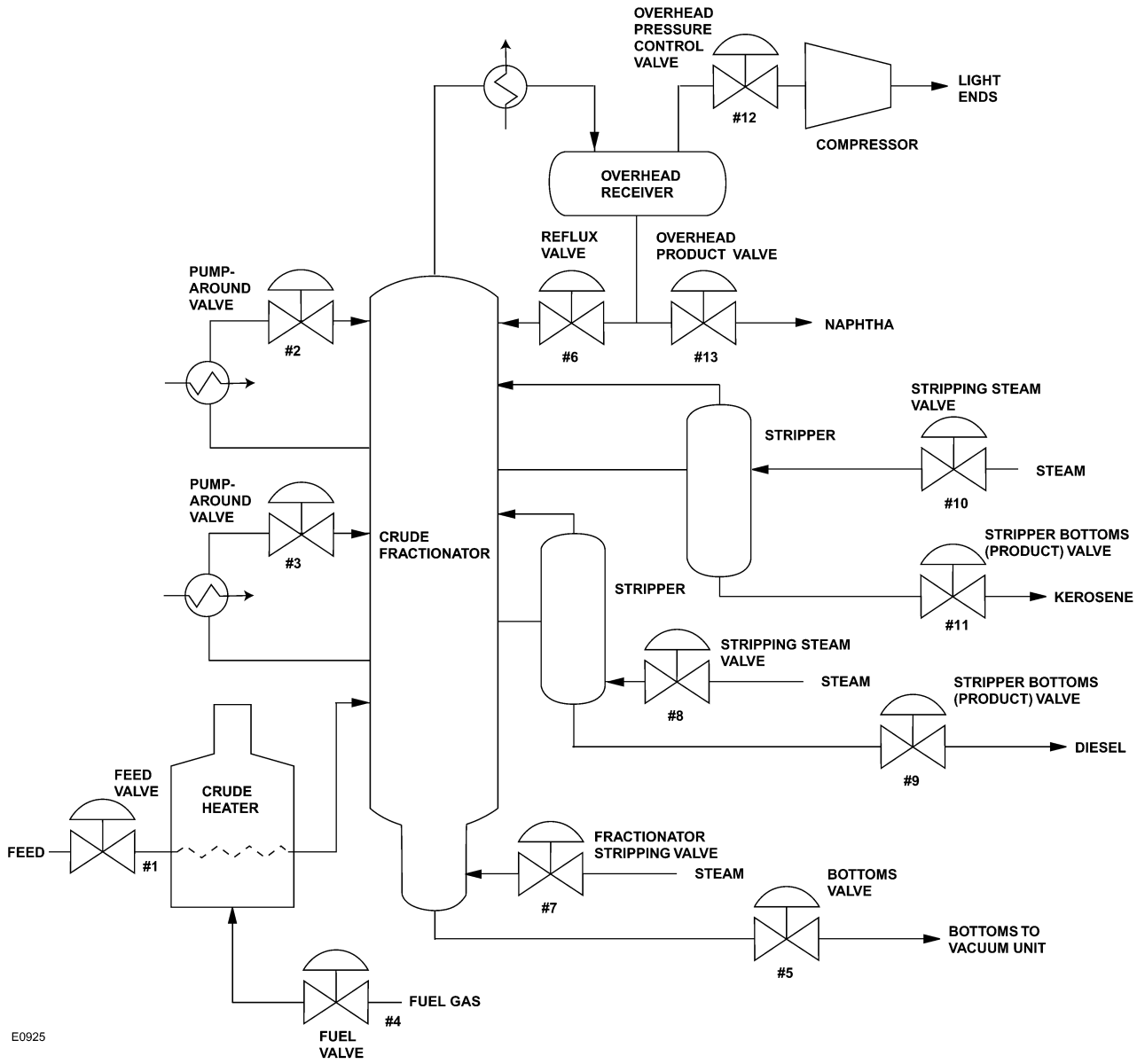
Crude unit, crude fractionator, crude column, pipestill

Description

The crude distillation unit is the first processing unit in a refinery. The unit is a complex distillation column that is used to separate crude oil into the basic product streams. The basic product streams from a crude distillation unit can vary widely depending on the refinery operating objectives. Typical basic product streams are naphtha, kerosene, diesel, gas oil, heavy gas oil and bottoms. Normally, these product streams are sent to downstream units for further processing before being sent to product tanks.

The crude oil is sent through a process heater and is partially vaporized before entering the fractionator near the bottom of the column. Refer to the chapter

covering the furnace (process heater). Stripping steam also is injected at the bottom of the column. One or more process pump-around heat exchanger loops and a top reflux stream are used to cool the rising vapors, separating the crude mixture into the product streams. The product streams are extracted through side draws to steam stripping columns. The column pressure and product draw temperatures are used to control the product streams to quality specifications, usually a final or 95% boiling point of the product steam.

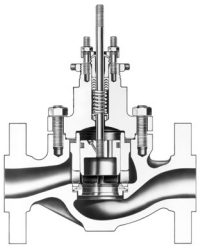


Typical Crude Distillation Column

Control Valves

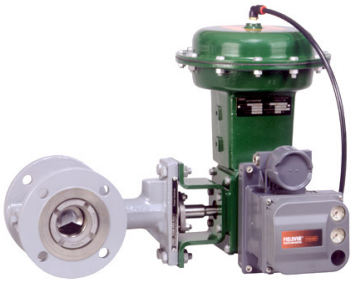
Feed Valve Function (#1)

W8119



W3162

***easy-e®** Valve*



W8192

***Vee-Ball®** Valve*

The feed to a crude distillation unit is crude oil from the oil fields. Feed valves are usually set up as flow-control loops. They are configured to fail open so that a valve failure will protect the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences, as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke build-up. If a flow valve is alternately provided too much and then too little flow, the temperature will also swing and will usually lead to excessive coke buildup. This will shorten the furnace cycle time between decoking procedures, which will normally require the process unit downstream to shutdown.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Feed Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Primarily reactor effluent	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line sizes 4 inches and smaller)	Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line sizes 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Minimal impact to process

Special Considerations

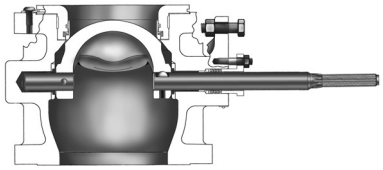
- Flashing might be present depending on the process variables

Pump-Around Valve Function (#2, #3)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

A crude fractionator will always have at least one pump-around heat exchanger loop for controlling the heat balance. Most fractionators will have more than one pump-around loop. The pump-around loop is used to extract heat from the column, creating the separation between the product draws immediately above and below the pump-around loop. The pump-around valves are usually flow controllers.

A poorly performing or bypassed pump-around valve will increase the variability in the quality specifications of the product draws. A valve failure most likely will create an upset lasting from 30 minutes to a few hours depending on the severity of the failure.

Pump-Around Valve Specification (#2, #3)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon liquid	Dependent on distillation column pressure	Dependent on where steam is taken from the column: 93 to 316°C (200 to 600°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

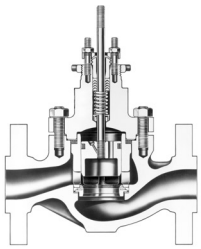
- Critical to maintaining heat balance around the column

Special Considerations

- Typically none: dependent on distillation unit and process
- NACE materials

Fuel Valve Function (#4)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

Depending on the furnace service and configuration, this valve will normally be part of a loop that controls either the fuel flow or pressure. These valves are specified as fail closed so that a control loop failure will not allow an excessive amount of fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. Although many fuel valves have bypass circuits, Refinery operations personnel are usually reluctant to run a furnace on bypass for any length of time because of safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the set point of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides inferior control performance to a cascade configuration. It is extremely susceptible to any valve dead band, such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there often will be a pressure control valve upstream of the fuel valve. This valve also will fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, operations personnel will be more willing to run a fuel valve in bypass as they still have a way to shut off the fuel quickly in an emergency.

Fuel Valve Specification (#4)

Process Media

Media	Pressure Range	Temperature Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature
- Performance is critical to reducing energy costs associated with the furnace

Special Considerations

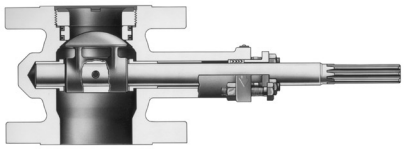
- Potential for acidic fouling gases (for example, H_2S, HCL)

Bottoms Valve Function (#5)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

The bottom material becomes the vacuum distillation unit charge.

The bottoms flow does not usually have any impact on the operation of the crude fractionator unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Bottoms Valve Specification (#5)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

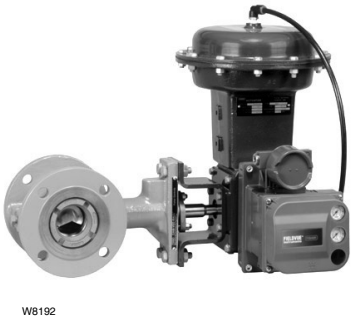
- Dependent on downstream destination

Special Considerations

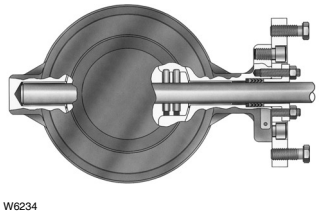
- Could encounter higher viscosity materials, sludge and process media with entrained particles
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves.

Reflux Valve Function (#6)

Design EW Valve



Vee-Ball*® *Valve



edisc*® *Valve

The reflux valve is used to control the separation between the top product (usually naphtha) and the highest-side draw product. The reflux valve can be either a flow or a temperature controller.

A poorly performing or bypassed reflux valve will increase the variability in the quality specifications of the overhead product and the top side draw. A valve failure will most likely create an upset lasting from 30 minutes to a few hours, depending on the severity of the failure.

Reflux Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

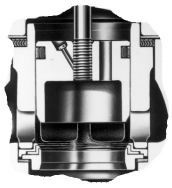
Special Considerations

- Typically none

Fractionator Stripping Steam Valve Function (#7)


W8119


W2966


W3162


W0451

easy-e*® *Valve

Stripping steam is injected into the bottoms of the fractionator to strip out lighter components from the crude bottoms stream. The amount of stripping steam also affects the separation efficiency of the crude fractionator. A valve failure most likely will create an upset lasting from 30 minutes to a few hours depending on the severity of the failure.

Fractionator Stripping Steam Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

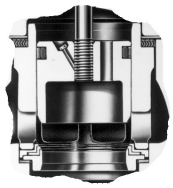
Special Considerations

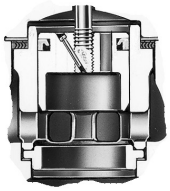
- Consideration of materials for steam application

Stripping Steam Valve Function (#8, #10)


W8119


W2966


W3162


W0451

***easy-e®** Valve*

Each side-draw product stream usually feeds a product stripper. The stripper uses steam to drive off any light components remaining in the product stream. Poor steam valve performance can lead to variability in the quality specifications for the product stream.

Stripping Steam Valve Specification (#8, #10)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

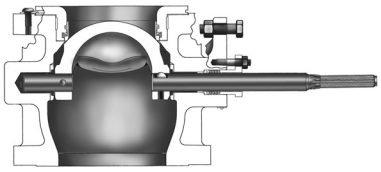
- This valve is important in that it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

- Consideration of materials for steam application

Stripper Bottoms (Product) Valves Function (#9, #11)

W8192



W7435

W5791

Vee-Ball® *Valve*

eplug® *Valve*

The stripper products are kerosene and diesel.

The stripper bottoms valves are used to control the bottoms level in the strippers. These valves do not usually have any impact on the operation of the strippers unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allows the operator to catch this before it causes an upset.

Stripper Bottoms (Product) Valves Specification (#9, #11)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug**® valves	High capacity, rugged	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

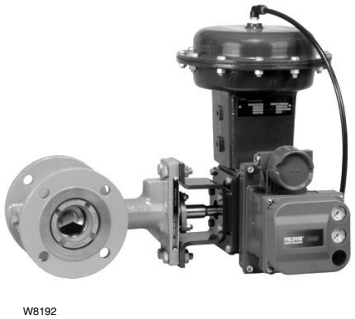
Special Considerations

- Could encounter higher viscosity materials, sludge, and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

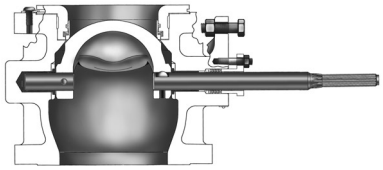
Overhead Pressure Control Valve Function (#12)

W8119

***easy-e®** Valve*



W8192



W7435

***Vee-Ball®** Valve*

The overhead pressure control valve releases gases including H_2, H_2S, methane, ethane, propane, and butane. This stream is very normally very small (1 to 3% of feed).

The column pressure has a significant effect on fractionator operation. A valve failure that allows the column to over or under pressure can cause an upset that might take hours of recovery time. A problem valve can create pressure oscillations that prevent the fractionator from being operated optimally. Valve sizing is critical for this service. If the valve is too large, the column pressure will be prone to rapid swings. If the value is too small and has a large response time, it can cause long slow swings.

Overhead Pressure Control Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Controls the pressure to the distillation column and is very important in controlling the stability of the tower. Many columns use tray temperature to control overhead composition, thus stable pressure is required to ensure that temperature changes reflect composition changes, not pressure changes.

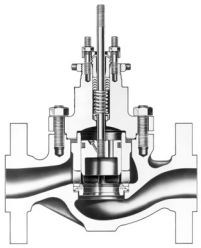
Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

- Consider using special materials if there is an acid gas environment.

Overhead Product Valve Function (#13)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

The overhead product is naphtha, a blending component in gasoline.

The overhead product valve is usually on level control from the overhead receiver. This valve does not usually have any impact on the operation of the crude fractionator unless a failure causes the liquid level in the overhead receiver to over fill or empty. In this case, the column pressure would be affected, and the fractionator would experience an upset until the pressure stabilized. Usually, level alarms on the unit would allow the operator to catch this before it becomes an upset.

It is more likely that a poorly performing product valve could cause stability problems to a downstream processing unit in configurations where there is no surge tank between the units.

Overhead Product Valve Specification (#13)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High- capacity, high- rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

Chapter 5

Vacuum Distillation

Other Names

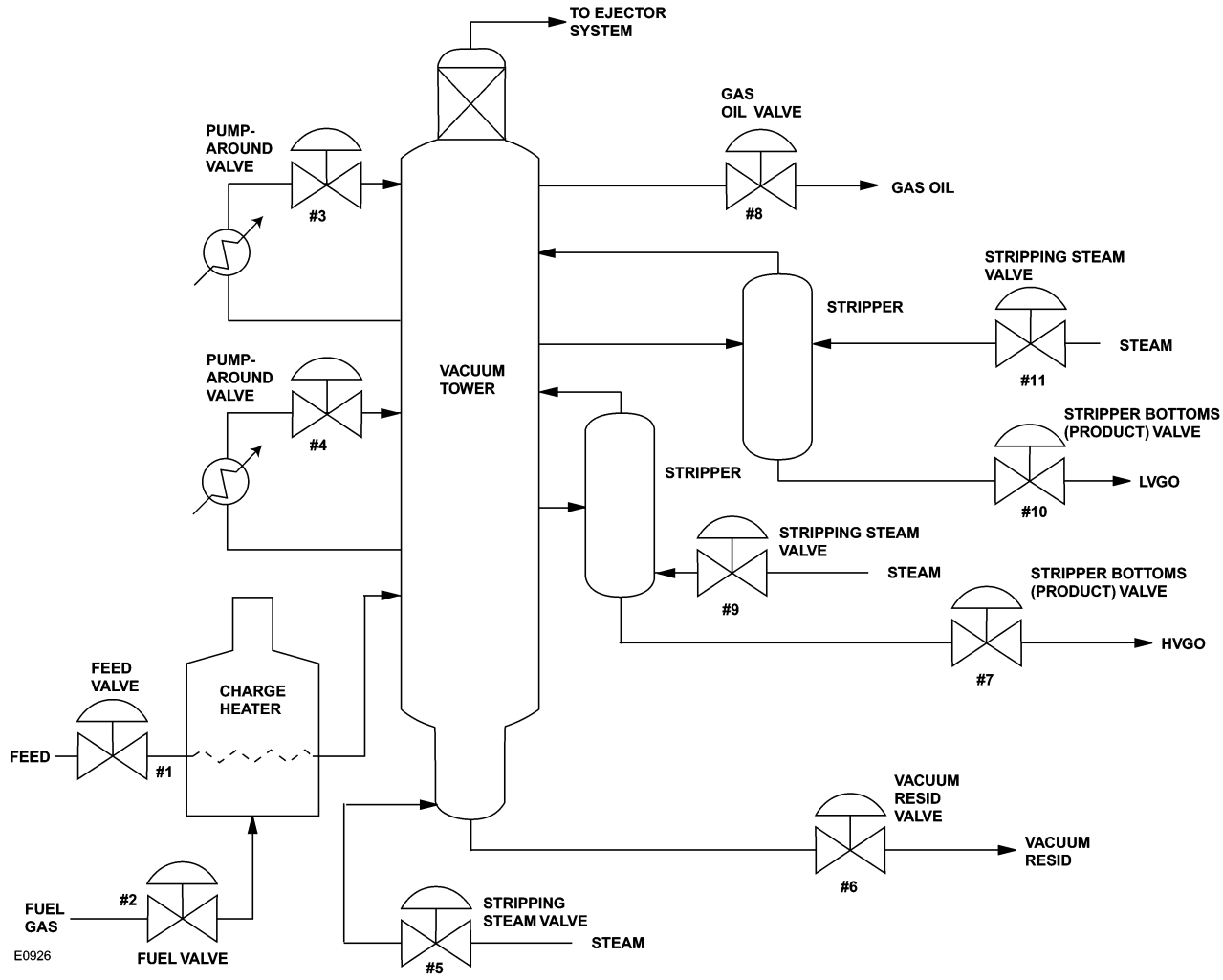
Vacuum tower, vacuum flash

Description

The vacuum distillation unit is fed the bottoms from the crude unit. The unit is a complex distillation column that fractionates the crude bottoms under a vacuum to improve separation into basic product streams. The basic product streams from a vacuum distillation unit can vary widely depending on the refinery operating objectives. Typical basic product streams are gas oil, LVGO (light vacuum gas oil), HVGO (heavy vacuum gas oil), and residual (resid) bottoms. Normally, these product streams are sent on to downstream units for further processing.

The crude bottom stream is sent through a process charge heater and is partially vaporized before entering the vacuum fractionator near the bottom of the column. Refer to the chapter covering the

furnace (also called a process heater). Stripping steam is also injected at the bottom of the column. One or more process pump-around exchanger loops are used to cool the rising vapors, separating the crude bottom mixture into the product streams. The product streams are extracted through side draws to steam stripping columns. The column vacuum is controlled by an overhead ejector system. The column vacuum pressure and product draw temperatures are used to control the product streams to quality specifications, usually viscosity or flash point.



Typical Vacuum Distillation Column

Control Valves

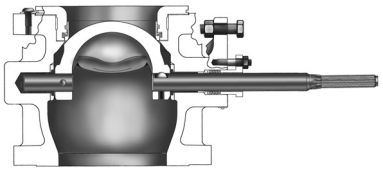
Note: Valve applications in this process might require alternative packing orientations to account for vacuum pressure conditions.

Feed Valve Function (#1)


W8119

***easy-e®** Valve*


W8192


W7435

***Vee-Ball®** Valve*

The feed to a vacuum distillation unit is crude oil from the oil fields.

Feed valves are usually set up as flow-control loops. They are configured to fail open so that a valve failure protects the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke build-up. If a flow valve is alternately provided too much and then too little flow, the temperature will also swing and will usually lead to excessive coke buildup. This typically shortens the furnace cycle time between decoking procedures, which normally requires the process unit downstream to shutdown.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Feed Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Primarily reactor effluent	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line sizes 4 inches and smaller)	Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line sizes 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

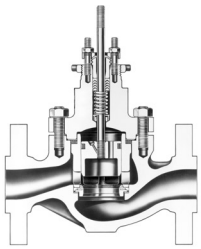
- Minimal impact to process

Special Considerations

- Flashing might be present depending on the process variables

Fuel Valve Function (#2)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

Depending on the furnace service and configuration this valve will normally be part of a loop that controls either the fuel flow or pressure. These valves are specified as fail closed so that a control loop failure will not allow an excessive amount of fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. Although many fuel valves have bypass circuits, refinery operations personnel are usually reluctant to run a furnace on bypass for any significant time because of safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the setpoint of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides inferior control performance to a cascade configuration. It is extremely susceptible to any valve dead band such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there will often be a pressure control valve upstream of the fuel valve. This valve will also fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, Operations will be more willing to run a fuel valve in bypass as they still have a way to quickly shut off the fuel in an emergency.

Fuel Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature
- Performance is critical to reducing energy costs associated with furnace

Special Considerations

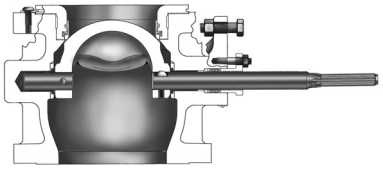
- Potential for acidic fouling gases (for example, H_2S, HCL)

Pump-Around Valve Function (#3, #4)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

A vacuum tower will always have at least one pump-around heat exchanger loop for controlling the heat balance. Many towers will have more than one pump-around loop. The pump-around loop is used to extract heat from the column, creating the separation between the product draws immediately above and below the pump-around loop. The pump-around valves are usually flow controllers.

A poorly performing or bypassed pump-around valve will increase the variability in the quality specifications of the product draws. A valve failure will most likely create an upset lasting from 30 minutes to a few hours, depending on the severity of the failure.

Pump-Around Valve Specification (#3, #4)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Critical to maintaining heat balance around the column

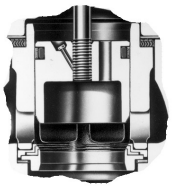
Special Considerations

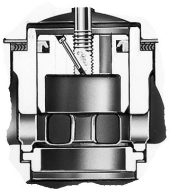
- Typically none: dependent on distillation unit and process
- NACE Materials

Stripping Steam Valve Function (#5)


W8119


W2966


W3162


W0451

easy-e® *Valve*

Stripping steam is injected into the bottoms of the tower to strip out lighter components from the crude bottom stream. The amount of stripping steam also affects the separation efficiency of the vacuum tower. A valve failure will most likely create an upset lasting from 30 minutes to a few hours depending on the severity of the failure.

Stripping Steam Valve Specification (#5)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

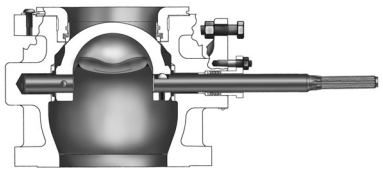
Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

- Consideration of materials for steam application

Vacuum Resid Valve Function (#6)



***Vee-Ball®** Valve*

***eplug®** Valve*

The bottom material is vacuum resid.

The bottoms do not usually have any impact on the operation of the vacuum tower unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Vacuum Resid Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

Special Considerations

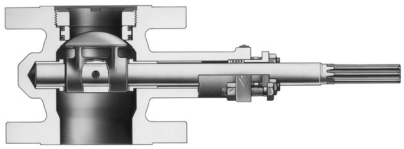
- Could encounter higher-viscosity materials, sludge and process media with entrained particles
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Stripper Bottoms (Product) Valve Function (#7, #10)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

The stripper products are LVGO (light vacuum gas oil) and HVGO (heavy vacuum gas oil).

The stripper bottoms valves are used to control the bottoms level in the strippers. These valves do not usually have any impact on the operation of the Strippers unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit would the operator to catch this before it causes an upset.

Stripper Bottoms (Product) Valve Specification (#7, #10)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

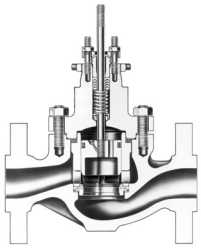
Special Considerations

- Could encounter higher viscosity materials, sludge and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line size applications could use globe valves

Gas Oil Valve Function (#8)

W8119

***easy-e®** Valve*



W3162

W8192

***Vee-Ball®** Valve*

The top product is gas oil. Normal production rate is usually minor.

