“ VALVES “

TECHNICAL FULL PAPER

A REFORMER FEED PREPARATION UNIT IN AROMATICS PLANT OF M/s BHARAT PETROCHEMICAL CORPORATION LTD – MAHUL REFINERY-MUMBAI MS -2019-20

HALDIA PANAGARH PIPE LINE PROJECT HPPL HPCL HALDIA WB 2024 -25

ABSTRACT : A REVIEW

Valves have many uses, including controlling water for irrigation, industrial uses for controlling processes, residential uses such as on/off and pressure control to dish and clothes washers and taps in the home. Even aerosol spray cans have a tiny valve built in. Valves are also used in the military and transport sectors. In HVAC ductwork and other near-atmospheric air flows, valves are instead called dampers. In compressed air systems, however, valves are used with the most common type being ball valves.

Definition of a Valve:

Valves are mechanical devices specifically designed to direct, start, stop, mix, or regulate the flow, pressure, or temperature of a process fluid. Valves can be designed to handle either liquid or gas applications.

Valves are used in every engineering industry on the planet. When you wash your hands, you open a valve. When you shower, you open a valve. Valves are required any time you want to start, stop, or control flow within a system.

There are many valve designs, types and models, with a wide range of industrial applications. All satisfy one or more of the functions identified above. Valves are expensive items, and it is important that a correct valve is specified for the function, and must be constructed of the correct material for the process liquid.

Regardless of type, all valves have the following basic parts: the body, bonnet, trim (internal elements), actuator, and packing.

Valves are found in virtually every industrial process, including water and sewage processing, mining, power generation, processing of oil, gas and petroleum, food manufacturing, chemical and plastic manufacturing and many other fields.

TECHNICAL FULL PAPER- " VALVES "

A REFORMER FEED PREPARATION UNIT IN AROMATICS PLANT OF M/s BHARAT PETROCHEMICAL CORPORATION LTD – MAHUL REFINERY-MUMBAI

COMPREHENSION OF THE VALVES IN GIST- A REVIEW PAPER

The different types of valves used in the petrochemical industry suit any of the following applications:

1. Start/stop the flow of the fluid (hydrocarbons, oil & gas, steam, water, acids) through the pipeline (example: gate valve, ball valve, butterfly valve, knife gate valve, or plug valve)
2. Modulate the flow of the fluid through the pipeline (example: globe valve)
3. Control the flow of the fluid (control valve)
4. Change the direction of the flow (for example a 3-way ball valve)
5. Regulate the pressure of a process (pressure reducing valve)
6. Protect a piping system or a device (pump, motor, tank) from overpressures (safety or pressure relief) or back-pressures (check valve)
7. Filter debris flowing through a pipeline, to protect equipment that may be damaged by solid parts (y and basket strainers)

Valves used in the oil and gas industry and for piping applications can be classified in multiple ways:

VALVES BY DISC TYPE

- LINEAR MOTION: gate, globe, diaphragm, pinch, and check valves
- ROTARY MOTION: butterfly, ball, plug, eccentric- and swing check valves
- QUARTER TURN: devices that require approximately a quarter turn motion, from 0 to 90° of the stem to move from fully close to a fully open position or vice versa.

VALVES BY BODY MATERIAL

- CAST (the body is obtained by casting steel). The main casting materials for valves are listed in this article.
- FORGED (the body is manufactured by forging steel)

The difference between steel casting and forging is explained in this article.

VALVES BY TYPE OF ACTUATION

- MANUAL: the valve is operated manually, via levers, wheels and/or gears;
- ACTUATED: the valve is actioned via electromechanical devices, called actuators, that may be electric, pneumatic, hydraulic and gas over oil

VALVE BY DESIGN

- GATE VALVE: This type is the most used in piping and pipeline applications. Gate valves are linear motion devices used open and close the flow of the fluid (shutoff valve). Gate valves cannot be used for throttling applications, i.e. to regulate the flow of the fluid (globe or ball valves should be used in this case). A gate valve is, therefore, either fully opened or closed (by manual wheels, gears or electric, pneumatic and hydraulic actuators)
- GLOBE VALVE: This type of valve is used to throttle (regulate) the fluid flow. Globe valves can also shut off the flow, but for this function, gate valves are preferred. A globe valve creates a pressure drop in the pipeline, as the fluid has to pass through a non-linear passageway.
- CHECK VALVE: this type of valve is used to avoid backflow in the piping system or the pipeline that could damage downstream apparatus as pumps, compressors, etc. When the fluid has enough pressure, it opens the valve; when it comes back (reverse flow) at a design pressure, it closes the valve – preventing unwanted flows.

