Granulation • Faustina
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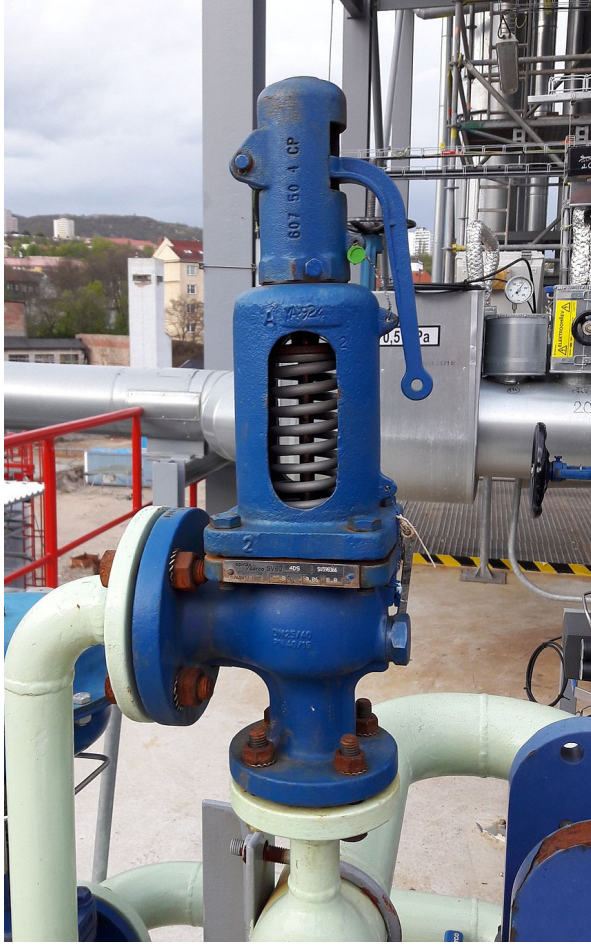
Operating Valves and Pumps **Training Module**



	Training Information
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Before Beginning this Module

Pre-requisites

The mandatory pre-requisite **training modules** for this module are:

- Safety Policies and Procedures
- Environmental Policies and Procedures
- Process Overview Training

Support Materials and Resources

The following table lists the required support materials for this module:

	Material	Links and References
documents	Routine Work PPE Minimum Requirements Matrix	Louisiana PPE Matrix
	Safety Data Sheets (SDSs) for: • Phosphoric Acid • Ammonia • Sulfuric Acid	SiteHawk Login ***Note:*** SDSs are also available at the Faustina Main Lab on a non-networked computer.

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About the Training in this Module

Tools Included in This Module

This module consists of two tools for training new operators:

- the training material
- the On-the-Job Training (OJT) checklists

Both the training material and the OJT checklists cover the same procedures, but in different ways. Compare the two in the table below:

Training Material	OJT Checklists
used in non-field training to teach skills	used in field training to verify skills
takes in-depth look at each action step of a procedure with photos, equipment and process descriptions	only states the action steps of a procedure
action steps grouped into ***stages*** by systems and equipment, making it easy to learn	action steps ordered in the exact ***sequence*** taken during real startups, shutdowns and washes
gives knowledge components that will be used to complete each action step	states knowledge components to be verified during field training

The Training Materials

The trainer and trainee will use the training material during classroom (trainer-guided) sessions.

The training material provides the background knowledge the trainee will use to complete tasks and actions required during the field training sessions.

The OJT Checklists

The trainer and the trainee will use the OJT checklist during the demonstration and skill verification portions of the training.

The checklist identifies all steps the trainee must perform during each procedure, and the success criteria for each.

Knowledge components in the checklist provide reminders and references to information presented in this training module, as well as additional information to be introduced by the trainer during the OJT (such as location of controls).

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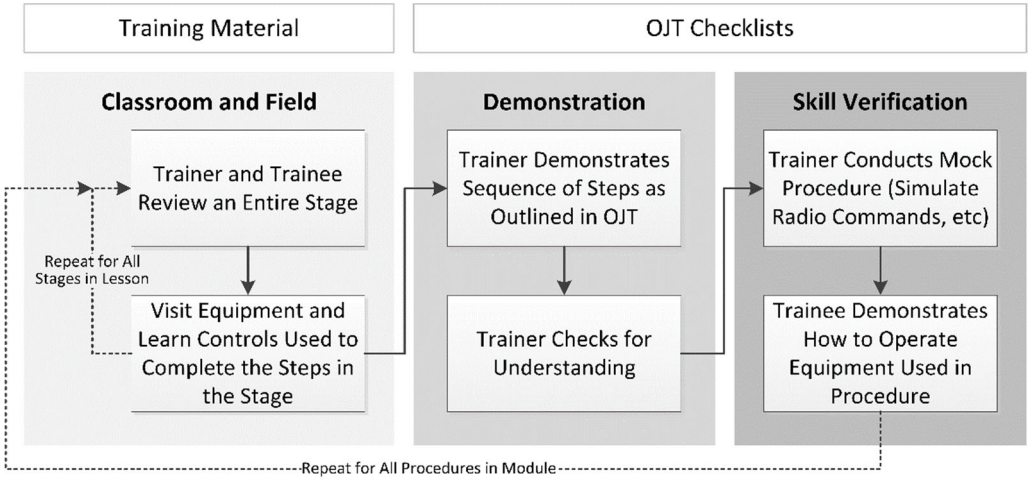
About the Training in this Module, Continued

Suggested Training Sequence

The trainer and the trainee will use the training material and OJT checklists included with this module as follows:



Classroom and Field Training

The steps for each procedure covered in the training material is broken up by ***stages***. This gives the trainer and the trainee natural stopping points to go out in the field and review the equipment and controls used in that stage.

After all stages of a procedure are reviewed, the trainer can then move on to the OJT for that procedure.

Demonstration

The trainer will use the OJT checklist to demonstrate all steps of a procedure in the field. During this time, the trainer will review the location and operation of the valves and equipment used in each step.

The trainer will also allow the trainee the opportunity to perform the tasks (when possible) so they gain some hands-on experience performing the steps.

Skill Verification

During the skill verification, the trainer will conduct a mock procedure (for example, a mock equipment startup). The trainer should simulate the conditions of a real procedure as much as possible, including radio commands.

The OJT Checklist includes specific success criteria to determine when the operator has completed a task, and whether the task was completed correctly.

Continued on next page

About the Training in this Module, Continued

Skill Verification, (continued)

Both the trainer and the trainee must place their initials in the column beside each action in the OJT checklist when:

- the trainee has completed the section of the training material covering that step
- the trainee has demonstrated they are able to independently meet the success criteria for each of the identified actions

⚠ ***Important:*** It is assumed that that the success criteria outlined in the OJT checklists can be met ***every time*** an operator performs the specific task, not just for final demonstration. He or she is not considered a fully-trained granulation operator until such time.

Support after the Training

After a new operator's skills are verified using the OJT checklists, it is important to observe and support the new operator for a minimum of two (2) weeks.

During this time, the trainer and area management should be aware of opportunities for the new operator to practice operating the valves and equipment they learned about in this training.

Example:
If the supervisor knows B-train will be swapping scrubber pumps tomorrow, he should have the new operator there to observe (or even operate) the valves used to line up the pumps, and operate the controls to start / stop the pumps.