Gas Oil Valve Specification (#8)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

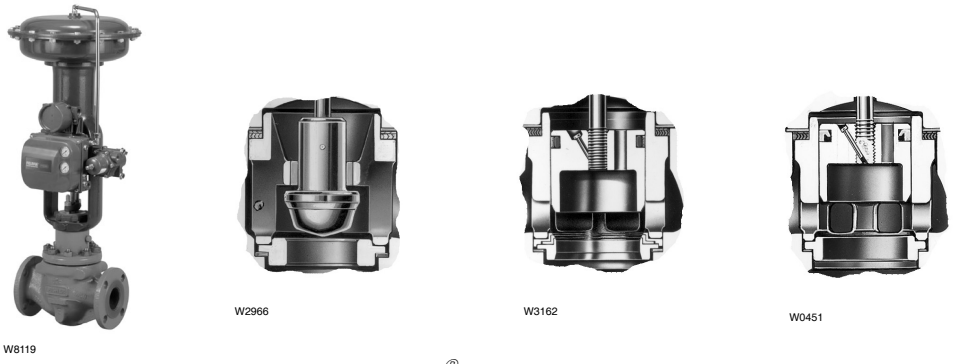
Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

Stripping Steam Valve Function (#9, #11)



***easy-e®** Valve*

Each side draw product stream usually feeds a product stripper. The stripper uses steam to drive off any light components remaining in the product stream. Poor steam valve performance can lead to variability in the quality specifications for the product stream.

Stripping Steam Valve Specification (#9, #11)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

- Consideration of materials for steam application

Chapter 6

Delayed Coking Unit

Other Names

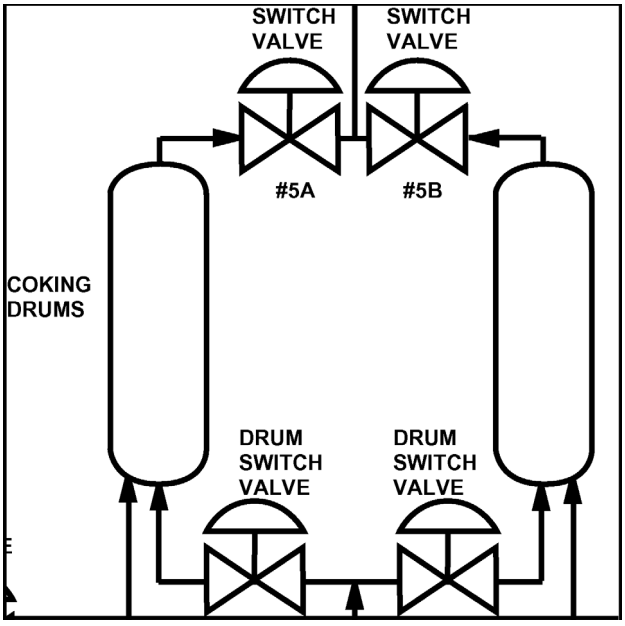
Coker

Description

The delayed coking unit process thermally cracks heavy feedstocks such as crude unit bottoms, vacuum unit bottoms or other heavy gas oils. The products are sponge or needle coke, gas oil, naphtha, and light ends.

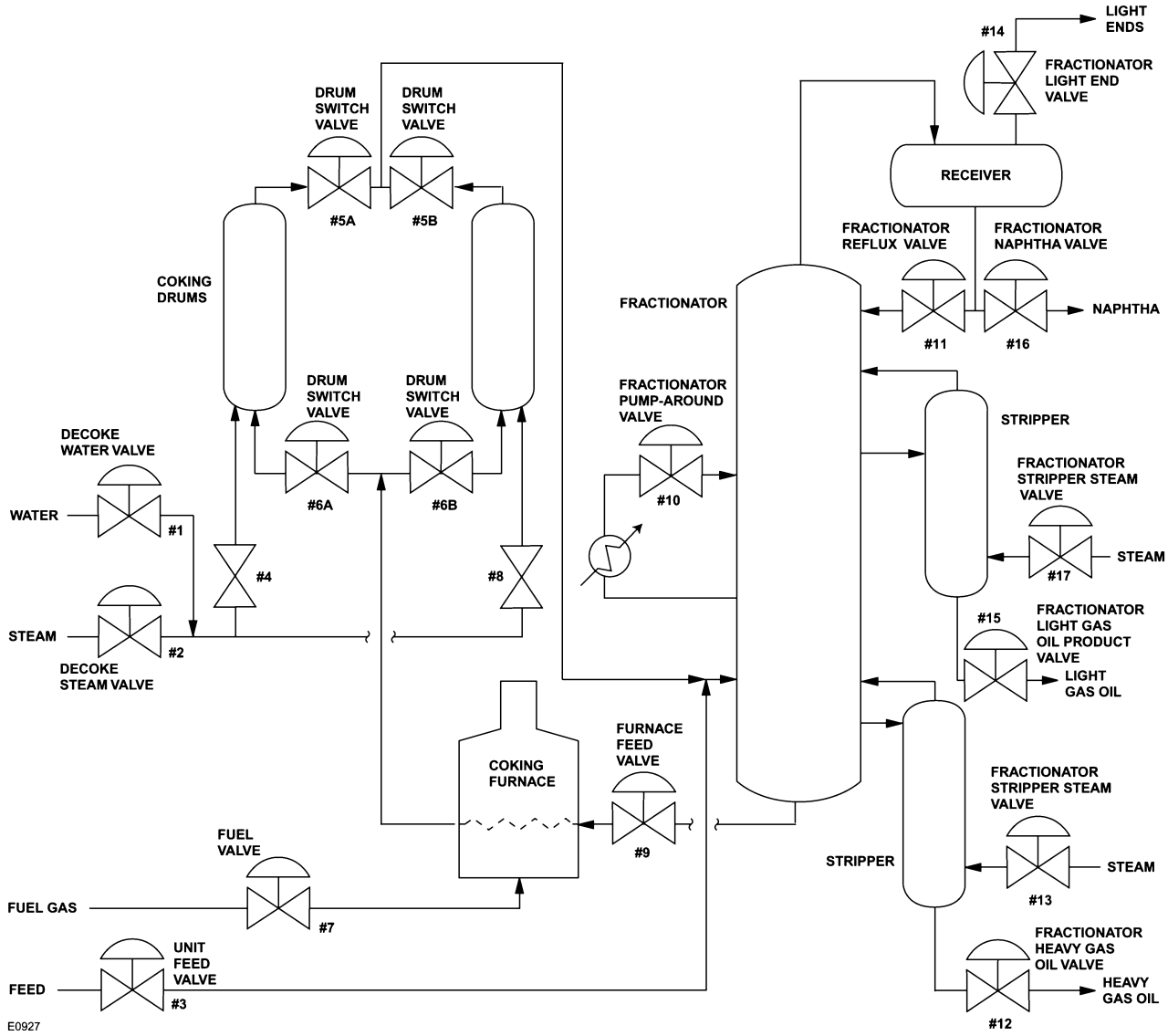
The incoming feed is sent, along with coke drum vapors, to the bottom of a fractionator. The fractionator bottoms are sent to the coking furnace. In this furnace, the feed is rapidly heated and partially vaporized. Steam is often injected into the feed oils to control the furnace residence time. The vapor-liquid mixture leaves the furnace and enters the bottom of a coke drum. In the coke drum the entrained liquid is thermally cracked to coke and other vapor products. The vapors leave the top of the coke drum and enter the bottom of the fractionator.

Over the course of several hours, the coke drum will fill with coke. When a drum is full, the furnace effluent will be switched to another drum. The filled drum is cooled, then hydraulically drilled to remove the coke. Once empty, it is put back into service



when the other drum is filled. Typical drum cycle times are 12 to 18 hours depending on the unit design.

The fractionator separates the drum vapors into typical product streams. For this example, the streams are light ends, naphtha, light gas oil, and heavy gas oil. All fractionator bottom materials are typically sent back through the coking furnace.

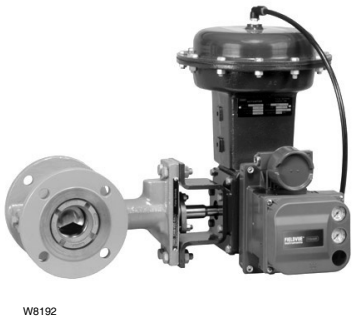


Typical Delayed Coking Unit

Control Valves
Decoke Water Valve Function (#1)


W8119

***easy-e®** Valve*


W8192

***Vee-Ball®** Valve*


W5791

***eplug®** Valve*

This valve delivers water to the coke drum during the decoke portion of the drum cycle. It is not normally critical to coker operation. Sometimes coke will block the valve and prevent water from entering the coke drum.

Process conditions vary widely for this application. It is not a critical valve, and many different valve styles can be used.

Decoke Water Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Water	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Can impact decoking time if not working properly or is partially/fully plugged with coke.

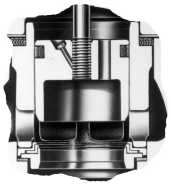
Special Considerations

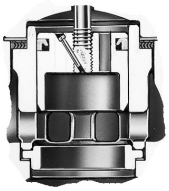
- Will potentially be exposed to coke fines that may cause valve to stick or plug

Decoke Steam Valve Function (#2)


W8119


W2966


W3162


W0451

***easy-e®** Valve*

This valve delivers steam to the coke drum during the decoker portion of the drum cycle. It is not critical to coker operation.

Decoke Steam Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

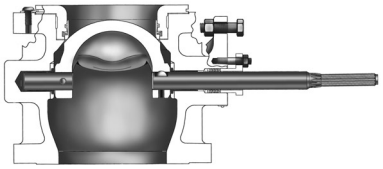
- Utilize materials suited to steam application

Unit Feed Valve Function (#3)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

A problem valve in this service can cause quality specification swings in all of the product streams.

Feed valves are usually set up as flow control loops. They are configured to fail open so that a valve failure will protect the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke build-up. If a flow valve is alternately provided too much and then too little flow, the temperature also swings and usually leads to excessive coke buildup. This shortens the furnace cycle time between de-coking procedures, which normally requires the process unit downstream to shutdown.

Feed valves can be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Unit Feed Valve Specification (#3)

Process Media

Media	Pressure Range	Temperature Range
Primarily reactor effluent	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line sizes 4 inches and smaller)	Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line sizes 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Minimal impact to process

Special Considerations

- Flashing might be present depending on the process variables

Drum Decoke Block Valve Function (#4, #8)

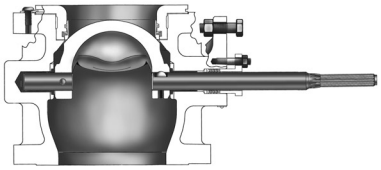
These are actually block valves, not control valves. However, if they are leaking through into a hot drum they can cause a significant upset to the fractionator as steam will cause the column pressure to rise or fluctuate.

Drum Decoke Block Valve Specification (#4, #8)

Fisher does not offer a block valve.

Drum Switch Valve Function (#5a, #5b, #6a, #6b)

W8192



W7435

W5791

***Vee-Ball®** Valve*

***eplug®** Valve*

These valves are used to switch the process stream from one drum to another. If one these valves fails or leaks through, immediate maintenance will be required. If not corrected quickly, it is likely that the coker will have to be shut down, and upstream units will have to cut back on production.

Drum Switch Valve Specification (#5a, #5b, #6a, #6b)

Process Media

Media	Pressure Range	Temperature Range
Bottom-of-the-barrel material such as heavy hydrocarbon slug	Dependent on process design	Approximately 371°C (700°F)

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact:

- Important that the valve opens and shuts when required

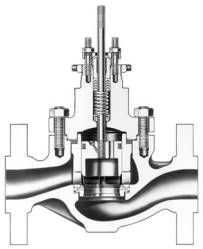
Special Considerations

- Materials that best hold up under corrosive, high-temperature, erosive applications

Fuel Valve Function (#7)

W8119

***easy-e®** Valve*



W3162

W8192

***Vee-Ball®** Valve*

Depending on the furnace service and configuration this valve normally will be part of a loop that controls either the fuel flow or pressure. These valves are specified as fail–closed so that a control loop failure will not allow an excessive amount of fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. Although many fuel valves have bypass circuits, refinery operations personnel are usually reluctant to run a furnace on bypass for any significant time because of safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the setpoint of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides inferior control performance to a cascade configuration. It is extremely susceptible to any valve dead band such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there will often be a pressure control valve upstream of the fuel valve. This valve will also fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, operations personnel will be more willing to run a fuel valve in bypass as they still have a way to quickly shut off the fuel in an emergency.

Fuel Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature.

- Performance is critical to reducing energy costs associated with the furnace.

Special Considerations

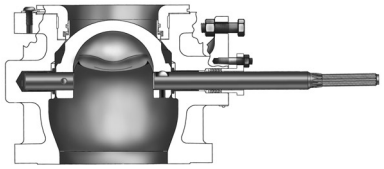
- Potential for acidic fouling gases (for example, H_2S, HCL)

Furnace Feed Valve Function (#9)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

Feed valves are usually set up as flow-control loops. They are configured to fail open so that a valve failure will protect the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences, as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke build-up. If a flow valve is alternately provided too much and then too little flow, the temperature also swings and usually leads to excessive coke buildup. This shortens the furnace cycle time between decoking procedures, which normally requires the process unit downstream to shut down.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Furnace Feed Valve Specification (#9)

Process Media

Media	Pressure Range	Temperature Range
Primarily reactor effluent	Dependent on process design	Dependent on process design

Valve Types

Lower flow rates (line sizes 4 inches and smaller)	Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line sizes 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

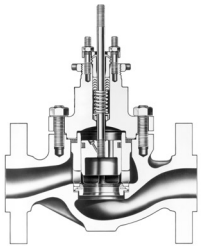
- Minimal impact to process

Special Considerations

- Flashing might be present depending on the process variables

Fractionator Pump-Around Valve Function (#10)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

A crude fractionator will always have at least one pump-around heat exchanger loop for controlling the heat balance. Most fractionators will have more than one pump-around loop. The pump-around loop extracts heat from the column, creating the separation between the product draws immediately above and below the pump-around loop. The pump-around valves are usually flow controllers.

A poorly performing or bypassed pump-around valve will increase the variability in the quality specifications of the product draws. A valve failure will most likely create an upset lasting from 30 minutes to a few hours depending on the severity of the failure.

Fractionator Pump-Around Valve Specification (#10)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon liquid	Dependent on distillation column pressure	Dependent on where steam is taken from the column, 93 to 316°C (200 to 600°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Critical to maintaining heat balance around the column

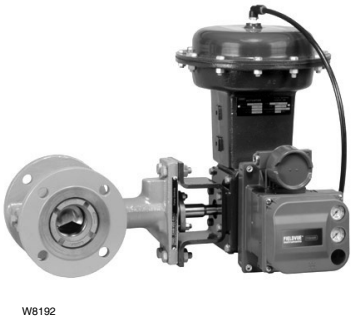
Special Considerations

- Typically none; dependent on distillation unit and process
- NACE Materials

Fractionator Reflux Valve Function (#11)

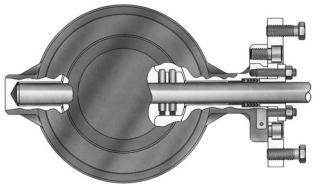
W2777

Design EW Valve



W8192

Vee-Ball*® *Valve



W6234

edisc*® *Valve

The reflux valve is used to control the separation between the top product (usually naphtha), and the highest-side draw product. The reflux valve can be either a flow or a temperature controller.

A poorly performing or bypassed reflux valve will increase the variability in the quality specifications of the overhead product and the top-side draw. A valve failure will most likely create an upset lasting from 30 minutes to a few hours, depending on the severity of the failure.

Fractionator Reflux Valve Specification (#11)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High- performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

Special Considerations

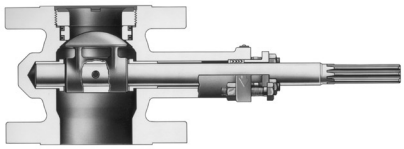
- Typically none

Fractionator Heavy Gas Oil Product Valve Function (#12)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

This valve is used to control the bottoms level in the strippers. These valves do not usually have any impact on the operation of the strippers unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Fractionator Heavy Gas Oil Product Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

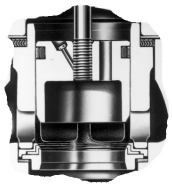
Special Considerations

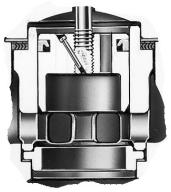
- Could encounter higher viscosity materials, sludge, and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.

Fractionator Stripper Steam Valve Function (#13, #17)


W8119


W2966


W3162


W0451

easy-e*® *Valve

Each side-draw product stream usually feeds a product stripper. The stripper uses steam to drive off any light components remaining in the product stream. Poor steam valve performance can lead to variability in the quality specifications for the product stream.

Fractionator Stripping Steam Valve Specification (#13 & #17)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

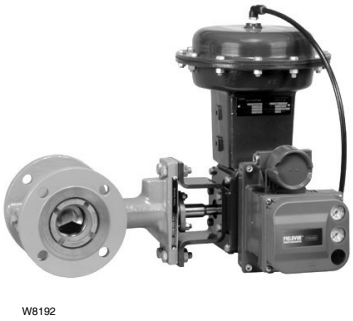
Special Considerations

- Utilize materials suited to steam application

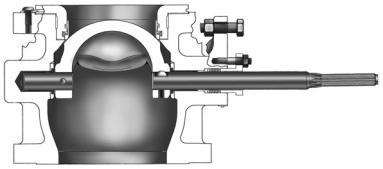
Fractionator Light-Ends Valve Function (#14)

W8119

***easy-e®** Valve*



W8192



W7435

***Vee-Ball®** Valve*

The overhead pressure control valve releases gases including H_2, H_2S, methane, ethane, propane, and butane. This stream is very normally very small (Less than 3% of feed).

The column pressure has a significant effect on fractionator operation. A valve failure that allows the column to over or under pressure can cause an upset that might take hours of recovery time. A problem valve can create pressure oscillations that prevent the fractionator from being operated optimally. Valve sizing is critical for this service. If the valve is too large, the column pressure will be prone to rapid swings. If the value is too small and has a large response time, it can cause long slow swings.

Fractionator Light-Ends Valve Specification (#14)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Controls the back pressure to the distillation column and is very important in controlling the stability of the tower. Many columns use tray temperature to control overhead composition; therefore, stable pressure is required to ensure that temperature changes reflect composition changes, not pressure changes.

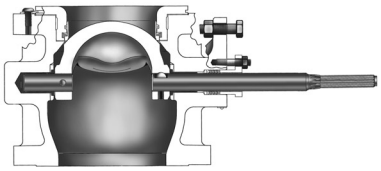
Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

- Consider using special materials if there is an acid gas environment

Fractionator Light Gas Oil Product Valve Function (#15)


W8192


W7435


W5791

***Vee-Ball®** Valve*

***eplug®** Valve*

The stripper bottoms valves are used to control the bottoms level in the strippers. These valves do not usually have any impact on the operation of the strippers unless a failure caused the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Fractionator Light Gas Oil Product Valve Specification (#15)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

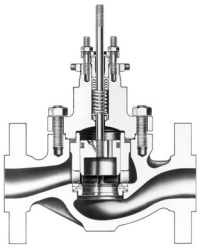
- Dependent on downstream destination

Special Considerations

- Could encounter higher viscosity materials, sludge, and process media with entrained particles
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves.

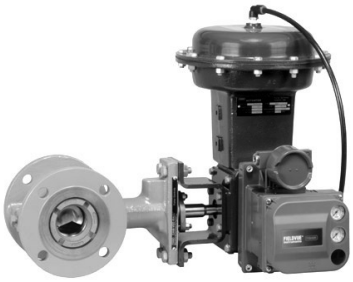
Fractionator Naphtha Valve Function (#16)

W8119



W3162

***easy-e®** Valve*



W8192

***Vee-Ball®** Valve*

The overhead product valve is usually on level control from the overhead receiver. This valve does not usually have any impact on the operation of the crude fractionator unless a failure causes the liquid level in the overhead receiver to over fill or empty. In this case, the column pressure would be affected, and the fractionator would experience an upset until the pressure became stable again. Usually, level alarms on the unit allow the operator to catch this before it becomes an upset.

It is more likely that a poorly performing product valve could cause stability problems to a downstream processing unit in configurations where there is no surge tank between the units.

Fractionator Naphtha Valve Specification (#16)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy-duty, general- purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High-capacity, high- rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

Chapter 7

Hydrotreater

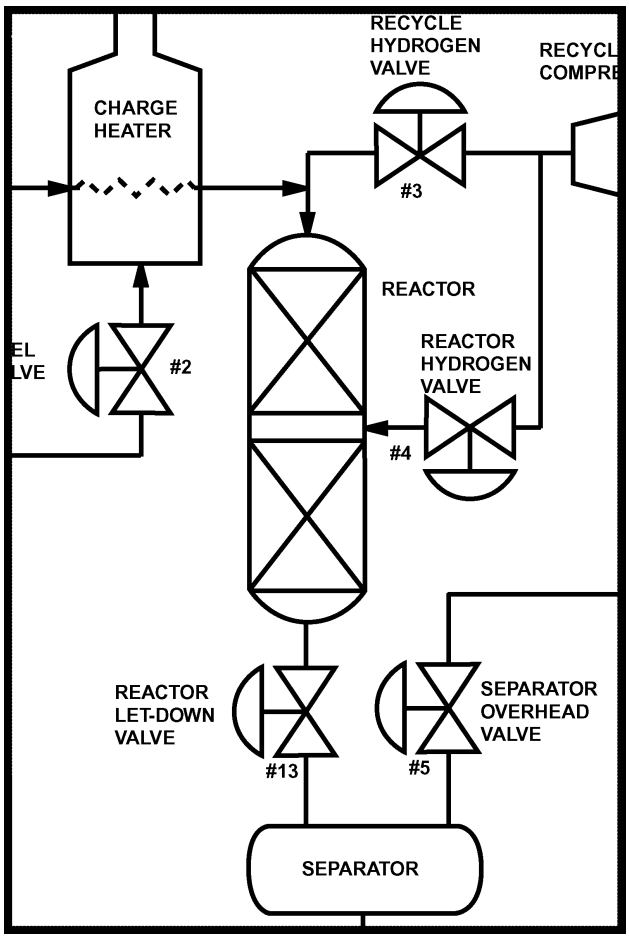
Other Names

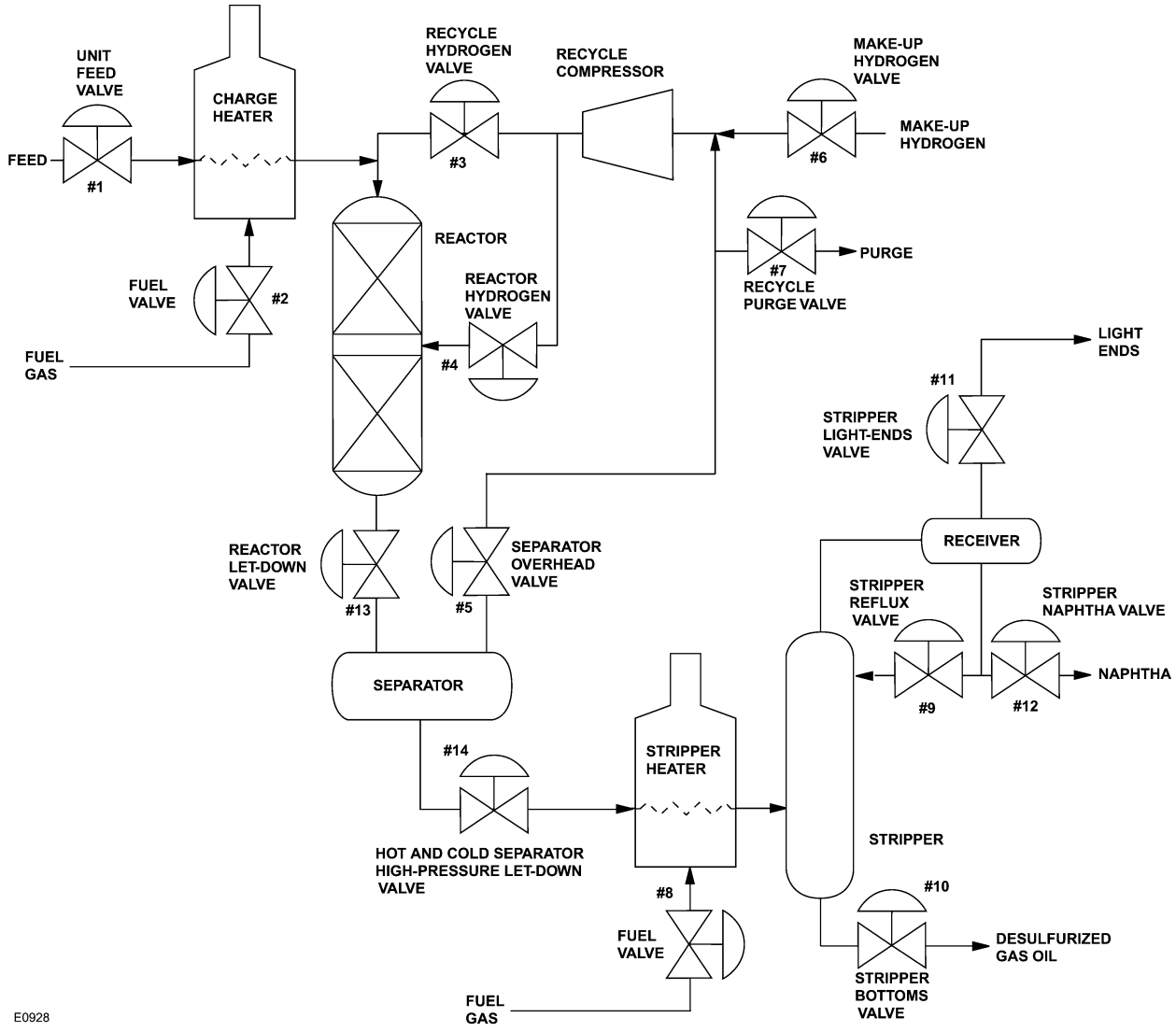
Hydroprocesser, unionfining, unifiner, desulfurizer, HDS (hydrodesulfurizer)

Description

The Hydrotreating process removes undesirable materials from a feedstock by selective reactions with hydrogen in a heated catalyst bed. Sulfur, nitrogen, and certain metal contaminants are removed from the feed. Olefins and aromatics are converted to saturated hydrocarbons. Hydrotreating is often used to remove catalyst poisons from a feedstock before downstream processing. It also is used to remove contaminants from product streams to meet environmental standards.