- BALL VALVE: A Ball valve is a quarter-turn valve used for shut-off application. The valve opens and closes the flow of the fluid via a built-in ball, that rotates inside the valve body. Ball valves are industry standard for on-off applications and are lighter and more compact than gate valves, which serve similar purposes. The two main designs are floating and trunnion (side or top entry)
- BUTTERFLY VALVE: This is a versatile, cost-effective, valve to modulate or open/close the flow of the fluid. Butterfly valves are available in concentric or eccentric design (double/triple), have a compact shape and are becoming more and more competitive vs. ball valves, due to their simpler construction and cost.
- PINCH VALVE: This is a type of linear motion valve that can be used for throttling and shut-off application in piping applications that handle solid materials, slurries and dense fluids. A pinch valve features a pinch tube to regulate the flow.
- PLUG VALVE: Plug valve is classified as a quarter-turn valve for shut-off applications. The first plug valves were introduced by the Romans to control water pipelines.
- SAFETY VALVE: A safety valve is used to protect a piping arrangement from dangerous overpressures that may threaten human life or other assets. Essentially, a safety valve releases the pressure as a set-value is exceeded.
- CONTROL VALVE: these are valves to automate complex petrochemical processes.
- Y-STRAINERS: while not properly a valve, Y-strainers have the important function of filtering debris and protect downstream equipment that may be otherwise damaged

VALVE SIZES

To make sure that valves of different manufacturers are interchangeable, the face to face dimensions (i.e. the distance in mm or inches between the inlet and the outlet of the valve) of the key types of valves have been standardized by the ASME B16.10 specification.

VALVES BY BODY MATERIAL

- CAST (the body is obtained by casting steel). The main casting materials for valves are listed in this article.
- FORGED (the body is manufactured by forging steel)

The difference between steel casting and forging is explained in this article.

VALVES BY TYPE OF ACTUATION

- MANUAL: the valve is operated manually, via levers, wheels and/or gears;
- ACTUATED: the valve is actioned via electromechanical devices, called actuators, that may be electric, pneumatic, hydraulic and gas over oil

VALVE BY DESIGN

- GATE VALVE: This type is the most used in piping and pipeline applications. Gate valves are linear motion devices used open and close the flow of the fluid (shutoff valve). Gate valves cannot be used for throttling applications, i.e. to regulate the flow of the fluid (globe or ball valves should be used in this case). A gate valve is, therefore, either fully opened or closed (by manual wheels, gears or electric, pneumatic and hydraulic actuators)
- GLOBE VALVE: This type of valve is used to throttle (regulate) the fluid flow. Globe valves can also shut off the flow, but for this function, gate valves are preferred. A globe valve creates a pressure drop in the pipeline, as the fluid has to pass through a non-linear passageway.
- CHECK VALVE: this type of valve is used to avoid backflow in the piping system or the pipeline that could damage downstream apparatus as pumps, compressors, etc. When the fluid has enough pressure, it opens the valve; when it comes back (reverse flow) at a design pressure, it closes the valve – preventing unwanted flows.
- BALL VALVE: A Ball valve is a quarter-turn valve used for shut-off application. The valve opens and closes the flow of the fluid via a built-in ball, that rotates inside the valve body. Ball valves are industry standard for on-off applications and are lighter and more compact than gate valves, which serve similar purposes. The two main designs are floating and trunnion (side or top entry)
- BUTTERFLY VALVE: This is a versatile, cost-effective, valve to modulate or open/close the flow of the fluid. Butterfly valves are available in concentric or eccentric design (double/triple), have a compact shape and are becoming more and more competitive vs. ball valves, due to their simpler construction and cost.
- PINCH VALVE: This is a type of linear motion valve that can be used for throttling and shut-off application in piping applications that handle solid materials, slurries and dense fluids. A pinch valve features a pinch tube to regulate the flow.

