# Gate Valves Right Selection with Right Features for the Right Application

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Gate valve is a common type of isolation valve for on-off service. The gate valve's closure member (gate) moves out of the flow stream perpendicular to the flow path. Typical process gate valve uses wedge gate. Upon closing the gate to effect shutoff, the two faces of the gate engage the matching angle of the valve body seats. Turning the hand wheel forces the disc firmly into seats, which, assisted by line pressure, provides for shut off of flow.

**Fig 1**

***Typical Gate Valve, Flexible wedge, Bolted Bonnet, Rising Stem***

The wedge gate sluice valve was invented by James Nasmyth in 1839 with the intention of eliminating deficiencies observed in traditional taper plug valves.

Typical Gate valve is shown in Fig 1.

Basically gate valves are classified based on type of disc/wedge, body bonnet joint and type of stem movement.

I. Based on Types of Disc
   - Solid wedge
   - Flexible wedge (Fig 1)
   - Split wedge or Parallel Discs (Fig 2)

II. Based on Body Bonnet Joint method
   - Screwed Bonnet
   - Welded Bonnet
   - Bolted Bonnet
   - Pressure Seal Bonnet (Fig 2)

III. Based on Stem movement
   - Rising Stem (Fig 1)
   - Non-rising Stem

## Gate Valve Standards

The popular / common standards covering gate valves are API 600, API 602 and API 603.

API 600 covers sizes from NPS 1 and larger in pressure classes from Class 150 to Class 2500 with flanged or butt-welding ends. This standard was developed for refinery applications to provide a robust, heavy wall design suitable for service up to 538°C (1000°F). Pressure-temperature ratings for these valves are given in ASME B16.34 (standard class) for the listed materials.

API 602 covers the smaller gate valves in sizes up to NPS 4 for pressure classes from Class 150 to Class 1500 including Class 800. API 602 gate valves are commonly used in process plants in sizes from NPS 1/2 to NPS 2 in Class 800 with threaded or socket-welding ends.

API 603 was developed to provide valves for corrosive, lower pressure services. They provide a lighter-weight,

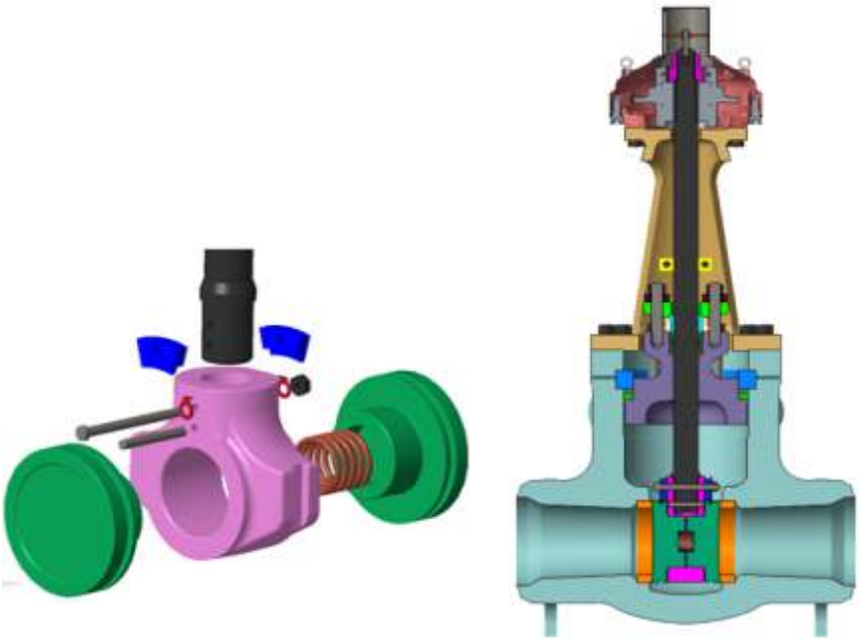

*Fig 2 : Parallel Discs, Pressure seal Bonnet, Rising Stem*

corrosion-resistant design made of a stainless or nickel alloy. API 603 specifies wall thicknesses comparable to those in ASME B16.34.

