Basic Concepts of Valves

What is a Valve?

A valve is a mechanical device which regulates either the flow or the pressure of the fluid. Its function can be stopping or starting the flow, controlling flow rate, diverting flow, preventing back flow, controlling pressure, or relieving pressure.

Basically, the valve is an assembly of a body with connection to the pipe and some elements with a sealing functionality that are operated by an actuator. The valve can be also complemented whit several devices such as positioners, transductors, pressure regulators, etc.

Different types of Valves are available: gate, globe, plug, ball, butterfly, check, diaphragm, pinch, pressure relief, and control Valves. Each of these types has a number of models, each with different features and functional capabilities. Some Valves are self-operated while others manually or with an actuator or pneumatic or hydraulic is operated.

What are the main Functions from Valves?:

- Stopping and starting flow
- Reduce or increase a flow
- Controlling the direction of flow
- Regulating a flow or process pressure
- Relieve a pipe system of a certain pressure

Classification of Valves

The following are some of the commonly used Valve classifications, based on mechanical motion:

- Linear Motion Valves. The Valves in which the closure member, as in gate, globe, diaphragm, pinch, and lift Check Valves, moves in a straight line to allow, stop, or throttle the flow.
- Rotary Motion Valves. When the Valve-closure member travels along an angular or circular path, as in butterfly, ball, plug, eccentric- and Swing Check Valves, the Valves are called rotary motion Valves.
- Quarter Turn Valves. Some rotary motion Valves require approximately a quarter turn, 0 through 90°, motion of the stem to go to fully open from a fully closed position or vice versa.

What is a Gate valve?

Isometric symbol and images

Gate Valves are primarily designed to start or stop flow, and when a straight-line flow of fluid and minimum flow restriction are needed. In service, these Valves generally are either fully open or fully closed.
The disk of a Gate Valve is completely removed when the Valve is fully open; the disk is fully drawn up into the Valve Bonnet. This leaves an opening for flow through the Valve at the same inside diameter as the pipesystem in which the Valve is installed.

A Gate Valve can be used for a wide range of liquids and provides a tight seal when closed.

Advantages of using Gate Valves:

- Good shutoff features
- Gate Valves are bidirectional and therefore they can be used in two directions
- Pressure loss through the Valve is minimal

The major drawbacks to the use of a Gate Valve are:

- They cannot be quickly opened or closed
- Gate Valves are not suitable for regulate or throttle flow
- They are sensitive to vibration in the open state

Construction of a Gate Valve

Gate Valves consists of three main parts: body, Bonnet, and trim. The body is generally connected to other equipment by means of flanged, screwed or welded connections. The Bonnet, which containing the moving parts, is attached to the body, usually with bolts, to permit maintenance. The Valve trim consists of the stem, the gate, the disc or wedge and the seat rings.

What is a Globe valve?

Isometric symbol and images

A Globe Valves is a linear motion Valve and are primarily designed to stop, start and regulate flow. The disk of a Globe Valve can be totally removed from the flowpath or it can completely close the flowpath.

The fundamental principle of the Globe Valve operation is the perpendicular motion of the disk away from the seat. This ensures that the ring-shaped space between the disk and seat ring gradually close as the Valve is closed. This property gives a Globe Valve reasonably good throttling capability. Therefore, the Globe Valve can be used for starting and stopping flow and to regulate flow.

Advantages of using Globe Valves:

- Good shutoff capability
- Reasonably good throttling capability

The major drawbacks to the use of a Globe Valve are:

- Higher pressure drop compared to a Gate Valve
- Large Valve sizes require considerable power or a larger actuator to operate

Body designs of Globe Valves

There are three primary body designs for Globe Valves, namely: Z-body, Y-body and Angle body.

- **Z-body** design is the most common body type, with a Z-shaped diaphragm. The horizontal setting of the seat allows the stem and disk to travel perpendicular to the horizontal line.

- **Y-body** design is an alternative for the high pressure drop, inherent in Globe Valves. Seat and stem are angled at approximately 45 degrees, what gives a straighter flowpath at full opening.