- PLUG VALVE: Plug valve is classified as a quarter-turn valve for shut-off applications. The first plug valves were introduced by the Romans to control water pipelines.
- SAFETY VALVE: A safety valve is used to protect a piping arrangement from dangerous overpressures that may threaten human life or other assets. Essentially, a safety valve releases the pressure as a set-value is exceeded.
- CONTROL VALVE: these are valves to automate complex petrochemical processes.
- Y-STRAINERS: while not properly a valve, Y-strainers have the important function of filtering debris and protect downstream equipment that may be otherwise damaged

VALVE SIZES

To make sure that valves of different manufacturers are interchangeable, the face to face dimensions (i.e. the distance in mm or inches between the inlet and the outlet of the valve) of the key types of valves have been standardized by the ASME B16.10 specification.

FLOW CONTROL VALVE ACTUATORS

The selection of actuators is based on the required thrust of the rod and the movement of the valve.

Engineers must determine if the diagram or piston actuator is the most suitable type. Actuators are the primary energy source used to move and position the flow control element within the valve body.

A variety of types are available, including pneumatic, electric, hydraulic, electro-hydraulic and manual. Pneumatic actuators are the most widely used for throttling applications.

Considered the standard for automatic control for more than a century, three types of pneumatic actuators are available: piston, spring-and-diaphragm, and rotary vane. The first two can be adapted for use on either rotary or sliding-stem valves; the latter is used only on rotary valves.

FLOW CONTROL VALVE ACCESSORIES

Normally, the selection of accessories such as positioners transducers, boosters, solenoid valves, limit switches, hand wheels and travel stop, snubbers, regulators, transmission lines, is based on engineering specifications.

Cost is a major factor in material selection.

Not just the cost of material in dollars per pound, but also the cost of fabrication and inspection contribute to the uninstalled cost of the valve. Installed cost includes not only the cost of installation but also the cost of any damage from improper installation and costs the inspection.

The latter consists of such things as analysis of material chemistry, radiographic and surface examination of castings and welds, and check to see that the installed valve is the correct one and that it is properly oriented.

The selection of the appropriate or optimal control valve type depends on the particular study of the pipe system and the conditions of its fluid, but the size of the control valve should be such that pressure drops through it and not the drop of pressure of the pipe is the one that controls the flow.

All valves, including steam control valves, are designed to meet an allowable internal leakage standard (FCI / ANSI). The higher the number of leaks, the lower the permissible internal leakage rate.

A Class I valve will have the highest internal leakage rate and usually the lowest cost; While a Class VI valve will have the lowest allowable internal leakage rate. Steam valves must be specified to have a leak rate of not less than Class IV. A class IV steam control valve will maintain a long service life.

FLOW CONTROL VALVES TYPES

Control valves can be classified into two main types, based on the stem movement:

- Linear motion/reciprocating: globe (straight, angle, 3-way), diaphragm and, pinch control valves
- Rotary stem: ball, butterfly and, plug control valves types

Globe control valves can be either single or double seat.

CONTROL VALVE SELECTION

Process engineers must consider many factors to select the correct control valve. The general criteria to be considered for selection are summarized below:

- Type of control; the degree of control; the degree of shutoff.
- Design temperature; design pressure; allowable pressure drop.
- Fluid corrosivity; fluid erosion properties; other characteristics, such as fouling or coking.
- Inherent characteristics, such as valve Cv: degree of hazard from leakage; heat or cold conservation; cost.

As the design criteria are known, process engineers can proceed to make a selection of the correct type of control valve and related equipment, as well as the material of the valve itself.

The next step is to create the detailed specification (generally drafted by a specialized piping engineer) and create a purchase specification describing the valve for suppliers.

The specification should contain, as minimum: a description of the type of control valve (rotary, sliding); bore size and pressure rating; end-connections; type of body joints; material specification for body components, trim, gaskets and bolting; positioner and controller requirements; a reference to an industry design standard for type of valve.

Generally, a computerized system help engineers determine the most suited control valve and its features based on process parameters.