The incoming feed is assumed to be distillate for this description. The gas oil is heated in a furnace to reaction temperature. It is combined with a recycle hydrogen stream before flowing through the reactor with one or more catalyst beds. The reactor effluent is sent to a separator. The vapor from the separator is recycled through a compressor back to the feed. Makeup hydrogen is added to this stream as necessary. The liquid from the separator is sent to a stripper. In the stripper, hydrogen sulfide, ammonia, and light ends are sent overhead as vapors. Naphtha is produced as the overhead liquid product. The stripper bottom is treated, desulfurized distillate.





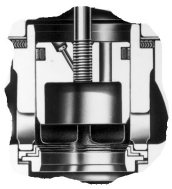
Typical Hydrotreater

Control Valves

Unit Feed Valve Function (#1)


W8119


W2966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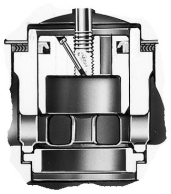

W0451

***easy-e®** Valve*

A problem valve in this service can cause swings in the amount of conversion through the unit. If the swings are wide enough, this will actually limit unit throughput and will lead to increased coke laydown on the catalyst, potentially shortening reactor life.

Feed valves usually are set up as flow-control loops. They are configured to fail open so that a valve failure will protect the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences, as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke buildup. If a flow valve is alternately provided too much and then too little flow, the temperature also swings and usually leads to excessive coke buildup. This shortens the furnace cycle time between decoking procedures, which normally require the process unit downstream to shut down.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Unit Feed Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Heavier gas and oil Naphtha	Dependent on process design	

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED

Process Impact

- Control is critical to maintaining integrity of internal furnace tubes, such as preventing coke laydown

- Valve performance is critical to overall reliability of the furnace

- Critical to furnace safety; process fluid flow is required at all times through the tubes while the furnace is firing

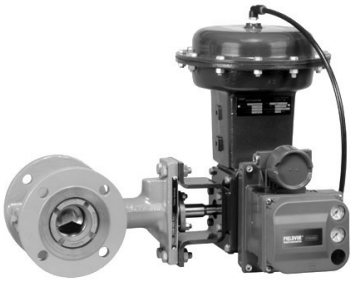
Special Considerations

- Sour feed stocks could require NACE trim materials.

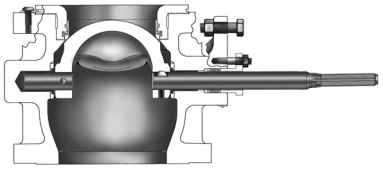
Fuel Valve Function (#2, #8)

W8119

***easy-e®** Valve*



W8192



W7435

***Vee-Ball®** Valve*

Depending on the furnace service and configuration this valve will normally be part of a loop that controls either the fuel flow or pressure. These valves are specified as fail closed so that a control loop failure will not allow an excessive amount of fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. Although many fuel valves have bypass circuits, Refinery operations personnel are usually reluctant to run a furnace on bypass for any significant time because of safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the set point of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides inferior control performance to a cascade configuration. It is extremely susceptible to any valve dead band, such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there will often be a pressure control valve upstream of the fuel valve. This valve will also fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, operations personnel will be more willing to run a fuel valve in bypass as they still have a way to shut off the fuel quickly in an emergency.

Fuel Valve Specification (#2, #8)

Process Media

Media	Pressure Range	Temperature Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced,cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature.
- Performance is critical to reducing energy costs associated with the furnace.

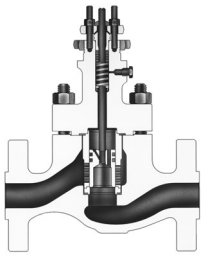
Special Considerations

- Potential for acidic fouling gases (for example, H_2S, HCL)

Recycle Hydrogen Valve Function (#3)

W8119

***easy-e®** Valve*



W5815

Design HP Valve

W6848

The amount of hydrogen delivered to the hydrotreater often limits the unit throughput. The hydrogen/oil ratio is a major parameter for determining the treating conversion of the unit. If the ratio is too low, an excessive amount of coke can build upon the catalyst, shortening reactor life. If the ratio is too high, throughput on the unit is wasted.

The hydrogen flow can be set manually or through a bypass if necessary. If swings in the hydrogen are wide enough, this will not only limit unit throughput, but also lead to increased coke laydown on the catalyst, potentially shortening reactor life.

Recycle Hydrogen Valve Specification (#3)

Process Media

Media	Pressure Range	Temperature Range
Hydrogen	69 to 138 bar (1000 to 2000 psig)	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

- Important to maintaining back pressure on the compressor
- Important to maintain hydrogen/feed ratio
- Critical to overall reliability and efficiency of hydrotreater unit

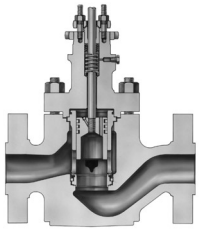
Special Considerations

- H_2S with hydrogen in a high-pressure service; always a concern for sulfur stress cracking (metallurgy considerations).

Reactor Hydrogen Valve Function (#4)

W8119

easy-e*® *Valve



W3379

Design EH Valve

W6848

Design HP Valve

This valve is used to control the reactor bed temperature. The reactor bed temperatures are another major parameter in determining the unit treating conversion. If the temperatures are allowed to get too high, then the reactor catalyst life will be shortened, as excessive amounts of coking will occur. Therefore, it is important that this valve function properly.

Reactor Hydrogen Valve Specification (#4)

Process Media:

Media	Pressure Range	Temperature Range
Hydrogen	69 to 138 bar (1000 to 2000 psig)	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE	HPT, EHT

Process Impact

- Critical to maintaining reactor temperature

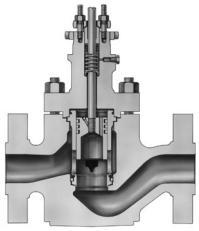
Special Considerations

- None

Separator Overhead Valve Function (#5)

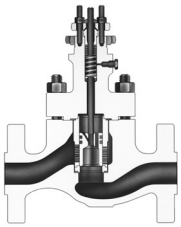
W8119

***easy-e**® Valve*



W3379

Design EH Valve



W5815

Design HP Valve

A poorly performing separator overhead valve will affect the recovery of the recycle gas, possibly causing pressure swings in the recycle gas system. It can also pulse light gases into the liquid entering the stripper, where these gases can cause the stripper to pressure up, making separations difficult.

Separator Overhead Valve Specification (#5)

Process Media:

Media	Pressure Range	Temperature Range
Hydrocarbon gas Hydrogen gas	69 to 138 bar (1000 to 2000 psig)	38 to 93°C (100 to 200°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE	HPT, EHT

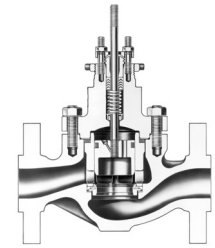
Process Impact

- Critical to recovery of recycle gas and reactor efficiency
- Poor performance can cause pressure swings in recycle gas system and can create instability.
- Poor performance can cause reactor to pressure up and inhibit separation efficiency.

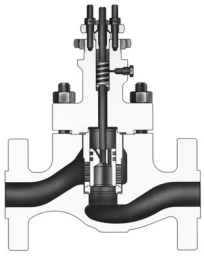
Special Considerations

- Will have entrained H_2S in process media

Makeup Hydrogen Valve Function (#6)



easy-e*® *Valve



Design EH Valve

Design HP Valve

This valve, along with the recycle purge valve, is used to control hydrogen purity. Makeup hydrogen is high purity, usually above 90% hydrogen. This valve is usually not critical to short-term operation because the unit can run totally on recycle gas for short periods.

Makeup Hydrogen Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Hydrogen	69 to 138 bar (1000 to 2000 psig)	Less than 38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

- Critical to maintaining reactor temperature

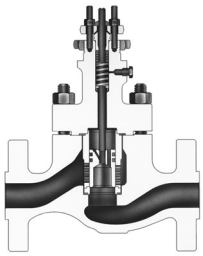
Special Considerations

- None

Recycle Purge Valve Function (#7)

W8119

***easy-e®** Valve*



W5815

Design EH Valve

W6848

Design HP Valve

This valve, along with the makeup valve, is used to control hydrogen purity. As the hydrogen is recycled through the unit, it eventually becomes dirty with light hydrocarbons such as methane and ethane. A continuous purge is taken from the recycle gas and is replaced with makeup hydrogen to prevent the recycle gas from becoming too heavy.

Generally this valve is not critical to unit operation since it is possible to run the unit on total recycle without makeup or purge for short periods of time. It would be possible if the valve were sticking badly to cause pressure swings that could affect the conversion reaction and catalyst coking rate.

Recycle Purge Valve Specification (#7)

Process Media:

Media	Pressure Range	Temperature Range
Hydrogen	69 to 138 bar (1000 to 2000 psig)	Less than 38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

- Critical to maintaining reactor temperature

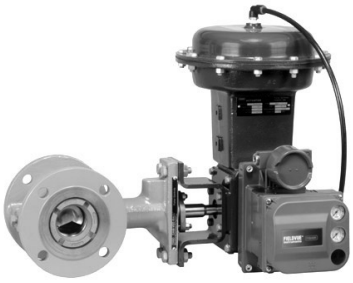
Special Considerations

- Could experience high pressure drop
- Will have entrained H_2S in process media

Stripper Reflux Valve Function (#9)

W5811

POSI-SEAL® *Valve*



W8192

Vee-Ball® *Valve*

W8299

edisc® *Valve*

The reflux valve is typically either a flow or column temperature-control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and will eventually flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate, and the column will be difficult to control.

Stripper Reflux Valve Specification (#9)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

Special Considerations

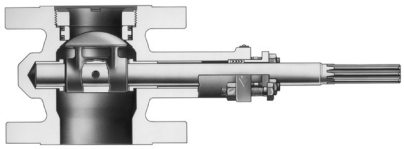
- Typically none

Stripper Bottoms Valve Function (#10)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Stripper Bottoms Valve Valve Specification (#10)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

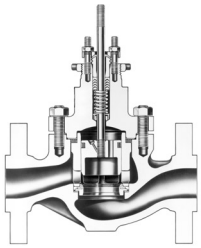
- Dependent on downstream destination

Special Considerations

- Could encounter higher viscosity materials, sludge, and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Stripper Light-Ends Valve Function (#11)

W8119



W3162

W8192

***easy-e®** Valve*

***Vee-Ball®** Valve*

Stripper light-ends valves are used to control the column pressure. Higher column pressures yield better product purities, but require more energy to operate. Normal operating procedure is to minimize the pressure to lower energy costs while maintaining product specifications. There is a low limit because lower pressures reduce the amount of vapor/liquid traffic the column can handle and can make it more likely to flood.

The simplest way to control pressures is to continuously vent gas from the system. Sizing of this valve is critical. If the valve is too large, a small valve movement will cause a large pressure swing. If the valve is too small, the pressure response will be very sluggish. It is likely that a valve that is too small will operate from completely closed to completely open. In either scenario, an oscillating column pressure and difficult column control are the result. A sticking pressure control valve will present the same problem. A sticking valve is a common concern on vent gas valves because the valve packing will normally be tight to prevent fugitive emissions.

Many distillation columns also use what is known as a “hot vapor bypass” valve to control pressure. In this case, some of the hot overhead vapors are bypassed around the overhead condenser heat exchanger. The amount of bypass will control the pressure. This eliminates the constant venting of process gas, which usually goes to a low-value refinery waste fuel gas system. Unfortunately, the pressure response on a hot vapor bypass valve is normally very sluggish due to slow process response time. Like the vent gas valve, this valve is a concern for fugitive emissions, and the packing is likely to be tight. A sticking valve will cause wide, slow oscillations in column pressure. The product purities will likewise swing widely and slowly. The response of refinery operations personnel will usually be to over-purify.

A majority of columns with hot-vapor bypass valves will use it in combination with a vent gas valve. In these cases, a single pressure control loop will manipulate both valves. At lower pressures, the hot vapor bypass valve is used. As the pressure rises, there will be a transition point where the hot vapor bypass valve closes fully and the vent gas valve starts to open. At high pressures, the vent gas valve controls the pressure. This configuration often leads to pressure control problems, as the hot vapor bypass and vent gas valves will have different control characteristics. Also, it is unlikely that one valve will close precisely at the same time the other valve opens. If the column is constantly making a transition between using the hot vapor bypass and vent gas valves, the pressure will normally oscillate. This is a tuning problem rather than a valve problem, but it should be kept in mind for column design or valve resizing.

Stripper Light-Ends Valve Specification (#11)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300

Process Impact

- Controls the back pressure to the distillation column and is very important in controlling the stability of the tower. Many columns use tray temperature to control overhead composition, thus stable pressure is required to ensure temperature changes reflect composition changes not pressure changes.

Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

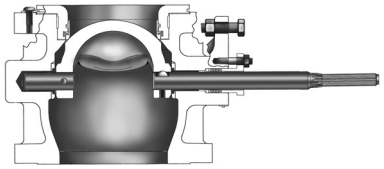
- Consider using special materials on valves that will encounter an acid gas environment.

Stripper Naphtha Valve Function (#12)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

This valve is typically used to control the level in the overhead receiver. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Stripper Naphtha Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High- capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

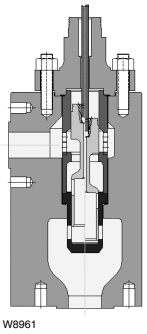
- None

Reactor Let-Down Valve Function (#13)

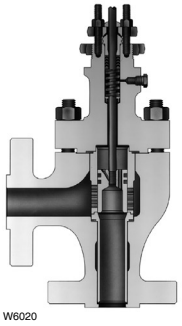
461 Valve

DST

DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim



Design DST-G Valve



Design HPA Valve

The reactor let-down valve controls the liquid level in the high pressure separator. In the accompanying diagram, this valve dumps the liquid effluent from the high pressure separator to the low pressure separator. This application will have high pressure drops where erosion, flowing particulate or flashing can cause severe valve damage.

Normally, two valves are used in this application. Both valves will be piped with bypass valves and can be rapidly switched between to ensure continuous process operation in the likely event one of the valves requires repair.

Valves used in this application are normally angle style with ANSI Class 900/1500 pressure ratings. The angle design helps protect the valve body from erosion due to flashing, cavitation, outgassing and flowing particulate.

Reactor Let-Down Valve Specification (#13)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon gases and liquids Hydrogen	69 to 138 bar (1000 to 2000 psig)	Greater than 260°C (500°F)

Valve Types

Cold high-pressure separator let-down valve	High-pressure, severe-service angle valves with DST trim	Balanced with graphite cage-plug seal	HPAD, EHAD
		Balanced with PTFE cage-plug seal	HPAT, EHAT
	High-pressure, severe-service angle valves with NotchFlo™ DST trim	Balanced with graphite cage-plug seal	HPAD
		Balanced with PTFE cage-plug seal	HPAT
Hot high-pressure separator let-down valve	High-pressure, severe-service angle valves with DST trim	DST-G forged valve	
		Balanced with graphite cage-plug seal	HPAD, EHAD
		Balanced with PTFE cage-plug seal	HPAT, EHAT
	High-pressure, severe-service angle valve	Cylinder-guided contour valve plug	461

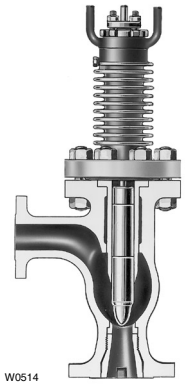
Process Impact

- Impacts volume and quality of recycle gas

Special Considerations

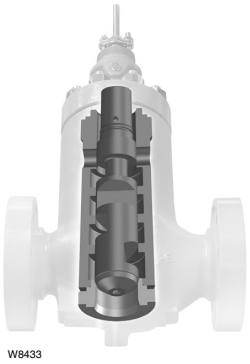
- Will more than likely see flashing across this valve
- Will have entrained H_2S gas in process media

Hot and Cold High-Pressure Separator Let-Down Valve Function (#14)

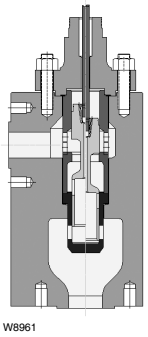


461 Valve

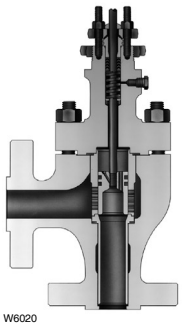
DST



DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim



Design DST-G Valve



Design HPA Valve

The separator let-down valve controls the liquid level in the high-pressure separator. This valve dumps the liquid effluent from the high-pressure separator to the low-pressure separator. This application involves high pressure drops where erosion, flowing particulate or flashing can cause severe valve damage.

Normally, two valves are used. Both valves will be piped with bypass valves and can be rapidly switched between to ensure continuous process operation should one of the valves require repair. Valves used in this application are normally angle style with ANSI Class 900/1500 pressure ratings. The angle valve design helps protect the body from erosion due to flashing, cavitation, outgassing and flowing particulate.

DST (dirty service trim) uses a staged pressure reduction to eliminate the formation of damaging cavitation, and it compensates for volume expansion of flashing, outgassing fluids via expanded area staging. DST also is designed to pass particulate up to 19.1 mm (3/4 inches) in diameter, avoiding possible plugging due to catalyst fines.

Hot and Cold High Pressure Separator Let-Down Valve Specification (#14)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon gases and liquids Hydrogen	69 to 138 bar and as low as 14 bar (1000 to 2000 psig and as low as 200 psig)	66 to 288°C (150 to 550°F)

Valve Types

Cold high-pressure separator let-down valve	High-pressure, severe-service angle valves with DST trim	Balanced with graphite cage-plug seal	HPAD, EHAD
		Balanced with PTFE cage-plug seal	HPAT, EHAT
	High-pressure, severe-service angle valves with NotchFlo™ DST trim	Balanced with graphite cage-plug seal	HPAD
		Balanced with PTFE cage-plug seal	HPAT
Hot high-pressure separator let-down valve	High-pressure, severe-service angle valves with DST trim	DST-G forged valve	
		Balanced with graphite cage-plug seal	HPAD, EHAD
		Balanced with PTFE cage-plug seal	HPAT, EHAT
	High-pressure, severe-service angle valve	Cylinder-guided contour valve plug	461

Process Impact

- Susceptible to failures, so there often will be two valves in parallel
- This valve is subject to severe service conditions (for example, outgassing) because of large pressure drops.

Special Considerations

- This is a workhorse valve.
- The process media flowing through this valve can have catalyst fines in it.

Chapter 8

Hydrocracker

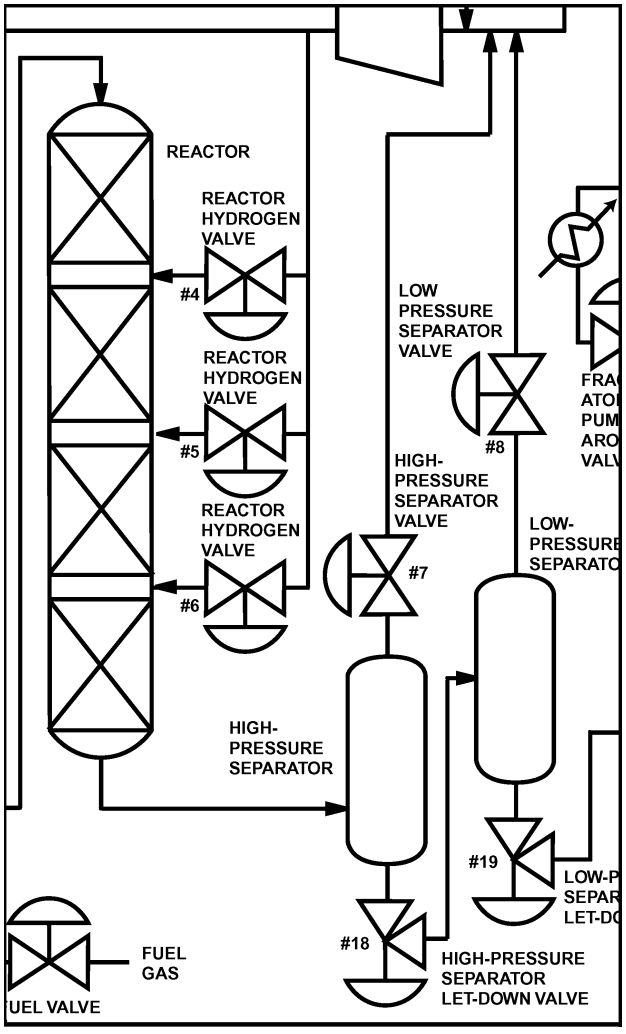
Other Names

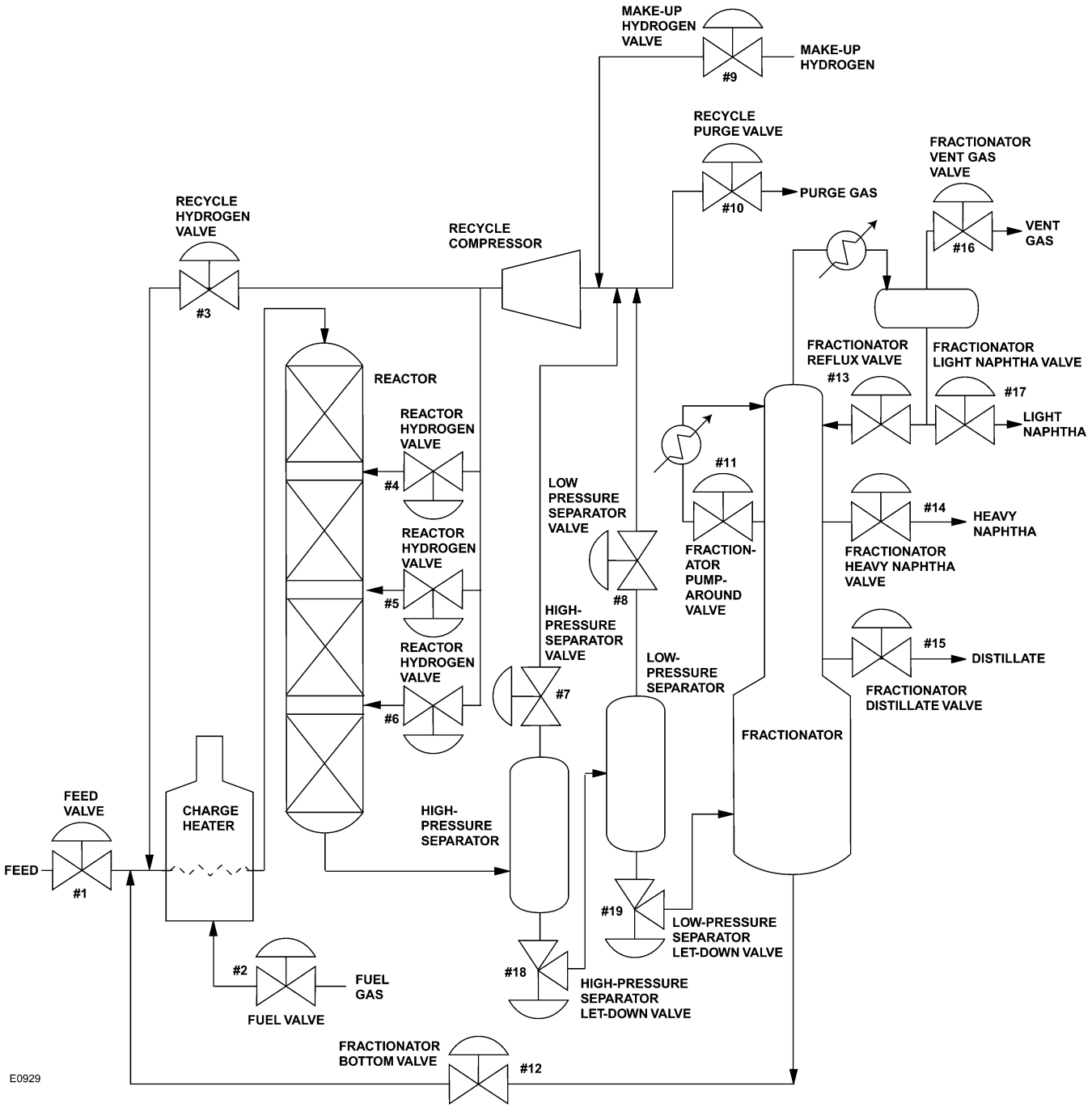
Unicracker

Description

The hydrocracking process converts (or cracks) heavy feedstocks into lighter components by selective reactions with hydrogen in multiple heated catalyst beds. The process is most commonly used to create gasoline or diesel product streams.

