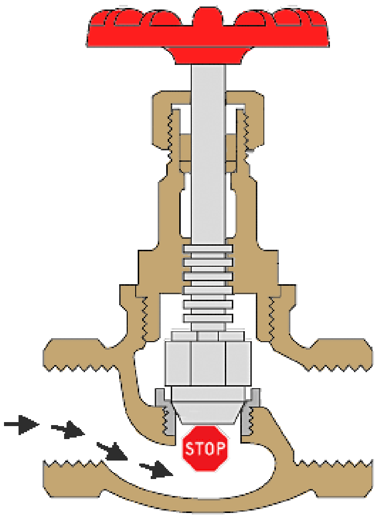
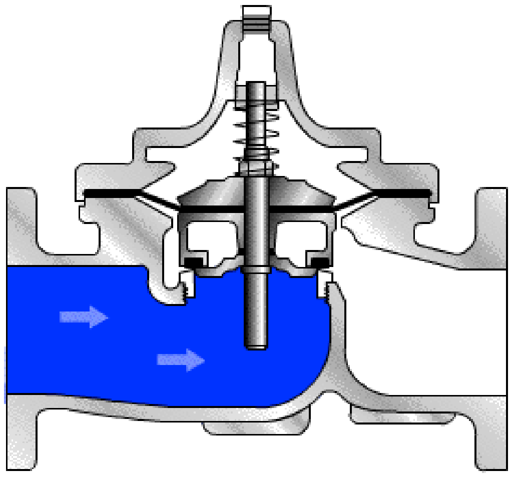
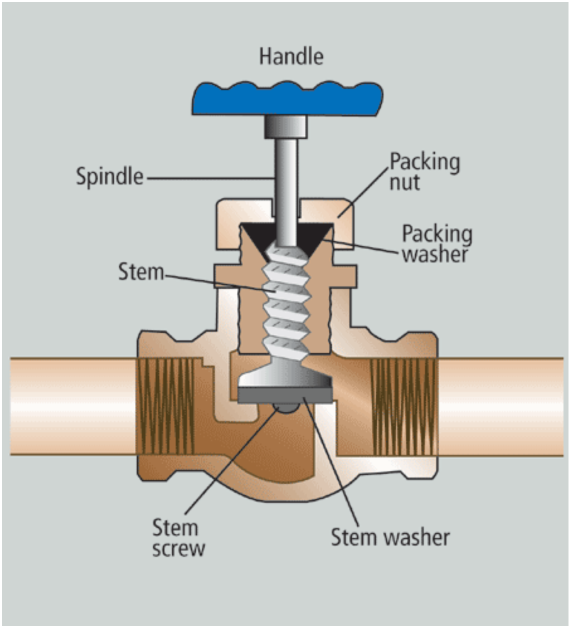
CONTROL VALVES

GROUP 6







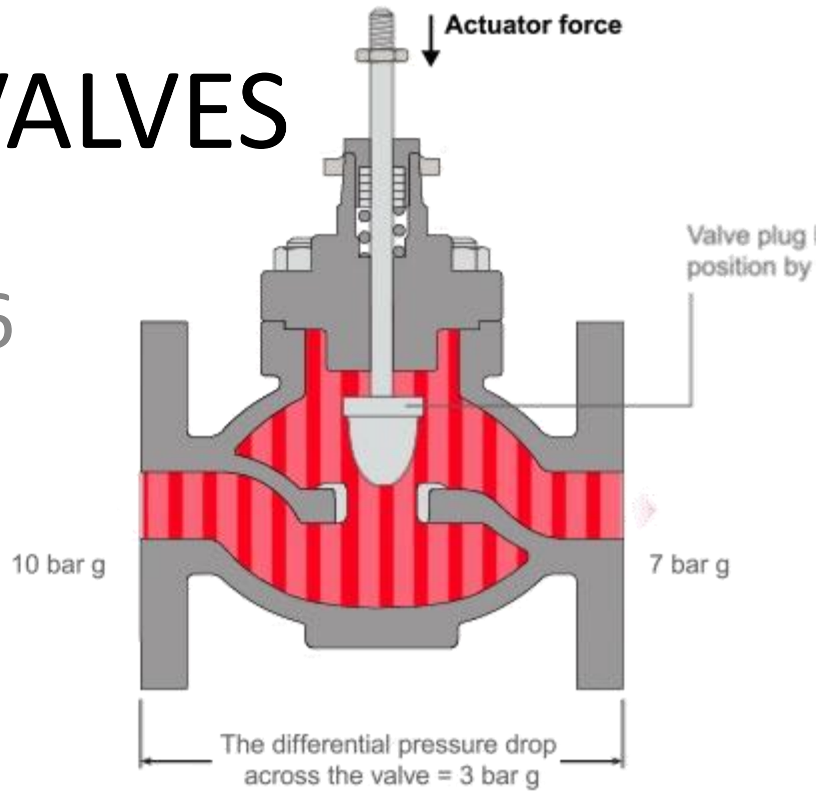
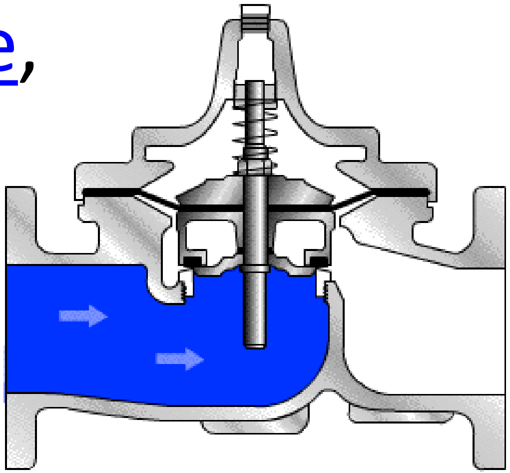


Fig. 6.2.1 Differential pressure across a valve

Control Valve

- A **control valve** is a valve used to control fluid flow by varying the size of the flow passage as directed by a signal from a controller. This enables the direct control of flow rate and the consequential control of process quantities such as pressure, temperature, and liquid level.



Principles of Control Valves

- Control valves are used to provide a number of functions and are typically selected on the following basis:

- Application function
- Operating conditions
- Construction
- Sizing

Application Function

- This relates to the function which the valve is to perform.

- Isolation, ON-OFF valves

These are typically ball valves and are used for shut off and isolation purposes.

- Flow control

This course is primarily aimed at regulating valves for the purpose of modulation control in continuous systems.

- Directional control

Check valves are typically used for this purpose.

- Protection, overpressure

Pressure relief valves provide suitable overpressure protection.

Operating Conditions

- As with all process equipment, the conditions of the system and the environment in which it is to perform are of significant importance. Such factors of consideration are:

- Process pressures
- Process temperature
- Ambient conditions
- Process material and nature of fluid

Construction

- A large range of valve designs are available and provide differing performance, both with advantages and disadvantages.

- Valve body type
- Plug and stem design
- Stem seals
- Materials of construction

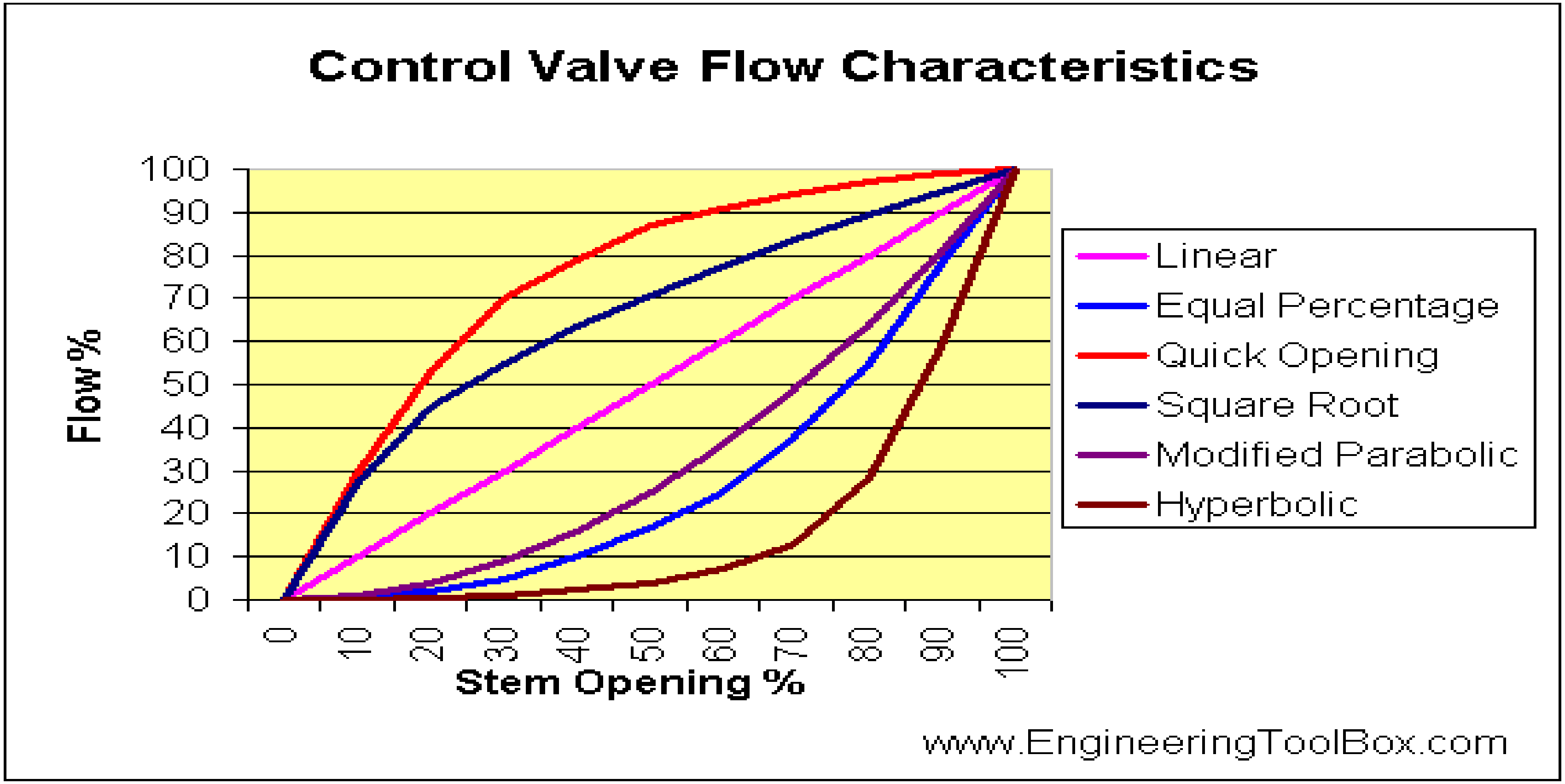
Sizing

- The size of a valve is dependent on the flow that is required through the valve. The performance of valves is well defined which simplifies the selection process for a valve without the need to resort to complicated calculations.

Sliding Stem Valves

- Valve trim designs are provided by most manufacturers to give three different flow characteristics:

- Equal percentage
- Linear
- Quick opening


Control Valve Flow Characteristics
Flow %
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
Stem Opening %
Linear
Equal Percentage
Quick Opening
Square Root
Modified Parabolic
Hyperbolic
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Control Valve Flow Characteristics

- **Linear** - flow capacity increases linearly with valve travel.
- **Equal percentage** - flow capacity increases exponentially with valve trim travel. Equal increments of valve travel produce equal percentage changes in the existing C_v.
- **A modified parabolic characteristic** is approximately midway between linear and equal-percentage characteristics. It provides fine throttling at low flow capacity and approximately linear characteristics at higher flow capacity.
- **Quick opening** provides large changes in flow for very small changes in lift. It usually has too high a valve gain for use in modulating control. So it is limited to on-off service, such as sequential operation in either batch or semi-continuous processes.

Sliding Stem Valves

- The basic body styles are:

- Globe
- Cage
- Angle body
- Y pattern
- Split body
- Three way
- Single seated
- Double seated

Globe Valve

- The trim of a valve is essentially the internal parts that are in contact with the flow stream. Because the trim absorbs the pressure of the flow (with a pressure loss across the valve) the trim design is an important consideration in determining the flow characteristics of the valve.

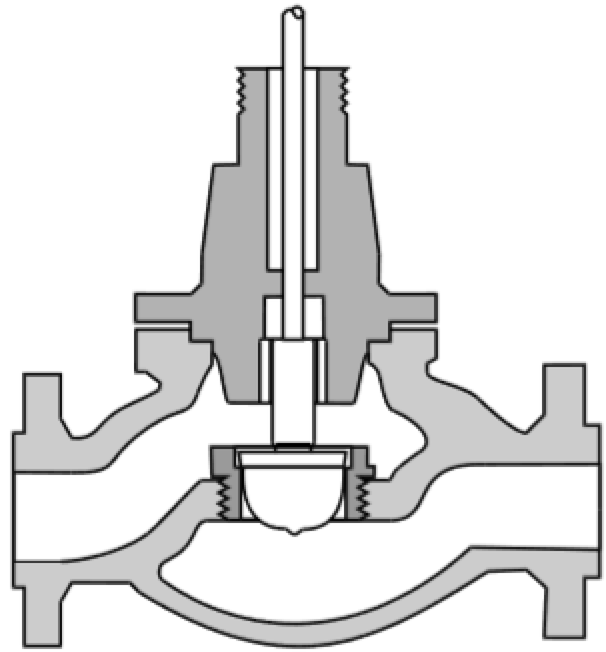


Figure 6.1
Top-entry, top guided single-seated globe valve.

Cage Valves

- Cage valves use the principle of cage guiding, where the plug rides inside the cage. This is quite common in most valves, because the bearing forces on the plug are near the fluid forces. As the plug is aligned by the cage, the valve effectively self-aligns itself so that during assembly all the pieces fit together. Correct alignment reduces the problems of side loads.