Chapter 1

Valves

Practically all non-solid process material in the Granulation area is moved from one piece of equipment to another through pipes.

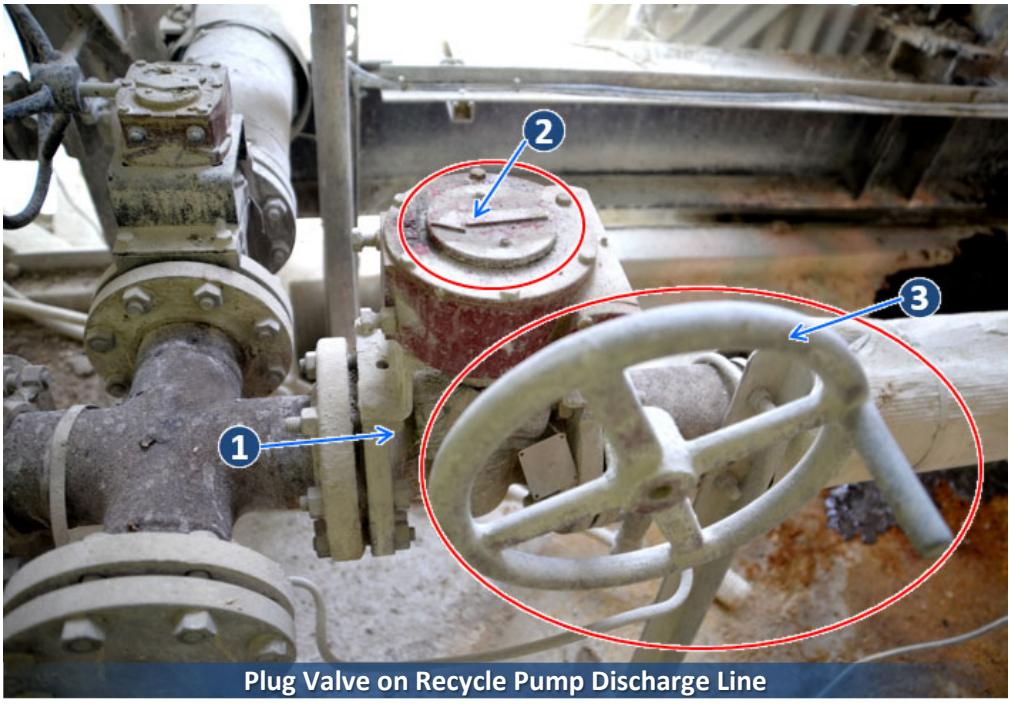
One of your most important jobs as an operator will be to control the movement of this material through the process—restricting direction, changing flow rate, etc.—by manipulating valves in specific ways.

Plug Valve

How to Identify a Plug Valve

Plug valves have a cylindrical or conically-tapered body, and an arrow or diamond-shaped status indicator.

Manual plug valves may have a hand wheel (shown below), or a lever.



Plug Valve on Recycle Pump Discharge Line

1. plug valve body
2. valve position indicator
3. hand wheel

Features of a Plug Valve

- visual indicator of valve status
- easy to operate (quarter-turn)
- self-cleaning action
- no cavities where solids can accumulate

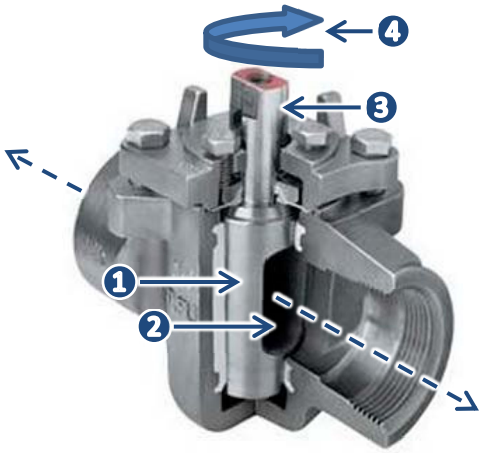
Continued on next page

Plug Valve, Continued

How a Plug Valve Works

A plug valve has a cylindrical or conically-tapered plug (item ❶) with a passageway through it (item ❷).

When the valve stem (item ❸) is rotated one-quarter turn, the plug also turns which enlarges or closes the passageway to allow or restrict the flow of liquids.



Plug Valve Cutaway

❶	plug	❸	valve stem (operating mechanism not shown)
❷	passageway	❹	one-quarter turn to operate

How to Operate a Manual Plug Valve

You will use the valve's lever-type handle or hand wheel to open and close it:

	Hand Wheel Operated	Lever Operated
to open	turn the wheel 90° ***counterclockwise*** until it stops	move the lever so it is ***parallel*** with the piping or valve body
to close	turn the wheel 90° ***clockwise*** until it stops	move the lever so it is ***perpendicular*** to the piping or valve body

How to Verify Valve State

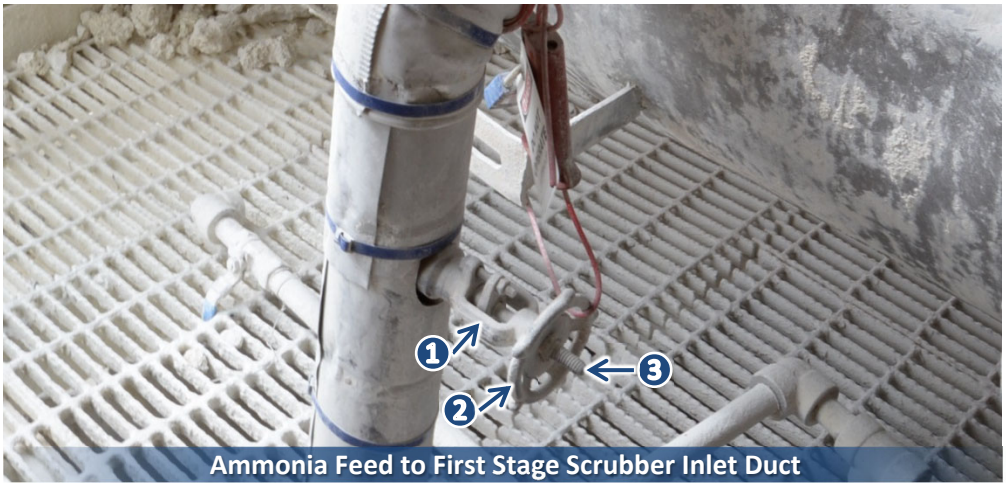
To verify whether a plug valve is opened or closed, you will look at the lever or the position indicator.

The valve is open if…	The valve is closed if…
the lever or position indicator is ***parallel*** to the pipe	the lever or position indicator is ***perpendicular*** to the pipe

Gate Valve

How to Identify a Gate Valve

Gate valves are easily identified by its open-body frame and hand wheel operator with exposed stem.