The incoming gas oil feed is heated in a furnace to reaction temperature. It is combined with a recycle hydrogen stream before flowing through the reactor with multiple catalyst beds. Additional recycle hydrogen is added between each bed to control the cracking conversion. The reactor effluent is sent to high-pressure, then low-pressure separators. The vapor from the separators is recycled through a compressor back to the feed. Makeup hydrogen is added to this stream as necessary. The liquid from the low pressure separator is sent to a fractionator where the reactor effluent is separated into component product streams.



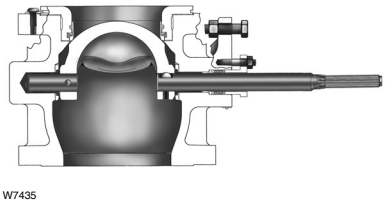


Typical Hydrocracker

Control Valves

Feed Valve Function (#1)

***easy-e®** Valve*



***Vee-Ball®** Valve*

Design HP Valve

A problem valve in this service can cause swings in the amount of conversion through the unit. If the swings are wide enough, this will actually limit unit throughput and lead to increased coke laydown on the catalyst, potentially shortening reactor life.

Feed valves are usually set up as flow-control loops. They are configured to fail open so that a valve failure will protect the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences, as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke build-up. If a flow valve is alternately provided too much and then too little flow, the temperature will also swing and will usually lead to excessive coke buildup. This will shorten the furnace cycle time between decoking procedures, which will normally require the process unit downstream to shut down.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Feed Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Heavy gas oil	34.5 to 207 bar (500 to 3000 psig)	288 to 343°C (550 to 650°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHP
		Balanced with PTFE cage-plug seal	HPT, EHT
High-capacity, high-rangeability V-notch rotary ball valves (for lower pressures)	**Vee-Ball®** valves	Class 300	V300

Process Impact

- Valve control is critical to product conversion
- Will require material consideration for the given process

Special Considerations

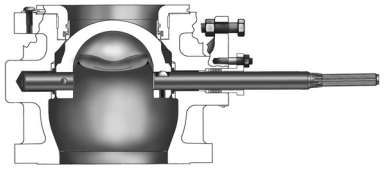
- The process media might have high sulfur content (sulfur stress cracking concerns).
- Consider process fluid when selecting valve materials.

Fuel Valve Function (#2)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

Depending on the furnace service and configuration, this valve will normally be part of a loop that controls either the fuel flow or pressure. These valves are specified as fail closed so that a control loop failure will not allow an excessive amount of fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. Although many fuel valves have bypass circuits, refinery operations personnel are usually reluctant to run a furnace on bypass for any length of time because of safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the set point of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides inferior control performance to a cascade configuration. It is extremely susceptible to any valve dead band, such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there will often be a pressure control valve upstream of the fuel valve. This valve will also fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, operations personnel will be more willing to run a fuel valve in bypass as they still have a way to shut off the fuel quickly in an emergency.

Fuel Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature.
- Performance is critical to reducing energy costs associated with furnace.

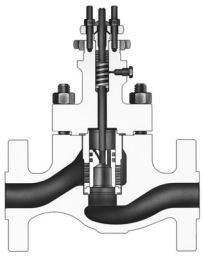
Special Considerations

- Potential for acidic fouling gases (for example, H_2S, HCL)

Recycle Hydrogen Valve Function (#3)

W8119

***easy-e®** Valve*



W5815

Design EH Valve

W6848

Design HP Valve

The amount of hydrogen delivered to the hydrocracker often limits the unit throughput. The hydrogen/oil ratio is an important parameter for determining the cracking conversion of the unit. If the ratio is too low, an excessive amount of coke can build up on the catalyst, shortening reactor life. If the ratio is too high, throughput on the unit is wasted.

The hydrogen flow can be set manually or through a bypass if necessary. If swings in the hydrogen are wide enough, this will not only limit unit throughput, but also lead to increased coke laydown on the catalyst, potentially shortening reactor life.

Recycle Hydrogen Valve Specification (#3)

Process Media

Media	Pressure Range	Temperature Range
Hydrogen Hydrogen sulfide	69.0 to 207 bar (1000 to 3000 psig)	288 to 343°C (550 to 650°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

- Valve control influences the pressure on the hydrocracking unit.
- Valve control affects the hydrogen/oil ratio that is critical to maintaining on-spec product.

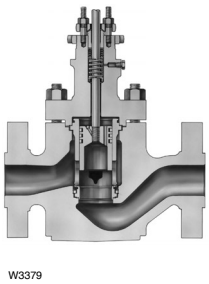
Special Considerations

- The process media might have high sulfur content.
- Will require material consideration for the given process

Reactor Hydrogen Valve Function (#4, #5, #6)


W8119

***easy-e®** Valve*


W3379

Design EH Valve


W6848

Design HP Valve

These valves are used to control the reactor bed temperatures. These temperatures are another major parameter in determining the unit cracking conversion. If the temperatures are allowed to get too high, a runaway reaction may occur. Therefore, it is important that these valves function properly.

A sticking valve will cause the bed temperature oscillate. Depending on the severity of the oscillations, this can lead to accelerated coking on the affected bed.

Reactor Hydrogen Valve Specification (#4, #5, #6)

Process Media

Media	Pressure Range	Temperature Range
Hydrogen Hydrogen sulfide	69.0 to 207 bar (1000 to 3000 psig)	288 to 343°C (550 to 650°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

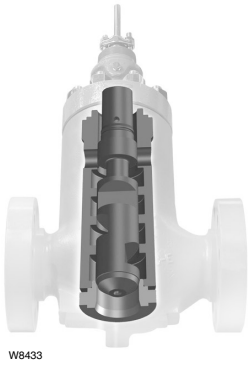
- Valve control influences the temperature on the hydrocracking unit (very important valves here!).
- Valve control affects the hydrogen/oil ratio that is critical to maintaining on-spec product.

Special Considerations

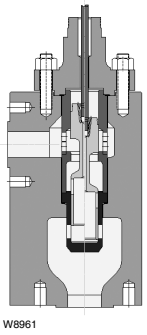
- The process media might have high sulfur content.
- Will require material consideration for the given process

High-Pressure Separator Valve Function (#7)

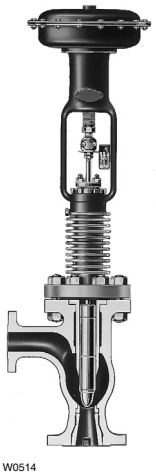
DST



DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim



Design DST-G Valve



Design 461 Valve

A poorly performing separator overhead valve will affect the recovery of the recycle gas. It can also cause pressure swings in the recycle gas system. If the valve is sticking badly or is stuck it can conceivably overload the low pressure separator, sending light gases to the fractionator, causing it to pressure up.

High-Pressure Separator Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Processed hydrocarbon liquid that is lighter than straight gas oil and cleaner (for example, gasoline and diesel)	103 to 241 bar (1500 to 3500 psig)	204 to 454°C (400 to 850°F)

Valve Types

High-pressure, severe service angle valve	Cylinder-guided contour valve plug	461
High-pressure, severe service angle valves with DST trim	DST-G forged valve	
	Balanced with graphite cage-plug seal	HPAD, EHAD
	Balanced with PTFE cage-plug seal	HPAT, EHAT
High-pressure, severe service angle valves with NotchFlo™ DST trim	Balanced with graphite cage-plug seal	HPAD
	Balanced with PTFE cage-plug seal	HPAT

Process Impact

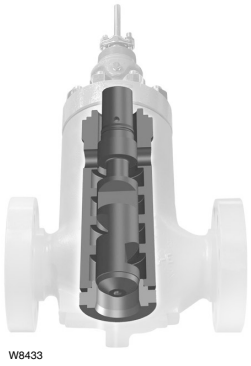
- Valve control has significant influence on the pressure of the high-pressure separator and the low-pressure separator.
- Poor performing valve in this application can restrict flow to the low-pressure separator because of uncontrolled outgassing.

Special Considerations

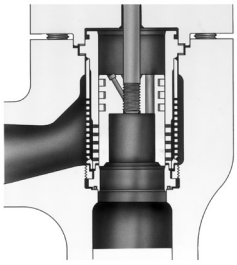
- Severe service valve (high pressure drops, outgassing, corrosive caused by entrained sulfur and H_2S)
- NACE materials might be required.

Low-Pressure Separator Valve Function (#8)

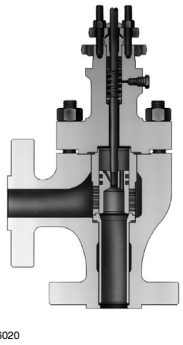
DST



DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim



Design EHA Valve



Design HPA Valve

A poorly performing separator overhead valve will affect the recovery of the recycle gas, possibly causing pressure swings in the recycle gas system. It can also pulse light gases into the liquid entering the fractionator, where these gases can cause the fractionator to pressure up, making separations difficult.

Low-Pressure Separator Valve Specification (#8)

Process Media

Media	Pressure Range	Temperature Range
Processed hydrocarbon liquid that is lighter than straight gas oil and cleaner (for example, gasoline and diesel)	62.1 to 103 bar (900 to 1500 psig)	93 to 260°C (200 to 500°F)

Valve Types

High-pressure, severe-service angle valves with NotchFlo DST (dirty-service trim)	Balanced with graphite cage-plug seal	HPAD
	Balanced with PTFE cage-plug seal	HPAT
High-pressure, severe-service angle valves with DST (dirty-service trim)	Balanced with graphite cage-plug seal	HPAD, EHAD
	Balanced with PTFE cage-plug seal	HPAT, EHAT

Process Impact

- Valve control has significant influence on the pressure of the high-pressure separator and the low-pressure separator.
- Poor performing valve in this application can restrict flow to the low-pressure separator because of uncontrolled outgassing.

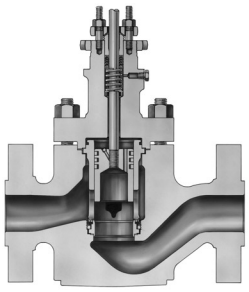
Special Considerations

- Severe service valve (high pressure drops, outgassing, corrosion caused by entrained sulfur and H_2S)
- NACE materials might be required.

Makeup Hydrogen Valve Function (#9)


W8119

***easy-e**® Valve*


W3379

Design EH Valve


W6848

Design HP Valve

This valve, along with the recycle purge valve, is used to control hydrogen purity. Makeup hydrogen is high purity, usually above 90% hydrogen. This valve is usually not critical to operation because the unit can run totally on recycle gas for short periods of time.

Makeup Hydrogen Valve Specification (#9)

Process Media

Media	Pressure Range	Temperature Range
Hydrogen	69.0 to 138 bar (1000 to 2000 psig)	Less than 38°C (less than 100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

- Critical to maintaining reactor temperature.

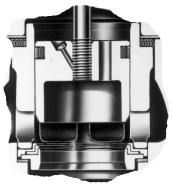
Special Considerations

- None

Recycle Purge Valve Function (#10)

W8119

easy-e*® *Valve



W3162

W6848

Design HP Valve

This valve, along with the makeup valve, is used to control hydrogen purity. As the hydrogen is recycled through the unit, it eventually becomes dirty with light hydrocarbons, such as methane and ethane. A continuous purge is taken from the recycle gas and is replaced with makeup hydrogen to prevent the recycle gas from becoming too heavy.

Generally this valve is not critical to unit operation because it is possible to run the unit on total recycle without makeup or purge for short periods of time. It would be possible if the valve were sticking badly to cause pressure swings that could affect the conversion reaction.

Recycle Purge Valve Specification (#10)

Process Media

Media	Pressure Range	Temperature
Hydrogen	69.0 to 138 bar (1000 to 2000 psig)	Less than 38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

- Critical to maintaining reactor temperature

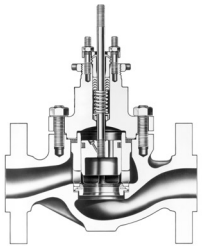
Special Considerations

- Could experience high pressure drop across this valve
- Will have entrained H_2S in process media

Fractionator Pump-Around Valve Function (#11)

W8119

***easy-e®** Valve*



W3162

W8192

***Vee-Ball®** Valve*

A crude fractionator will always have at least one pump-around heat exchanger loop for controlling the heat balance. Most fractionators will have more than one pump-around loop. The pump-around loop is used to extract heat from the column, creating the separation between the product draws immediately above and below the pump-around loop. The pump-around valves are usually flow controllers.

A poorly performing or bypassed pump-around valve will increase the variability in the quality specifications of the product draws. A valve failure will most likely create an upset lasting from 30 minutes to a few hours depending on the severity of the failure.

Fractionator Pump-Around Valve Specification (#11)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon liquid	Dependent on distillation column pressure	Dependent on where steam is taken from the column, 93 to 316°C (200 to 600°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Critical to maintaining heat balance around the column

Special Considerations

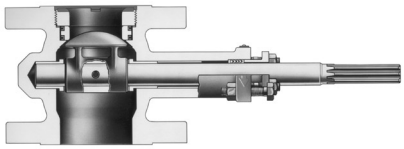
- Typically none; dependent on distillation unit and process
- NACE Materials

Fractionator Bottom Valve Function (#12)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

The bottom material becomes the vacuum distillation unit charge.

The bottoms flow does not usually have any impact on the operation of the crude fractionator unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Fractionator Bottom Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

Special Considerations

- Could encounter higher viscosity materials, sludge, and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves.

Fractionator Reflux Valve Function (#13)

W5811

POSI-SEAL® *Valve*

W8192

Vee-Ball® *Valve*

W8299

edisc® *Valve*

The reflux valve is used to control the separation between the top product, (usually naphtha) and the highest side-draw product. The reflux valve can be either a flow or a temperature controller.

A poorly performing or bypassed reflux valve will increase the variability in the quality specifications of the overhead product and the top side draw. A valve failure will most likely create an upset lasting from 30 minutes to a few hours, depending on the severity of the failure.

Fractionator Reflux Valve Specification (#13)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

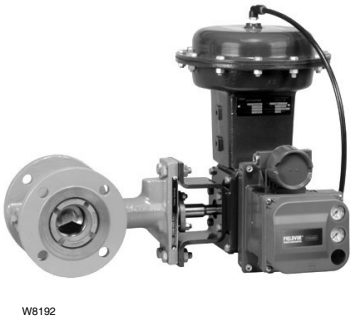
- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

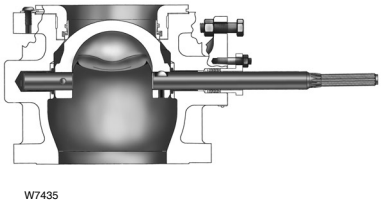
Special Considerations

- Typically none

Fractionator Heavy Naphtha Valve Function (#14)

***easy-e®** Valve*





***Vee-Ball®** Valve*

The stripper bottoms valves are used to control the bottoms level in the strippers. These valves do not usually have any impact on the operation of the strippers unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Fractionator Heavy Naphtha Valve Specification (#14)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

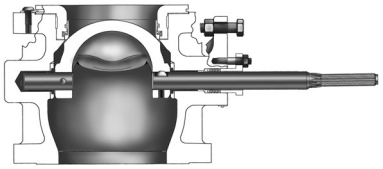
- None

Fractionator Distillate Valve Function (#15)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

The stripper bottoms valves are used to control the bottoms level in the strippers. These valves do not usually have any impact on the operation of the strippers unless a failure caused the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Fractionator Distillate Valve Specification (#15)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

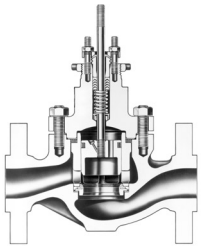
- Dependent on downstream destination

Special Considerations

- Could encounter higher viscosity materials, sludge and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low flow, clean fluids or small line-size applications could use globe valves.

Fractionator Vent Gas Valve Function (#16)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

The overhead pressure control valve releases gases including H_2, H_2S, methane, ethane, propane, and butane. This stream is very normally very small (1 to 3 % of feed).

The column pressure has a significant effect on fractionator operation. A valve failure that allows the column to over or under pressure can cause an upset that might take hours of recovery time. A problem valve can create pressure oscillations that prevent the fractionator from being operated optimally. Valve sizing is critical for this service. If the valve is too large, the column pressure might be prone to rapid swings. If the valve is too small and has a large response time, it could cause long, slow swings.

Fractionator Vent Gas Valve Specification (#16)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High- capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

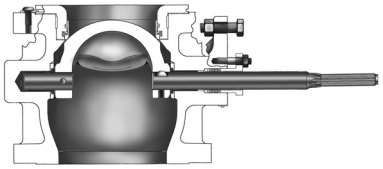
- None

Fractionator Light Naphtha Valve Function (#17)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

The overhead product valve is usually on level control from the overhead receiver. This valve does not usually have any impact on the operation of the crude fractionator unless a failure causes the liquid level in the overhead receiver to over fill or empty. In this case, the column pressure would be affected and the fractionator would experience an upset until the pressure became stable again. Usually, level alarms on the unit allow the operator to catch this before it becomes an upset.

It is more likely that a poorly performing product valve could cause stability problems to a downstream processing unit in configurations where there is no surge tank between the units.

Fractionator Light Naphtha Valve Specification (#17)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High- capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

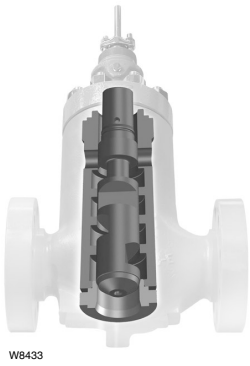
- Typically no critical impact
- Dependent on downstream destination

Special Considerations

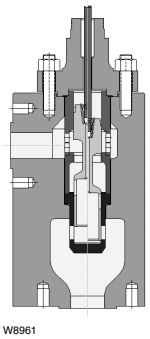
- None

High-Pressure Separator Let-Down Valve Function (#18)

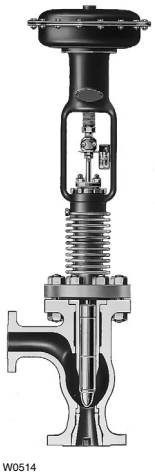
DST



DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim



Design DST-G Valve



Design 461 Valve

The separator let-down valve controls the liquid level in the high-pressure separator. In the accompanying diagram, this valve dumps the liquid effluent from the high-pressure separator to the low-pressure separator. This application will have high pressure drops where erosion, flowing particulate or flashing can cause severe valve damage.

Normally, two valves are used in this application. Both will be piped with bypass valves and can be rapidly switched to ensure continuous process operation in the likely event that one of the valves requires repair.

Valves used in this application normally utilize NotchFlo™ DST trim or are angle style valves with ANSI Class 900/1500 pressure ratings. The angle valve design helps protect the valve body from erosion due to flashing, cavitation, outgassing and flowing particulate. DST uses a staged pressure reduction to eliminate the formation of damaging cavitation and also compensates for volume expansion of flashing, outgassing fluids via expanded area staging. DST also is designed to pass particulate up to 19.1 mm (3/4 inches) in diameter, which avoids plugging by catalyst fines.

High-Pressure Separator Let-Down Valve Specification (#18)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon gases and liquids Hydrogen	69 to 138 bar and as low as 14 bar (1000 to 2000 psig and as low as 200 psig)	66 to 288°C (150 to 550°F)

Valve Types

High-pressure, severe service angle valve	Cylinder-guided contour valve plug	461
High-pressure, severe service angle valves with DST trim	DST-G forged valve	
	Balanced with graphite cage-plug seal	HPAD, EHAD
	Balanced with PTFE cage-plug seal	HPAT, EHAT
High-pressure, severe service angle valves with NotchFlo™ DST trim	Balanced with graphite cage-plug seal	HPAD
	Balanced with PTFE cage-plug seal	HPAT

Process Impact

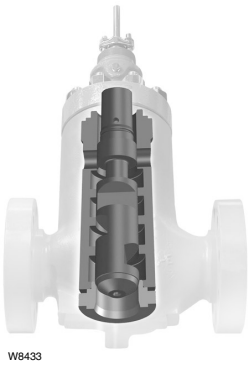
- Susceptible to failures, so there often will be two valves in parallel
- This valve is subject to severe service conditions (for example, outgassing) because of large pressure drops.

Special Considerations

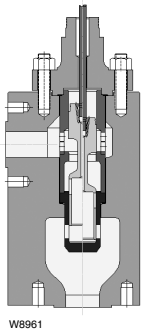
- This is a workhorse valve.
- The process media flowing through this valve can have catalyst fines in it.

Low-Pressure Separator Let-Down Valve Function (#19)

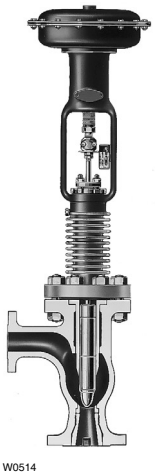
DST



DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim



Design DST-G Valve



Design 461 Valve

Using a low-pressure separator allows for additional removal of hydrogen and light hydrocarbons. The low-pressure separator let-down valve controls the liquid level in the low–pressure separator flowing to the fractionalization tower. This application involves moderate pressure drops where erosion, flowing particulate and flashing or outgassing can cause severe valve damage. Normally, two valves are used. Both will be piped with bypass valves and can be rapidly switched between to ensure continuous process operation in the likely event one of the valves requires repair.

Valves in this application are normally utilize NotchFlo™ trim or are angle-style valves with ANSI Class 600 ratings. The angle valve design protects the valve body from erosion caused by flashing and flowing particulate. DST uses a staged pressure reduction to eliminate the formation of damaging cavitation and also compensates for volume expansion of flashing fluids via expanded area staging. DST also is designed to pass particulate up to 19.1 mm (3/4 inches) in diameter, which avoids plugging by catalyst fines.