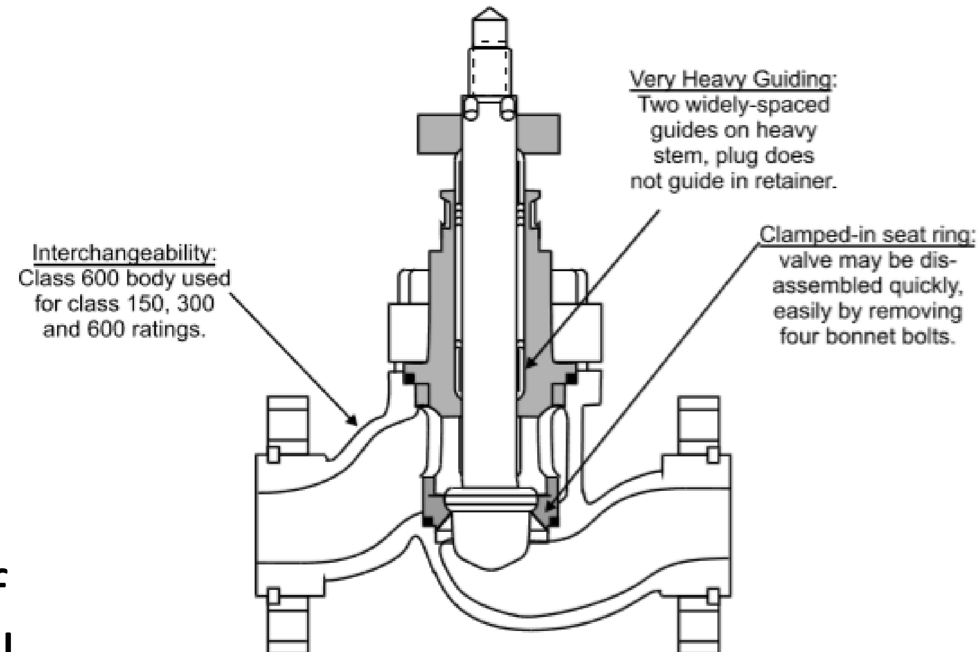


Figure 6.2
Cage valves with clamped-in seat ring and characterised plug (courtesy of Valtek, Inc.).

Split Body Valves

- Split body valves provide streamlined flow and reduce the number of bolted joints. These valves use one bolt to secure the valve with the seat ring clamped between the body halves. Their original design and subsequent operation was for difficult flows with high viscosity. Fouling is minimised due to the valves simple streamlined construction.

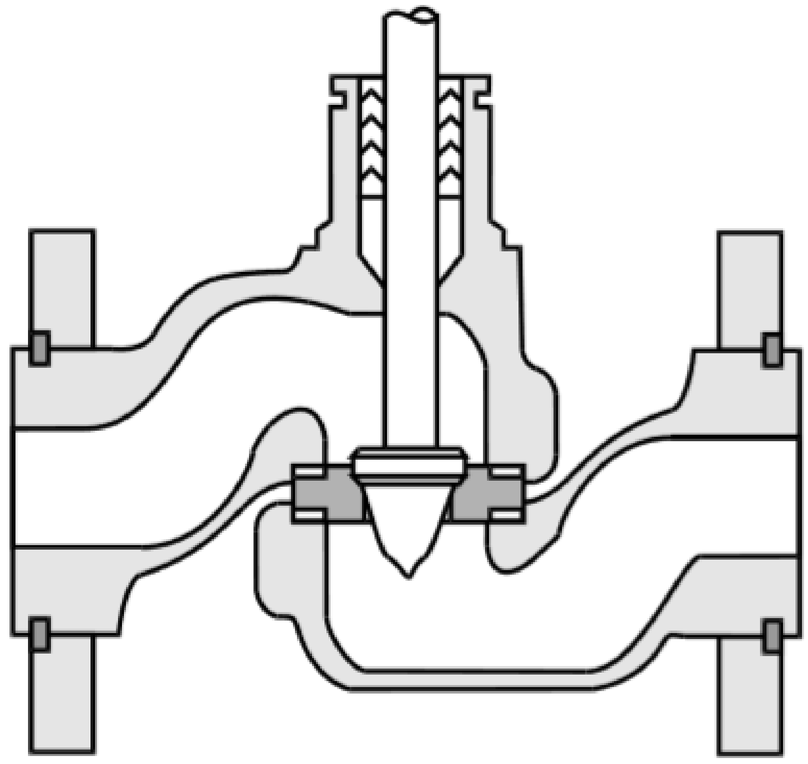


Figure 6.3
Split body valve with removable flanger (courtesy of Masoneilan).

Angle Valves

- These valves can be likened to mounting a globe valve in an elbow. The exiting flow is 90 degrees to the inlet flow.
- The Angle valve has little restriction on the out flow, so if flashing or cavitation occurs then it tends to do so further downstream from the valve. This saves not only on the maintenance life of the valve, but also minimises any degradation in valve performance.

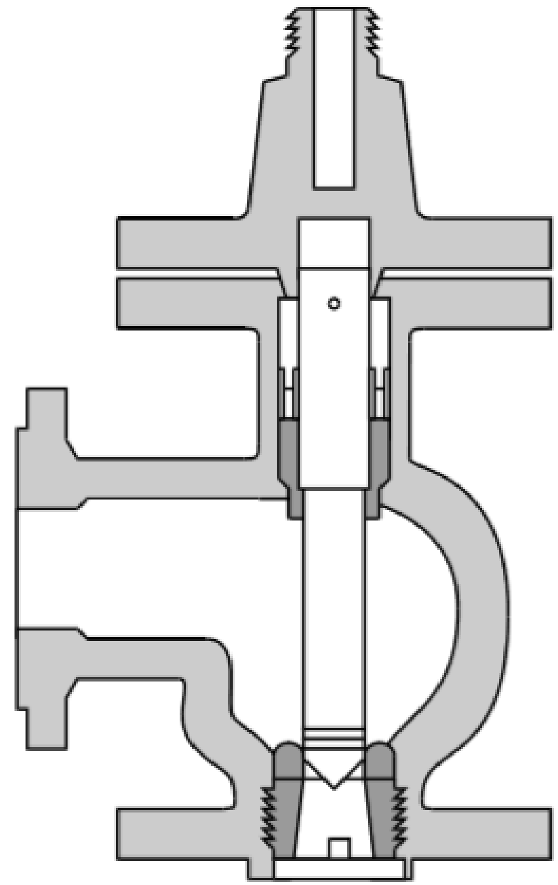


Figure 6.4
Streamlined angle valve with lined Venturi outlet.

Y-Style Valves

- This style of valve has the operating components tilted at a 45 degree angle to the flow path. In theory, the flow stream has fewer turns when fully open. In practice they are mainly used for drainage applications, operating at or near the closed position.

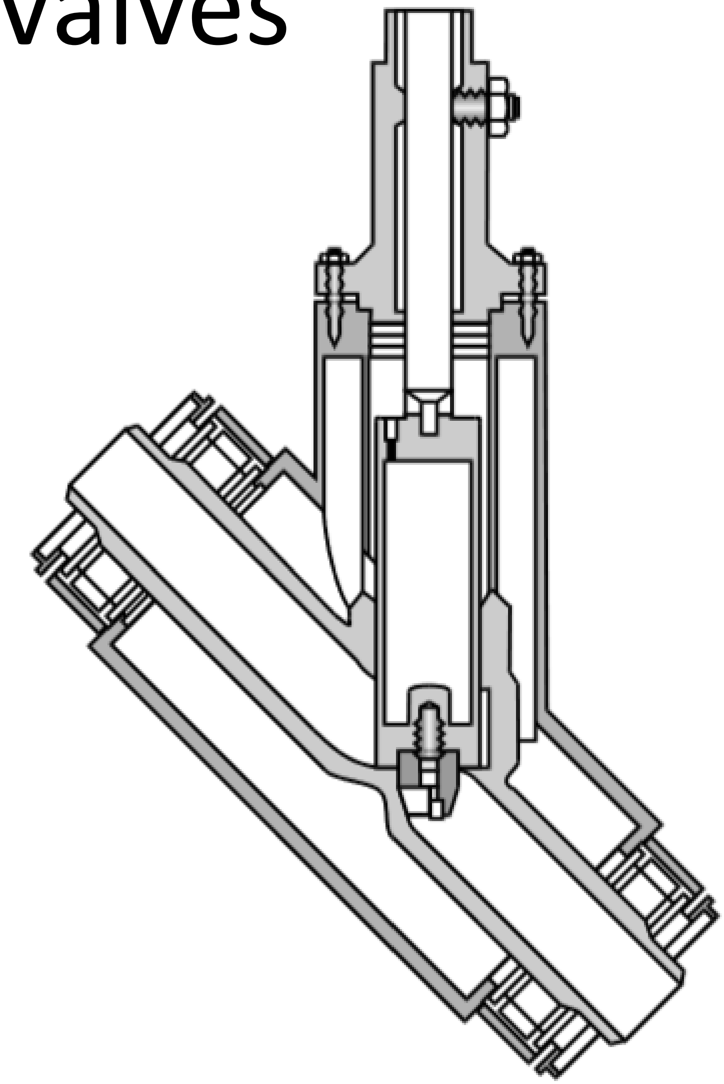


Figure 6.5
Y-valve fitted with vacuum jacket.

Three-Way Valves

- Three-way valves are a special type of double ported valve.

- Two types of Three-way valve are available:
- Mixing
- Diverting

Mixing

- The mixing valve has two inlets and one outlet.

- This type of valve would be used for blending of two fluids with the associated ratio control of the mix.

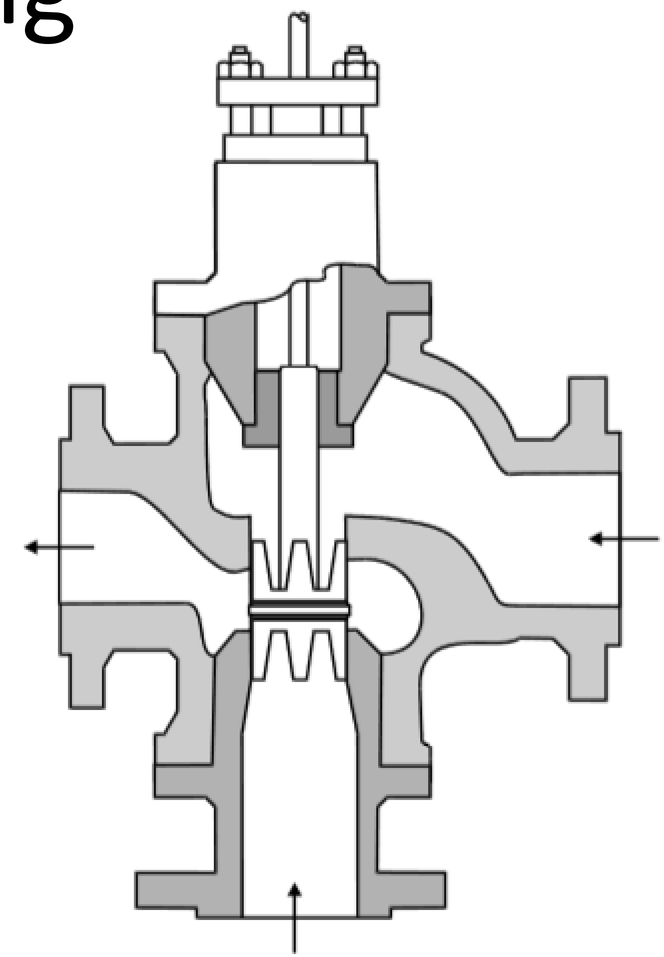


Figure 6.6
Three-way valve mixing flow.

Diverting

- The diverting valve has one inlet and two outlets.
- Diverting valves can be used for switching or for bypass operations. The relative split provides the required controlled flow with one outlet, while allowing a constant flow through the system with the other outlet. Such valves are used in chilled water systems to prevent freezing in the pipes.

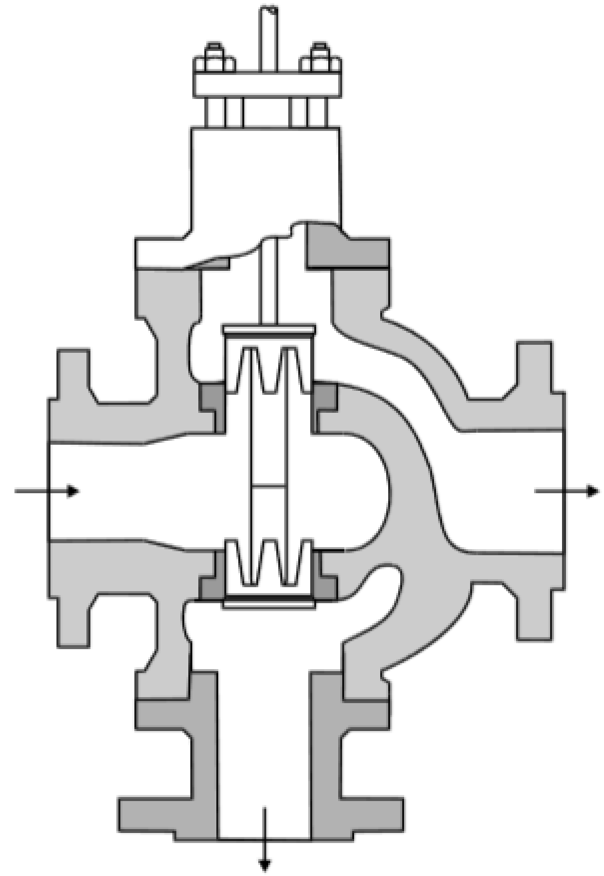


Figure 6.7
Three-way valve for diverting service.

Single Seated

- Single seated valves are one form of globe valve that are very common and quite simple in design. These valves have few internal parts. They are also smaller than double seated valves and provide good shut off capability.

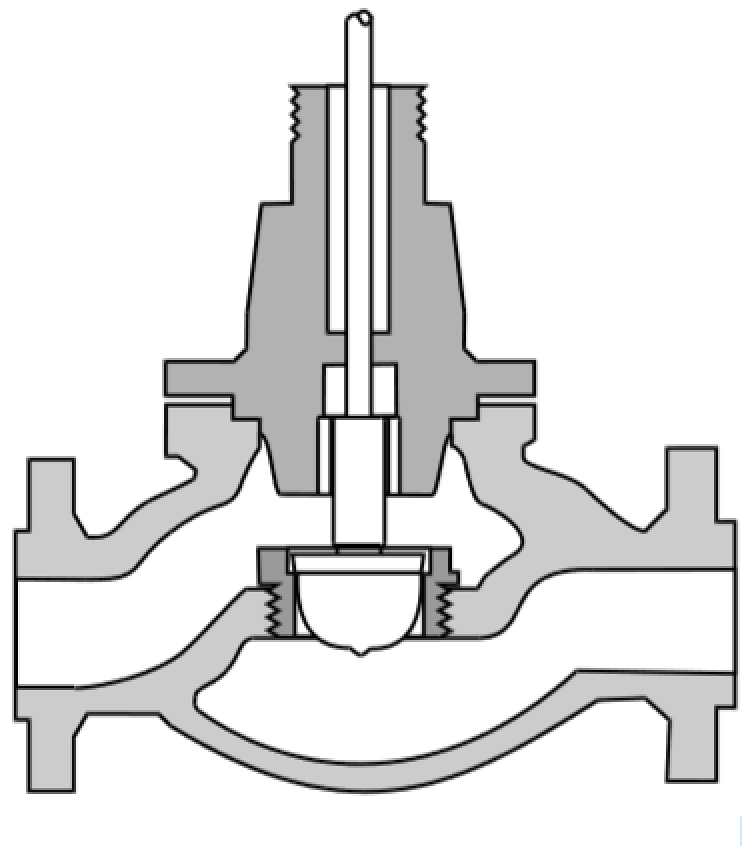


Figure 6.8
Top-entry, top guided single-seated globe valve.