Ammonia Feed to First Stage Scrubber Inlet Duct

1. open valve body frame
2. hand wheel
3. exposed stem

Features of a Gate Valve

- durable
- minimal maintenance (only lubrication for the packing)
- when fully open, there is no obstruction in the flow path, resulting in very low friction loss

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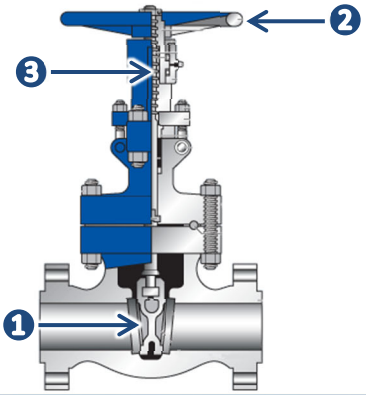
Gate Valve, Continued

How a Gate Valve Works

A gate valve has a wedge-shaped gate (item ❶) which moves up or down. When the hand wheel (item ❷) is turned, a threaded stem (item ❸) raises or lowers the gate to allow or stop the flow of liquids.



Gate Valve Cutaway

❶ wedge-shaped gate
❷ hand wheel
❸ threaded stem

How to Operate a Manual Gate Valve

You will use the valve's hand wheel to open and close it:

	Hand Wheel Operated
to open	turn the wheel ***counterclockwise*** until it stops
to close	turn the wheel ***clockwise*** until it stops

How to Verify Valve State

To verify whether a gate valve is opened or closed, you will look at its exposed, threaded stem.

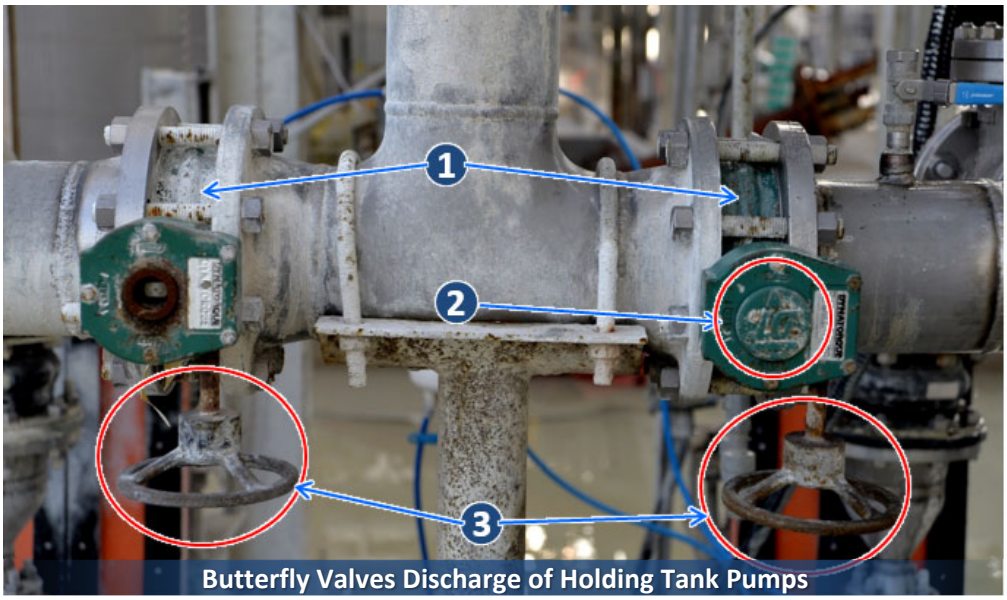
The valve is open if…	The valve is closed if…
the stem is ***raised*** up from the hand wheel	the stem is ***lowered*** all the way down to the hand wheel

Butterfly Valve

How to Identify a Butterfly Valve

Butterfly valves often look like common pipe connectors, except they have a hand wheel or lever, a status indicator, and a thin body which gives it a layered look.

Valves that are out of reach (like those in overhead piping racks) will have a chain hanging down that you will use to operate the hand wheel.



Butterfly Valves Discharge of Holding Tank Pumps

1. butterfly valve bodies
2. position indicator
3. hand wheels

Features of a Butterfly Valve

- easy to operate (quarter-turn)
- less prone to plugging
- easy to repair
- less expensive
- fewer parts than other types of valves

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Butterfly Valve, Continued

How a Butterfly Valve Works

A butterfly valve has a flat disc (item ❶) which is rotated to allow, restrict, or stop the flow of liquid through the piping system.

Butterfly Valve Cutaway

❶ valve disc

❷ hand wheel

How to Operate a Manual Butterfly Valve

You will open and close most butterfly valves by using a chain to operate its wheel, but there may be some butterfly valves with hand wheels or levers.

	Chain Wheel Operated	Hand Wheel Operated	Lever Operated
to open	pull one side of the chain so the wheel turns 90° ***counter-clockwise*** until it stops	turn the wheel 90° ***counterclockwise*** until it stops	move the lever so it is ***parallel*** with the piping or valve body
to close	pull the other side of the chain so the wheel turns 90° ***clockwise*** until it stops	turn the wheel 90° ***clockwise*** until it stops	move the lever so it is ***perpendicular*** to the piping or valve body

How to Verify Valve State

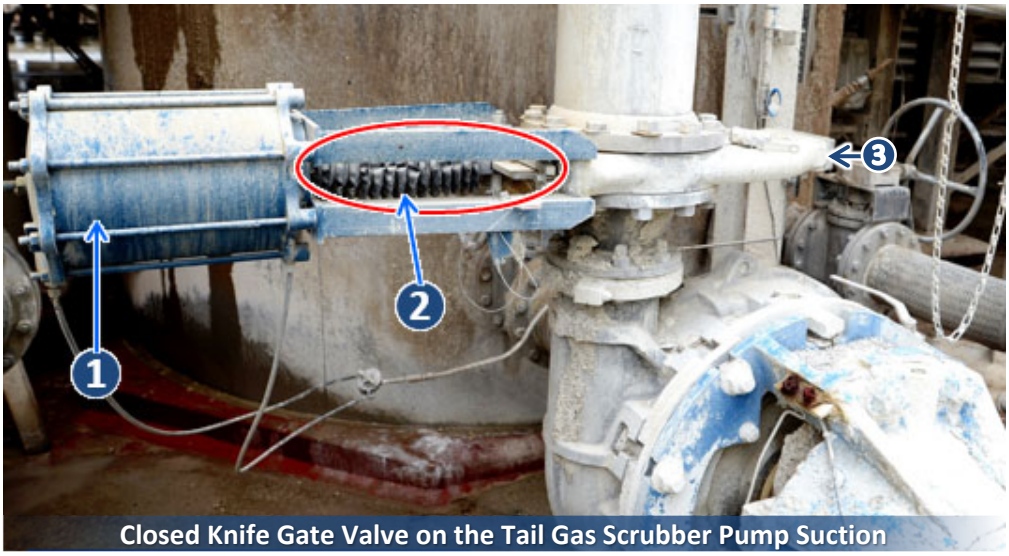
To verify a butterfly valve is opened or closed, you will look at its position indicator.

The valve is open if…	The valve is closed if…
the position indicator is ***parallel*** to the pipe	the position indicator is ***perpendicular*** to the pipe

Knife Gate Valve

How to Identify a Knife Gate Valve

Knife gate valves have a tall open-frame body and a metal knife-like disc that slides up and down inside the frame.