Gate valves complying to API standards shall be qualified for API 624 which warrants the use of API 622 qualified packings having 100 ppm fugitive emission tightness requirements. This ensures the quality of packings and minimize the emissions.

API gate valves manufactured at L&T Valves comply to API norms including fugitive emission requirements.

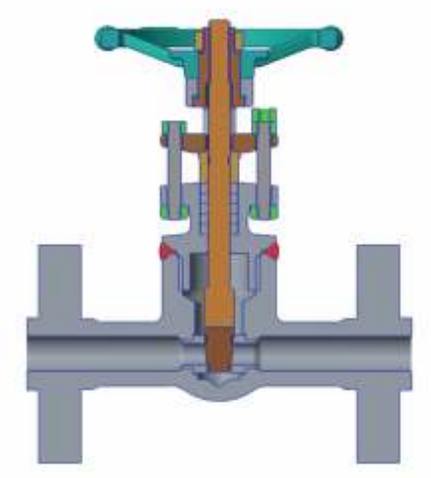

*Fig 3 : Screwed, Welded Bonnet, Rising Stem*

Standard Gate valves used without proper understanding of its suitability for applications can lead to certain issues. This article deals with the right selection of gate valve with right features for the right application.

## Challenging Applications for using a Gate Valve

Gate valves are isolation valves and should not be used for throttling, regulation or inching services. Improper usage causes noise, vibration, damage to internals and premature failure.

## 1. Piping Stress:

Valve sealing performance is affected when the piping stresses are transmitted to the seating area. Flexible wedge (Fig 1) accommodates some deviation from the ideal seat position caused by deflection of the valve body due to pipe line stresses, thereby resulting improved seat tightness. Solid wedge Gate Valves are not suitable for such applications.

## 2. High Temperature Service:

Thermal binding happens on wedge gate valves for high temperature applications. Parallel slide valves (Fig 2) are closed and opened according to the stem travel position and not with toque as wedge gate design. Because of this, sealing capability and operating forces are virtually unaffected by wide temperature variations. The disc assembly compensates for angular misalignment of the seats or longitudinal shrinkage of the valve body on cooling.

## 3. Cavity Over Pressure:

Gate valve cavity gets "over pressurised" during heating/restarting the plant due to entrapped liquid when the valve closed condition. This can be solved by providing vent hole at high pressure side. It is also solved by providing suitable equalising arrangement (Fig 4).

## 4. Cover Joint Leak Tightness:

Typical bolted bonnet construction is generally bulky compared to pressure seal joint particularly for class 900 and higher. For less weight consideration and trouble free gasket joint, pressure seal construction with butt weld ends are preferred (Fig 2). However, bolted bonnet joints are preferred where periodical valve maintenance is involved.

## 5. Hot Tap Application:

For hot tap application, the flow bore shall be large enough to pass the hot tap cutter. Leak tightness as per codes shall be ensured prior to installation.

## 6. Operating Effort:

Gate valves shall be designed to have the operating effort requirements as per MSS SP 91 / EN 12570 which generally permits 700 N to 1000 N effort. However, there is a stringent requirement specified by customers for 360 N or less