Double Seated

- Another globe valve body design is double seated. In this approach, there are two plugs and two seats that operate within the valve body.
- In a single seated valve, the forces of the flow stream can push against the plug, requiring greater actuator force to operate the valve movement. Double seated valves use opposing forces from the two plugs to minimise the actuator force required for control movement. Balancing is the term used when the net force on the stem is minimised in this way.

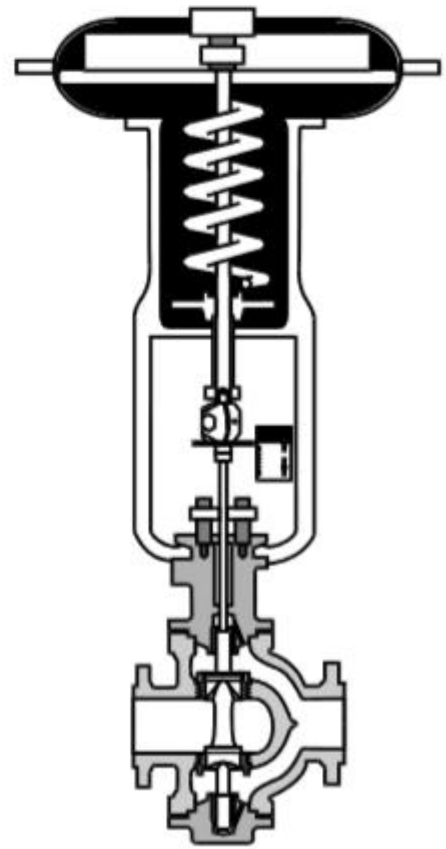


Figure 6.9
Double ported valve
(courtesy of Fisher Controls International).

Balanced Valves

- Balancing is the term used when the resultant force on a plug is neutral. This means that the plug is neither forced up or down by the pressure of the flow stream.

- The advantage with balancing is that the actuator force required for controlled movement is greatly reduced. This allows for smaller and cheaper actuators.

- Balancing is applied to single-seated and double-seated valves in different ways.

Double-Seated Balancing

- Double-seated valves were originally designed for balancing. These valves use opposing forces from the two plugs to minimise the actuator force required for control movement. That is, the pressure of the flowstream acting on the upper plug is intended to cancel the pressure acting on the lower plug.
-
- The force on the upper plug is in the opposite direction to that on the lower plug and as such the result should be zero. However, because the plug sizes differ, the forces are not equal and the result is an unbalanced force.
-
- Double-seated valves are actually semi-balanced.

Single-Seated Balancing

- In a single seated valve, the forces of the flow stream can push against the plug, requiring greater actuator force to operate the valve movement.
-
- To balance a single-seated valve, balancing holes are added to equalise the pressure on both sides of the plug. This eliminates any unbalanced force on the plug, however further seals are required for the extra leakage path between the plug and the cage.
-
- An unbalanced valve has better shut off capability because there is only the problem of leakage between the seat and the plug.

Guiding

- The control valve guide is used to support and position the valve plug over the full range of travel. Various control valve guiding designs are available and should be considered as they affect the operating life and reliability of a valve.
- The guide provides the support for the valve plug. Any forces on the plug are resisted by the guide. If the guide wears or fails then vibration can become a problem.
- Under high bearing loads, the surface of the guide can break down causing increased friction and impeding valve performance.

- In choosing suitable guides:
- Use bearing materials with different hardness levels
- Avoid nickel and unhardened stainless steel

Cage guiding

- The most common type of guiding is Cage guiding. The plug moves within a cage with little tolerance between the two. This design enables the loading on the plug to be supported by the cage with a large bearing area between the two.

- Maintenance is reduced as the assembly is simplified with the components self aligning.

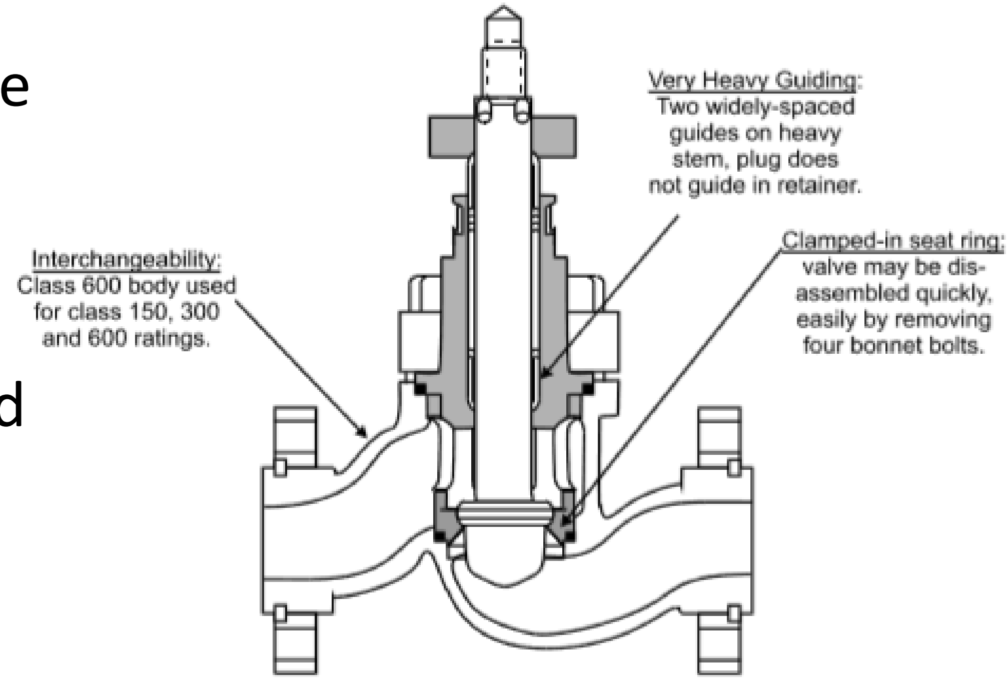


Figure 6.10
Cage valve with clamped-in seat ring and characterised plug (courtesy of Valtek, Inc).

Stem guiding

- Stem guiding is a simple design where the stem itself is responsible for supporting and controlling the plug.

- Limitations occur due to the stem's strength as the support of the stem is farther away from the load on the plug. Guiding performance is impaired but this type of valve is cheaper to manufacture and maintain.

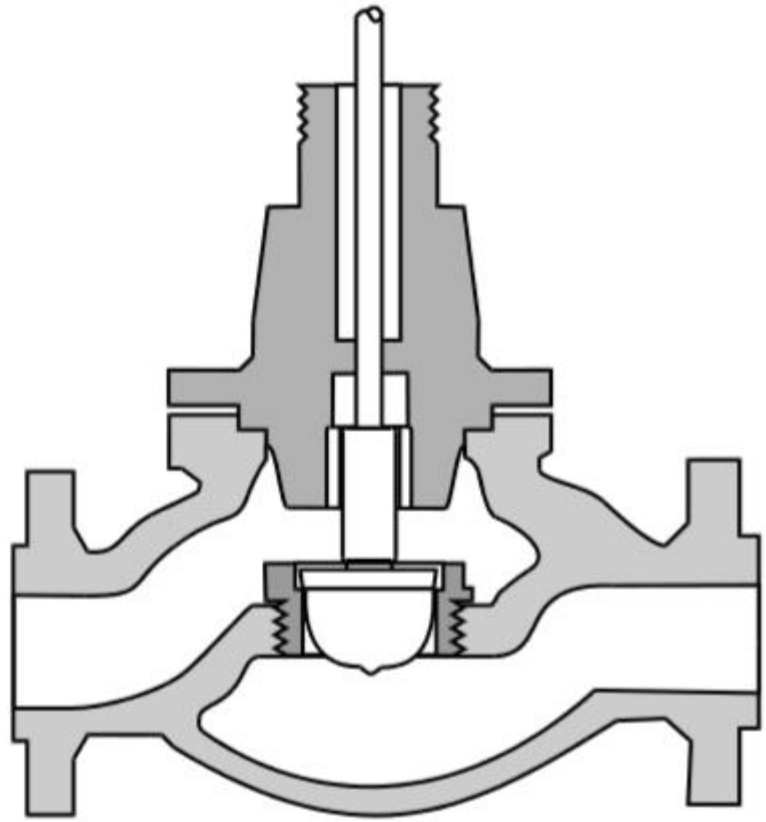


Figure 6.11
Top-entry, top guided single seated globe valve.

Post guiding

- Post guiding is mostly used if there is a risk of fouling. The post is a section of the stem from the plug that extends into the valve body. The post is smaller in diameter than the plug but larger than the stem.
- The post supports the plug from bearing loads, with the narrower stem providing positioning control.
- This type of guiding also helps keep the bearing surfaces out of the flow stream. This reduces the buildup of fluid.

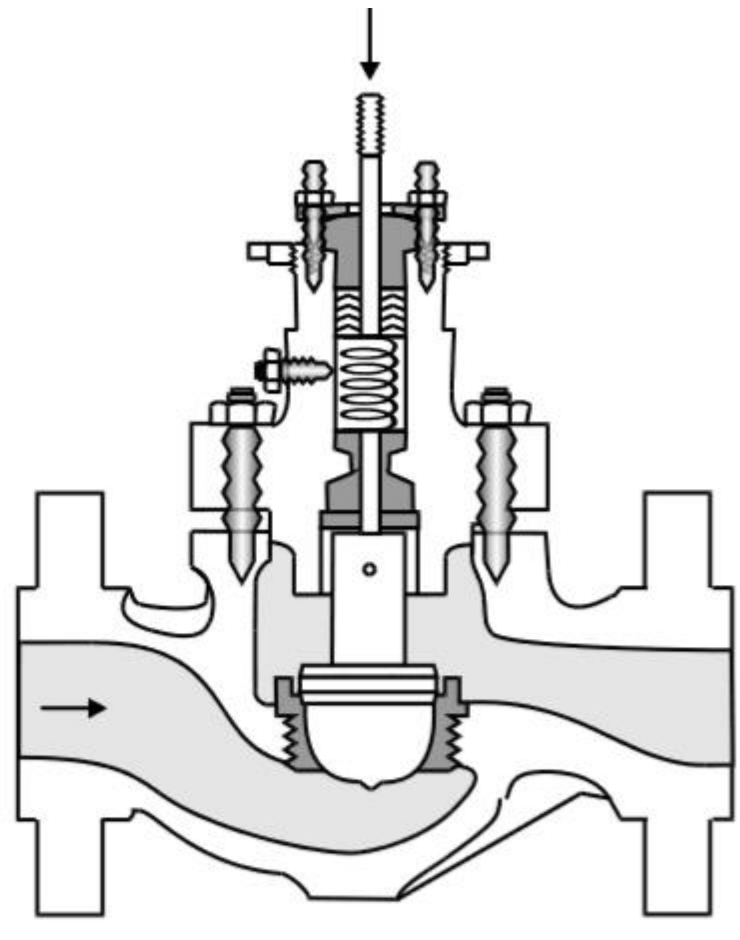


Figure 6.12
Post guiding – top
(courtesy of Fisher Controls International).

Port guided

- Very seldom used but still in existence is the port guided valve. In this design the port is used to align and guide the plug. The port guided design also has a relatively small bearing surface and has the same problems with fouling as with the cage guided valves.

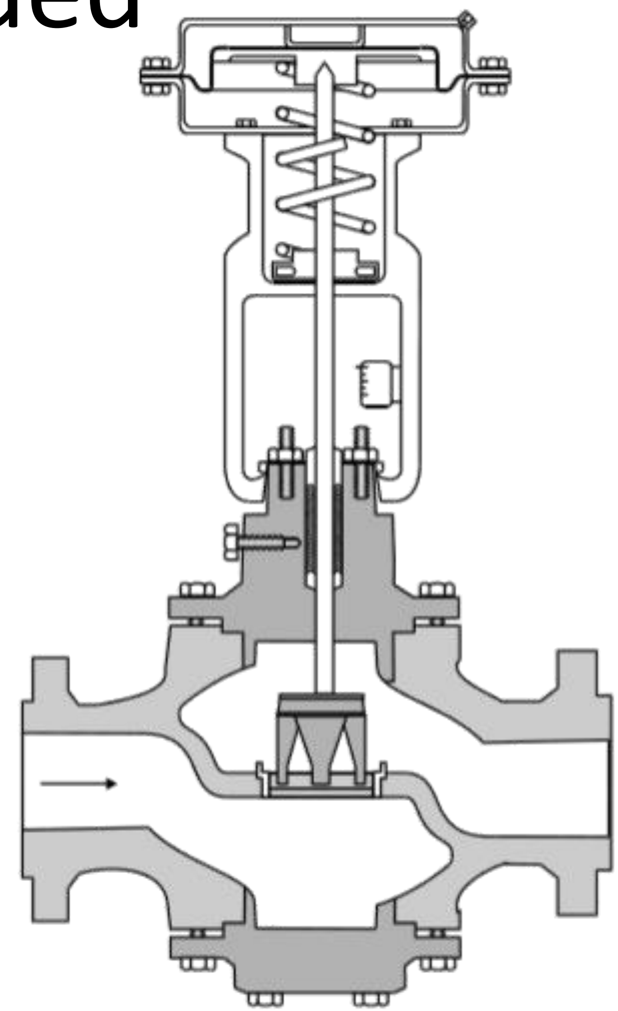


Figure 6.13
Port or skirt guiding
(courtesy of Fisher Controls International).

Rotary Valves

- is a type of valve in which the rotation of a passage or passages in a transverse plug regulates the flow of liquid or gas through the attached pipes.