Low-Pressure Separator Let-Down Valve Specification (#19)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon gases and liquids Hydrogen	69 to 138 bar and as low as 14 bar (1000 to 2000 psig and as low as 200 psig)	66 to 288°C (150 to 550°F)

Valve Types

High-pressure, severe service angle valve	Cylinder-guided contour valve plug	461
High-pressure, severe service angle valves with DST trim	DST-G forged valve	
	Balanced with graphite cage-plug seal	HPAD, EHAD
	Balanced with PTFE cage-plug seal	HPAT, EHAT
High-pressure, severe service angle valves with NotchFlo™ DST trim	Balanced with graphite cage-plug seal	HPAD
	Balanced with PTFE cage-plug seal	HPAT

Process Impact

- Susceptible to failures, so there often will be two valves in parallel

Special Considerations

- This is a workhorse valve and is subject to severe service conditions (for example, outgassing) because of large pressure drops.
- The process media flowing through this valve can have catalyst fines in it.

Chapter 9

Catalytic Reformer Unit

Other Names

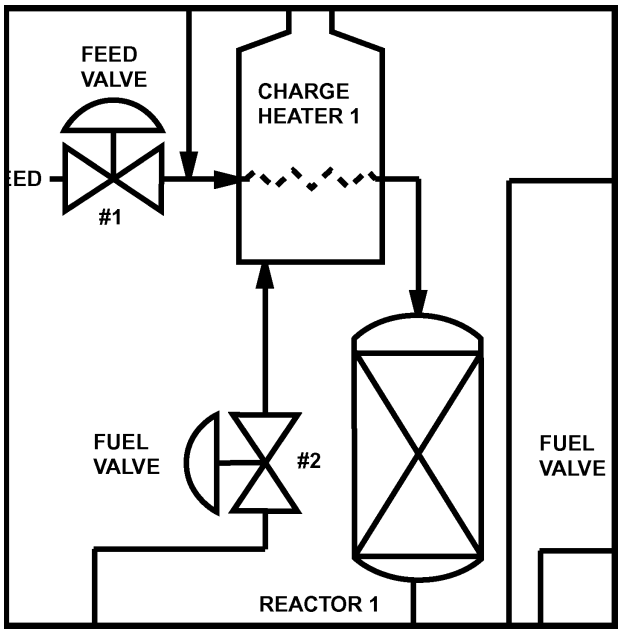
Reformer, cat reformer, platformer, CCR (continuous catalytic reformer)

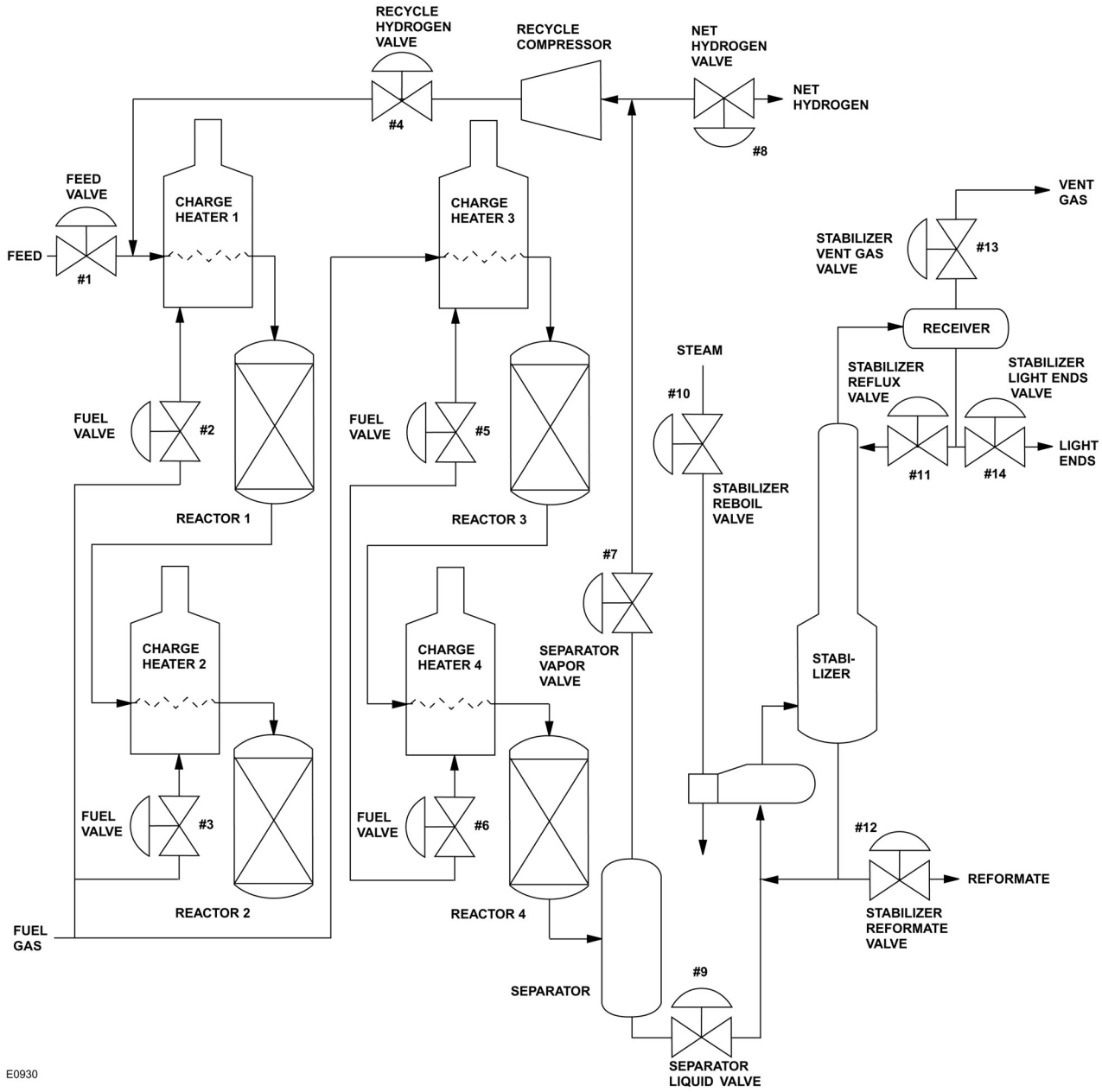
Description

The catalytic reforming process upgrades low-octane naphtha feedstocks to high octane reformate for the gasoline blending pool. Heated naphtha is reacted with hydrogen in the presence of a catalyst to reform the naphtha components into a stream that is rich with high octane aromatic hydrocarbons. The unit is also a net hydrogen producer, as the reactions strip hydrogen away from saturated hydrocarbons to create the aromatics.

The catalytic reformer process used for illustration in this sourcebook uses four fixed bed reactors. This type of reformer is subject to catalyst degradation due to coke formation. The catalyst must be regenerated or replaced every few years depending on how hard the unit is used. Many newer reformers are CCR (continuous catalytic reformers), which use a continuous catalyst regeneration and makeup process somewhat similar to that of a FCC (fluid catalytic cracker).

The incoming naphtha feed is heated in a furnace to reaction temperature. It is combined with a recycle hydrogen stream before flowing through the first of four reactors. This process repeats, and after the fourth reactor the effluent is sent to a separator. Vapor from the separators is recycled through a compressor back to the feed, or it becomes export hydrogen. Liquid from the separator is sent to a stabilizer. In the stabilizer, the reactor effluent is separated into vent gases, light end liquids, and high octane reformate product streams. Makeup hydrogen is used only to start up the unit.





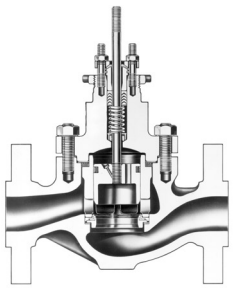
Typical Catalytic Reformer Unit

Control Valves

Feed Valve Function (#1)


W8119


W2966


W3162

***easy-e®** Valve*

A problem valve in this service can cause swings in the amount of conversion through the unit. If the swings are wide enough, this will actually limit unit throughput and lead to increased coke laydown on the catalyst, potentially shortening reactor life.

Feed valves are usually set up as flow-control loops. They are configured to fail open so that a valve failure will protect the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences, as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties with controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke build-up. If a flow valve is alternately provided too much and then too little flow, the temperature will also swing and will usually lead to excessive coke buildup. This will shorten the furnace cycle time between decoking procedures, which will normally require the process unit downstream to shut down.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Feed Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Heavier gas oil Naphtha	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED

Process Impact

- Control is critical to maintaining integrity of internal furnace tubes, such as preventing coke lay-down.

- Valve performance is critical to overall reliability of furnace.

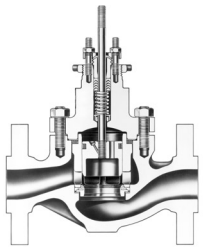
- Critical to furnace safety; process fluid flow is required at all times through the tubes while the furnace is firing.

Special Considerations:

- Sour feed stocks could require NACE trim materials.

Fuel Valve Function (#2, #3, #5, #6)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

Depending on the furnace service and configuration, this valve will normally be part of a loop that controls either the fuel flow or pressure. These valves are specified as fail closed so that a control loop failure will not allow an excessive amount of fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. While many fuel valves have bypass circuits, Refinery operations personnel are usually reluctant to run a furnace on bypass for any length of time due to safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the setpoint of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides control performance that is inferior to a cascade configuration. It is extremely susceptible to any valve dead band, such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there will often be a pressure control valve upstream of the fuel valve. This valve will also fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, operations personnel will be more willing to run a fuel valve in bypass as they still have a way to quickly shut off the fuel in an emergency.

Fuel Valve Specification (#2, #3, #5, #6)

Process Media

Media	Pressure Range	Temperature Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature.
- Performance is critical to reducing energy costs associated with the furnace.

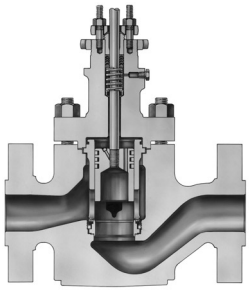
Special Considerations

- Potential for acidic fouling gases (for example, H_2S, HCL)

Recycle Hydrogen Valve Function (#4)

W8119

***easy-e®** Valve*



W3379

Design EH Valve

W6848

Design HP Valve

The amount of hydrogen delivered to the reformer helps to control conversion and catalyst degradation caused by coking. The hydrogen/oil ratio is a major parameter for determining the catalyst life of the unit. If the ratio is too low, an excessive amount of coke can build up on the catalyst, shortening reactor life. If the ratio is too high, throughput of the unit is wasted as yields drop.

The hydrogen flow can be set manually or through a bypass if necessary. If swings in the hydrogen are wide enough, this will not only limit unit throughput, but also lead to increased coke laydown on the catalyst, potentially shortening reactor life.

Recycle Hydrogen Valve Specification (#4)

Process Media

Media	Pressure Range	Temperature Range
Hydrogen Hydrogen sulfide	69.0 to 207 bar (1000 to 3000 psig)	288 to 343°C (550 to 650°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-pressure, severe-service globe valves		Balanced with graphite cage-plug seal	HPD, EHD
		Balanced with PTFE cage-plug seal	HPT, EHT

Process Impact

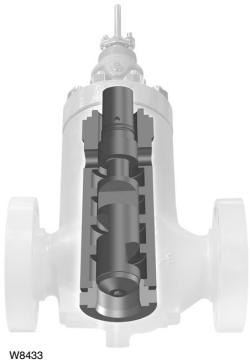
- Valve control influences the pressure on the hydrocracking unit.
- Valve control affects the hydrogen/oil ratio that is critical to maintaining on-spec product.

Special Considerations

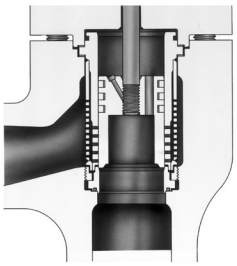
- The process media might have high sulfur content.
- Will require material consideration for the given process

Separator Vapor Valve Function (#7)

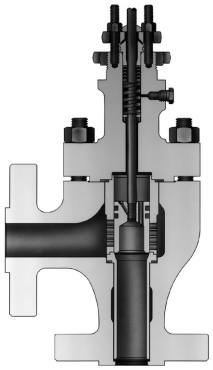
DST



DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim



Design EHA Valve



Design HPA Valve

A poorly performing separator overhead valve will affect the recovery of the recycle hydrogen. It also can cause pressure swings in the recycle gas. system. If the valve becomes stuck it conceivably can overload the separator, sending light gases to the stabilizer and causing it to pressure up.

Separator Vapor Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon gases and liquids Hydrogen	69 to 138 bar and as low as 14 bar (1000 to 2000 pig and as low as 200 psig)	66 to 288°C (150 to 550°F)

Valve Types

Cold high-pressure separator let-down valve	High-pressure, severe-service angle valves with DST trim	Balanced with graphite cage-plug seal	HPAD, EHAD
		Balanced with PTFE cage-plug seal	HPAT, EHAT
	High-pressure, severe-service angle valves with NotchFlo™ DST trim	Balanced with graphite cage-plug seal	HPAD
		Balanced with PTFE cage-plug seal	HPAT
Hot high-pressure separator let-down valve	High-pressure, severe-service angle valves with DST trim	DST-G forged valve	
		Balanced with graphite cage-plug seal	HPAD, EHAD
		Balanced with PTFE cage-plug seal	HPAT, EHAT

Process Impact

- Susceptible to failures, so there often will be two valves in parallel

Special Considerations

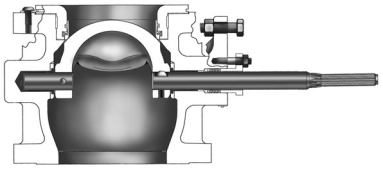
- This is a workhorse valve.
- This valve is subject to severe service conditions (for example, outgassing) because of large pressure drops.
- The process media flowing through this valve can have catalyst fines in it.

Net Hydrogen Valve Function (#8)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

This valve normally has no effect on reformer operation. If the valve is sticking badly, it is possible for it to create pressure swings in the recycle hydrogen supplied to the reformer. If it becomes stuck, it can eventually cause the reformer to pressure up or down depending on the valve's last position.

Net Hydrogen Valve Specification (#8)

Process Media

Media	Pressure Range	Temperature Range
Hydrogen gas	17.2 to 34.5 bar (250 to 500 psig)	204 to 260°C (400 to 500°F)

Valve Types

Heavy duty, general- purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

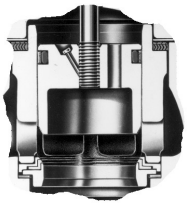
Process Impact

- Valve controls source of hydrogen feed to multiple refinery units.

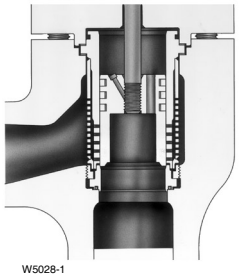
Special Considerations

- None

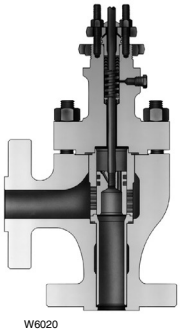
Separator Liquid Valve Function (#9)



easy-e*® *Valve



Design EHA Valve



Design HPA Valve

The separator liquid valve controls the separator level and is also the feed valve of the stabilizer. It normally does not affect the recovery of the recycle gas. A problem valve can create stability problems for the stabilizer.

Feed valves are usually set up as flow or level control loops. An upstream unit or process often controls the valve.

Unstable feed flow will make the distillation column difficult to control. A problem valve will often cause the feed flow to oscillate. As a result, the column will alternate between too little and too much reboil heat. Depending upon the size and number of trays in the column the effect of a swing in the feed will take anywhere from several minutes to more than an hour to reach the ends of the column. Sometimes, the reboil and reflux controls will amplify the swings. The final result is that meeting product purity targets will become more difficult. Refinery operations personnel will normally respond by over-purifying the products, wasting energy to compensate for the bad feed control valve.

Separator Liquid Valve Specification (#9)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon gases and liquids Hydrogen	69 to 138 bar (1000 to 2000 pig)	Greater than 260°C (500°F)

Valve Types

Heavy-duty, general-purpose angle valves	**easy-e**® valves	Balanced with graphite cage-plug seal	EAD
		Balanced with polymer cage-plug seal	EAT
High-pressure, severe-service angle valves		Balanced with graphite cage-plug seal	HPAD, EHAD
		Balanced with PTFE cage-plug seal	HPAT, EHAT

Process Impact

- Impacts volume and quality of recycle gas

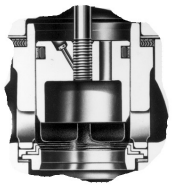
Special Considerations

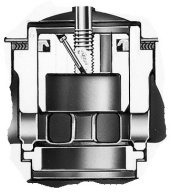
- There will more than likely be flashing across this valve.
- Will have entrained H_2S gas in process media

Stabilizer Reboil Valve Function (#10)


W8119


W2966


W3162


W0451

easy-e® *Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases steam is used as a heat source. Steam valves are usually very reliable. The service is very clean, and fugitive emissions are not a concern. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries integrate the units so that higher-temperature process streams are used to provide heat for lower temperature processes. In these cases, the reboil valve may foul more easily and might create fugitive emissions concerns.

Stabilizer Reboil Valve Specification (#10)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. This affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

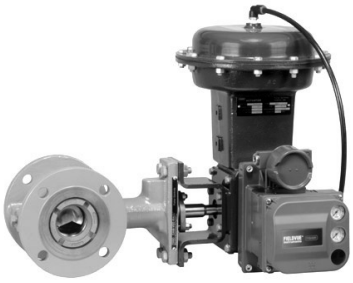
Special Considerations

- Consideration of materials for steam application

Stabilizer Reflux Valve Function (#11)

W5811

POSI-SEAL® *Valve*



W8192

Vee-Ball® *Valve*

W8299

edisc® *Valve*

The reflux valve is typically either a flow or column temperature-control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and will eventually flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate, and the column will be difficult to control.

Stabilizer Reflux Valve Function (#11)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, ~~high-rangeability~~ V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High- performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

Special Considerations

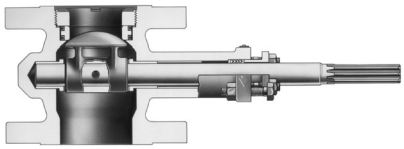
- Typically none

Stabilizer Reformate Valve Function (#12)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

This valve will have no effect on the stabilizer operation unless it causes level problems. There is no consequence for any downstream unit because the reformate is sent to a component blend tank in the gasoline blender unit. This valve can be run in manual or bypass without significant problems.

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Stabilizer Reformate Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, ~~high-rangeability~~ V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination.

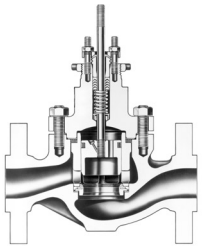
Special Considerations

- Could encounter higher viscosity materials, sludge and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Stabilizer Vent Gas Valve Function (#13)

W8119

***easy-e®** Valve*



W3162

W8192

***Vee-Ball®** Valve*

The pressure control valves are used to control the column pressure. Higher column pressures will yield better product purities, but require more energy to operate. Normal operating procedure is to minimize the pressure to lower energy costs while maintaining product specifications. There is a low limit because lower pressures reduce the amount of vapor/liquid traffic the column can handle, which also makes the column more likely to flood.

The simplest way to control pressure is to continuously vent gas from the system. Sizing of a vent valve is critical. If the valve is too large, a small valve movement will cause a large pressure swing. If the valve is too small, the pressure response will be very sluggish. It is likely that a valve that is too small will operate from completely closed to completely open. In either scenario, an oscillating column pressure and difficult column control are the result. A sticking pressure control valve will present the same problem. A sticking valve is a common concern on vent gas valves because the valve packing will normally be tight to prevent fugitive emissions.

Many distillation columns also use what is known as a “hot vapor bypass” valve to control pressure. In this case, some of the hot overhead vapors are bypassed around the overhead condenser heat exchanger. The amount of bypass will control the pressure. This eliminates the constant venting of process gas, which usually goes to a low-value refinery waste fuel gas system. Unfortunately, the pressure response on a hot vapor bypass valve is normally very sluggish due to slow process response time. Like the vent gas valve, this valve is a concern for fugitive emissions, and the packing is likely to be tight. A sticking valve will cause wide, slow oscillations in column pressure. The product purities will likewise swing widely and slowly. The response of refinery operations personnel will usually be to over-purify.

A majority of columns with a hot-vapor bypass valve will use it with a vent gas valve. In these cases, a single pressure control loop will manipulate both valves. At lower pressures, the hot vapor bypass valve is used. As the pressure rises, there will be a transition point where the hot vapor bypass valve closes fully and the vent gas valve starts to open. At high pressures, the vent gas valve controls the pressure. This configuration often leads to pressure control problems, as the hot vapor bypass and vent gas valves will have different control characteristics. Also, it is unlikely that one valve will close precisely at the same time the other valve opens. If the column is constantly making a transition between using the hot vapor bypass and vent gas valves, the pressure will normally oscillate. This is a tuning problem rather than a valve problem, but it should be kept in mind for column design or valve resizing.

Stabilizer Vent Gas Valve Specification (#13)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
			Class 300	V300

Process Impact

- Controls the back pressure to the distillation column and is very important in controlling the stability of the tower. Many columns use tray temperature to control overhead composition; therefore, stable pressure is required to ensure temperature changes reflect composition changes not pressure changes.

Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

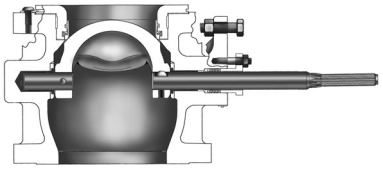
- Consider use of special materials on valves in an acid gas environment.

Stabilizer Light-Ends Valve Function (#14)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

The overhead product valve is typically used to control the level in the overhead receiver. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Stabilizer Light-Ends Valve Specification #14

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

Chapter 10

Fluid Catalytic Cracking Unit

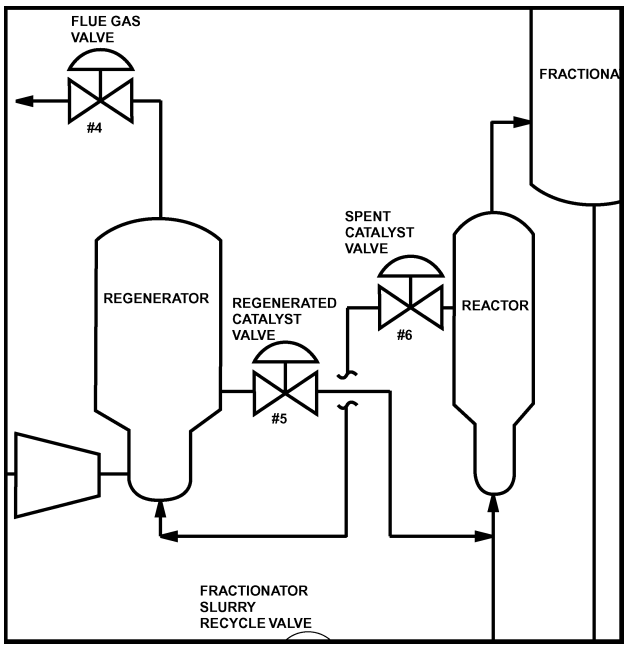
Other Names

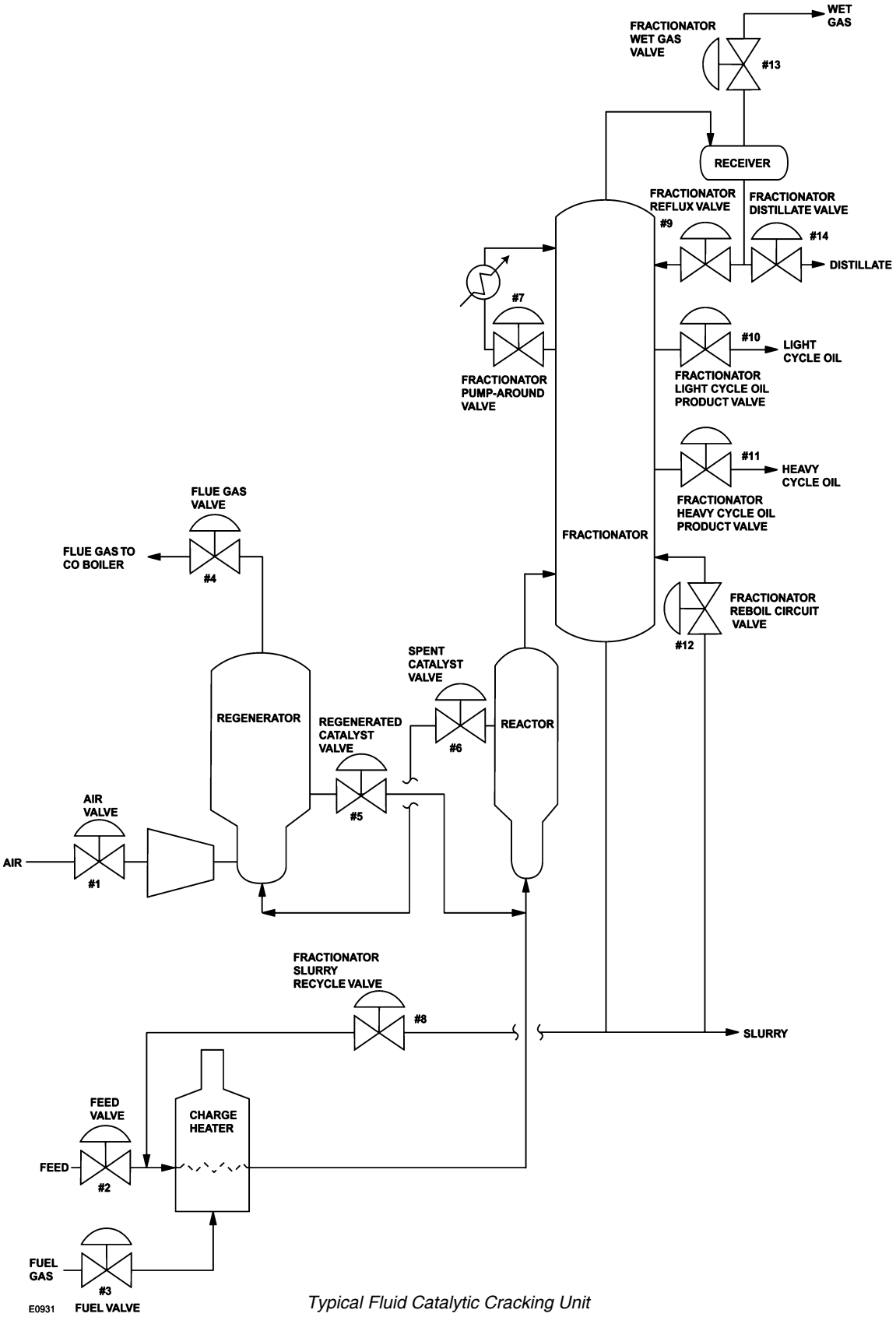
FCC, “cat cracker,” fluid unit

Description

The FCC (fluid catalytic cracking) process cracks heavy feedstocks such as gas oils, vacuum gas oils, and resid material into gasoline, light fuel oils, and light ends. The cracked components are produced by selective reactions in a fluidized catalyst bed in the presence of heat.