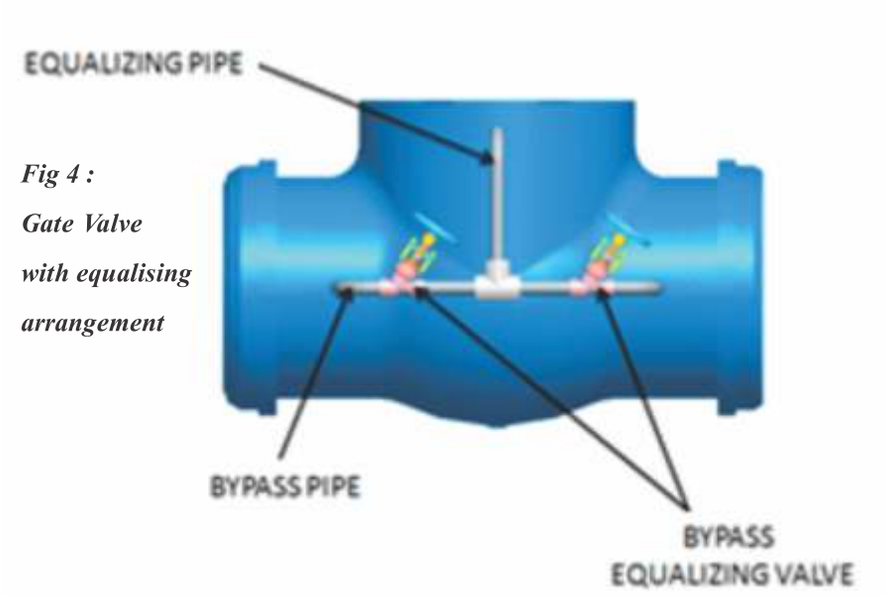


*Fig 4 : Gate Valve with equalising arrangement*

efforts. For such cases the higher strength stem MOC shall be selected or Torque Limiting device shall be provided.

## 7. Installation Orientation:

Generally, Gate valves are preferred to be installed with stem upwards. However, accumulation of dirt and particles to be considered in vertical installation and drain connections may be provided to take care of the same ( Fig 5).

For flare gas application it's preferred to be installed upside down (Fig 6).

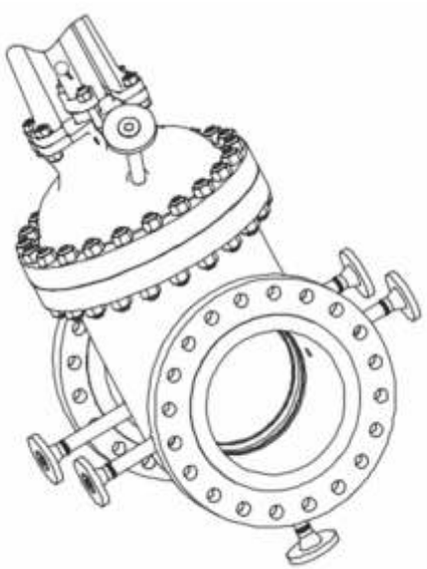

*Fig 5 : Gate Valve with Drain and Purge Connections.*

For other orientations, special attention to guiding arrangement including clearances, avoidance of sharp corners on the leading edge, and the use of machining / hard facing on the guides is recommended to avoid galling/ jamming.

## 8. Stainless Steel Trim:

When both seat faces are provided with Stainless Steel overlay/facing, it leads to galling. For such cases, hard face overlay is preferred on seat faces to improve the valve life.

## 9. Hazardous / toxic applications:

For hazardous and toxic applications, fugitive emission to atmosphere is prohibited. For such applications bellows seal arrangement shall be provided which ensure almost nil leakage to atmosphere (Fig 7).

## 10. Space Constraint:

As the gate travels to clear the flow bore, the overall height of valve is comparatively higher. Hence it is not suitable for the services such as marine application where space availability is a constraint. For such application, Non Rising Stem Gate Valves are suitable.

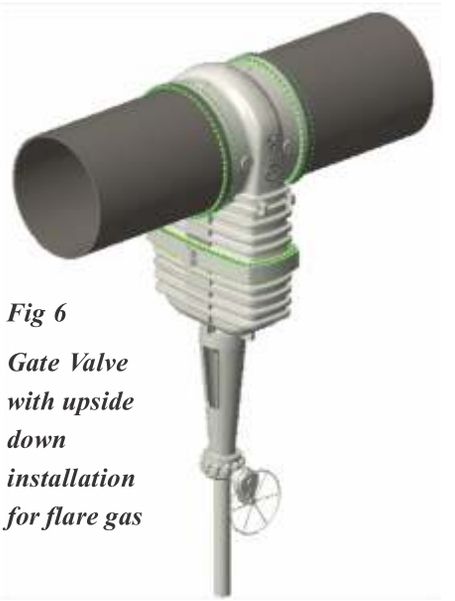

*Fig 6 Gate Valve with upside down installation for flare gas*

## 11. Cost:

Use of cost competitiveness API 603 design gate valves are considered over heavy duty API 600 design for stainless steel valves. In addition, gate valve types in the following order can be selected to get the cost advantage.