Application of Rotary Valves

- Changing the pitch of brass instruments.
- Controlling the steam and exhaust ports of steam engines, most notably in the Corliss steam engine.
- Periodically reversing the flow of air and fuel across the open hearth furnace.
- Loading sample on chromatography columns.
- Certain types of two-stroke engines.
- Most hydraulic automotive power steering control valves.

Type of rotary valves

- Butterfly Valves
- Ball Valves

Butterfly Valves

- is a valve that isolates or regulates the flow of a fluid. The closing mechanism is a disk that rotates.
- are dampers that are shaped from discs which rotate in the flow path to regulate the rate of flow.
- Operation is similar to that of a ball valve, which allows for quick shut off

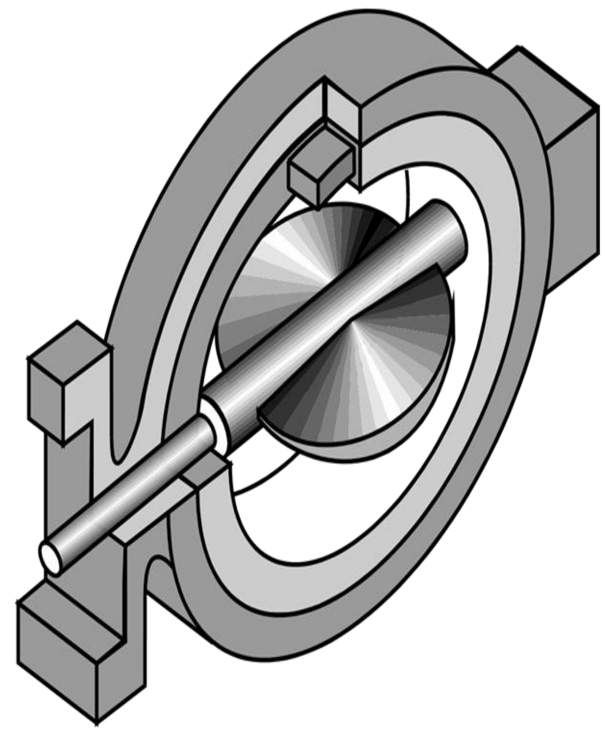


Figure 6.14

Types of Butterfly Valves

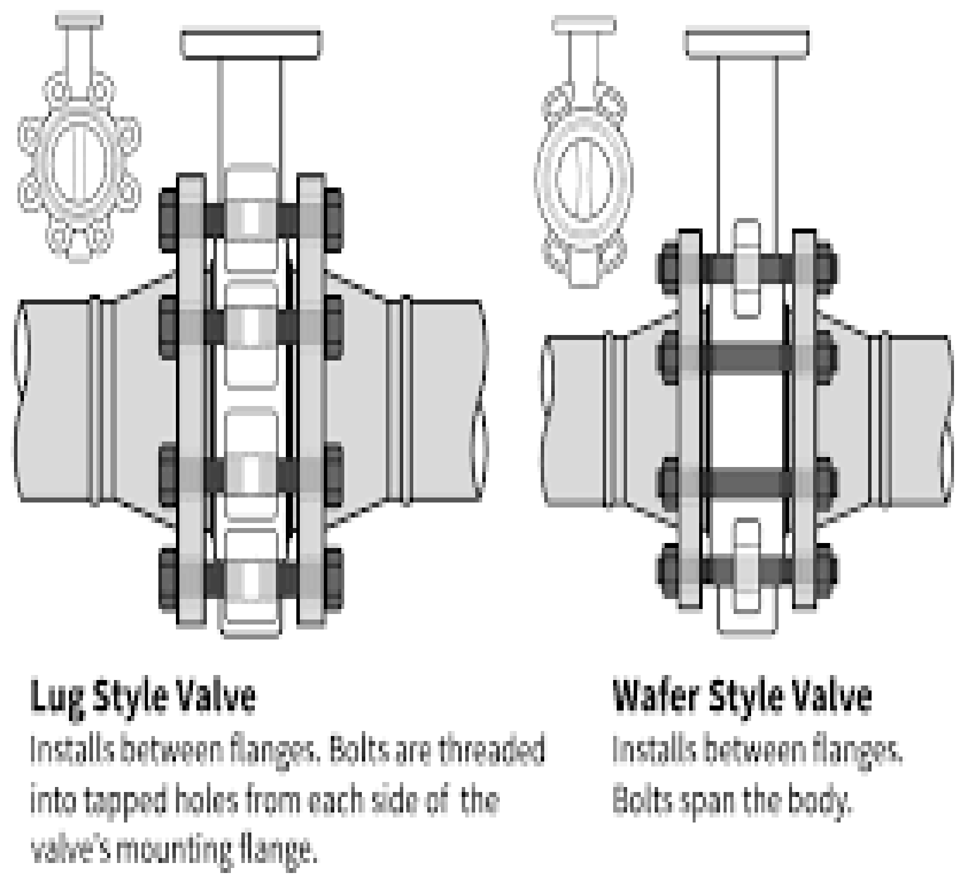
- Wafer-style butterfly valve
- Lug-style butterfly valve
- Rotary valve

Wafer-style butterfly valve

- The wafer style butterfly valve is designed to maintain a seal against bi-directional pressure differential to prevent any backflow in systems designed for unidirectional flow. It accomplishes this with a tightly fitting seal; i.e., gasket, O-ring, precision machined, and a flat valve face on the upstream and downstream sides of the valve.

Lug-style butterfly valve

- Lug-style valves have threaded inserts at both sides of the valve body. This allows them to be installed into a system using two sets of bolts and no nuts.
- Lugged valves are extremely resistant to chemicals and solvents and can handle temperatures up to 200 °C, which makes it a versatile solution.



Rotary valve

- Rotary valves constitute a derivation of the general butterfly valves and are used mainly in powder processing industries.
- Instead of being flat, the butterfly is equipped with pockets.

Disc Shape

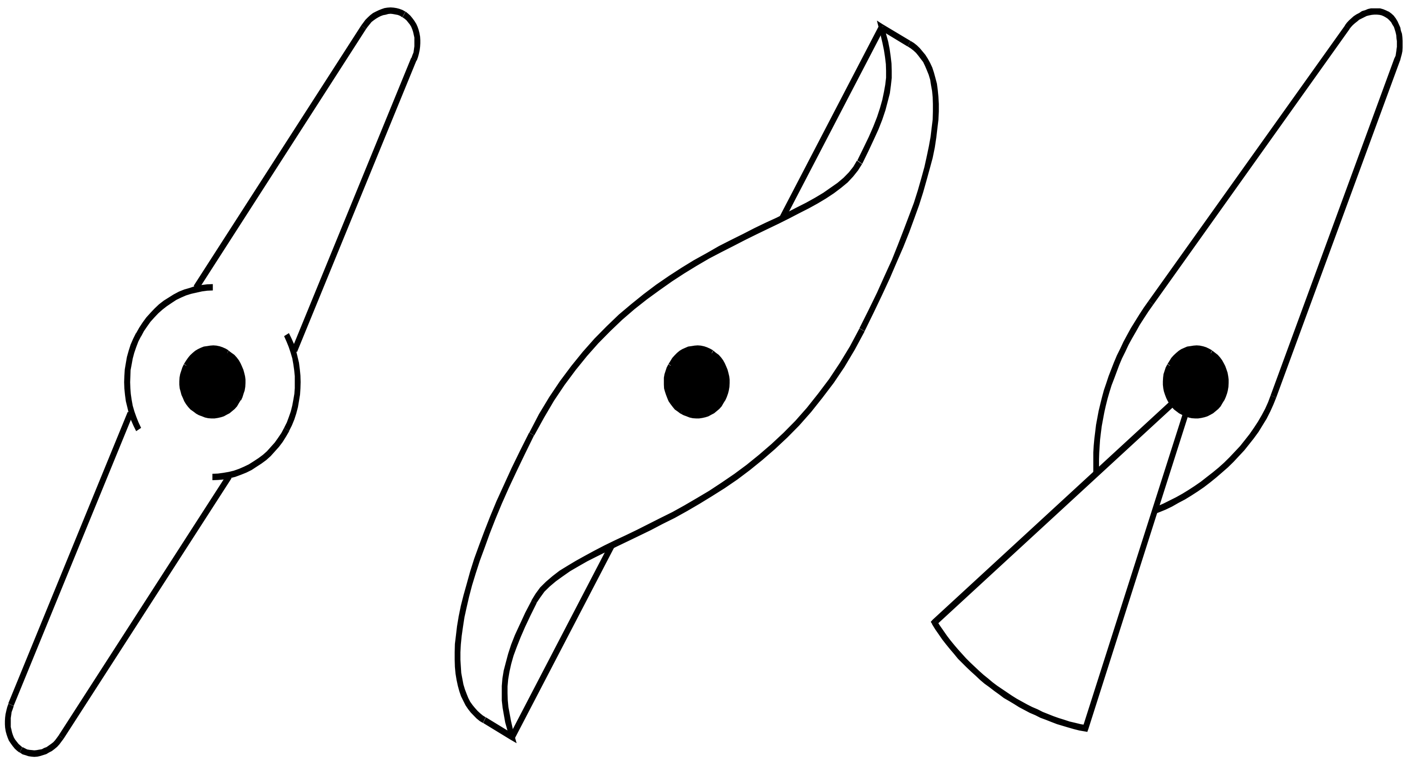


Figure 6.15

Advantages and Disadvantages

Advantages

- The valves can be part open in any position from fully closed to fully opened
- Fast operation
- The handle shows if the valve is open or closed.
- They can receive flow from both side.

Disadvantages

- Can only used with low flows rates
- Not suitable for tight shut-off
- Oversizing.

Ball Valves

- is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball to control flow through it.
- It is open when the ball's hole is in line with the flow and closed when it is pivoted 90-degrees by the valve handle.
- The ball valve's ease of operation, repair, and versatility lend it to extensive industrial use, supporting pressures up to 1000 bar and temperatures up to 752 °F (400 °C), depending on design and materials used.

Full port

- commonly known full bore ball valve has an over-sized ball so that the hole in the ball is the same size as the pipeline resulting in lower friction loss.

Reduced port or reduced bore

- flow through the valve is one pipe size smaller than the valve's pipe size resulting in flow area being smaller than pipe.

Reduced Port Ball Valve

V port

- has either a 'v' shaped ball or a 'v' shaped seat.
- When the valve is in the closed position and opening is commenced the small end of the 'v' is opened first allowing stable flow control during this stage.

Advantages and Disadvantages

Advantages

- Lower cost and weight.
- Higher flow capacity
- Tight shutoff.
- Fire safe.
- Low stem leakage.

Disadvantages

- Oversizing.

Control Valve Selection and Sizing

Factors in Selection

- **Fluid Flow**(Laminar & Turbulent Flow)
- **Density(ρ)-** define as mass per unit volume of a substance
- **Velocity(V)** -is a physical vector quantity and defined as distance per unit of time.
- **Viscosity(μ)-** the property of a fluid which opposes the relative motion between two surfaces of the fluid that are moving at different velocities.
- **Diameter of the Pipe**

Problems with oversized valves

- Poor control results as the gain of the process (control valve) is quite low at the bottom end of its operation. Because the resolution and accuracy are low, control becomes difficult and cycling can occur near the closed position
- Near the closed position, high velocity flows occur which can cause excessive seat wear between the plug and seat.

Reasons of the Problems

- Insufficient information about the process.
- Inaccurate input conditions.
- Accumulated safety margins.

Control valve sizing

Flow Coefficient, Cv(when expressed in imperial units)

- The valve flow coefficient is defined as the number of US gallons of water per minute (at 60oF) that will flow through a wide-open valve with a pressure drop of 1psi

- QL = Cv √ DP/GL
- Where:

Q = flow rate in US gallons per minute

G = specific gravity of liquid (water = 1.0)

DP = pressure drop across the valve in psi

Flow Coefficient, Kv (when in European units)

- is defined as the number of cubic meters per hour (at 15oC) that will flow through a wide-open valve with a pressure drop of 1bar (100kPa).

- $Q_L = K_v \sqrt{\underline{DP}} /G_L$

Where:

Q = flow rate in cubic metres per minute

G = specific gravity of liquid (water = 1.0)

DP = pressure drop across the valve in bar

Flow Coefficient, Av (when in SI metric units)

- The control valve capacity can be evaluated using the flow coefficient Av, and is described in the British standard 4740.

- The valve sizing formula is based on liquid flow:

QL = Av √ DP/P

Where:

Q = flow rate in cubic meters per second

G = density of liquid in kg/m3 (water = 1000)

DP = pressure drop across the valve in Pascal

Control Valve Characteristics

Control Valve Characteristics

The flow characteristics of a control valve show the rate of flow for the range of valve operation. There are two types of flow characteristics for control valves:

- **Inherent**
- **Installed**

Inherent

- determined by testing the valve flow versus valve lift using a constant differential pressure drop across the valve throughout the test.
- valves of any size or inherent flow characteristic
- The physical shape of the plug and seat arrangement, sometimes referred to as the valve ‘trim’, causes the difference in valve opening between these valves.

Inherent

- The inherent characteristic is based on a constant differential pressure drop across the valve throughout the test. The installed characteristic differs in that the pressure drop changes in relation to the valve stroke.

- When the valve opens and flow increases, the pressure drop across the valve decreases.