Globe valve

Gate valve

Ball valve

Check valve

Butterfly valve

Plug valve

Diaphragm valve

CONTROL VALVES INSTALLATION

- Always expand the discharge steam line piping at least one pipe diameter. It is not uncommon to expand the discharge piping at least two or three pipe diameters. It should be noted that the expansion of the pipe reduces the valve outlet velocities thus prolonging the valve life. The valve manufacturer will provide the appropriate pipe size after the control valve. Match the pipe size to the heat transfer inlet connection.
- The distance after the steam control valve should be at least ten pipe diameters before the inlet connection of any heat transfer. In pressure reduction applications at least 20 horizontal pipe diameters must be left before a change of flow direction.
- The control valve must always be installed in a horizontal vapor line, never vertically.
- It is more important to properly select the valve at low flow operating conditions that at its assumed high flow operating conditions.

- Bypass valves must be used in the control valve installation. The by-pass valve is used to allow the personnel of the industrial facility to operate the process without the control valve if valve failure or maintenance reactive, preventive and predictive.
- Installing pressure gauges before and after the steam control valve allows the line diagnostics in real time. The importance of proper installation cannot be overstated. In many cases, the source of a troublesome startup can be traced to a control valve that is not properly installed. It is strongly recommended that personnel with an instrumentation background be used at least to supervise the installation and setup of control valves.

PROCUREMENT OF VALVES:

Manufacturers of valves used in the oil and gas industry need to know the following information to supply the right device:

- Valve type
- Bore size in NPS or DN
- Valve pressure rating (class range from 150# to 4500#)
- Specification (example API 6D, API 600, API 602, etc)
- Body and trim materials (at least)
- Required end connection (flanged, threaded, butt weld, lug and others)
- Fluid in the pipeline (>oil, gas, water, steam, solids)
- Working temperature and pressure
- Quantity
- Delivery time
- Origin restrictions (Chinese and Indian origins allowed or not)

Oil & Gas Valve Types	Linear motion valves	Rotary motion valves	Quarter turn valves
Gate valve	X		
Globe valve	X		
Check valve		X	
Lift check valve	X		
Tilting-disc check valve		X	
Stop check valve	X	X	
Ball valve		X	X
Pinch valve	X		
Butterfly valve		X	X
Plug valve		X	X
Diaphragm valve	X		
Safety valve / Pressure Relief Valve	X		

ASME B16.34: VALVE COMPLIANCE

The ASME valve standard B16.34 is a globally accepted standard to design, manufacture and test valves used in the oil and gas industry. ASME B16.34 is also mentioned in the more general ASME spec ASME B31.1, “Power Piping Design”.

Back in 1988, the scope of this standard was modified to include threaded-end and weld-end valves in addition to flanged-end valves.

A valve complies with ASME B16.34 when the following conditions are met:

- The valves body & shell materials comply with ASME and ASTM material standards for chemistry and strength
- Body & shell materials are heat-treated to ensure proper grain structure, corrosion resistance, and hardness.
- Wall thicknesses of body and other pressure-containing components meet ASME B16.34 specified minimum values for each pressure class.
- NPT and SW end connections comply with ASME B1.20.1 or ASME B16.11.
- Stems are internally loaded and blowout proof.
- All bolting will be ASTM grade with maximum applied stress controlled by B16.34.
- Each valve is shell tested at 1,5x rated pressure for a specific test time duration.

REVIEW OF VALVES

- Each valve is tested for seat leakage in both directions for a specific test time duration.
- Each valve is permanently tagged with materials of construction, operating limits and name of the manufacturer.

Parameters for Procurement:

GS – F – 6" / 150 – 316 – B

1 2 3 4 5

1. Valve type	2. End type	3. Size / Class	4. Body Material	5. Options
C: Check Valve CL: Lift Check Valve CS: Check pressure Sealed Valve CW: Swing Check Valve G: Gate Valve GG: Forged Gate Valve GL: Light Type Gate Valve (API 603) GS: Gate Pressure Sealed Valve O: Globe Valve OB: Globe Bellowed Sealed Valve OS: Globe Pressure Sealed Valve Y: Y-strainer	F: Flanged End T: Threaded End W: Butt Weld End S: Socket Weld End	Size: NPS 1/2 – 80" ANSI Standard: 150: 150 LB Class 300: 300 LB Class 600: 600 LB Class 1500: 1500 LB Class DIN Standard : PN16 PN25 PN40 JIS Standard : 10K: JIS 10K 20K: JIS 20K	GG: Forged Gate Valve 316: Casting S.S CF8M 304: Casting S.S CF8 F316: Forgings S.S F316 F304: Forgings S.S F304 WCB: Steel WCB LCB: Steel LCB HB: Hastelloy B IN: Inconel	B: By-Pass G: Gear Operator D: Drains