The incoming feed is heated in a furnace to the reaction temperature. The feed enters a vertical reactor where it contacts hot catalyst powder. The feed vaporizes and cracks as it moves up the reactor, carrying catalyst with it. Coke is formed on the catalyst as the reactions take place. The catalyst and the cracked material are separated. The spent catalyst is sent to a regenerator where it is regenerated by burning off the coke. The regenerated coke is recycled to the reactor. The cracked material continues on to a fractionating tower, where it is separated into wet gas, distillate, LCO (light cycle oil), HCO (heavy cycle oil), and slurry. The wet gas continues on to a gas plant. The distillate cut might be suitable for use as a gasoline blend component.





Typical Fluid Catalytic Cracking Unit

Control Valves

Air Valve Function (#1)

W5811

POSI-SEAL® *Valve*

W8192

Vee-Ball® *Valve*

W8299

edisc® *Valve*

Air flow is critical for operating the catalyst regenerator. Because the regenerator process is the combustion of coke on the spent catalyst, changes in air flow can have a significant effect on the regenerator temperature. Catalyst that is not regenerated properly will have an effect on the conversion in the reactor.

A valve failure on the air flow will shut down the regenerator. If not corrected quickly, the rest of the FCC will need to be shut down as well.

Air Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Air	1.7 to 3.4 bar (25 to 50 psig)	Ambient

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A

Process Impact

- Very critical to catalyst regeneration

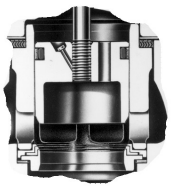
Special Considerations

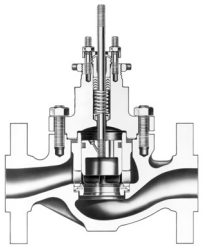
- None

Feed Valve Function (#2)


W8119


W2966


W3162


W3162

***easy-e®** Valve*

A problem valve in this service can cause swings in the amount of conversion through the unit. If the swings are wide enough, this can lead to increased coke laydown on the catalyst. This will increase the regenerator load, potentially limiting the unit throughput.

Feed valves are usually set up as flow control loops. They are configured to fail open so that a valve failure protects the furnace radiant section tubes. If a radiant tube loses or has insufficient flow, the tube can quickly become so hot that the metal can melt. This can have disastrous consequences as most process feeds make excellent fuels. A furnace can be destroyed very quickly if a ruptured tube is dumping into the firebox of the furnace.

Problem valves can lead to difficulties in controlling the outlet temperature of the furnaces. Also, many process feeds slowly build layers of coke on the inside of the radiant tubes. Coking is a non-linear reaction, and in some processes even a few extra degrees of temperature can lead to excessive coke build-up. If a flow valve is alternately provided too much and then too little flow, the temperature will also swing and will usually lead to excessive coke buildup. This will shorten the furnace cycle time between decoking procedures, which normally will require the process unit downstream to shut down.

Feed valves can easily be bypassed when necessary. A combination of the measured flow and any available pass temperatures can be used to regulate the bypass valve.

Feed Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Heavier gas and oil Naphtha	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED

Process Impact

- Control is critical to maintaining integrity of internal furnace tubes, such as preventing coke lay-down.

- Valve performance is critical to overall reliability of furnace.

- Critical to furnace safety; process fluid flow is required at all times through the tubes while the furnace is firing.

Special Considerations

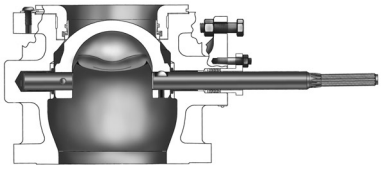
- Sour feed stocks could require NACE trim materials

Fuel Valve Function (#3)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

Depending on the furnace service and configuration this valve will normally be part of a loop that controls either the fuel flow or pressure. It is specified as fail closed so that a control loop failure will not allow an excessive amount of fuel to be dumped into a hot furnace. A fuel valve failure will almost always shut down the processing unit downstream. Although many fuel valves have bypass circuits, refinery operations personnel are usually reluctant to run a furnace on bypass for any significant time because of safety concerns.

The preferred control loop configuration for the outlet temperature is a cascade to the setpoint of the loop controlling the fuel valve. Many furnaces will be set up such that the temperature control loop directly manipulates the fuel valve. This direct connection usually provides inferior control performance to a cascade configuration. It is extremely susceptible to any valve dead band such as that caused by a sticking valve. This can be detected by excessive oscillation in the outlet temperature.

When the fuel valve is manipulated by the temperature loop or by a flow control loop, there will often be a pressure control valve upstream of the fuel valve. This valve will also fail closed and will have the same consequences as a failure of the fuel valve. However, with this configuration, refinery operations personnel will be more willing to run a fuel valve in bypass as they still have a way to quickly shut off the fuel in an emergency.

Fuel Valve Specification (#3)

Process Media

Media	Pressure Range	Pressure Range
Natural gas-fuel gas mixture Fuel oil with atomizing steam	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced,cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Performance is critical to controlling furnace temperature
- Performance is critical to reducing energy costs associated with furnace operation

Special Considerations

- Potential for acidic fouling gases (for example, H_2S, HCL)

Flue Gas Valve Function (#4)

POSI-SEAL® *Valve*

A problem valve in this service will swing the regenerator pressure as well as the feed to the CO boiler. If pressure swings are severe, it can cause problems with regenerator operation.

If the regenerator is designed such that complete combustion is achieved in the regenerator, a CO boiler will not be included as part of the unit and the flue gas will be released to the atmosphere.

Flue Gas Valve Specification (#4)

Process Media

Media	Pressure Range	Temperature Range
Air, CO, CO_2	1.7 bar (25 psig)	538 to 760°C (1000 to 1400°F)

Valve Types

High-performance butterfly valves	**POSI-SEAL**® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A

Process Impact

- Critical to controlling the differential pressure between the reactor and the regenerator

Special Considerations

- Hot process fluid

Regenerated Catalyst Valve Function (#5)

These valves are extremely critical to the operation of a FCC. These are typically slide valves that can be controlled very tightly. The reactor temperature is used to control these valves. The most common valve problems are hysteresis or sticking. Either problem will make it difficult to control the reactor temperature and subsequently the cracking conversion and coke rate. A valve failure will shut down the FCC unit.

Regenerated Catalyst Valve Specification (#5)

Special knife gate valves are normally used. Fisher Controls does not offer a valve of this type.

Spent Catalyst Valve Function (#6)

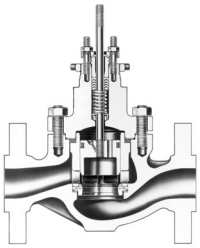
Like the regenerated catalyst valve, this is also a slide valve. Although not as immediately critical as the fresh catalyst valve, a valve failure will shut down the FCC unit.

Spent Catalyst Valve Specification (#6)

Special knife gate valves are normally used. Fisher Controls does not offer a valve of this type.

Fractionator Pump-Around Valve Function (#7)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

A fractionator will always have at least one pump-around heat exchanger loop to control the heat balance. Most fractionators will have more than one pump-around loop. The pump-around loop is used to extract heat from the column, creating the separation between the product draws immediately above and below the pump-around loop. The pump-around valves are usually flow controllers.

A poorly performing or bypassed pump-around valve will increase the variability in the quality specifications of the product draws. A valve failure will most likely create an upset lasting from 30 minutes to a few hours, depending on the severity of the failure.

Fractionator Pump-around Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Hydrocarbon liquid	Dependent on distillation column pressure	Dependent on where steam is taken from the column, 93 to 316°C (200 to 600°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Critical to maintaining heat balance around the column

Special Considerations

- Typically none: dependent distillation unit and process
- NACE materials

Fractionator Slurry Recycle Valve Function (#8)

***Vee-Ball®** Valve*

***eplug®** Valve*

Design 461 Valve

This valve might not be used on some FCC units. If it is not used, then all of the bottoms will become a clarified oil product.

The bottom material becomes the vacuum distillation unit charge.

The bottoms flow does not usually have any impact on the operation of the crude fractionator unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit would allow the operator to catch this before it causes an upset.

Although this service is similar to any other fractionator bottom valve, there is a specific potential problem for this valve. If the separation of the catalyst from the reactor effluent is not complete, then this line will have catalyst fines in it. If enough fines are present in the slurry oil, then plugging of the valve becomes likely.

Fractionator Slurry Recycle Valve Specification (#8)

Process Media

Media	Pressure Range	Temperature Range
Heavy, bottom of the barrel oil slurry-greater than a 538°C (1000°F) boiling point material	3.4 bar (50 psig)	538°C (1000°F)

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500
Self-cleaning angle valve		Increased outlet size	461

Process Impact

- Not Critical

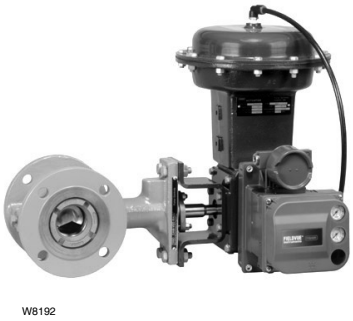
Special Considerations

- Very erosive, corrosive, viscous process conditions
- Could have concentrated amounts of catalyst fines
- Temperatures are very high

Fractionator Reflux Valve Function (#9)

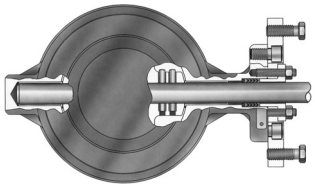
W2777

Design EW Valve



W8192

Vee-Ball*® *Valve



W6234

edisc*® *Valve

The reflux valve is used to control the separation between the top product (usually naphtha) and the highest side-draw product. The reflux valve can be either a flow or a temperature controller.

A poorly performing or bypassed reflux valve will increase the variability in the quality specifications of the overhead product and the top side draw. A valve failure will most likely create an upset lasting from 30 minutes to a few hours depending on the severity of the failure.

Fractionator Reflux Valve Specification (#9)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

Special Considerations

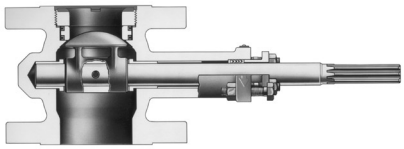
- Typically None

Fractionator LCO (Light Cycle Oil) Product Valve Function (#10)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

The stripper bottoms valves are used to control the bottoms level in the strippers. These valves do not usually have any impact on the operation of the strippers unless a failure causes the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Fractionator LCO (Light Cycle Oil) Product Valve Specification (#10)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

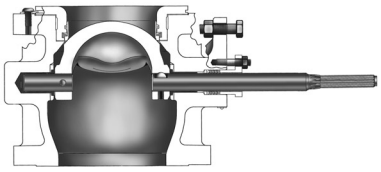
Special Considerations

- Could encounter higher viscosity materials, sludge, and process media with entrained particles
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Fractionator HCO (Heavy Cycle Oil) Product Valve Function (#11)

W8192

***Vee-Ball®** Valve*



W7435

W5791

***eplug®** Valve*

The stripper products are kerosene and diesel.

The stripper bottoms valves are used to control the bottoms level in the strippers. Typically, these valves do not have any impact on the operation of the strippers unless a failure caused the liquid level of the bottoms to overfill or empty. Usually, level alarms on the unit allow the operator to catch this before it causes an upset.

Fractionator HCO (Heavy Cycle Oil) Product Valve Specification (#11)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination.

Special Considerations

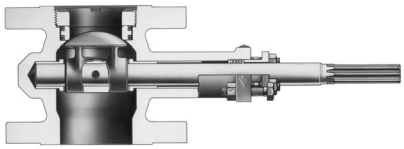
- Could encounter higher viscosity materials, sludge and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Fractionator Reboil Circuit Valve Function (#12)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

This valve is shown to represent the reboil circuit on the bottom of the fractionator (details of the reboiler are not provided in the FCC process diagram.)

Like the slurry reflux valve (#8), this valve might have problems caused by catalyst fines in the slurry oil.

Fractionator Reboil Circuit Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

Special Considerations

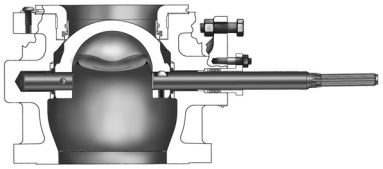
- Could encounter higher viscosity materials, sludge and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Fractionator Wet Gas Valve Function (#13)


W8119

***easy-e®** Valve*


W8192


W7435

***Vee-Ball®** Valve*

About 9 MBPD of wet gas is produced. The value of the wet gas is about $8 to $10/BBL.

The overhead pressure control valve releases gases including H_2, H_2S, methane, ethane, propane and butane. This stream is typically very small (1 to 3 % of feed).

The column pressure has a significant effect on fractionator operation. A valve failure that allows the column to over or under pressure can cause an upset that might take hours of recovery time. A problem valve can create pressure oscillations that prevent the fractionator from being operated optimally. Valve sizing is critical for this service. If the valve is too large, the column pressure is prone to rapid swings. If the valve is too small and the valve has a large response time, it could cause long, slow swings.

Fractionator Wet Gas Valve Specification (#13)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Controls the pressure to the distillation column and is very important in controlling the stability of the tower. Many columns use tray temperature to control overhead composition, therefore stable pressure is required to ensure temperature changes reflect composition changes, not pressure changes.

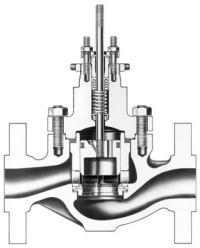
Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

- Consider using special materials if there is an acid gas environment.

Fractionator Distillate Valve Function (#14)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

This valve is usually on level control from the overhead receiver and typically does not impact the operation of the crude fractionator unless a failure causes the liquid level in the overhead receiver to over fill or empty. In either case, the column pressure would be affected, and the fractionator would experience an upset until the pressure became stable again. Usually, level alarms on the unit allow the operator to catch this before it became an upset.

It is more likely that a poorly performing product valve could cause stability problems to a downstream processing unit in configurations where there is no surge tank between the units.

Fractionator Distillate Valve Specification (#14)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

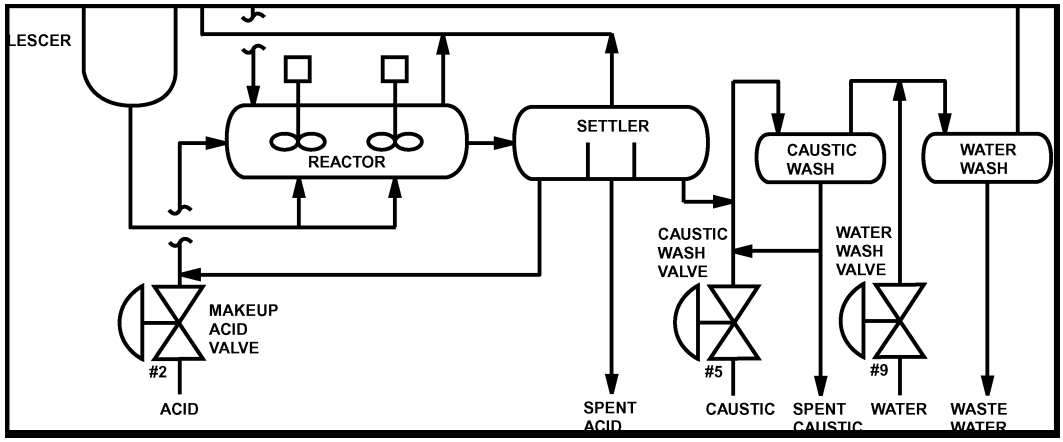
- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

Chapter 11

Alkylation Unit



Other Names

Alky

Description

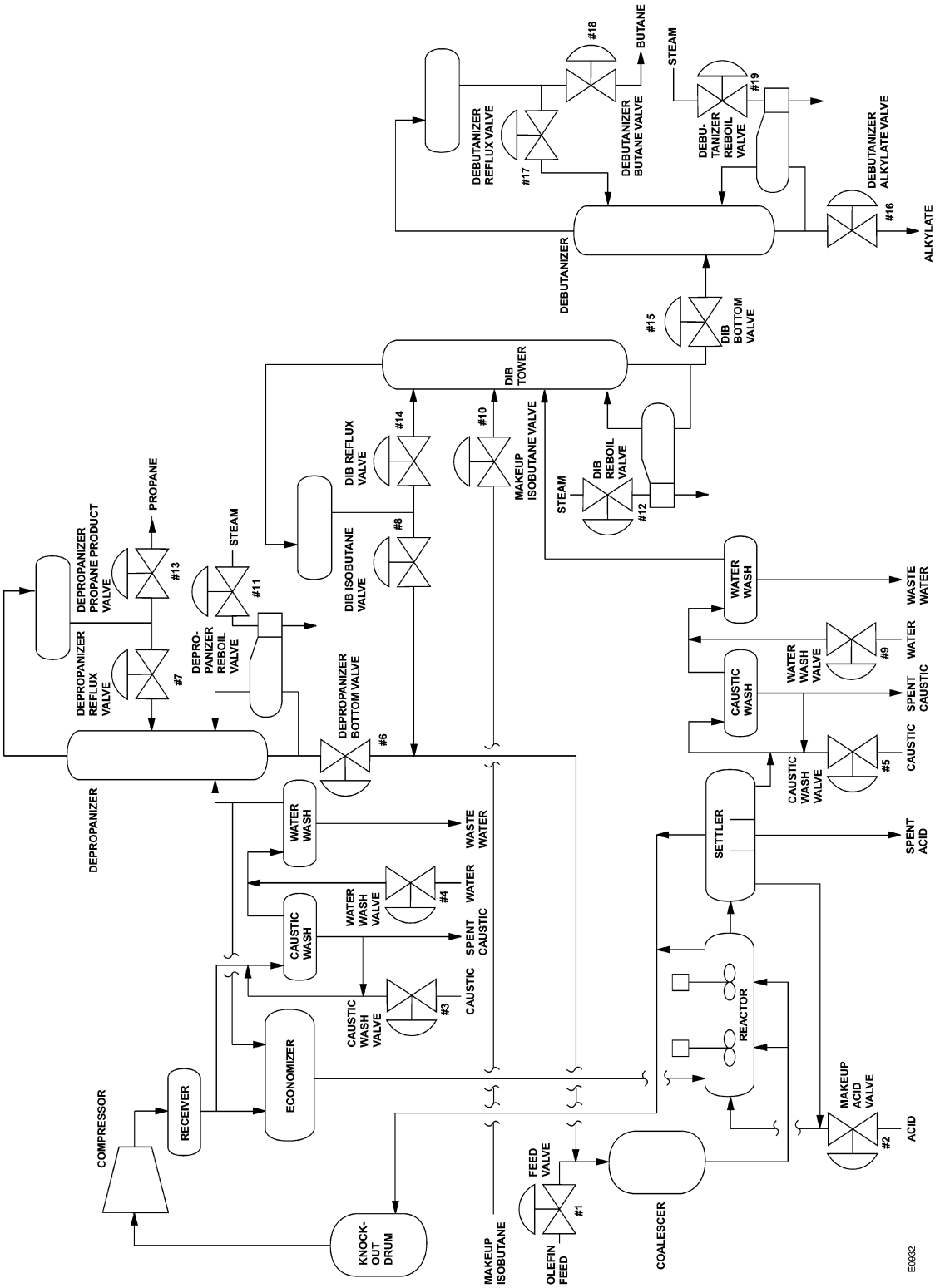
The alkylation unit is used to convert light olefins, usually propylene or butylene, produced by a FCC or delayed coker unit into a gasoline blending component called alkylate. Alkylate is one of the more valuable blending components for gasoline because it has a high octane rating coupled with a low Reid vapor pressure.

The light olefin feed to an alkylation unit is mixed with recycled isobutane from the DIB (deisobutanizer) tower overhead and is cooled before entering the reactor. The isobutane-olefin mixture, along with sulfuric acid and refrigerant, is sent to the stirred reactor. In the presence of the acid, the olefins and isobutane react, forming the alkylate compounds and generating heat.

There are several systems for removing the heat. The process illustrated uses an auto-refrigeration system where some of the isobutane is vaporized to provide cooling. The vapors are routed through a compression section and are condensed before being returned to the reactor.

Any propane that is produced in the reactor is concentrated in the refrigeration system and, after caustic and water washes, is sent to a depropanizer. The depropanizer overhead is a propane product, and the bottom stream is returned to the process.

The reactor effluent is sent to a settler where acid is removed from the hydrocarbon. The acid is recycled to the reactor. The hydrocarbon continues through caustic and water washes before entering the DIB tower. Any makeup isobutane is generally added as feed to the DIB tower. The DIB overhead stream is mostly isobutane and is returned to the reactor. The DIB bottom stream becomes the feed to the debutanizer. The debutanizer overhead is a butane product stream. The debutanizer bottom stream is the alkylate product for gasoline blending.



Typical Alkylation Unit

Control Valves

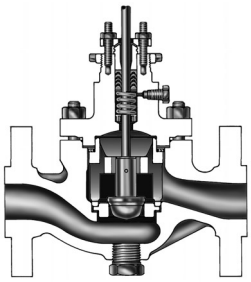
It is important to keep in mind that Alloy 20 is a predominate valve trim material used in a sulfuric acid alkylation unit depending upon the process media. Also, Monel (high-nickel alloy) is a predominate valve trim material used in an HF (hydrofluoric) acid alkylation unit depending on the process media.

Please refer to Fisher PS Sheet 59.1:041(A) for HF alkylation valve specifications on hydrofluoric acid service.

Note that some applications might not be suitable for cage-guided valves. Refer to the refinery's accepted valve specification for a given application.