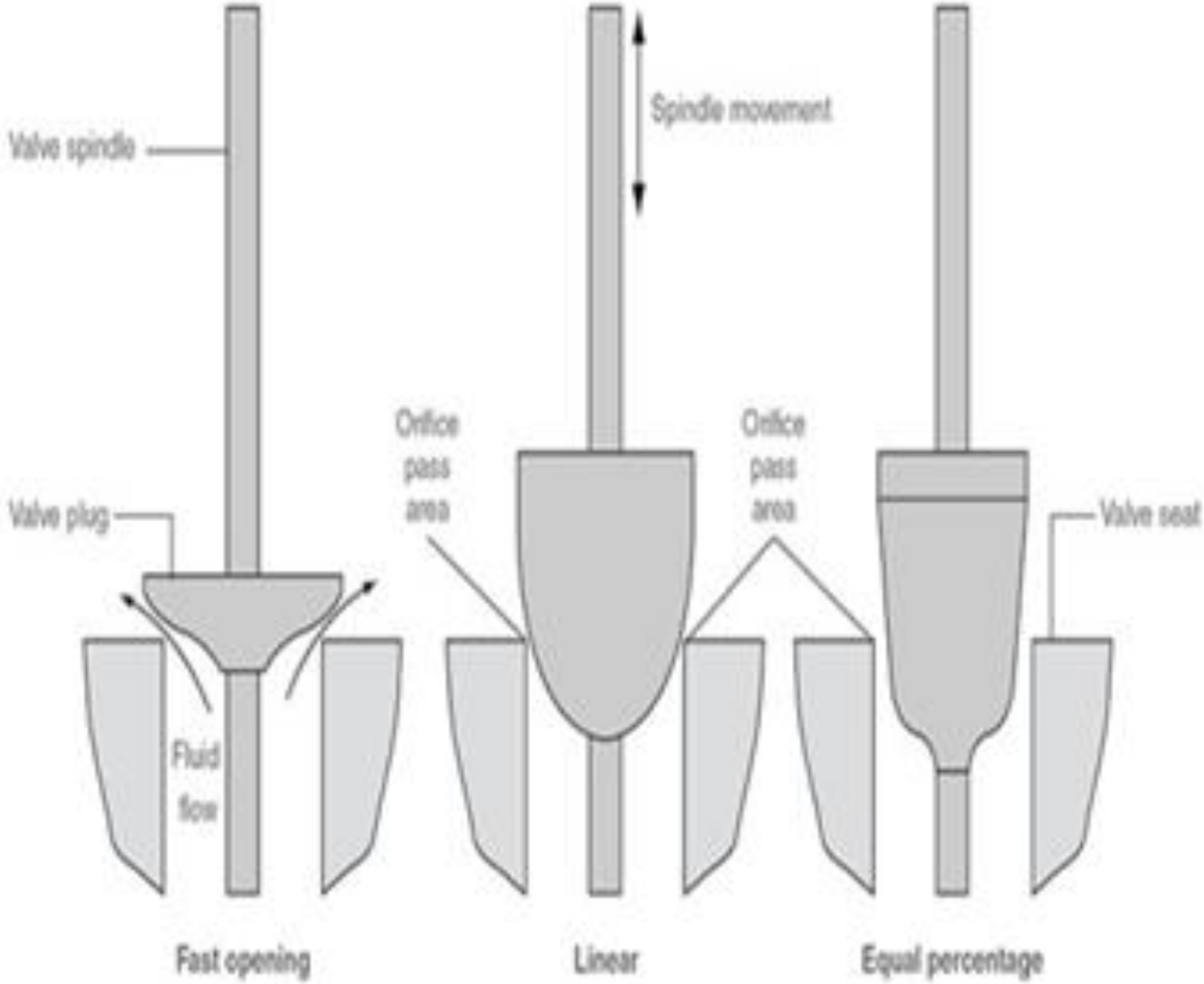
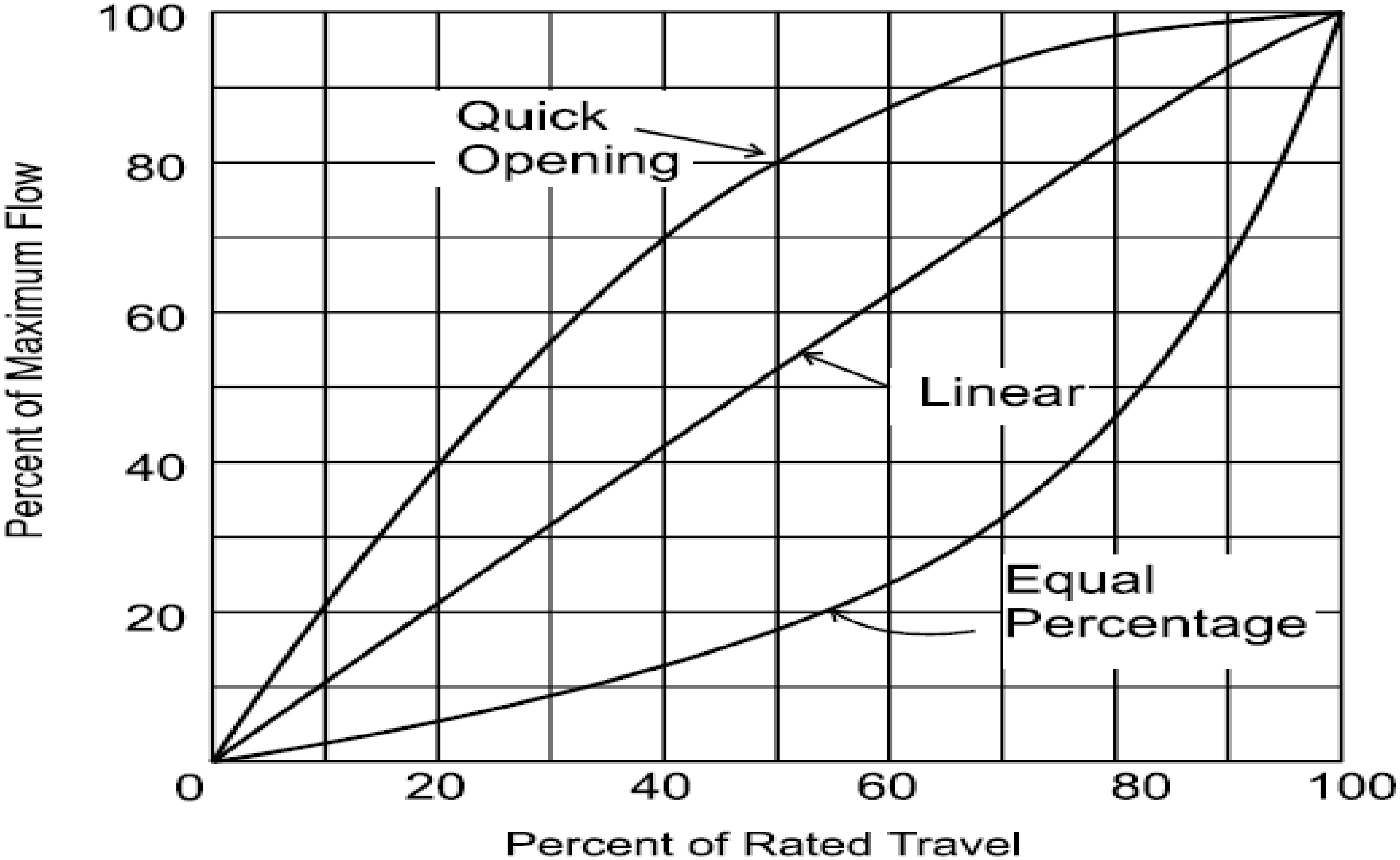


Fig. 6.5.1 The shape of the trim determines the valve characteristic


100
80
60
40
20
0
20
40
60
80
100
Percent of Maximum Flow
Percent of Rated Travel
Quick
Opening
Linear
Equal
Percentage

Inherent

- Quick opening
- Linear
- Equal percentage

These are the three curves which show the expected flow rate for valve position. These are ideal or theoretical valve characteristics and generally change when the valve is installed. The differences in the characteristic curves can be due to the reproducibility of the valve. This includes the quality control of manufacturing tolerances.

Fast opening

- The fast opening characteristic valve plug will give a large change in flowrate for a small valve lift from the closed position.
- A valve using this type of plug is sometimes referred to as having an ‘on/off’ characteristic.
- Fast opening valves tend to be electrically or pneumatically actuated and used for ‘on/off’ control.

Linear characteristic

- the linear characteristic valve plug is shaped so that the flowrate is directly proportional to the valve lift (H), at a constant differential pressure. A linear valve achieves this by having a linear relationship between the valve lift and the orifice pass area

Equal percentage characteristic (or logarithmic characteristic)

- these valves have a valve plug shaped so that each increment in valve lift increases the flowrate by a certain percentage of the previous flow. The relationship between valve lift and orifice size (and therefore flowrate) is not linear but logarithmic, and is expressed mathematically

Equal percentage characteristic (or logarithmic characteristic)

Equation 6.5.1	$\dot{V} = \dfrac{e^x}{\tau}\,\dot{V}_{max}$

Where:

$\dot{V}$ = Volumetric flow through the valve at lift H.

e = Exponential constant 2.718 3

x = (ln τ) H **Note:** 'ln' is a mathematical function known as 'natural logarithm'

τ = Valve rangeability (ratio of the maximum to minimum controllable flowrate, typically 50 for a globe type control valve)

H = Valve lift (0 = closed, 1 = fully open)

$\dot{V}_{max}$ = Maximum volumetric flow through the valve

Installed characteristics

- depends on how much of the total system pressure drop is across the valve. If all of the system pressure drop is across the valve, the installed characteristic is the same as the inherent characteristic.
- The installed valve characteristic can be modified to approximate the theoretical one using compensators in the control system

Control valve noise and cavitation

Control valve noise and cavitation

- Sound is generated from the movement of fluid through a valve.
- Noise is also a good diagnostic tool. As sound or noise is generated by friction, excessive noise indicates the possible damage occurring within a valve.
- The damage can be caused by the friction itself or vibration.

Control valve noise and cavitation

- There are three main sources of noise:
  - **Mechanical vibration**
  - **Hydrodynamic noise**
  - **Aerodynamic noise**

Mechanical Vibration

Mechanical vibration is a good indication of the deterioration of valve components. Because the noise generated is usually low in intensity and frequency, it is generally not a safety problem for personnel. Vibration is more of a problem with stem valves compared with cage valves. Cage valves have a larger supporting area and are therefore less likely to cause vibration problems.

Hydrodynamic Noise

- Hydrodynamic noise is produced in liquid flows. When the fluid passes through a restriction and a pressure change occurs it is possible that the fluid forms vapour bubbles. This is called flashing. Cavitation is also a problem, where the bubbles form but then collapse. The noise generated is generally not dangerous to personnel, but is a good indication
  of potential damage to trim components.

Aerodynamic Noise

- Aerodynamic noise is generated by the turbulence of gases and is a main source of noise. The noise levels generated can be dangerous to personnel, and are dependent on the amount of flow and the pressure drop.

Cavitation and Flashing

- Flashing occurs in liquid flows when some of the liquid changes permanently into vapour. This is brought on by a reduction in pressure forcing the liquid to change to the gaseous state. The reduction in pressure is caused by the restriction in the flowstream generating a higher flow rate through the restriction and therefore a reduction in pressure.
  The two main problems cause with flashing are:
    - **Erosion**
    - **Reduced capacity**

Erosion

- flow from the outlet of the valve is composed of liquid and vapour. With increased flashing, the vapour carries the liquid. As the velocity of the flowstream is increased, the liquid acts like solid particles as it strikes the internal parts of the valve.

Reduced Capacity

- When the flowstream partly changes to a vapour, as in the case of flashing, the space that it occupies is increased. Because of the reduced available area, the capacity for the valve to handle larger flows is limited. Choked flow is the term used when the flow capacity is limited in this way

Cavitation

- same as flashing except that the pressure is recovered in the outlet flowstream such that the vapour is returned to a liquid. The main concern with cavitation, is the damage to the trim and body of the valve. This is primarily caused by the collapsing of the bubbles.

ACTUATORS AND POSITIONERS OPERATION

ACTUATORS

- Actuators provide the driving force that controls a valves position. They are also required to reliably perform the following:

➢ Move the valve ball, plug or stem to the required position.

➢ Hold the position against the forces of the flowstream.

➢ Close off the flow by applying sufficient force.

➢ Provide the required operation for full control, from fully open to fully closed.

➢ Operate the movement at the required speed.

TYPES OF ACTUATOR

ELECTROMECHANICAL

- turn an electric motor's power into linear motion

APPLICATION

- electric actuator are often used where it is not practical to locate and properly maintain the required air supply needed for pneumatic actuators.

ADVANTAGES

- high thrust
- easily interfaced to control system

DISADVANTAGES

- large
- more expensive than pneumatic
- High power electrical source
- Poor controllability

LIMITATION

- normally have a duty cycle, which limit their continued use.

PROBLEM

- they can overheat when stalled

TYPES OF ACTUATOR

SOLENOID

- An electric current is applied to a solenoid coil which forces a metal plunger. The position of the plunger is determined by the applied voltage.

ADVANTAGES

- electrically controlled, therefore interface directly
- less expensive than electromechanical actuators

DISADVANTAGES

- limited thrust
- more expensive than pneumatics

TYPES OF ACTUATOR

HYDRAULIC

- Simple hydraulic are used, where a piston is hydraulically driven and provides the necessary movement to position and control valve.

ADVANTAGES

- fast response to control signals
- high loads
- variable stroking speed and stiffness

DISADVANTAGES

- requires external hydraulic supply
- not spring loaded, generally not fail-safe

TYPES OF ACTUATOR

PNEUMATIC-PISTON

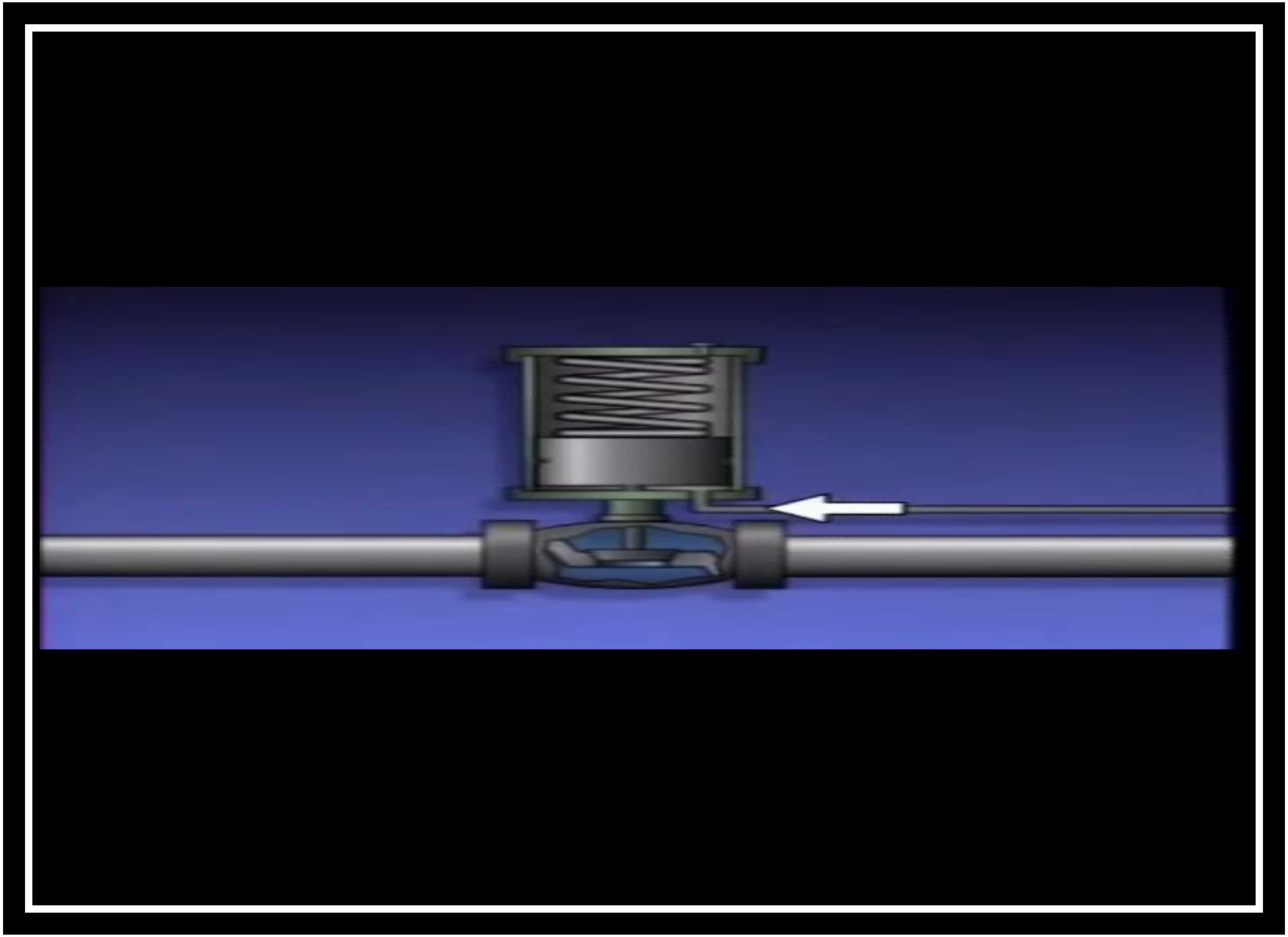
- Piston actuators provide very long travel with a very high thrust. They are more compact than the spring and diaphragm but do have increased stiffness.