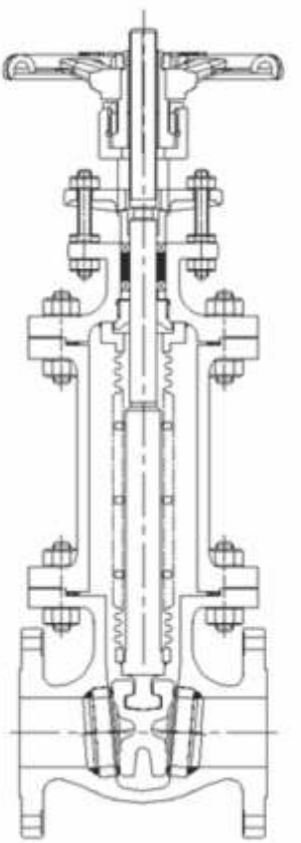

*Fig 7*

*Gate Valve with Bellows seal for Hazardous / Toxic application.*

## Table 1

## Application/Service Vs Challenges Vs Special Features of a Gate Valve

| S.No. | Application / Service Requirement | Challenge | Special Feature | Suitable Gate Valve |
|---|---|---|---|---|
| 1. | Piping Stress | Sealing Performance affected due to piping load | | Flex Wedge Gate Valve |
| 2. | High Temperature Service | Thermal binding / Wedge locking Operability issue | Stem wedge connection strength | Double disc gate valve |
| 3. | Cavity Over pressure | Wedge / Disc locking / Thermal Binding | Pressure relieving mechanisms, Vent hole drilled at high pressure side; Equalising piping | |
| 4. | Cover joint leak tightness | Typical cover joints leaks over a period | | Pressure seal bonnet; Welded Bonnet |
| 5. | Hot Tap Application | Hot tap cutter to pass the valve bore | Valve port shall be large enough to pass the hot tap cutter; Proper alignment between bores | Flex wedge gate valve |
| 6. | Operating Effort : Less manual effort than EN12570 / MSS SP 91 | Stem damage | Higher strength stem; Torque limiting device | |
| 7. | Installation Orientation :<br>• Stem Vertical with fluids containing dirt and particles<br>• Orientation other than vertical | • Accumulation of dirt and particles at bottom cavity, hindrance to full close operation<br>• Galling tendency at Guides | • Drain and purge connection<br>• Hard facing on guides | |
| 8. | Stainless Steel Trim | Galling leads to reduced life | Hard facing on seat faces | |
| 9. | Hazardous / toxic applications | Damage to the atmosphere by means of emission leak through joints and packing | Bellows seal arrangement | |
| 10. | Space constraint | Typical Gate Valves occupy more space | Non raising stem | |
| 11. | Cost | | Compact API 603 design gate valves over heavy duty API 600 design for Stainless steel valves | Selection of order :<br>• Screwed Ends<br>• Socket Weld Ends<br>• Screwed Bonnet<br>• Pressure seal bonnet |

Threaded Ends

Socket Weld Ends

Threaded Bonnets

Pressure Seal Bonnets

## To Conclude,

Table1 provides the typical application, associated challenges with details of special features / right type of gate valve to overcome the challenges associated with application.

## References:

1 G H Pearson, Valve Design, Mechanical engineering Publications Ltd, London, 1978.

2 API Recommended Practice 615 Second Edition, 2016

3 API Standard 600 Thirteenth Edition, January 2015, Steel Gate Valves - Flanged and Butt-welding Ends, Bolted Bonnets

4 K S Patil, Valves for High Pressure / High Temperature, Valve World 2004

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**Academic Background**

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