Closed Knife Gate Valve on the Tail Gas Scrubber Pump Suction

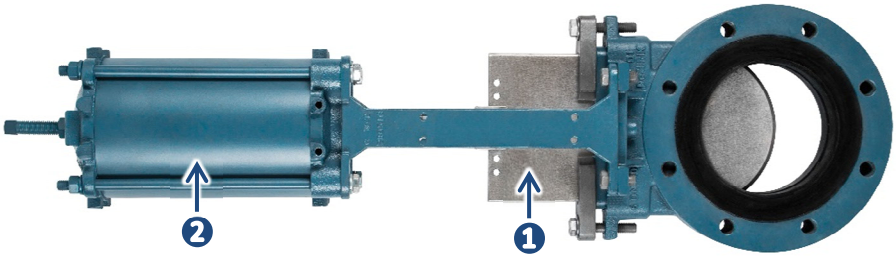
1. air-actuated mechanism
2. open body (shaft protector visible)
3. valve body (knife inside)

Features of a Knife Gate Valve

- bubble-tight shutoff
- secondary seal
- long lasting lubrication
- no seat cavity (no solids buildup)
- no packing, eliminating leakage and maintenance

How a Knife Gate Valve Works

A knife-gate valve has a flat, sharp-edged disc called a knife (item ❶) that moves up and down to allow or stop the flow of liquid through the piping system.



Knife Gate Valve Cutaway

1. knife
2. air-actuated mechanism

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Knife Gate Valve, Continued

How to Operate a Manual Knife Gate Valve

Knife gates do not have handles or wheels, but are operated by an air-actuated mechanism that you will control from a local control box near the valve.

You will use the valve's local controls to open or close it. You can find the correct control knob or lever in a control box somewhere near the valve.

Knife Gate Controls

	Local Control Box
to open	turn the control knob or lever to the open position until the knife valve is fully open
to close	turn the control knob or lever to the closed position until the knife valve is fully closed

Important: A single local control box can contain the controls for several knife gate valves. You will learn the location of these controls later in your training.

How to Verify Valve State

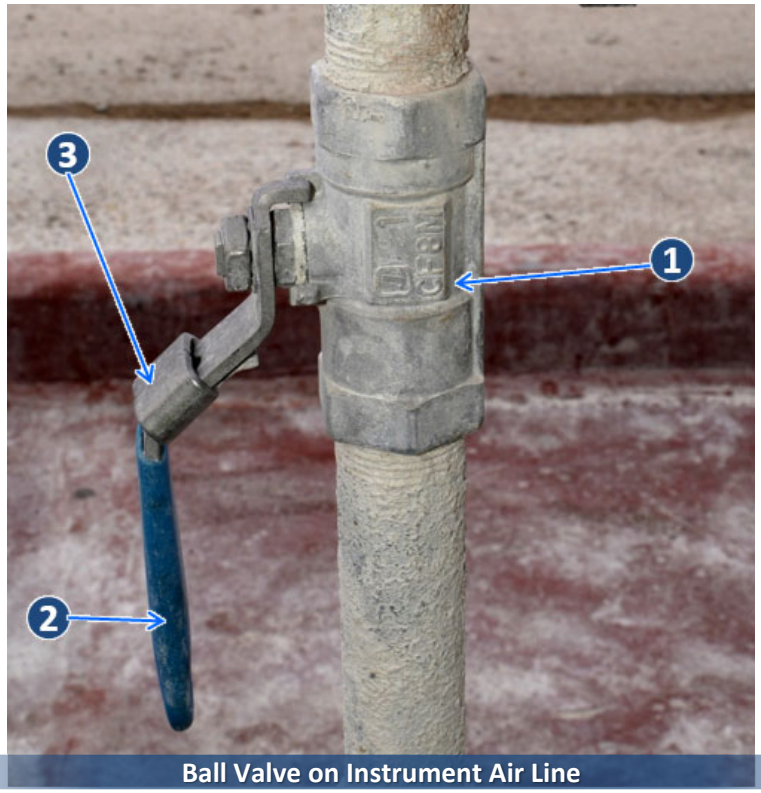
To verify whether a knife gate valve is opened or closed, you will look at the position of the knife.

The valve is open if…	The valve is closed if…
the knife gate is fully visible and ***raised***	when the knife gate is ***lowered*** and fully concealed into the pipe

Ball Valve

How to Identify a Ball Valve

Ball valves are smaller than other valves found in your work area, and have an angled hand lever.



Ball Valve on Instrument Air Line

1. valve body
2. lever handle
3. handle slide fitting

Features of a Ball Valve

- easy to operate (quarter-turn)
- compact and reliable
- compact and reliable

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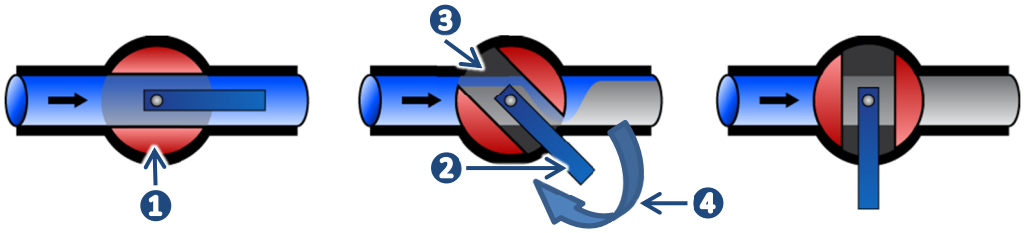
Ball Valve, Continued

How a Ball Valve Works

A ball valve has a spherical-shaped disk called a ball (item ❶), with a passageway through it (item ❸).

When the valve handle (item ❷) is rotated one-quarter turn, the ball pivots, and its passageway aligns with the piping to allow or restrict the flow of liquids.



Opening a Ball Valve

❶	ball	❸	passageway through the ball
❷	lever handle	❹	one-quarter turn to operate

How to Operate a Manual Ball Valve

You will use the valve's angled lever handle to open and close it:

	Lever Operated
to open	move the lever so it is ***parallel*** with the piping or valve body
to close	move the lever so it is ***perpendicular*** to the piping or valve body

How to Verify Valve State

To verify whether a ball valve is opened or closed, you will look at its lever handle.

The valve is open if…	**The valve is closed if…**
the lever indicator is ***parallel*** to the pipe	the lever is ***perpendicular*** to the pipe

ORBIT® Valve

How to Identify an ORBIT® Valve

ORBIT® valves look like gate valves due to its hand wheel operator and exposed stem. However, the body of an ORBIT® valve is usually enclosed, not open like a gate valve.