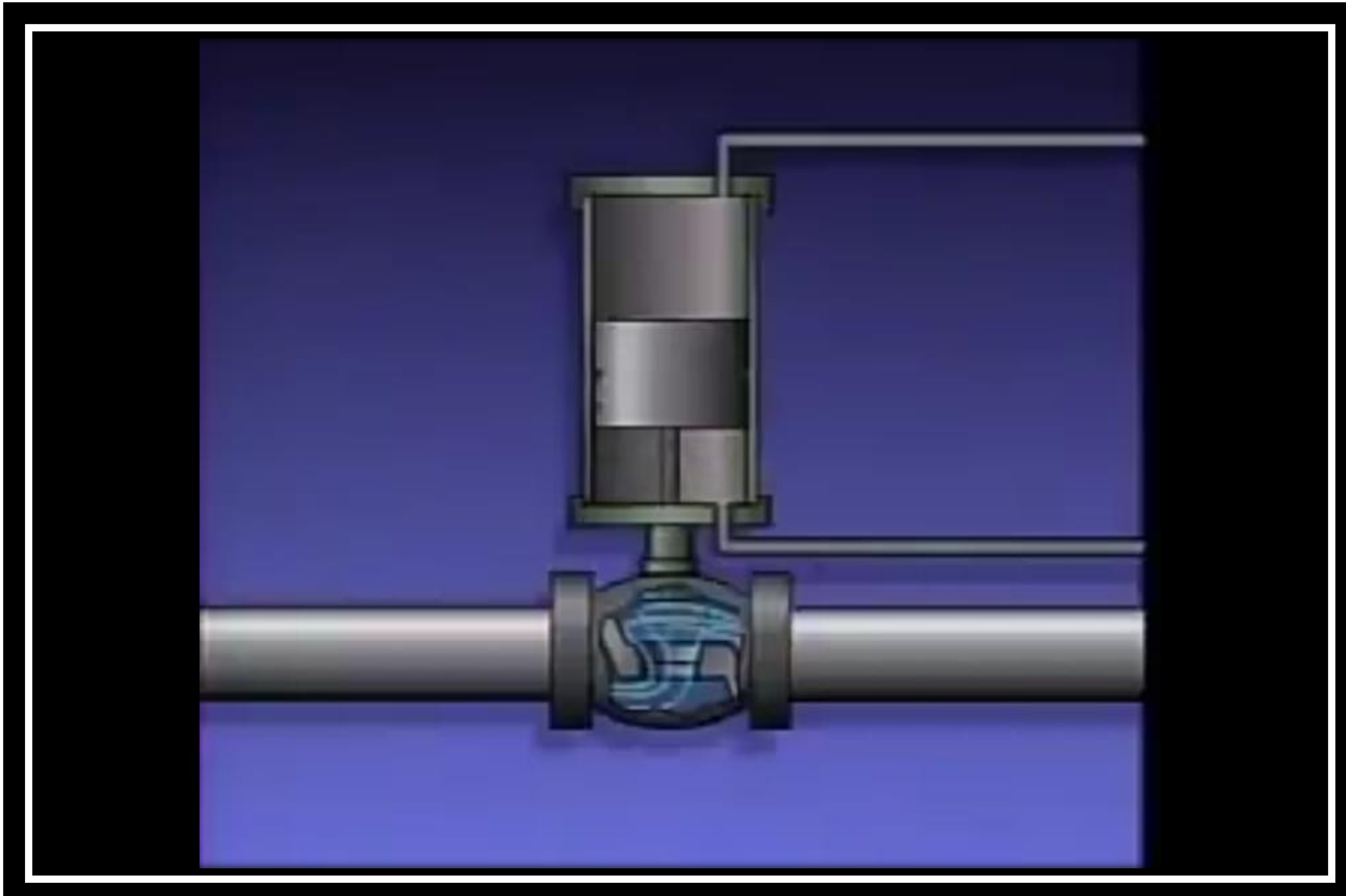
ADVANTAGES

- very long travel
- high thrust
- compact size
- increased stiffness

DISADVANTAGES

- fail safe requires trip system





TYPES OF ACTUATOR

PNEUMATIC–SPRING AND DIAPHRAGM

- It is very simple and reliable. The major advantage is the spring fail action that provides full shutoff in the event that the pneumatic air supply fails.

ADVANTAGES

- fail safe operation

DISADVANTAGES

- actuator force must work against spring

LIMITATION

- pneumatic actuators are susceptible to clogged air lines, particularly in low temperature applications which can cause condensate to freeze.

POSITIONER

- Positioners are used to feedback position information and ensure that the valve is in the correct position regardless of the opposing forces.
- Positioners can be limited if the correct position is opposed by forces greater than the actuator can provide.

ADVANTAGES

- assist in overcoming friction
- greater actuating pressure available

VALVE BENCHSET AND STROKING

VALVE BENCHSET AND STROKING

BENCHSET

- Are the actual pressure ranges for travel of the actuator with no friction

STROKING

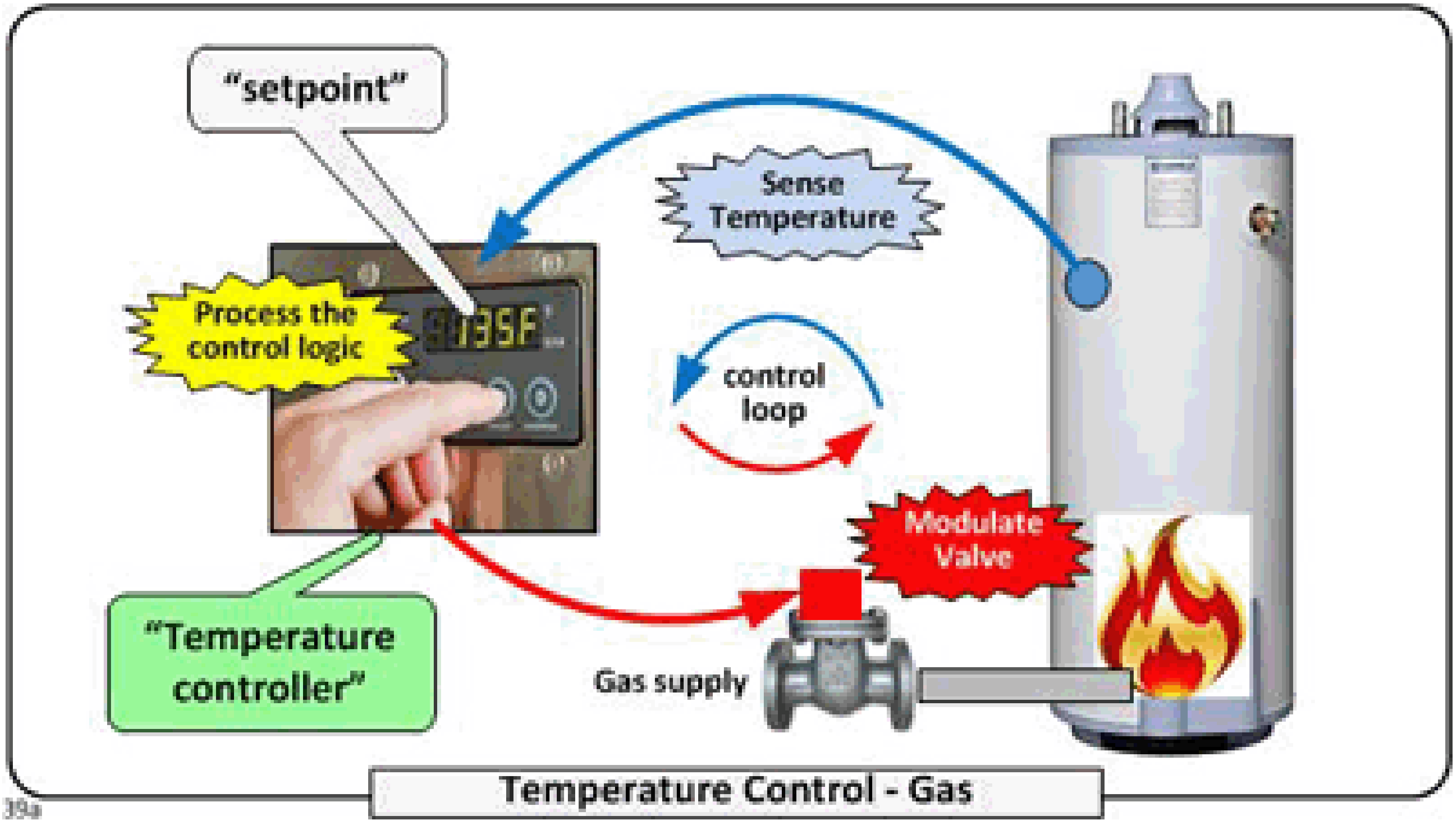
- Is the pressure range for the operation with friction
- Stroking takes into account the added pressure required to overcome friction forces when the actuator is connected to the valve assembly.

CONTROL LOOP

WHAT IS CONTROL LOOP?

CONTROL LOOP IS A GROUP OF COMPONENTS WORKING TOGETHER AS A SYSTEM TO ACHIEVE AND MAINTAIN THE DESIRED VALUE OF A SYSTEM VARIABLE BY MANIPULATING THE VALUE OF ANOTHER VARIABLE IN THE CONTROL LOOP.

EACH CONTROL LOOP HAS AT LEAST ONE INPUT AND AN OUTPUT.


"setpoint"
Sense Temperature
Process the control logic
135F
control loop
Modulate Valve
Gas supply
"Temperature controller"
Temperature Control - Gas
39a

THERE ARE TWO TYPES OF CONTROL LOOP

OPEN LOOP CONTROL SYSTEM

OPEN LOOP SYSTEM INCLUDES A CONTROLLER AND CONTROLLED DEVICE BUT NO MEANS FOR REPORTING THE VALUE OF THE PROCESS BACK TO THE CONTROLLER. THE CONTROLLED DEVICE ACTS DIRECTLY ON THE PROCESS INPUT.
NO MEANS IS PROVIDED TO MONITOR THE PROCESS OUTPUT AND CORRECT THE ERROR.

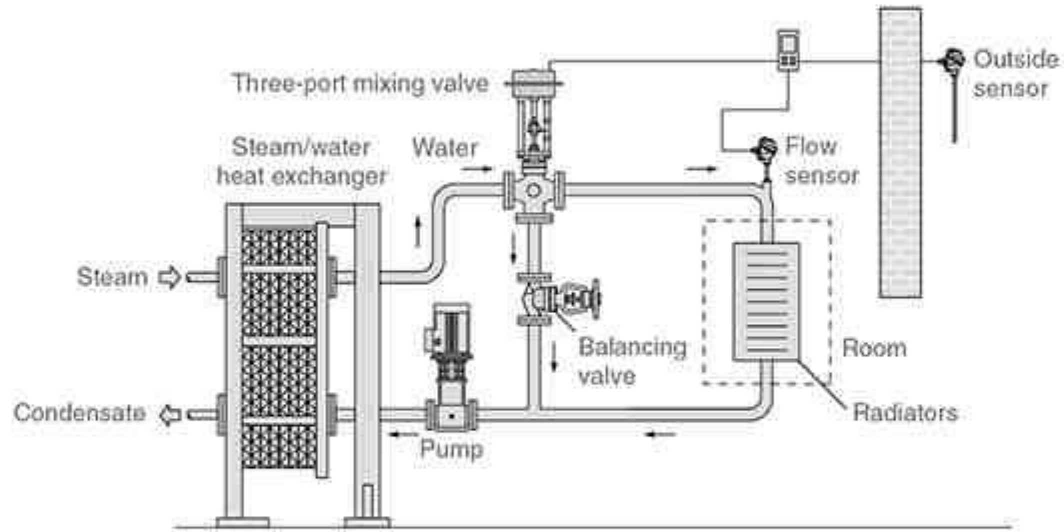
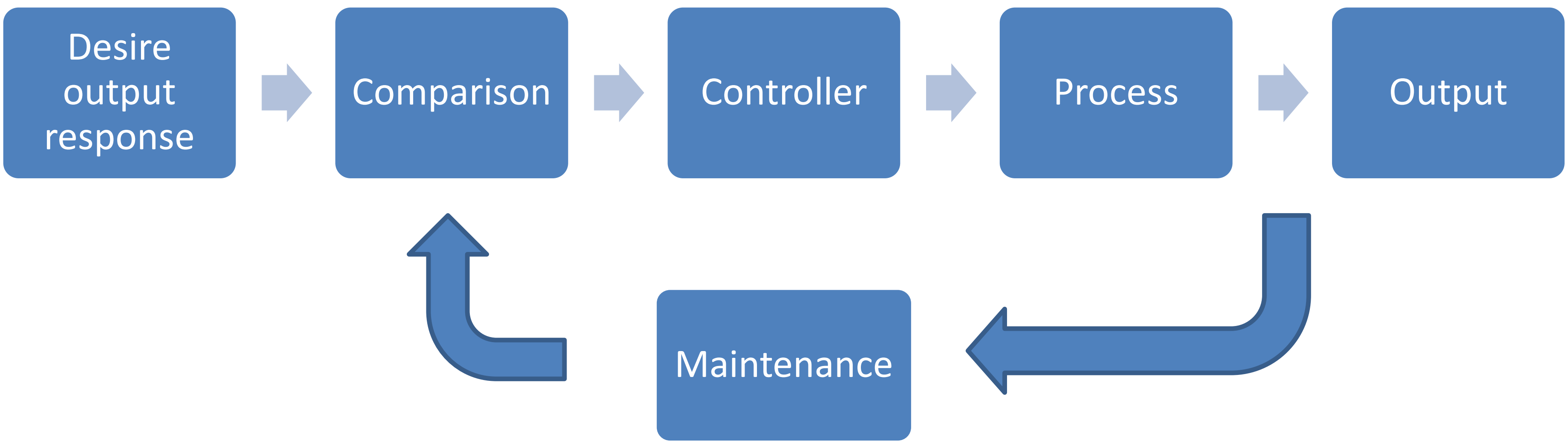