Feed Valve Function (#1)

W8119



W7027

W2966

easy-e® *Design EZ Valve*

This is an important valve, as the amount of flow and composition of this stream establish the isobutane and acid makeup requirements. Therefore, it is desirable to have this flow and composition as steady as possible. Extremely erratic valve movement such as sticking could make the reactor conversion cycle. However, because the reactor is continuously mixed, the effect of any small swings in flow will probably go unnoticed.

Feed Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Olefin feed (C3 and C4) from the FCC and the gas plant	13.8 to 24.1 (200 to 350 psig)	38 to 66°C (100 to 150°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ

Process Impact

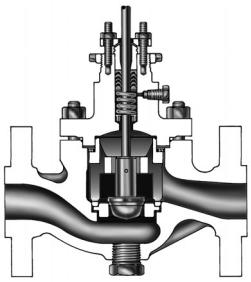
- Avoid high valve friction. To maintain proper olefin-to-acid ratio, it is important to avoid creating large process swings.

Special Considerations

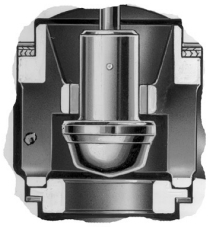
- None

Makeup Acid Valve Function (#2)

W8119



W7027



W2966

***easy-e®** Design EZ Valve*

The acid strength effects the octane rating of the alkylate as well as the likelihood of an acid runaway reaction. Increasing the recycle acid strength will increase octane, but it also increases operating costs. Lowering the acid strength will increase the chance of a runaway reaction. However, as long as this valve is not swinging wildly, the effect on the reactor conversion will be slow to appear as this is a makeup flow and is mixed with the recycled acid before going to the reactor.

Makeup Acid Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Concentrated acid	13.8 to 20.7 bar (200 to 300 psig)	38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ

Process Impact

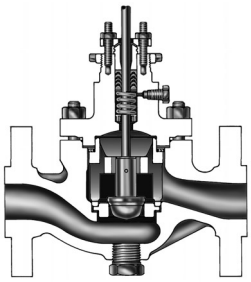
- It is important that the valve maintain good control so that acid runaway reaction is minimized This is where the octane is boosted. Too much acid can increase operating costs.

Special Considerations

- Ensure that the valve materials are compatible with process media.

Caustic Wash Valve Function (#3, #5)

W8119



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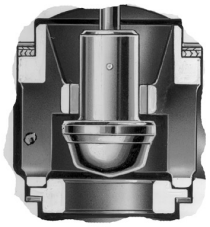


W2966

***easy-e®** Design EZ Valve*

These valves are typically not adjusted very often. All that is required is that enough caustic is being delivered to neutralize the leftover acidic material.

Caustic Wash Valve Specification (#3, #5)

Process Media

Media	Pressure Range	Temperature Range
Caustic flow media (typically sodium hydroxide, NaOH)	6.9 to 10.3 bar (100 to 150 psig)	16 to 52°C (60 to 125°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ

Process Impact

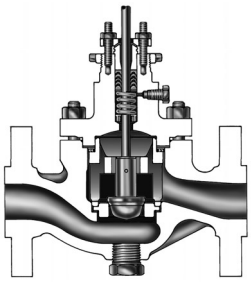
- Important for neutralizing acid and keeping corrosion to a minimum downstream

Special Considerations

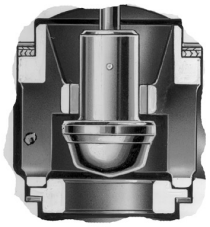
- Ensure that the valve materials are compatible with process media.

Water Wash Valve Function (#4, #9)

W8119



W7027



W2966

easy-e® *Design EZ Valve*

These valves are similar to the caustic valves in that they are not adjusted very often and only need to have enough flow to neutralize any remaining acidic components.

Water Wash Valve Specification (#4, #9)

Process Media

Media	Pressure Range	Temperature
Naphtha	6.9 to 10.3 bar (100 to 150 psig)	38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ

Process Impact

- Important to further neutralize acids in the product stream and reduce fowling downstream caused by salts.

Special Considerations

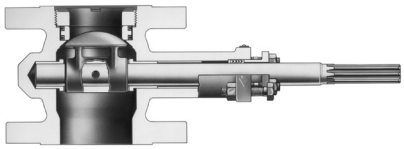
- Ensure valve material is compatible with process media.

Depropanizer Bottom Valve Function (#6)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

This is one of the more important valves in the alky unit. This stream is recycled as part of the isobutane feed to the reactor and has an effect on the reactor conversion.

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Depropanizer Bottom Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

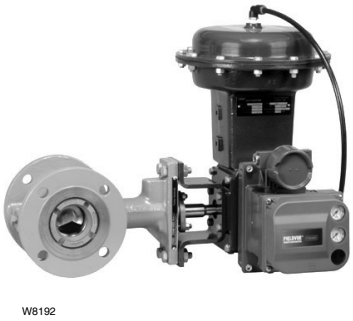
Special Considerations

- Could encounter higher viscosity materials, sludge and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line size applications could use globe valves

Depropanizer Reflux Valve Function (#7)

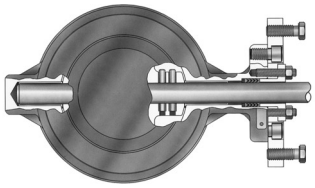
W2777

Design EW Valve



W8192

Vee-Ball*® *Valve



W6234

edisc*® *Valve

The reflux valve is typically either a flow or column temperature-control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and will eventually flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate, and the column will be difficult to control.

Depropanizer Reflux Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High- performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

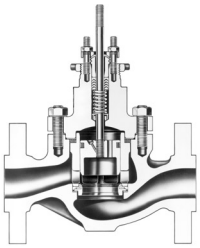
- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

Special Considerations

- Typically none

DIB Isobutane Valve Function (#8)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

This is one of the more important valves in the alky unit. This stream is recycled as part of the isobutane feed to the reactor and has an effect on the reactor conversion.

This valve is typically used to control the level in the overhead receiver. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

DIB Isobutane Valve Specification (#8)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

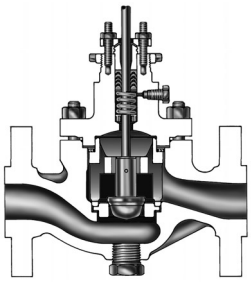
- Typically no critical impact
- Dependent on downstream destination

Special Considerations

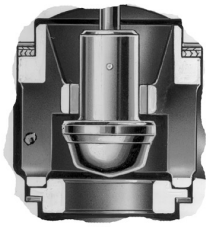
- None

Makeup Isobutane Valve Function (#10)

W8119



W7027



W2966

easy-e® *Design EZ Valve*

The Alkylation unit requires approximately 16 MBPD of isobutane to react with the 10 MBPD of olefin feed. The isobutane feed to the reactor is a combination of makeup and recycle isobutane recovered in the DIB and depropanizer towers. The makeup isobutane is usually added to the DIB tower and sent with the recycle material to the feed coalescer.

Makeup Isobutane Valve Specification (#10)

Process Media

Media	Pressure Range	Temperature Range
Isobutane gas	13.8 to 20.7 (200 to 300 psig)	16 to 66°C (60 to 150°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ

Process Impact

- Important to maintaining isobutane to olefin ratio

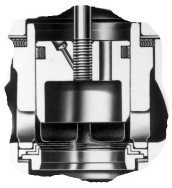
Special Considerations

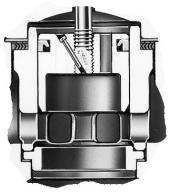
- None

Depropanizer Reboil Valve Function (#11)


W8119


W2966


W3162


W0451

***easy-e®** Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. Steam valves are usually very reliable. The service is very clean, and fugitive emissions are not a concern. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher temperature process streams are used to provide heat for lower temperature processes. In these cases, the reboil valve will foul more easily and might have fugitive emissions concerns.

Depropanizer Reboil Valve Specification (#11)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor though the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

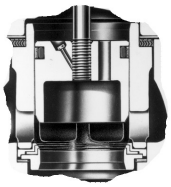
Special Considerations

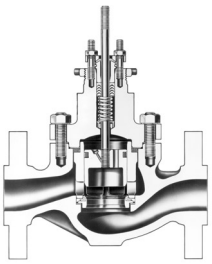
- Consideration of materials for steam application

DIB Reboil Valve Function (#12)


W8119


W2966


W3162


W3162

easy-e® *Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. Steam valves are usually very reliable. The service is very clean, and fugitive emissions are not a concern. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher temperature process streams are used to provide heat for lower temperature processes. In these cases, the reboil valve will foul more easily and may have fugitive emissions concerns.

DIB Reboil Valve Specification (#12)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important in that it drives the vapor back up through the column. This affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

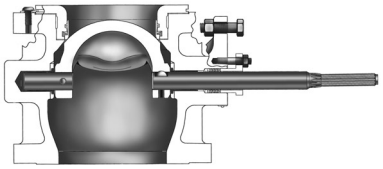
- Consideration of materials for steam application.

Depropanizer Propane Product Valve (#13)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

The overhead product valve typically is used to control the level in the overhead receiver. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Depropanizer Propane Product Valve Specification (#13)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

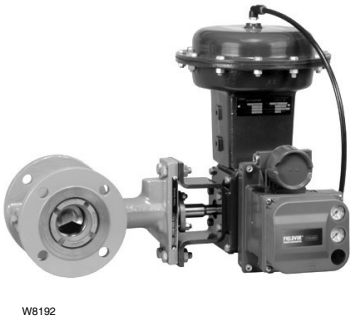
- Typically no critical impact
- Dependent on downstream destination

Special Considerations

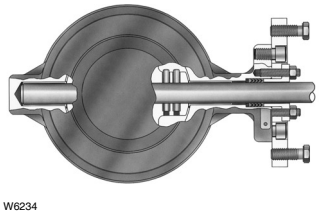
- None

DIB Reflux Valve Function (#14)

Design EW Valve



Vee-Ball*® *Valve



edisc*® *Valve

The reflux valve is typically either a flow or column temperature-control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and will eventually flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate, and the column will be difficult to control.

DIB Reflux Valve Specification (#14)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

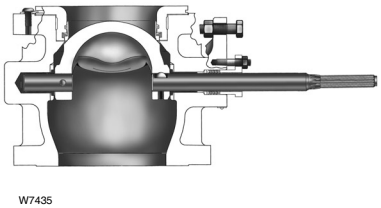
Special Considerations

- Typically none

DIB Bottom Valve Function (#15)


W8192

***Vee-Ball®** Valve*


W7435


W5791

***eplug®** Valve*

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Unstable feed flow will make the distillation column difficult to control. A problem valve will often cause the feed flow to oscillate. As a result, the column will alternate between too little and too much reboil heat. Depending on the size and number of trays in the column, the effect of a swing in the feed will take anywhere from several minutes to more than an hour to reach the ends of the column. Sometimes, the reboil and reflux controls will amplify the swings. The final result is that meeting product purity targets becomes more difficult. Refinery operations personnel will normally respond by over-purifying the products and wasting energy to compensate for the bad feed control valve.

DIB Bottom Valve Specification (#15)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, ~~high-rangeability~~ V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary- plug valves	**eplug®** valves	High capacity, rugged	CV500
		More rugged construction	V500

Process Impact

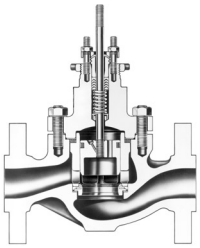
- Dependent on downstream destination.

Special Considerations

- Could encounter higher viscosity materials, sludge, and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves

Debutanizer Alkylate Valve Function (#16)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

The bottom product valve is typically used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Debutanizer Alkylate Valve Specification (#16)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

Special Considerations

- None

Debutanizer Reflux Valve Function (#17)

W5811

POSI-SEAL® *Valve*

W8192

Vee-Ball® *Valve*

W8299

edisc® *Valve*

The reflux valve is typically either a flow or column temperature control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate will also require more reboil heat and will eventually flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate and the column will be difficult to control.

Debutanizer Reflux Valve Specification (#17)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

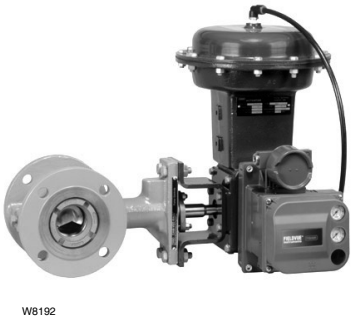
- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

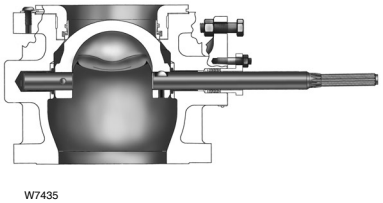
Special Considerations

- Typically none

Debutanizer Butane Valve Function (#18)

***easy-e®** Valve*





***Vee-Ball®** Valve*

This valve valve is typically used to control the level in the overhead receiver. Much of the butane is recycled back as feed. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Debutanizer Butane Valve Specification (#18)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Heavy-duty, general- purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Typically no critical impact
- Dependent on downstream destination

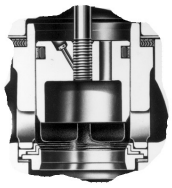
Special Considerations

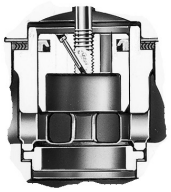
- None

Debutanizer Reboil Valve Function (#19)


W8119


W2966


W3162


W0451

easy-e® *Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. Steam valves are usually very reliable. The service is very clean, and fugitive emissions are not a concern. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher-temperature process streams are use to provide heat for lower-temperature processes. In these cases, the reboil valve will foul more easily and might have fugitive emissions concerns.

Debutanizer Reboil Valve Specification (#19)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the column affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

- Consideration of materials for steam application

Chapter 12

Amine Unit

Other Names

Amine contactor, amine scrubber

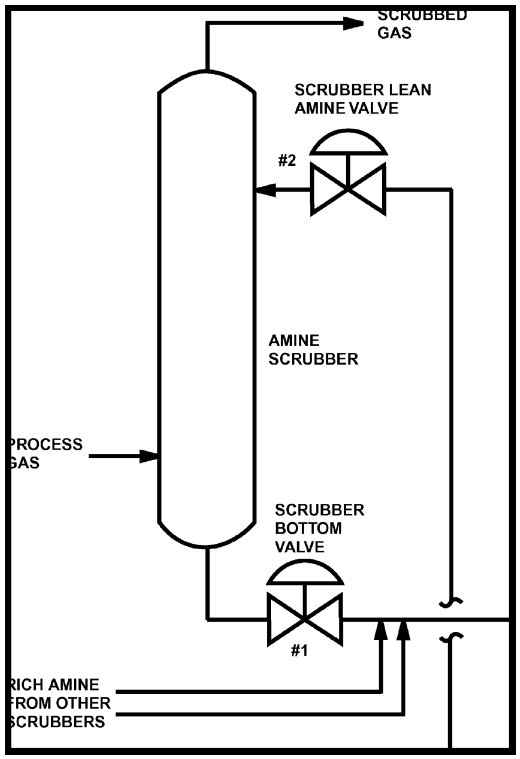
Description

Amine units are used to clean up the various sour light-gas streams created by the refinery cracking and treating units. The objective of an amine unit is to strip hydrogen sulfide (H_2S), sulfur dioxide (SO_2), and other environmental poisons from sour light gas streams. This prepares the light gas streams to be used in other processing units, to be sold as products, or to be burned as fuel gas.

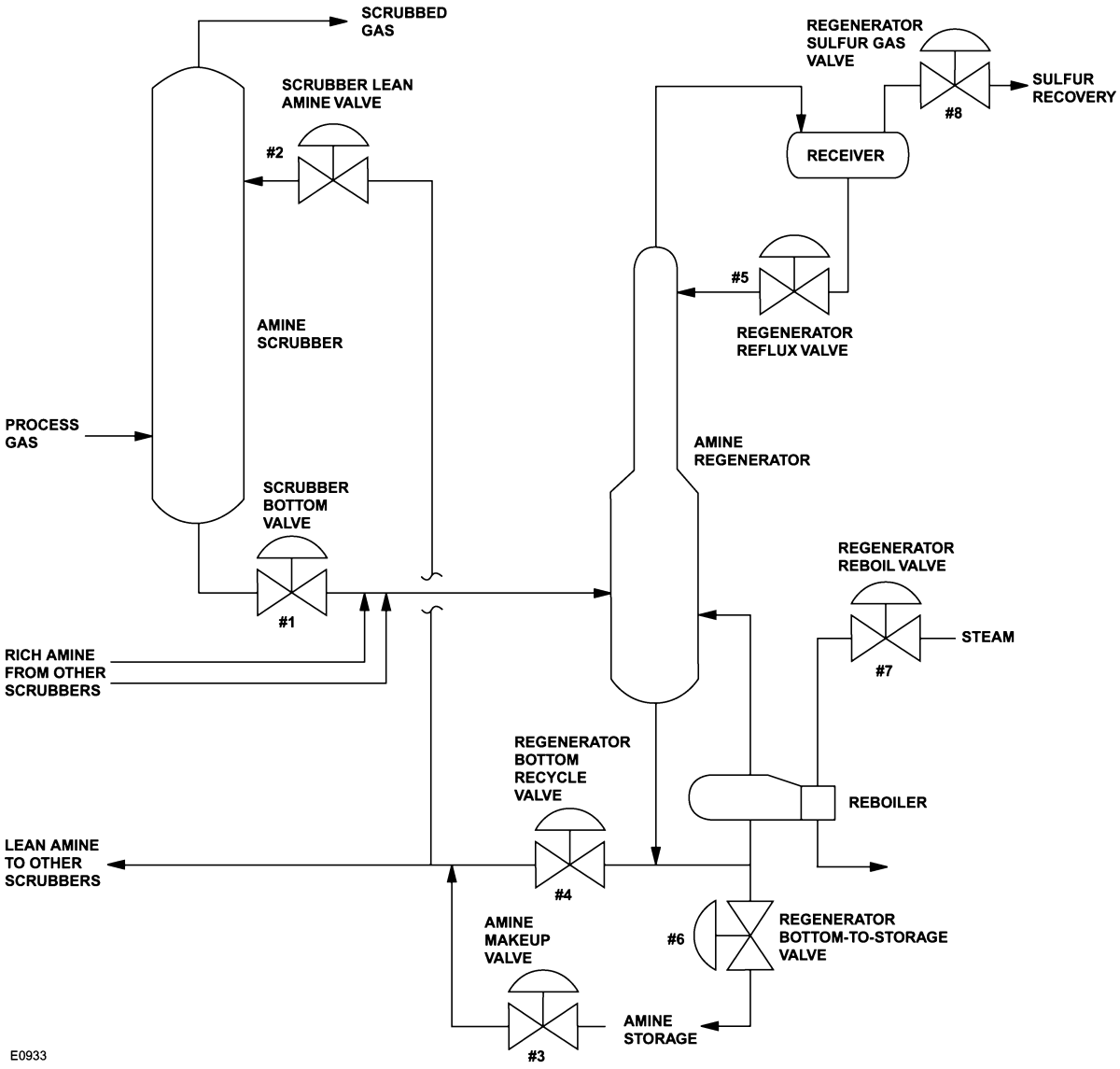
An amine unit, in its simplest form, refers to a single amine scrubber and an amine regenerator. This is the unit used for illustration in this document. However, usually several amine scrubbers will be serviced by a single amine regenerator.

The term “amine unit” can be misleading. Rarely is amine treating considered to be a standalone unit in a refinery. In many cases each processing unit will have a small amine scrubber located within its unit boundaries or will share a scrubber with a few other units. Several of these scrubbers will receive and return amine to a central regenerator located within one of the units.

The amine process begins with sour gas entering the bottom of an amine scrubber and then rising towards the top of the scrubber. Lean amine is added at the top of the scrubber and flows down to the bottom. As the lean amine drops to the bottom, it strips H_2S and SO_2 from the sour gas, becoming rich amine. The scrubbed gas exits the top of the scrubber and is ready for further use.



The rich amine leaves the bottom of the scrubber and becomes the feed to the amine regenerator. The amine regenerator is a distillation column where the sulfur gases leave at the top of the column and lean amine leaves the bottom. The sulfur gases are sent to a sulfur recovery unit. The lean amine is either recycled to the scrubbers or sent to storage. The amine gradually degrades and periodically needs to be freshened with new amine.

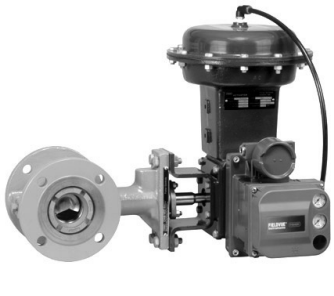


Typical Amine Unit

Control Valves

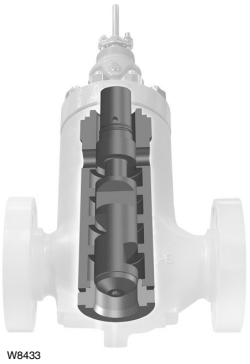
Scrubber Bottom Valve Function (#1)

easy-e *Valve*



Vee-Ball *Valve*

DST



DST (Dirty Service Trim) and Valve with NotchFlo ™ DST Trim

The scrubber bottoms flow becomes one of several feeds to the regenerator. This valve is usually used to control the level in the bottom of the scrubber. The valve is generally not a problem unless a total failure causes the scrubber to have a high or low bottom level.

Scrubber Bottom Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Diethanolamine (DEA or other chemical solvent) with entrained sour gases (H_2S, CO_2, SOx)	10.3 to 172 bar (150 to 2500 psig)	16 to 52°C (60 to 125°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	DST (dirty-service trim), NotchFlo™ DST trim, **Whisper**® Trim I or III noise-attunating trim	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED, HPAD
			Balanced with polymer cage-plug seal	ET, HPAT
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves		Class 150	V150
			Class 300	V300

Process Impact

- The only problem that typically is associated with this valve is improper control affecting the amine regenerator's bottom level (too high or too low).

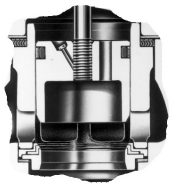
Special Considerations

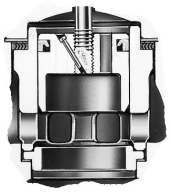
- Ensure valve material is compatible with process media.

Scrubber Lean Amine Valve Function (#2)


W8119


W2966


W3162


W0451

***easy-e®** Valve*

Lean Amine is normally added to the Scrubber to hold an amine/gas ratio. For 25 MMCFD of gas, the normal lean amine rate would be 200 to 300 GPM. A scrubber is much like a distillation column. Too much vapor or liquid traffic can cause the scrubber to flood. When this happens, the sulfur compounds are no longer completely stripped from the sour gas. If a scrubber is being operated close to loading constraints, and the lean amine valve is sticking badly, then this could cause the scrubber to flood.

Scrubber Lean Amine Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Regenerated diethanolamine (or other chemical solvent)	13.8 to 20.7 bar (200 to 300 psig)	38 to 93°C (100 to 200°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

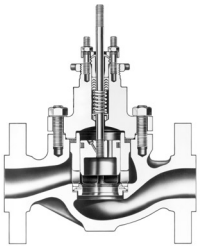
- The valve is important to ensure most complete gas treatment

Special Considerations

- Ensure valve material is compatible with process media.

Amine Makeup Valve Function (#3)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

The amine generally degrades as it is circulated to the scrubbers. Lab tests are run occasionally to check the strength of the amine. When it becomes low, fresh amine is added to the system to restore the circulating amine. This valve is not critical, as the amine system can run for long periods of time without makeup.

Amine makeup is normally around 50 MGPY. Poor operation of the scrubber can easily double or triple the cost of amine to the refinery on an annual basis.

Amine Makeup Valve Specification (#3)

Process Media

Media	Pressure Range	Temperature Range
Regenerated diethanolamine (or other chemical solvent)	10.3 to 20.7 bar (150 to 300 psig)	38 to 93°C (100 to 200°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Typically none

Special Considerations

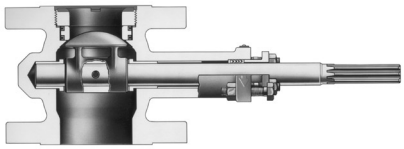
- Ensure valve material is compatible with process media.

Regenerator Bottom Recycle Valve Function (#4)

W8192

***Vee-Ball®** Valve*

W5791



W5793

***eplug®** Valve*

The flow through this valve is used to set the circulating amine rate. This valve might not exist in all configurations since the individual scrubber lean amine valves serve almost the same purpose.