ORBIT® Valve on Ammonia Feed to Granulator

1. enclosed valve body
2. hand wheel
3. exposed stem

Features of an ORBIT® Valve

- ball core that tilts as it turns to eliminate seal rubbing
- low-torque, friction-free opening and closing
- zero leakage
- single, stationary seat seals in both directions and eliminates trapped pressure between seals
- top-entry design for in-line inspection/repairs

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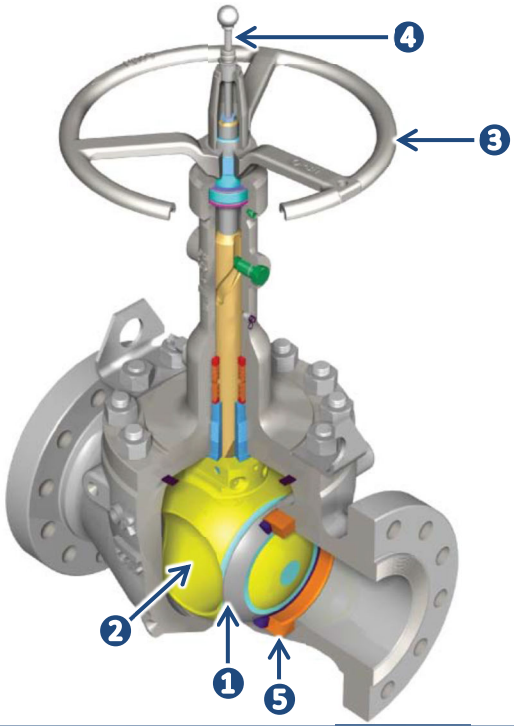
ORBIT® Valve, Continued

How an ORBIT® Valve Works

Like ball valves, ORBIT® valves have a ball-shaped core (item ❶), with a passageway through it (item ❷). When the hand wheel (item ❸) is turned, the ball core tilts and pivots, and its passageway aligns with the piping to allow or restrict the flow of liquids.

When an ORBIT® valve begins to open, the ball core tilts away from the seat (item ❺).

When an ORBIT® valve fully closes, the ball core wedges firmly onto the seat.



Cutaway of Closed ORBIT® Valve

1	ball-shaped core	3	hand wheel	5	seat
2	passageway	4	exposed stem		

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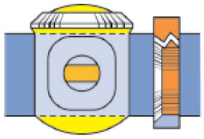
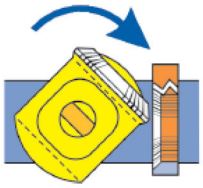
ORBIT® Valve, Continued

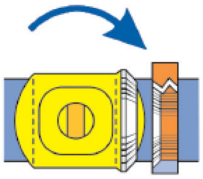
How an ORBIT® Valve Works, (continued)



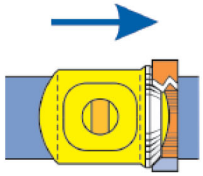
When the valve is open, the passageway through the core allows liquid to flow.



When the valve is closing, the core pivots normally, like a ball valve would.



When the valve is almost closed, the core is in-line with the valve body.



When an orbit valve is fully closed, the core is mechanically wedged against the seat.

How to Operate a Manual ORBIT® Valve

You will use the ORBIT® valve's hand-operated wheel to open and close it:

	Hand Wheel Operated
to open	turn the wheel ***counterclockwise*** until it stops
to close	turn the wheel ***clockwise*** until it stops

How to Verify Valve State

To verify whether an ORBIT® valve is opened or closed, you will look at its exposed stem.

The valve is open if…	The valve is closed if…
the stem is ***raised*** up from the hand wheel	the stem is ***lowered*** all the way down to the hand wheel

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Lesson Review Questions

Instructions Choose the correct answer(s) for the questions that follow.

1 How can you identify a knife gate valve? (select all that apply)

- **A** it has a wedge-shaped gate that moves up and down in its seat
- **B** it has a knife-like disc that swings open and closed inside the valve body
- x **C** it has a tall open-frame body
- x **D** it has a metal knife-like disc that slides up and down inside the frame

2 Which type of valve looks like a ***gate valve*** due to its hand wheel operator and exposed stem, but has a ball-shaped core like a ***ball valve***?

- **A** piston valve
- x **B** ORBIT® valve
- **C** plug valve
- **D** knife gate valve

3 What type of valve has a wedge-shaped gate which moves up or down when the hand wheel is turned?

- **A** butterfly valve
- **B** wedge valve
- **C** knife gate valve
- x **D** gate valve

4 Which of the following is true of butterfly valves (select all that apply)

- x **A** they have a flat disc which is rotated to allow, restrict, or stop the flow of liquid
- **B** they do not require valve position indicators because their handles indicate whether they are open or closed
- x **C** they often look like common pipe connectors, except they have a hand wheel or lever, a status indicator, and a thin body which gives it a layered look
- x **D** they have fewer parts than other types of valves

5 To open a gate valve, you will turn its hand wheel in which direction?

- x **A** counterclockwise
- **B** clockwise

Continued on next page

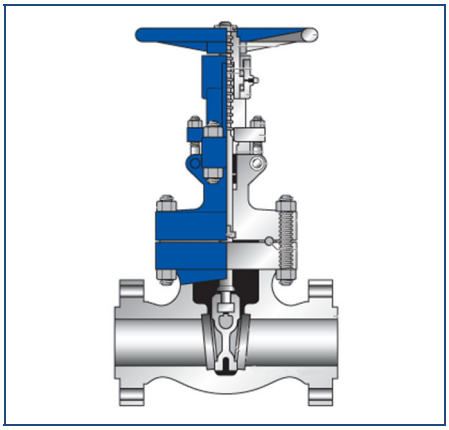
Lesson Review Questions, Continued

6 Which type of valve has a cylindrical or conically-tapered body and an arrow or diamond-shaped status indicator?

- **A** gate valve
- **B** ball valve
- x **C** plug valve
- **D** wedge valve

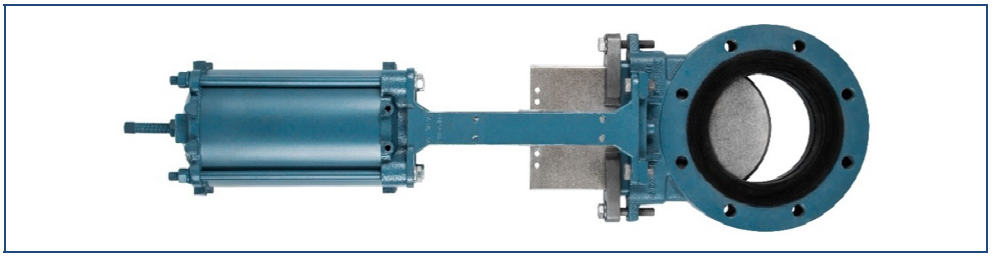
7 Which of the following images shows a gate valve?

x **A**

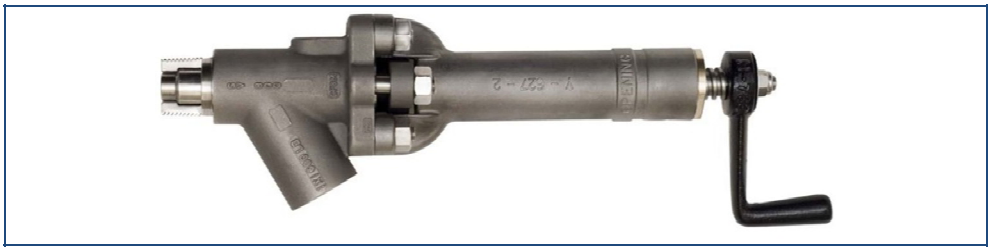


B

C



D



8 **True** or **False?**

Manual plug valves may have a hand wheel to operate it, but never a lever.

