6.23 Valve Types: Sliding Gate Valves

Types:  
A. Knife gate  
B. V-insert  
C. Plate and disc (multi-orifice)  
D. Positioned disc  

Sizes:  
A. On/off; 2 to 120 in. (50 mm to 3 m)  
B. Throttling: \( \frac{1}{2} \) to 24 in. (12 to 600 mm)  
C. Throttling: \( \frac{1}{2} \) to 6 in. (12 to 150 mm)  
D. Throttling: 1 to 2 in. (25 and 50 mm)  

Design Pressures:  
A and B. Up to ANSI Class 150; higher with “wedge within wedge” design  
C. Up to ANSI Class 300  
D. Up to 10,000 PSIG (69 MPa)  

Design Temperatures:  
A and B. Cryogenic to 500°F (260°C)  
C. −20 to 1125°F (−29 to 607°C)  

Rangeability:  
A. 10:1  
B. 20:1  
C. Up to 50:1 is claimed; see Section 6.7  

Characteristics:  
See Figure 6.23a  

Capacity:  
A. \( C_v = 45 \ d^2 \)  
B. \( C_v = 30 \ d^2 \)  
C. \( C_v = (6 \text{ to } 10) \ d^2 \)  
See Table 6.23b  

Leakage:  
A and B. ANSI Class I or II with metal seat; better with soft seat or lining  
C. ANSI Class IV; see Table 6.1gg for definitions  

Materials of Construction:  
A and B. Ductile iron, cast iron, carbon steel, 304, 316, 317 stainless steel, Alloy 20, Hastelloy  
B or C. Seating can be metal to metal, nylon, or RTFE  
C. Body: Ductile iron, bronze, carbon steel, stainless steel, aluminum, Monel  
Trim: Stainless steel is standard, which can be chrome-plated for hardness or Teflon-coated for corrosion resistance; Monel or Hastelloy trims are also available  

Costs:  
The cost of V-insert-type slide gate valves is similar to, but generally less than that of, single-seated globe valves, which are given in Figure 6.19b. The cost of plate and disc valves is given in Table 8.23j.  

Partial List of Suppliers:  
Anchor/Darling Valve Co. (www.flowserve.com)  
DeZurik/SPX Valves (www.spxvalves.com)  
ITT Industries, Engineered Valves (www.engvalves.com)  
Jordan Valve (www.joprdanvalve.com)  
Kurimoto Valves (www.kurimoto.co.jp)  
Red Valve Company Inc. (www.redvalve.com)  
Richards Industries (www.richardsind.com)  
Stockham Valves & Fittings (www.stockham.com)  
Zimmermann & Jansen Inc. (www.zjnc.com)
INTRODUCTION

The knife gate-type slide gate valves are relatively inexpensive, have high capacity, and are suited for slurry and dirty services. On the other hand they have poor control characteristics, do not provide tight shut-off, and are not suited for corrosive services. The V-insert type variation of this design has similar features, but as illustrated in Figure 6.23a, has better control characteristics.

The positioned sliding disc designs are ideal for high-pressure (up to 10,000 PSIG), cavitating, abrasive, or erosive services, but are relatively expensive and are not suited for sludge, slurry, viscous, or fibrous services. The multiport plate and disc type valves are similar, but provide superior control characteristics. These valves are available as pump governors or as unusually high rangeability (> 200:1) control valves in sizes from 0.5 to 6 in.

SLIDING GATE VALVE DESIGNS

Knife Gate Valves

Changing the process fluid’s flow rate by sliding a plate past a stationary hole is one of the oldest and most basic approaches to throttling flows. The most common valve, the sliding gate valve, operates like this. Although occasionally used for automatic control, it is not considered to be a throttling control valve. It is a form of “guillotine”-type gate valve (Figure 6.23c) and is much used in the pulp and paper industry due to its shearing ability and nonplugging body design.

The “slab-type” sliding gate is provided with a round opening (Figure 6.23d) and therefore its characteristics are determined by the two converging circles. Its characteristics approximates equal-percentage behavior up to about 70% of its flow capacity, and above that it becomes nearly linear. The flow rate of 70% is reached by opening the valve to about 30% of its stroke.

On critical services, such as in catalytic cracking, reforming, isomerization, or coal gasification applications, the “double” gate valves are often considered (Figure 6.23e). In this

![FIG. 6.23a](image1)
The characteristics of the various types of sliding gate-type valve designs.