API 600 Steel Valves – Flanged & Buttwelding Ends

API 600 is the primary steel gate valve purchase specification. Valve design and construction criteria are detailed, as well as materials and trim designations. An appendix contains information pertaining to pressure seal valves. ISO Standard 10434 is essentially the same as API 600, only published in the ISO format.

API 602 Compact Steel Gate Valves- Flanged, Threaded, Welding and Extended-Body Ends

API 602 is the 4" & smaller forged steel gate valve purchase specification. Valve design and construction criteria are detailed, as well as materials and trim designations. Future versions of this document are expected to include requirements for bellows seal gate valves.

API 603 Class 150, Cast, Corrosion-Resistant, Flanged-End Gate Valves

API 603 covers light walled gate valves in sizes NPS 1/2" through 24", in classes 150, 300 & 600. These valves are used in applications where the thicker API 600 casting is not needed.

API 608 Metal Ball Valves-Flanged and Butt-Welding Ends

API 608 is the purchase specification for class 150 and class 300 metal ball valves. Valve design and construction criteria are detailed. Important Note- ball valve working pressures should be based on seat material, not valve class.

API 609 Butterfly Valves, Lug-Type and Wafer Type

API 609 is the purchase specification for butterfly valves with lug-type and wafer-type configurations designed for installation between ANSI B16 flanges, through Class 600.

API 598 Valve Inspection & Testing

API 598 covers the testing and inspection requirements for gate, globe, check, ball, plug & butterfly valves. Steel valve pressure ratings found in ASME/ANSI B16.34 are required to determine API 598 test pressures for steel valves.

API 6D Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)

Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)
API 6D is the primary standard for valves used in pipeline service, including gate, plug, ball and check valves. Occasionally refinery and petrochemical purchasers will reference the more stringent testing requirements of 6D although the valve may have built under API 600, 602, 608 or 609 design criteria.

ASME/ANSI B16.34 Steel Valves – Flanged & Buttwelding Ends
ASME B16.34 is the base document from which steel valve pressure/temperature ratings are derived. It also offers additional valve specification data including nondestructive examination procedures for upgrading valves to Special Class. Note: Gate valves manufactured under B16.34 wall thickness minimums may not meet the minimum wall thickness requirement of API 600 & API 602 for class 150, 300 and 600.

ASME/ANSI B16.10 Face-to-Face Dimensions of Ferrous Valves
B16.10 lists the face to face dimensions of all flanged and buttweld end valves. Screwed and socketweld end valve face-to-face dimensions are not included in this specification.

MSS SP-55 Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components
SP-55 details the visual inspection criteria for castings. This specification is listed as part of the procedure under API 598. NACE MR-0175 Standard Material Requirements for Sulfide Stress Cracking Resistant Metallic Materials For Oilfield Equipment MR-0175 is the “standard” for materials used in “sour” environments such as found in piping systems in many refineries. It lists materials, mechanical properties and heat treatments for metals used in Hydrogen Sulfide bearing hydrocarbon service.

Conclusion :

It can give out look , and good understanding of the differences between the various types of valves, and how these differences affect the valve function. It will help to a proper application of each type of valve during the design and the proper use of each type of valve during operation.

Valves are typically rated for maximum temperature and pressure by the manufacturer.

AN INTRODUCTION ABOUT SELF:

I AM K VENKATESHWAR , BACHELOR OF ENGINEERING(MECHANICAL) –

FROM OSMANIA UNIVERSITY, HYDERABAD PASSED OUT IN 1991 IN FIRST DIVISION WITH DISTINCTION AND NOW WORKING FOR

Thermosystems Private Limited, Hyderabad, India

I HAVE 8 PROFESSION ACCREDITATIONS IMMENSELY WORKING FOR THE PROJECT MANAGEMENT OF THE MAINLY STEEL, POWER AND PETROCHEMCIAL SECTORS.