- **A** true
- x **B** false

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Lesson Review Questions, Continued

9 Which of the following valves are NOT quarter-turn valves? (select all that apply)

- **A** plug valve
- x **B** gate valve
- x **C** ORBIT® valve
- **D** butterfly valve

10 How can you verify a gate valve is open?

- x **A** the exposed, threaded stem is raised up from the hand wheel
- **B** the exposed, threaded stem is lowered all the way down to the hand wheel
- **C** the hand lever is parallel to the valve body and piping
- **D** the hand lever is perpendicular to the piping

11 Match the valves in the word bank with their identifying characteristics below.

Word Bank:

butterfly valve	gate valve	ball valve
ORBIT® valve	plug valve	knife gate valve

gate valve	easily identified by its open-body frame and hand wheel operator with exposed stem
plug valve	has a cylindrical or conically-tapered body, and an arrow or diamond-shaped status indicator
ORBIT® valve	looks like a gate valve, however, the body is usually enclosed
knife-gate valve	has a tall open-frame body and a metal knife-like disc that slides up and down inside the frame
ball valve	is smaller than other valves found in your work area, and has an angled hand lever
butterfly valve	often looks like common pipe connectors, except they have a hand wheel or lever, a status indicator, and a thin body which gives it a layered look

12 Which type of valve has a ball-shaped disc with a passageway through it?

- x **A** ball valve
- **B** ORBIT® valve
- **C** plug valve
- **D** butterfly valve

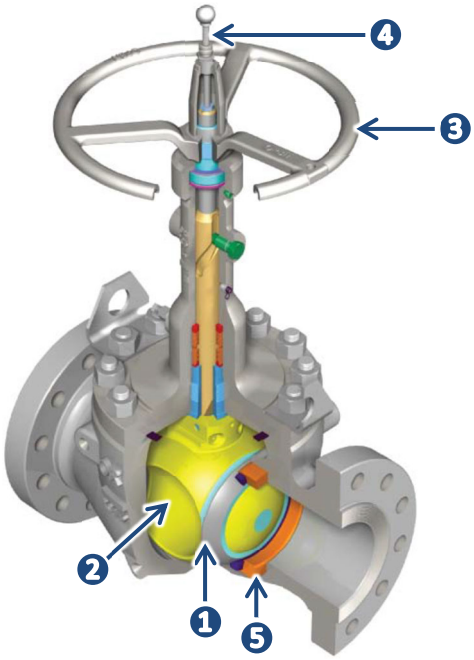
Continued on next page

Lesson Review Questions, Continued

13 When an orbit valve is closed, what happens to its ball-shaped core?

- **A** it is pivoting away from the seat
- **B** it allows liquid to flow through its passageway
- **C** it is almost in-line with the valve body
- x **D** it is mechanically wedged against the seat

14 Look at the cutaway of an ORBIT® valve. Match the component names below with the numbers shown on the diagram.



- 4 exposed stem
- 5 seat
- 2 passageway
- 1 ball-shaped core
- 3 hand wheel

Manual Valve Operation

How You Will Use Valves in the Granulation Process

Operators in the Granulation work area will open and close valves in order to:

- send liquids to and from various equipment and piping
- isolating (stop liquids from reaching) various equipment and piping

Valves can also adjust these equipment or process parameters as needed:

- pressure
- flow
- temperature

Controlling Valves in the Granulation Process

In terms of how valves are controlled, there are two types:

- manual valves
- control valves

	Manual Valves	Control Valves *(p. 42)*
method of control	locally (by hand or control box)	remotely (by electronic or pneumatic means)
operating mechanism	valve handle, crank, pull chain, air actuator, etc.	control room buttons, computer logic, etc.
operated by	outside operator	board operator

Note: The valves you learned about in the previous lesson can be either manual valves or control valves.

Types of Manual Valve Operation

Any of the manual valve types you learned about in the previous lesson can be operated in any of the following ways:

	Method of Operation
hand-turned	Rotate the valve's hand wheel or lever handle.
chain-operated	Pull the chain to rotate the valve's wheel. ***Warning:*** Do not stand beneath chain-operated valves while operating in case the chain system falls off.
mechanically-actuated (by local controls)	Turn the control knob or lever on the local control box located near the valve. The actuator will then operate the valve.

Continued on next page

Manual Valve Operation, Continued

Turning Direction

All hand-turned or chain-operated valves in your work area are known as CCO (counter-clockwise open). This means you must turn the wheel or lever:

- ***counterclockwise to open*** the valve
- ***clockwise to close*** the valve

⚠ ***Important:*** All instructions to open or close a valve (found in procedures or training) refer to opening or closing the valve ***fully*** unless otherwise stated.

How to Open a Manual Valve

Step	Action	Result
1	turn the handle or wheel ***counterclockwise*** very slightly then stop	the valve will release some pressure into the empty piping
2	continue to slowly turn the handle or wheel counterclockwise	the valve will continue to open, and piping will gradually adjust to full pressure
3	stop turning as soon as you meet resistance	the valve is fully open
	⚠ ***Warning:*** Turning the handle or wheel too far in the open position can jam the stem and cause damage, leaks and prevent closing.	

How to Close a Manual Valve

Step	Action	Result
1	turn the handle or wheel ***clockwise*** slowly	the valve will close, and flow will gradually stop
2	stop turning as soon as you meet resistance	the valve is fully closed
	⚠ ***Warning:*** Overtightening can permanently distort the seat and result in leakage. ⚠ ***Warning:*** Closing a valve too quickly can cause hydraulic hammering to occur (see page 41).	

Continued on next page

Manual Valve Operation, Continued

How to Change the Flow of a Manual Valve

Step	Action	Result
1	turn the handle or wheel slowly ***counterclockwise*** or ***clockwise***	the valve will open or close slowly to some percentage
2	stop turning when the desired flow is reached	the flow is adjusted
	Note: The board operator will tell you what to adjust the valve to. Always communicate with the board operator when adjusting flows.	

Hydraulic Hammer

Hydraulic hammer is the pressure surge that may occur when a fluid in motion is forced to stop or change direction suddenly. This sudden pressure increase can damage piping and equipment.

The main causes for hydraulic hammer are:

- opening or closing a valve too quickly
- heating steam lines too quickly or without sufficiently draining the condensate

When hydraulic hammer occurs, there are loud cracking sounds, and excessive vibration in the piping.

Control Valve Operation

What Is a Control Valve?

Almost any valve can be fitted with a remotely or automatically controlled mechanism instead of a hand wheel or lever, making it a ***control valve***.

Most control valves in your work area use a pneumatic actuator, which means compressed air is used to change the position of the valve stem.

Who Controls the Control Valve?