The valve typically is used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Regenerator Bottom Recycle Valve Specification (#4)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

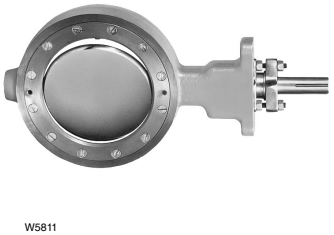
Process Impact

- Dependent on downstream destination

Special Considerations

- Could encounter higher viscosity materials, sludge and process media with entrained particles
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves.

Regenerator Reflux Valve Function (#5)



POSI-SEAL® *Valve*

Design EW Valve

edisc® *Valve*

The reflux valve is typically either a flow or column temperature-control loop. It is used to adjust the purity of the overhead product. The higher the reflux rate, the purer the overhead product will become. However, raising the reflux rate also will require more reboil heat and will eventually flood the tower.

A poorly operating reflux valve will have the same effects as a bad feed valve. Product purities will oscillate, and the column will be difficult to control.

Regenerator Reflux Valve Specification (#5)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11
Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW

Process Impact

- Critical to maintaining vapor/liquid balance in the column, ultimately affecting the efficiency of the column

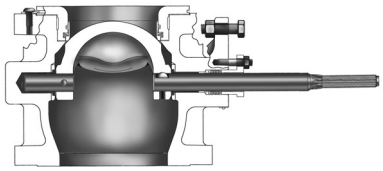
Special Considerations

- Typically none

Regenerator Bottom-to-Storage Valve Function (#6)

W8192

***Vee-Ball®** Valve*



W7435

W5791

***eplug®** Valve*

This valve, along with the amine makeup valve, is used to hold the regenerator bottom level. If a scrubber shuts down, some of the circulating amine will be sent to storage. Also, if fresh amine is being added to the system, the excess amine will be eliminated through this valve.

The valve typically is used to control the level in the bottom of the column. It normally has no effect on column operation unless it causes the level to change quickly and dramatically.

Regenerator Bottom-to-Storage Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300
General- and severe-service eccentric rotary-plug valves	**eplug®** valves	High capacity, rugged construction	CV500
		More rugged construction	V500

Process Impact

- Dependent on downstream destination

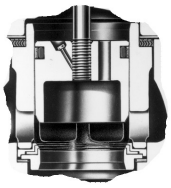
Special Considerations

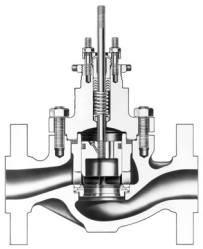
- Could encounter higher viscosity materials, sludge, and process media with entrained particles.
- Ball valves or eccentric plug valves might require Stellite (Alloy 6) or ceramic trim materials.
- Low-flow, clean fluids or small line-size applications could use globe valves.

Regenerator Reboil Valve Function (#7)


W8119


W2966


W3162


W3162

easy-e® *Valve*

The reboil valve controls the amount of heat put into the column by the reboiler. In many cases, steam is used as a heat source. Steam valves are usually very reliable. The service is very clean, and fugitive emissions are not a concern. However, a problem valve will make the column difficult to control precisely. This will be especially true if the column feed is subject to frequent changes.

Not all reboilers use steam as a heat source. To save energy, many refineries have integrated their units so that higher-temperature process streams are use to provide heat for lower-temperature processes. In these cases, the reboil valve will foul more easily and might create fugitive emissions concerns.

Regenerator Reboil Valve Specification (#7)

Process Media

Media	Pressure Range	Temperature Range
Steam	Dependent on process design, typically 10.3 bar (150 psig) saturated steam	Dependent on material being distilled

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET

Process Impact

- This valve is important because it drives the vapor back up through the column. Vapor through the colum affects column efficiency. Reboiler steam will have a direct effect on overhead reflux flow.

Special Considerations

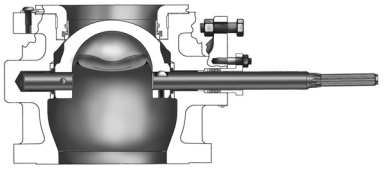
- Consideration of materials for steam application

Regenerator Sulfur Gas Valve Function (#8)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

Typical throughput rate for a 900 GPM regenerator is 150 MMCFD of gas to the sulfur recovery unit.

The pressure control valves are used to control the column pressure. Higher column pressures will yield better product purities, but require more energy to operate. Normal operating procedure is to minimize the pressure to lower energy costs while maintaining product specifications. There is a low limit because lower pressures reduce the amount of vapor/liquid traffic the column can handle and can make it more likely to flood.

The simplest way to control pressure is to continuously vent gas from the system. Sizing of the vent valve is critical. If it is too large, a small valve movement will cause a large pressure swing. If the valve is too small, the pressure response will be very sluggish. It is likely that a valve that is too small will operate from completely closed to completely open. In either scenario, an oscillating column pressure and difficult column control are the result. A sticking pressure control valve will present the same problem. A sticking valve is a common concern on vent gas valves because the valve packing will normally be tight to prevent fugitive emissions.

Many distillation columns also use what is known as a “hot vapor bypass” valve to control pressure. In this case, some of the hot overhead vapors are bypassed around the overhead condenser heat exchanger. The amount of bypass will control the pressure. This eliminates the constant venting of process gas, which usually goes to a low-value refinery waste fuel gas system. Unfortunately, the pressure response on a hot vapor bypass valve is normally very sluggish due to slow process response time. Like the vent gas valve, this valve is a concern for fugitive emissions, and the packing is likely to be tight. A sticking valve will cause wide, slow oscillations in column pressure. The product purities will likewise swing widely and slowly. The response of refinery operations personnel will usually be to over-purify.

A majority of columns with hot-vapor bypass valves will use them in combination with a vent gas valve. In these cases, a single pressure control loop will manipulate both valves. At lower pressures, the hot vapor bypass valve is used. As the pressure rises, there will be a transition point where the hot vapor bypass valve closes fully and the vent gas valve starts to open. At high pressures, the vent gas valve controls the pressure. This configuration often leads to pressure control problems, as the hot vapor bypass and vent gas valves will have different control characteristics. Also, it is unlikely that one valve will close precisely at the same time the other valve opens. If the column is constantly making a transition between using the hot vapor bypass and vent gas valves, the pressure will normally oscillate. This is a tuning problem rather than a valve problem, but it should be kept in mind for column design or valve resizing.

Regenerator Sulfur Gas Valve Specification (#8)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy duty, general- purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High- capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
			Class 300	V300

Process Impact

- Controls the back pressure to the distillation column and is very important in controlling the stability of the tower. Since many columns use tray temperature to control overhead composition, stable pressure is required to ensure that temperature changes reflect composition changes, not pressure changes.

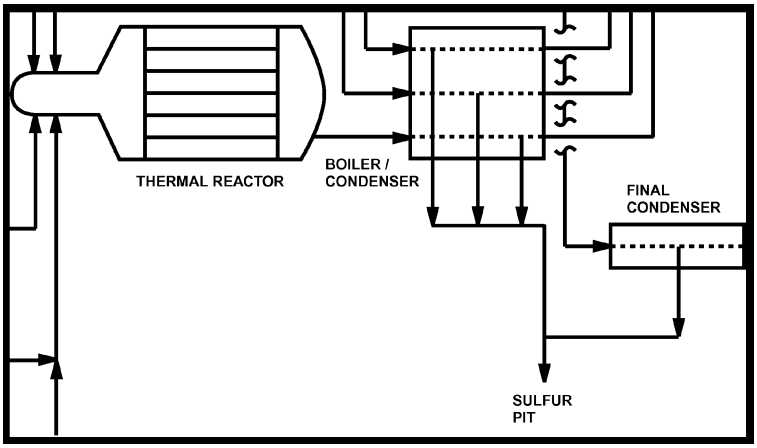
Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

- Consider use of special materials if the valve is in an acid gas environment.

Chapter 13

Sulfur Recovery Unit



Other Names

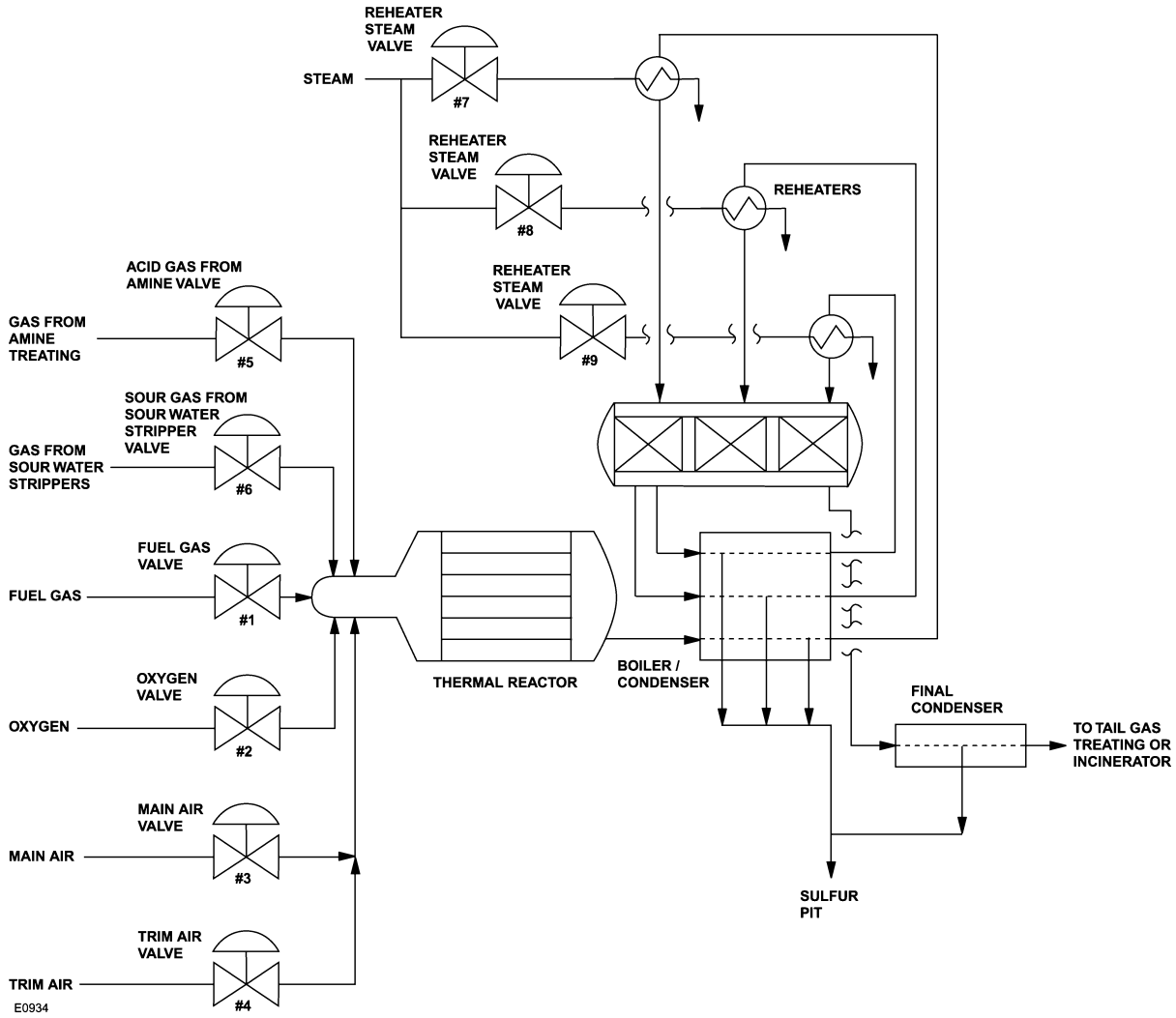
SRU, Claus unit

Description

The crude oil processed by refineries contains varying amounts of sulfur. The sulfur is removed during processing, mostly as hydrogen sulfide (H_2S). Environmental regulations restrict the amount of H_2S and other sulfur compounds that can be released to the environment. The SRU (sulfur recovery unit) is used to convert H_2S to elemental sulfur through a series of reactors. The unit illustrated is a common method known as the Claus process.

The feed sources for a SRU are acid gases from the amine treaters and sour gas from the sour water strippers. The acid and sour gases are burned in a reaction furnace in the presence of enough air and /or oxygen to combust approximately one third of the incoming H_2S plus any remaining hydrocarbons and ammonia. The combustion products are cooled in the waste heater boiler / thermal sulfur condenser. After the thermal reaction and condensation, there are three catalytic reactor stages. Each reactor stage consists of a reheater, catalytic converter, and condenser. The elemental sulfur recovered from each condenser is run down into a sulfur pit. The final tail gas stream can be sent to an incinerator or, depending on local environmental regulations, a tail gas treating unit.

The SRU is usually viewed by refinery operations personnel as an “overhead” or utility unit. However, because of the environmental regulations, this unit is extremely important to total refinery production. Most refineries have multiple SRUs so that a shutdown does not stop the entire refinery. If an SRU does shut down, the refinery almost immediately has to back off on production so as to keep from producing more acid gas than can be processed by the remaining SRUs. Also, the SRU capacity in many refineries dictates what types and how much high sulfur crudes can be processed. A small incremental gain in capacity for these refiners can yield significant profit.

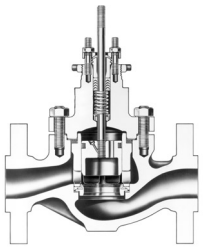


Typical Sulfur Recovery Unit

Control Valves

Fuel Gas Valve Function (#1)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

This valve is typically used only during startup. It may be necessary to use fuel gas when there are significant amounts of ammonia in the sour gas or significant amounts of hydrocarbons from either gas source.

Fuel Gas Valve Specification (#1)

Process Media

Media	Pressure Range	Temperature Range
Fuel gas	6.9 bar (100 psig)	38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Impacts temperature of thermal reactor

Special Considerations

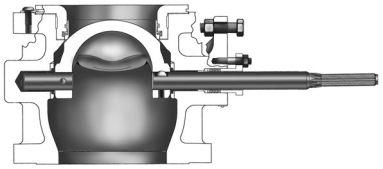
- None

Oxygen Valve Function (#2)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

This is an optional process stream for an SRU, and typically this valve is not present. It is sometimes used to boost the capacity of an SRU when another SRU is down.

Oxygen Valve Specification (#2)

Process Media

Media	Pressure Range	Temperature Range
Oxygen	6.9 bar (100 psig)	38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Only used if SRU requires additional capacity or throughput

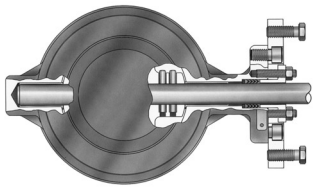
Special Considerations

- Ensure that the valve materials are compatible with oxygen service.

Main Air Valve Function (#3)

W5811

POSI-SEAL® *Valve*



W6234

W8299

edisc® *Valve*

The main air valve sets a bulk air flow rate to the thermal reactor. It is only adjusted to keep the trim air valve in the middle of its control range. Many units use butterfly valves in this service because of low C_V requirements, making flow control difficult at best.

Main Air Valve Specification (#3)

Process Media

Media	Pressure Range	Temperature Range
Air	6.9 bar (100 psig)	38°C (100°F)

Valve Types

High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11

Process Impact

- Sets the bulk rate of flow to the thermal reactor

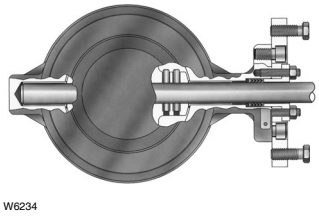
Special Considerations

- None

Trim Air Valve Function (#4)

Design EW Valve

***Vee-Ball**® Valve*



***edisc**® Valve*

This valve is typically tied to a tail gas analyzer and is used to set the total air flow rate precisely to the thermal reactor. The valve also receives feedforward inputs on the sour gas and acid gas flow rates. Many units use butterfly valves in this service because of low C_V requirements, making flow control difficult at best. It is recommended that an alternative type of valve be used.

Trim Air Valve Specification (#4)

Process Media

Media	Pressure Range	Temperature Range
Air	6.9 bar (100 psig)	38°C (100°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e**® valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
		Larger sizes; expanded ends; balanced or unbalanced	EW
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball**® valves	Class 150	V150
		Class 300	V300
High-performance butterfly valves	**edisc**® valves	Through 12 inches	8560
		Through 24 inches	8532
	POSI-SEAL® valves	Class 150, 300 through 12 inches	A41
		Larger sizes	A31A
		High pressure	A11

Process Impact

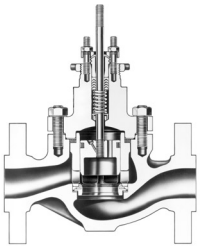
- Important to total air flow rate to the thermal reactor

Special Considerations

- None

Acid Gas from Amine Valve Function (#5)

W8119



W3162

***easy-e®** Valve*

W8192

***Vee-Ball®** Valve*

These valves belong to the various amine contactors located throughout the refinery. The SRU normally has no direct control on the amount of acid gas coming to the SRU.

Acid Gas from Amine Valve Specification (#5)

Process Media

Media	Pressure Range	Temperature Range
Sour waste gas	Dependent on process design	Dependent on process design

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Important for fueling the reaction in the thermal reactor

Special Considerations

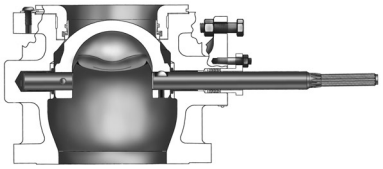
- Be sure that valve materials are compatible with process media.

Sour Gas from SWS Valve Function (#6)

W8119

***easy-e®** Valve*

W8192



W7435

***Vee-Ball®** Valve*

These valves belong to the various sour water strippers located throughout the refinery. The SRU normally has no direct control on the amount of sour gas coming to the SRU.

Sour Gas from SWS Valve Specification (#6)

Process Media

Media	Pressure Range	Temperature Range
Dependent on distillation process	Dependent on process design	Dependent on material being distilled

Valve Types

Lower flow rates (line size 4 inches and smaller)	Heavy duty, general- purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
			Balanced with graphite cage-plug seal	ED
			Balanced with polymer cage-plug seal	ET
Higher flow rates (line size 6 inches and larger)	High- capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
			Class 300	V300

Process Impact

- Controls the back pressure to the distillation column and is very important in controlling the stability of the tower. Since many columns use tray temperature to control overhead composition, stable pressure is required to ensure that temperature changes reflect composition changes, not pressure changes.

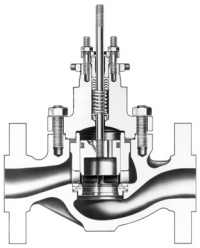
Special Considerations

- Packing on these valves is important to reduce fugitive emissions.

- May consider use of special materials on valves that encounter an acid gas environment.

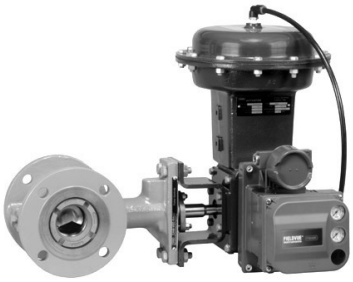
Reheater Steam Valve Function (#7, #8, #9)

W8119



W3162

***easy-e®** Valve*



W8192

***Vee-Ball®** Valve*

These valves are used to control the reaction temperature to the Claus reactors. If valve performance is erratic, it can result in swings in the sulfur conversion, possibly causing an environmental excursion or putting more load on the tail gas treater.

Reheater Steam Valve Specification (#7, #8, #9)

Process Media

Media	Pressure	Temperature Range
Steam	20.7 bar (300 psig)	149 to 204°C (300 to 400°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Important in maintaining process temperatures for Claus reactors

Special Considerations

- None

Chapter 14

Blending Unit

Other Names

Blender

Description

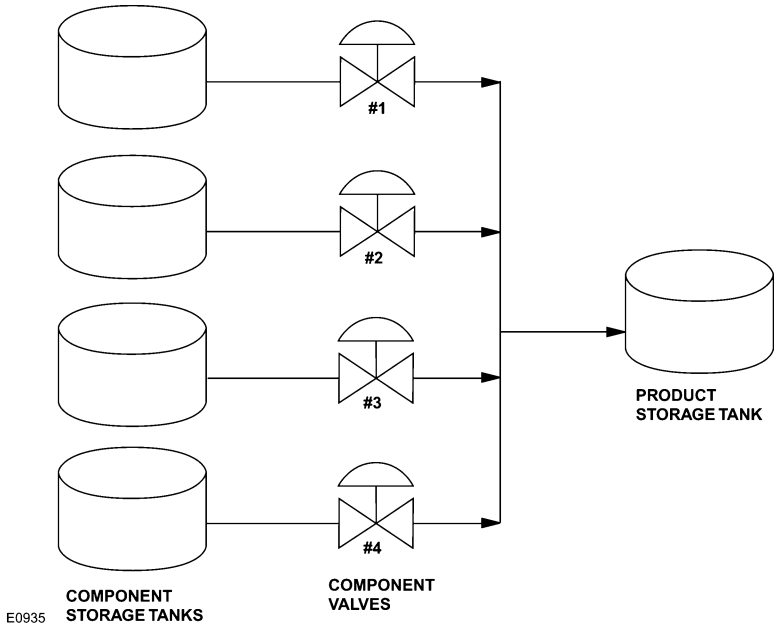
A blending unit creates a finished refinery product stream. The most common type is a gasoline blender. However, blenders are also used for other products, such as diesel or jet fuel.

A gasoline blender can create several different products from the same available components. For example, most refineries produce three octane grades of unleaded gasoline. There are different specifications on gasoline vapor pressure depending on whether it is summer or winter. Also, different regional environmental requirements exist depending on where the gasoline is to be marketed. Each of these considerations require a different mix of the gasoline components produced by the refinery.

For a given gasoline product there will be a calculated recipe for how much of each component should go into the product tank. The flow controller from each component tank will be set accordingly.

Note that the most frequent problems encountered within blenders are not usually caused by control valves. Inaccurate lab or on-line analyzer results or biased flow indications pose far greater problems. In addition there are lineup valves used to connect tanks that are either opened or closed. The lineup valves, whether manually or automatically manipulated, have the potential for ruining an entire tank (or tanks) of product if not set to the correct position.

The consequence of poor blending can be severe. Product specification giveaway can easily cost $0.05 to $0.10/BBL of gasoline, or $150M to $300M per year for every 10 MBPD of gasoline produced.

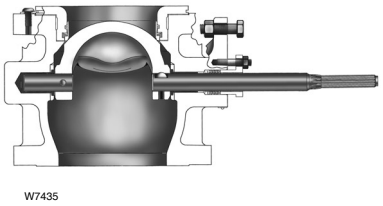


Typical Blending Unit

Control Valves

Component Valve Function (#1, #2, #3, #4)

***easy-e®** Valve*



***Vee-Ball®** Valve*

This example is based on 20 MBPD of gasoline production. These valves are manipulated by flow control loops. The flows are set according to product recipe requirements. Many blenders have sophisticated advanced control algorithms to monitor the flow through these valves.

A sticking valve is usually of no consequence to blending operation as long as the average flow target is met. A stuck valve is a bigger problem if it goes unnoticed and the blend is being done manually.

Once discovered, the control valve can be blocked in and bypassed. However, the amount of flow for that component must be recalculated to make up for the deviation from flow setpoint by the end of the blend for that product tank. Most blend control packages can pick up and correct this particular problem.

Component Valve Specification (#1, #2, #3, #4)

Process Media

Media	Pressure Range	Temperature Range
Various hydrocarbon product streams	13.8 to 24.1 bar (200 to 350 psig)	16 to 52°C (60 to 125°F)

Valve Types

Heavy-duty, general-purpose globe valves	**easy-e®** valves	Unbalanced, cageless	EZ
		Balanced with graphite cage-plug seal	ED
		Balanced with polymer cage-plug seal	ET
High-capacity, high-rangeability V-notch rotary ball valves	**Vee-Ball®** valves	Class 150	V150
		Class 300	V300

Process Impact

- Although problems with valves do not typically affect the blending process as do improperly functioning analyzers, they can have a significant impact on the product spec if the valve problem is not found and corrected within a reasonable time.

Special Considerations

- In selecting a valve, it is probably better to err on the side of better valve performance than on price.

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