- **Angle-body** design is a modification of the basic Z-type Globe Valve. The ends of this Globe Valve are at an angle of 90 degrees, and fluid flow occurs with a single 90 degrees turn.

What is a Check valve?

Isometric symbol and images

Check Valves are "automatic" Valves that open with forward flow and close with reverse flow. The pressure of the fluid passing through a system opens the Valve, while any reversal of flow will close the Valve. Exact operation will vary depending on the type of Check Valve mechanism. Most common types of Check Valves are swing, lift (piston and ball), butterfly, stop and tilting-disk.

Types of Check Valves

- **Swing Check Valve**
  A basic swing Check Valve consists of a Valve body, a Bonnet, and a disk that is connected to a hinge. The disk swings away from the Valve-seat to allow flow in the forward direction, and returns to Valve-seat when upstream flow is stopped, to prevent backflow.
  The disc in a swing type Check Valve is unguided as it fully opens or closes. There are many disk and seat designs available, in order to meet the requirements of different applications. The Valve allows full, unobstructed flow and automatically closes as pressure decreases. These Valves are fully closed when flow reaches zero, in order to prevent backflow. Turbulence and pressure drop in the Valve are very low.

- **Lift Check Valve**
  The seat design of a lift-Check Valve is similar to a Globe Valve. The disc is usually in the form of a piston or a ball.
  Lift Check Valves are particularly suitable for high-pressure service where velocity of flow is high. In lift Check Valves, the disc is precisely guided and fits perfectly into the dashpot. Lift Check Valves are suitable for installation in horizontal or vertical pipe-lines with upward flow.
  Flow to lift Check Valves must always enter below the seat. As the flow enters, the piston or ball is raised within guides from the seat by the pressure of the upward flow. When the flow stops or reverses, the piston or ball is forced onto the seat of the Valve by both the backflow and gravity.

  Recommended for:

  - Control of direction of flow and quick.
  - Automatic reaction to flow change.
  - Use in conjunction with gate valve.
  - They should not be used in air compressor
  - Service or on a reciprocating pump as these
  - Services will cause chattering and valve
  - Vibration damage.

What is a Ball valve?

Isometric symbol and images

A Ball Valve is a quarter-turn rotational motion Valve that uses a ball-shaped disk to stop or start flow. If the Valve is opened, the ball rotates to a point where the hole through the ball is in line with the Valve body inlet and outlet. If the Valve is closed, the ball is rotated so that the hole is perpendicular to the flow openings of the Valve body and the flow is stopped.

Advantages of using Ball Valves:

- Quick quarter turn on-off operation
- Tight sealing with low torque
- Smaller in size than most other Valves

Disadvantages of Ball Valves:

- Conventional Ball Valves have poor throttling properties
- In slurry or other applications, the suspended particles can settle and become trapped in body cavities causing wear, leakage, or Valve failure.

Types of Ball Valves

Ball Valves are basically available in three versions: full port, venturi port and reduced port. The full-port Valve has an internal diameter equal to the inner diameter of the pipe. Venturi and reduced-port versions generally are one pipe size smaller than the line size.

Ball Valves are manufactured in different body configurations and the most common are:

- Top entry Ball Valves allow access to Valve internals for maintenance by removal of the Valve Bonnet-cover. It is not required to be removed Valve from the pipe system.
- Split body Ball Valves consists of a two parts, where one part is smaller as the other. The ball is inserted in the larger body part, and the smaller body part is assembled by a bolted connection.

The Valve ends are available as butt welding, socket welding, flanged, threaded and others.

What is a Butterfly valve?

Isometric symbol and images

A Butterfly Valve is a quarter-turn rotational motion Valve that is used to stop, regulate, and start flow. Butterfly Valves are easy and fast to open. A 90° rotation of the handle provides a complete closure or opening of the Valve. Large Butterfly Valves are usually equipped with a so-called gearbox, where the handwheel by gears is connected to the stem. This simplifies the operation of the Valve, but at the expense of speed.