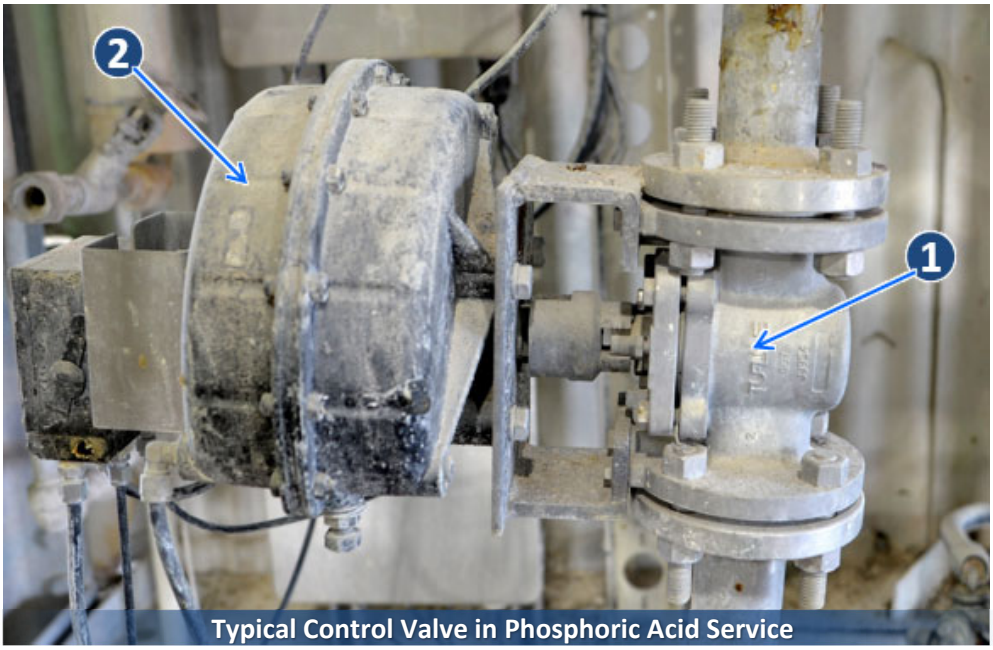
Control valves are connected remotely to the computer system and/or panel board in the control room. Using computer logic, the system automatically controls the valve's position to adjust flow based on one or more parameters.

In most cases, the board operator can override the automatic system, but can still operate the control valve from the control room as needed.

How to Identify a Control Valve

A control valve can have the body of almost any valve type, but its body is usually cylindrical in shape like a plug valve (page 20).

Instead of a wheel or lever, an electronic or pneumatic component is attached to the valve body.



Typical Control Valve in Phosphoric Acid Service

1 plug valve body

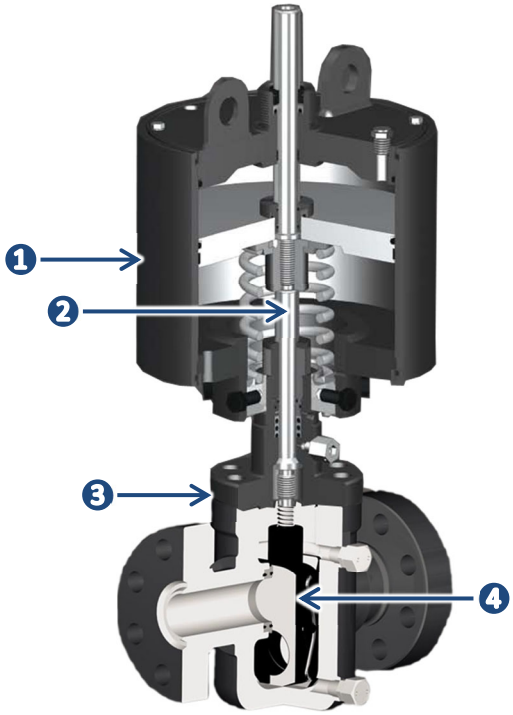
2 remotely controlled, air-actuated mechanism

Continued on next page

Control Valve Operation, Continued

How a Control Valve Works

A mechanical actuator turns the valve stem slowly and precisely. The plug also turns which enlarges or closes the passageway to allow or restrict the flow of liquids.

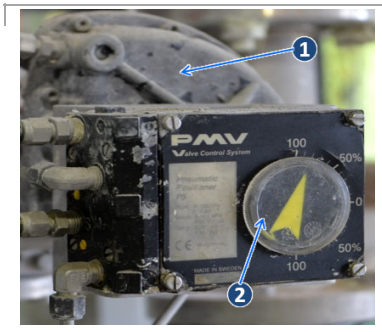


Control Valve Cutaway

1	actuator	3	plug valve body
2	internal valve stem	4	plug

How to Verify Control Valve State

There is a ***position indicator*** directly on the control valve to indicate the opening percentage of the control valve.



1	top of control mechanism body
2	position indicator (valve is opened 80%)

Monitoring and Troubleshooting Valves

When to Monitor

Operating valves must be monitored *continually* to keep equipment in top shape.

How to Monitor

A quick visual check can tell you a lot about a valve's operating condition. Observe open state, pressure gauges, flow rates, etc.

You can do this at any time, especially during your operator rounds and inspections.

Reporting Conditions

Anytime you observe abnormal conditions (like those shown in the table below), immediately report them to your board operator via radio. Work together with the board and other operators to troubleshoot the problem.

Troubleshooting Valves

Problem	Possible Cause
reduced liquid flow	solids accumulation or clogging in the valve
leak	valve body failure
	loose bolts or flanges
	seal failure
abnormal noise, odor, or vibration	leaks
	abnormal pressure or flow condition
	breakdown/failure of internal parts
valve actuator will not operate	insufficient energy feed (either pneumatic or hydraulic)
	breakdown or failure of the actuator
structural breakage	high mechanical stress (for example, a valve designed for on/off service used for throttling flow)
valve mechanism malfunction	mechanical failure of moving parts (for example, due to fatigue from thermal loading and impact loading)
difficulty opening or closing (stuck valve)	fault in actuator, limit switch or control system
	clogged with solids
	insufficient lubrication of the packing
	bent stem
	damaged gate, ring sleeve or secondary seal
	insufficient air pressure (for pneumatic actuators)

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Lesson Review Questions

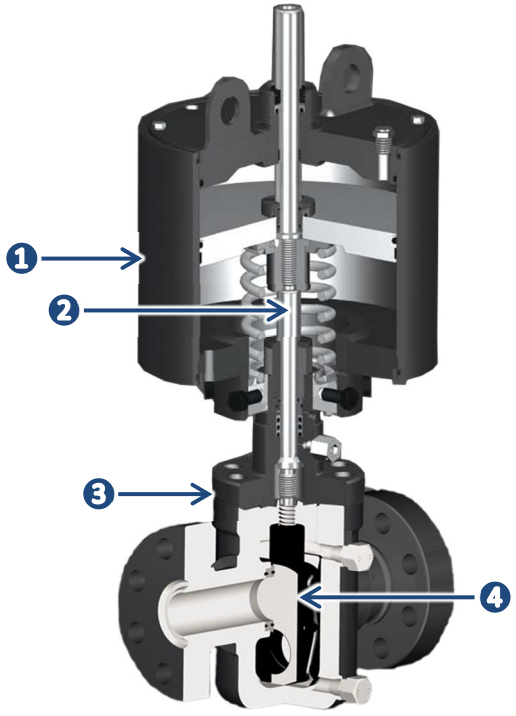
Instructions Choose the correct answer(s) for the questions that follow.

1 **True** or **False?**

All of the valves in your work area open counterclockwise.

x **A** true **B** false

2 Look at this cutaway of a control valve. Match the component names below with the numbers shown on the cutaway.



1 actuator
3 plug valve body
4 plug
2 internal valve stem

3 **True** or **False?**

Overtightening can permanently distort the seat and result in leakage.

x **A** true **B** false

Continued on next page

Lesson Review Questions, Continued

4 When opening a valve, you will first turn the handle or wheel counter-clockwise very slightly, then stop.

What is the result of this action?