Fig. 5.3.2
Open loop control system with outside temperature sensor and water temperature sensor

Desire output response → Actuating device → Process → Output

CLOSED LOOP CONTROL SYSTEM

UNLIKE AN OPEN LOOP SYSTEM,
A CLOSED LOOP SYSTEM PROVIDES FEEDBACK,THAT IS A MEANS FOR MEASURING AND CORRECTING THE VALUE OF THE PROCESS OUTPUT. THE MAIN ADVANTAGE OF CLOSED LOOP SYSTEM IS ITS ABILITY MORE ACCURATE CONTROL OF A PROCESS,WHICH JUSTIFIES ITS USE DESPITE ITS GREATER TOOL.


Desire output response
Comparison
Controller
Process
Output
Maintenance

FUTURE TECHNOLOGIES

- **SMART VALVE** – The microprocessor gives an instrument the ‘smarts’’ to look at other information and calculate an optimum output for the process.

Information that the device may monitor would be:

- Inlet pressure
- Outlet pressure
- Inlet temperature
- Position of stem
- Top and bottom actuator pressure
- Positioner signal

SMART VALVE

The SMART VALVE is the patented, NSF/ANSI 61 and NSF/ANSI 372, precision engineered MONEY and WATER saving device for your water system. This seemingly simple, yet extremely effective variable flow management device solves a number of problems inherent in water delivery.

In this age of drastically rising water costs, increasing water conservation and SUSTAINABILITY efforts, it is more important than ever to be sure you are not using more, or paying more for your water than you should.

How it works

•The SMART VALVE air compression benefit works on all single jet, multi jet, and turbine category positive displacement meters.

•These make up over 99% of all water meters in use. The science is based upon Boyle’s Law regarding gas pressure and volume and Le Chatelier’s Principal of volumetric dynamics.

• The SMART VALVE is installed in your water line on your side of the meter as close to the meter as possible.

•The variable spring loaded plunger maintains a constant pressure on the oncoming water supply.

- This ‘backpressure’ manifests itself into a high pressure point on the other side of the water meter.
- When air reaches this pressure point, the air becomes compressed and no longer maintains its volume.
- It passes by the water meter in this compressed state until after it passes through the SMART VALVE and soon returns to its original uncompressed state.
- The SMART VALVE does NOT remove the air, it just compresses it so the water meter can’t measure it.

Now Available
Next Generation SMART VALVE™

Next Generation SMART VALVE

Expected savings with the next generation SMART VALVE are maximized because the valve can be ‘custom-calibrated’ for PSI in the field rather than factory pre-set based on site survey data, resulting in maximum performance efficiency relative to PSI and flow rate (GPM).

Installation

The SMART VALVE is installed on the USER side of the water meter. Installation must be done in conjunction with all applicable laws, codes and standard plumbing practice in your area.

Smart Valve

Attribute	Type	Definition
Command	Output	0 = Closed; 1 = Open
State	Input	0 = Closed; 1 = Open
Device ID	Identity	Device description array
Fault Alarm	Status	0 = Normal ; 1 = See extended status
Cycle Limit Reg.	Configuration	Trigger limit for maintenance flag
Fault State	Configuration	Close if system declares fault condition
Cycle Counter	Diagnostic	Accumulates # of open/close cycles
Extended Status	Diagnostic	0 = OK; 1 = Bad State; 2 = Maintenance
Force Command	Diagnostic	Local control: 0 = Closed; 1 = Open

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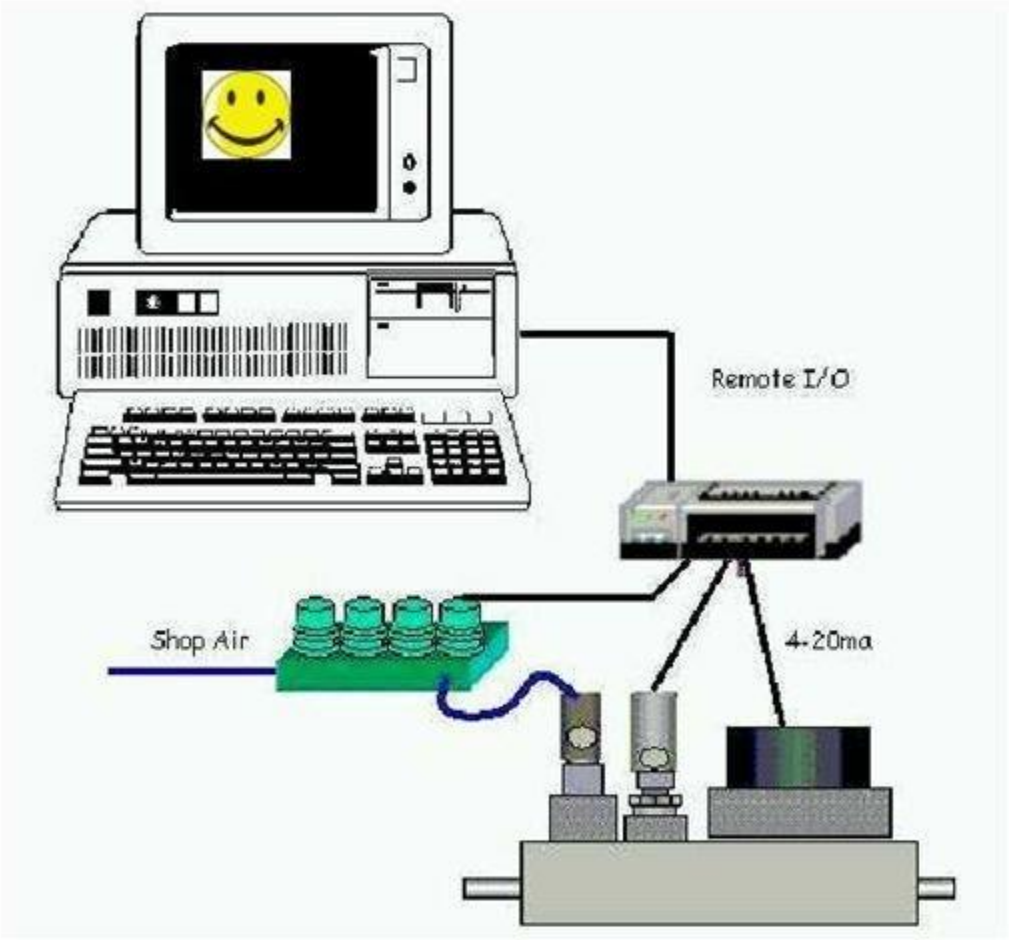
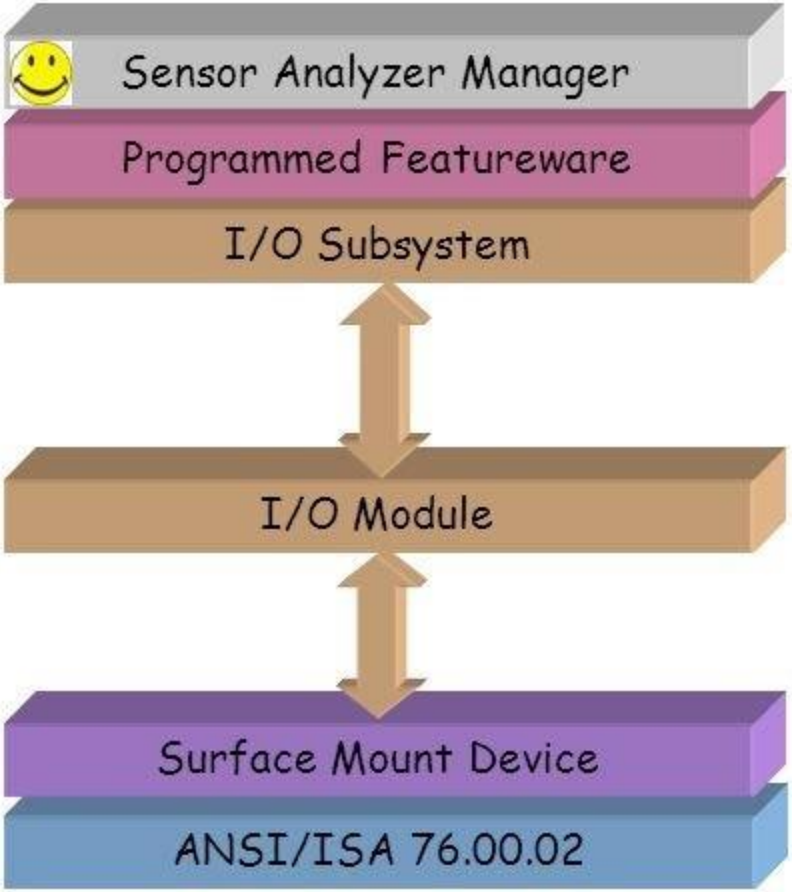
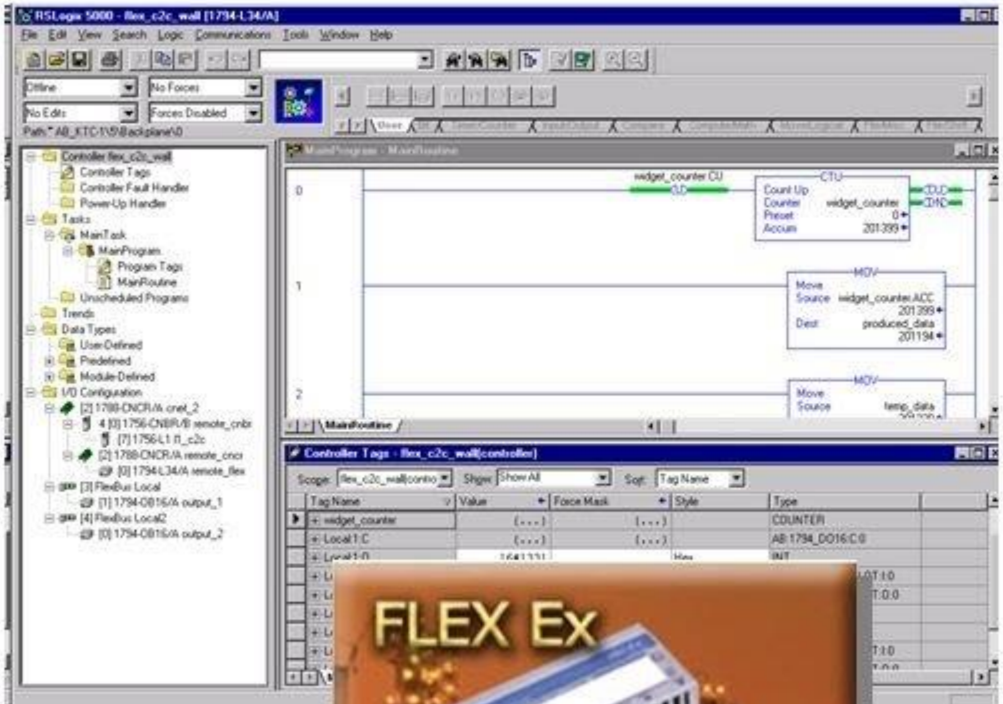
Generation I – The Present