Types of Butterfly Valves

Butterfly Valves has a short circular body, a round disc, metal-to-metal or soft seats, top and bottom shaft bearings, and a stuffing box. The construction of a Butterfly Valve body varies. A commonly used design is the wafer type that fits between two flanges. Another type, the lug wafer design, is held in place between two flanges by bolts that join the two flanges and pass through holes in the Valve's outer casing. Butterfly Valves are even available with flanged, threaded and butt welding ends, but they are not often applied.

Butterfly valves possess many advantages over gate, globe, plug, and ball valves, especially for large valve applications. Savings in weight, space, and cost are the most obvious advantages. The maintenance costs are usually low because there are a minimal number of moving parts and there are no pockets to trap fluids.

Butterfly valves are especially well-suited for the handling of large flows of liquids or gases at relatively low pressures and for the handling of slurries or liquids with large amounts of suspended solids.

Butterfly valves are built on the principle of a pipe damper. The flow control element is a disk of approximately the same diameter as the inside diameter of the adjoining pipe, which rotates on either a vertical or horizontal axis. When the disk lies parallel to the piping run, the valve is fully opened. When the disk approaches the perpendicular position, the valve is shut. Intermediate positions, for throttling purposes, can be secured in place by handle-locking devices.

Recommended for:

- Positive shut-off is necessary
- Fully open or fully closed applications
  (May be used for throttling applications)
- Quarter turn operation - 90º rotation from fully
  Open/fully closed
- Easily adapts to automation
- Lightweight design offers easy installation
- Replaces costly Iron body gate valves

What is a Plug valve?

Isometric symbol and images

A Plug Valve is a quarter-turn rotational motion Valve that use a tapered or cylindrical plug to stop or start flow. In the open position, the plug-passage is in one line with the inlet and outlet ports of the Valve body. If the plug 90° is rotated from the open position, the solid part of the plug blocks the port and stops flow. Plug Valves are similar to Ball Valves in operation.

Advantages of using Plug Valves:

- Quick quarter turn on-off operation
- Minimal resistance to flow
- Smaller in size than most other Valves

Disadvantages of Plug Valves:

- Requires a large force to actuate, due to high friction.
- NPS 4 and larger Valves requires the use of an actuator.
- Reduced port, due to tapered plug.

Types of Plug Valves and Sealing

Plug Valves are available in a nonlubricated or lubricated design and with several styles of port openings. The port in the tapered plug is generally rectangular, but they are also available with round ports and diamond ports.

Plug Valves are also available with cylindrical plugs. The cylindrical plugs ensure greater port openings equal to or larger than the pipe flow area.

- Lubricated Plug Valves are provided with a cavity in the middle along there axis. This cavity is closed at the bottom and fitted with a sealant-injection fitting at the top. The sealant is injected into the cavity, and a Check Valve below the injection fitting prevents the sealant from flowing in the reverse direction. The lubricant in effect becomes a structural part of the Valve, as it provides a flexible and renewable seat.
- Nonlubricated Plug Valves contain an elastomeric body liner or a sleeve, which is installed in the body cavity. The tapered and polished plug acts like a wedge and presses the sleeve against the body. Thus, the nonmetallic sleeve reduces the friction between the plug and the body.

Recommended for:

A Plug Valve can be used in many different fluid services and they perform well in slurry applications. The following are some typical applications of Plug Valves:

- Air, gaseous, and vapor services
- Natural gas piping systems
- Oil piping systems
- Vacuum to high-pressure applications

What is a Needle valve?

Isometric symbol and images

It is called needle valve due to the shape of the closure member. It consists on a threaded stem with a conical end.

Stems with fine threaded have a slow linear movement when they turn, therefore a great number of turns are needed to have a full flow section. This makes the needle valve suitable for regulating flow, with a minimal waste and without cavitation at important differential pressures.

This valve is also placed in the bypass of the turbine inlet valve. That valve is normally butterfly or spherical type and not prepared to open against all column water pressure. The slow opening and regulated closure of the needle valve avoid cavitation and water hammer in the pipeline system.

Uses:

Needle valves are used in almost every industry in an incredibly wide range of applications - anywhere control or metering of steam, air, gas, oil, water or other non-viscous liquids is required. However, needle valves should be avoided in applications where the media is viscous, or in the dispensation of slurries. The small flow orifice can easily trap thick materials or solids and become blocked.