- **A** the piping will gradually adjust to full pressure
- **B** the valve will be fully open
- x **C** the valve will release some pressure into the empty piping
- **D** the valve will be fully closed

5 When turning a valve's handle or wheel clockwise, what does it mean when you meet resistance?

- x **A** the valve is fully closed
- **B** the valve is fully opened
- **C** the valve is opened to exactly 50%
- **D** none of these

6 What are some equipment parameters that can be adjusted by opening and closing valves? (select all that apply)

- x **A** flow
- x **B** pressure
- **C** fan speed
- x **D** temperature

7 Look at the table of valve control, then answer the question below.

	A	B
method of control	locally (by hand or control box)	remotely (by electronic or pneumatic means)
operating mechanism	valve handle, crank, pull chain, air actuator, etc.	control room buttons, computer logic, etc.
operated by	outside operator	board operator

Which of these columns describes a manual valve?

- x **A** column A
- **B** column B

Continued on next page

Lesson Review Questions, Continued

8 **True** or **False?**

All instructions to open a valve refer to opening it to ***95% open*** unless otherwise stated.

A true x **B** false

9 What is hydraulic hammer?

x **A** the pressure surge that may occur when a fluid in motion is forced to stop or change direction suddenly

B the drop in equipment or vessel pressure due to opening or closing a valve too slowly

C the drop in equipment or vessel pressure due to the bursting of a pipe filled with a liquid

D the pressure surge that may occur when still fluid in a pipeline is forced to move suddenly by opening a valve too quickly

10 Label each step of opening a manual valve in sequential order (1 thru 3).

3 stop turning as soon as you meet resistance

2 continue to slowly turn the handle or wheel counterclockwise

1 turn the handle or wheel counterclockwise very slightly then stop

11 When changing the flow of a manual valve, how you will know what percent to adjust the valve to?

A the optimal percent for each valve is engraved on the side of the valve body

x **B** you will communicate with the board operator

C the position indicator will stop when the proper percentage has been reached

D none of these

Continued on next page

Lesson Review Questions, Continued

12 **True** or **False?**

Control valves in your work area are usually a modified butterfly valve.

	A	true	x	**B**	false

13 Instead of a wheel or lever, which of the following is attached to the body of a control valve to open and close it?

	A	a wrench	x	**C**	an electronic or pneumatic component
	B	a chain wheel		**D**	none of these

14 How can you verify what percentage a control valve is opened?

x	**A**	look at its position indicator		**C**	look at its flow rate meter
	B	look at its handle or wheel		**D**	look at the equipment it is attached to

15 If you have difficulty opening or closing a manual valve, which of the following could be the cause? (select all that apply)

	A	there is abnormal pressure or flow in the pipeline	x	**C**	there is insufficient lubrication of the packing
x	**B**	it is clogged with solids	x	**D**	it has a damaged gate

Chapter 2

Pumps

Pumps in the Granulation area move liquid material through the process piping from one piece of equipment to another.

As you have learned, valves can restrict or allow flow, but it is the pumps that provide that flow.

Centrifugal Pump

How to Identify a Centrifugal Pump

Most of the pumps in your work area centrifugal pumps. Typically, they:

- are horizontally mounted
- are round or slightly conical in shape
- have an offset discharge outlet.

Granulation Plant Holding Tank West Transfer Pump

1. centrifugal pump
2. offset discharge outlet

Continued on next page

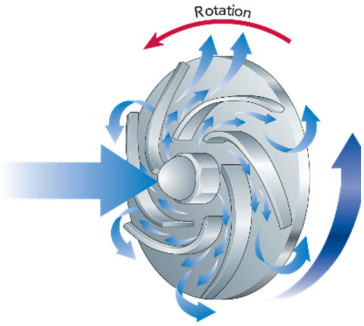
Centrifugal Pump, Continued

How a Centrifugal Pump Works

The centrifugal pump converts kinetic energy (typically from a drive motor that turns an internal impeller) into hydrodynamic energy, thereby increasing the pressure of a liquid, forcing it through the discharge piping.

Centrifugal Pump Cutaway

1. drive shaft (mechanical input)
2. packing seal (p. 60)
3. pump housing
4. internal impeller
5. pump intake
6. pump discharge



As the impeller turns, the liquid is forced toward its edges. As a result of this centrifugal force, the liquid leaves the impeller at a higher pressure and velocity than it entered it.

Vertical Pump

How to Identify a Vertical Pump

Vertical pumps can be any centrifugal pump mounted vertically.

Granulation Trains Sump, Northeast Corner of A and B-Train Building

1. east sump pump
2. west sump pump
3. drive motors
4. flow of pump discharge

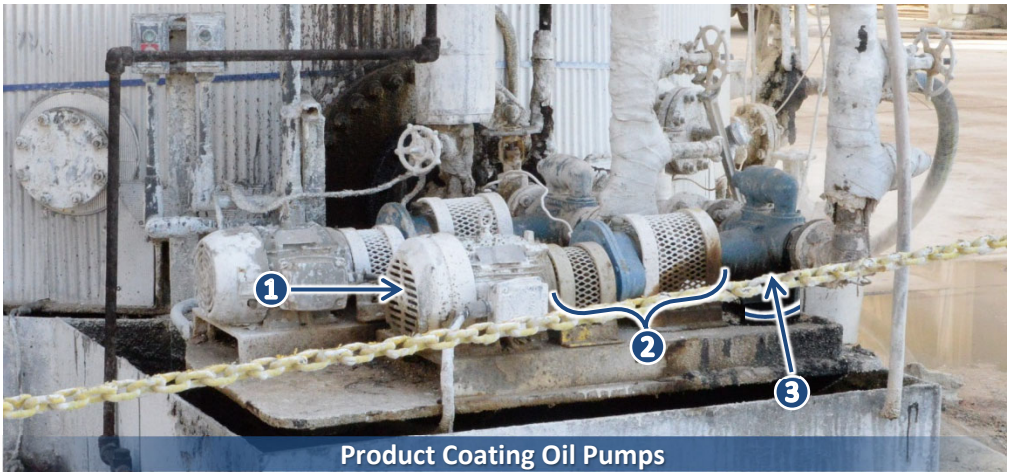
Benefits to Mounting a Pump Vertically

For service below grade like in pits and sumps, mounting a centrifugal pump vertically allows the actual pump to remain submerged in the liquid to be pumped. This alleviates problems with pump priming, and gives easy access to the motor drive components.

Positive-Displacement Gear Pump

How to Identify a Positive-Displacement Gear Pump

Positive displacement gear pumps and their associated piping can be smaller than centrifugal pumps, and the flow of liquid through the pump is typically linear.



Product Coating Oil Pumps

1. drive motor
2. coupling
3. positive displacement gear pump

Benefits of This Type of Pump

In a positive-displacement pump, a specific quantity of fluid is discharged each cycle, thereby giving a fixed amount of fluid delivered over time.

How a Positive-Displacement Gear Pump Works

Instead of using centrifugal force the way an impeller does, positive-displacement pumps use a solid object like a piston (in our case, a ***gear***) to push the fluid.

The spaces between the gear teeth physically entrap a quantity of fluid at the pump suction and pushes, or ***displaces***, it out of the pump discharge.