Generation I Smart Valve – Today



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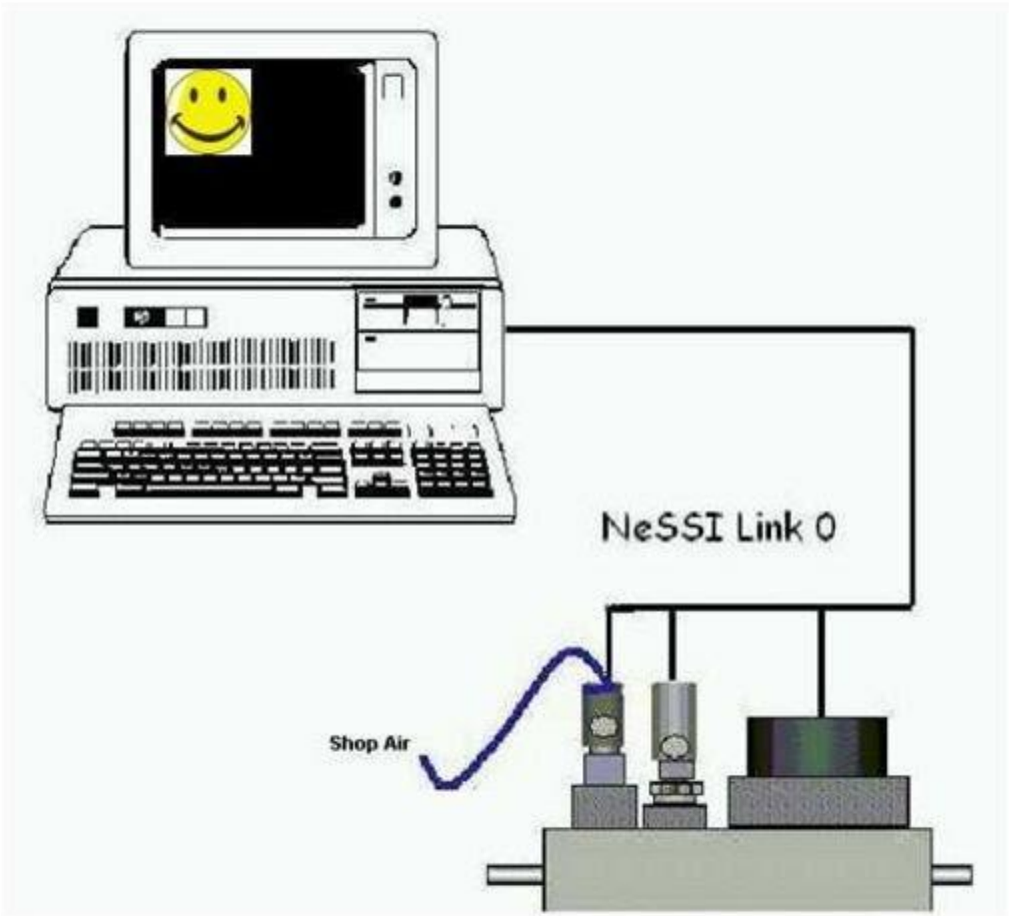
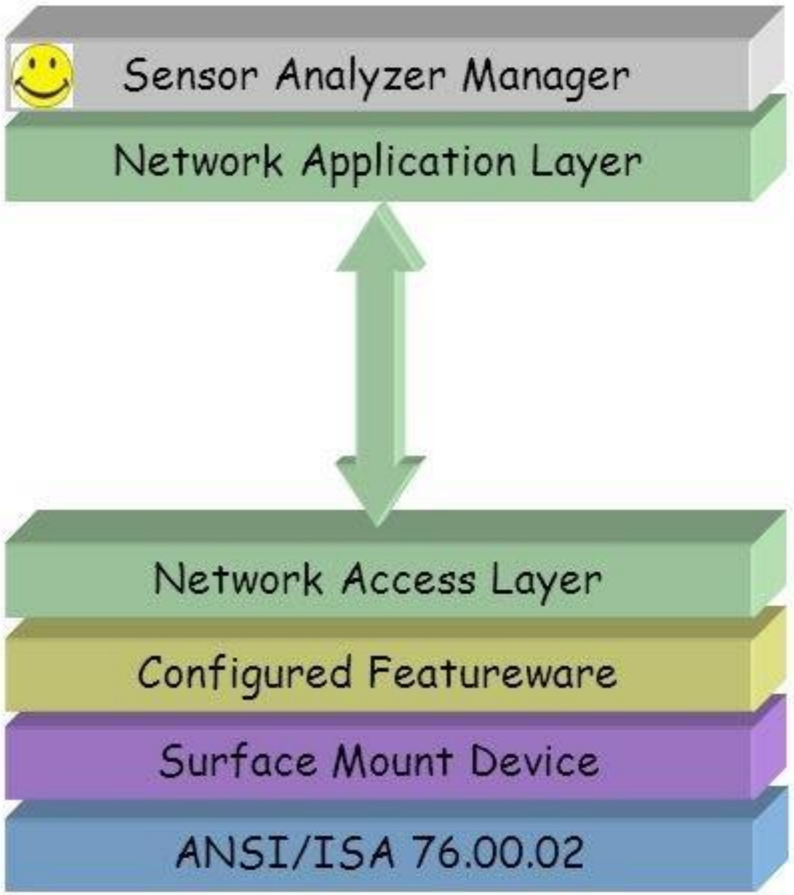
Generation II – The future





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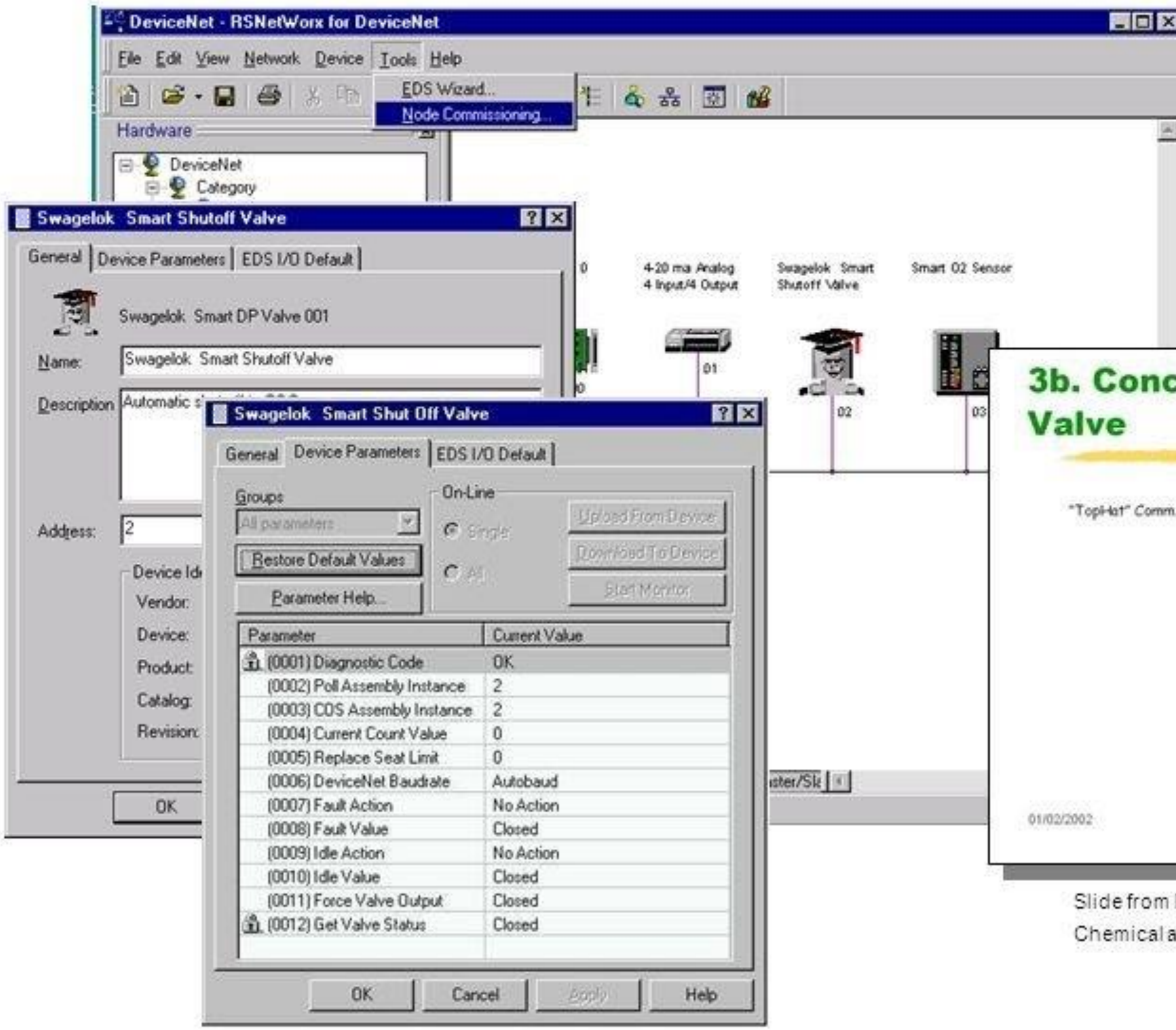
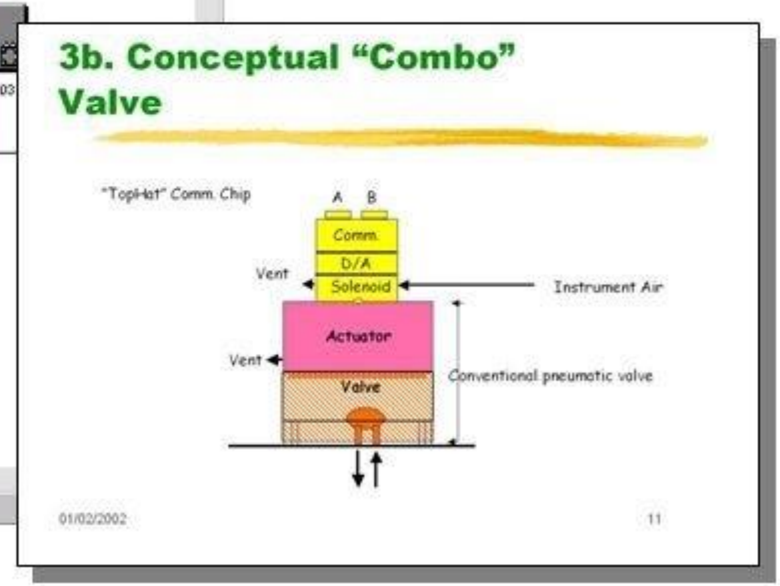
Generation II Smart Valve – The future





Slide from NeSSI Tutorial presented by Rob DuBois of Dow Chemical at ISA 2001

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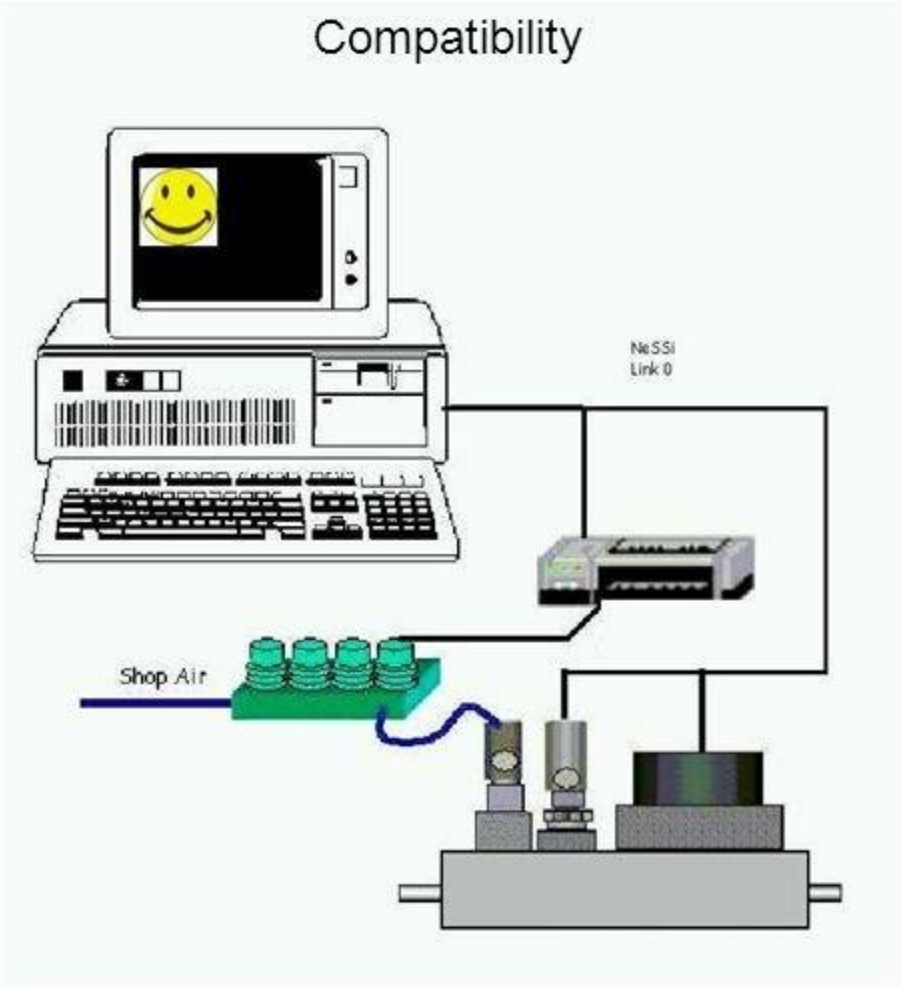
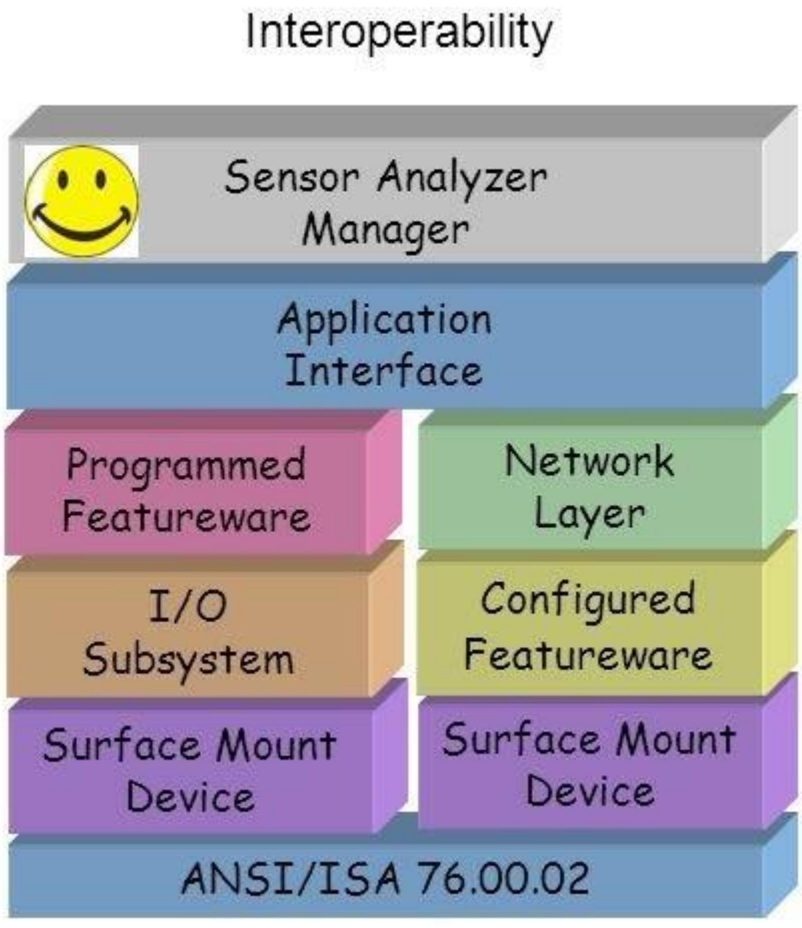
Migration Strategy





Smart Valve Advantages

- One-time installation
- Consistently better performance
- Ability to adjust to changes
- Greater flow rates
- Highly visible Facility
- Fully Certified