![FIG. 6.23b](image2)
The guillotine-type sliding gate valve.
design a “wedge” is provided within the wedge-shaped sliding gate. This inner wedge forces the two sliding gates on its two sides against the two seats, thereby guaranteeing tight closure.

**V-Insert Type**  
The addition of a V-shaped insert (Figure 6.23f) in the valve opening creates a parabolic flow characteristic. As shown in Figure 6.23a, this characteristic is somewhat similar to that of the V-ported globe valve. The performance of these valves is much dependent on the type of actuator and positioner used, because the quality of control is dependent upon the ability to provide very accurate positioning of the sliding gate.

**Positioned-Disc Valves**
Rotation of a movable disc with two holes, which if rotated can progressively cover two holes in the stationary disc, can successfully throttle flow (Figure 6.23g). This variable choke was designed to control flow from high-pressure oil wells.

The use of ceramic or tungsten carbide discs allows it to handle pressures up to 10,000 PSIG (69 MPa). Such valves are presently furnished in 1 and 2 in. (25 and 50 mm) sizes with areas from $0.05 \text{ in.}^2$ with 0.25 in. hole (32 mm² with 6.3 mm hole) to $1.56 \text{ in.}^2$ with two 1 in. holes (1006 mm² with two 25 mm holes).

An angle version of this valve design is used for proportioning control, with an actuator capable of controlling the discharge flow at quarter-turn movement. Both linear and rotary type actuators can be used. The valve opening (the relationship between the discs) remains in the last position if power fails.

A stepping actuator (Figure 6.23h) positions the inner valve disc in $1^\circ$ increments as a function of a pneumatic controller input to a double-acting, spring-centered piston. Rotation occurs through a rack and pinion assembly. Limit
Control Valve Selection and Sizing

switches are provided, and a stepping switch can be used for position transmission and for position feedback in automatic control systems.

Plate and Disc Valves

A wide variety of flow characteristics are available using a stationary plate in the valve body and a disc that is moved by the valve stem. The plate (Figure 6.23i) is readily replaceable by removing a flanged portion of the body, which retains the plate with a pressure ring. Areas of the plate are undercut to reduce friction. A circumferential groove provides flexibility and allows the plate to remain flat in spite of differential pressures or expansion or contraction of the body. The stem contacts the disc by a pin through a slot in the plate.

The disc is held in contact with the plate by upstream pressure and by retaining guides. The contacting surfaces of the disc and plate are lapped to light band flatness. The chrome-plated surface of the stainless steel plate has a hardness comparable to 740 Brinell to resist galling and corrosion and obtain smooth movement of the disc. The material, with the registered name of Jordanite, is reported to have an extremely low coefficient of friction, is applicable to high-pressure drops, and has great resistance to heat and corrosion.

Flow occurs through mating slots in the disc and the plate. Positive shut-off occurs when the slots are separated (Figure 6.23i). Flow increases on an approximately linear relationship until the slots are lined up for maximum flow. Capacities are about \( C_v = 6.5 \, d^2 \) through the 2 in. (50 mm) size and about \( C_v = 12 \, d^2 \) through the 6 in. (150 mm) size.

Stem travels to obtain full flow are very short due to the slot relationship, and low-lift diaphragm actuators can be used for positioning. Forces needed for positioning are low, requiring only sufficient power to overcome friction between the plate and disc, which is right-angle motion and not opposed to the direction of flow.

Valve bodies are offered in sizes between \( \frac{1}{4} \) and 6 in. (6.3 and 150 mm) and with ratings through 300 PSIG (2.1 MPa), depending on the material, with a selection of trims and packings. Many styles of actuators are used, including one with a thermal unit and cam actuation. This body design has been adapted for extensive use in self-contained pressure or temperature regulators.

This valve is also used to control the steam flow to steam-driven pumps, so as to maintain the pump discharge pressure constant. The sizes and costs of these pump governors are given Table 6.23j.

### TABLE 6.23j

<table>
<thead>
<tr>
<th>Valve Size (Inches)</th>
<th>Carbon Steel</th>
<th>Stainless Steel</th>
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<tbody>
<tr>
<td>0.5</td>
<td>$2,000</td>
<td>$2,600</td>
</tr>
<tr>
<td>1.0</td>
<td>$2,300</td>
<td>$3,300</td>
</tr>
<tr>
<td>1.5</td>
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<td>$3,600</td>
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<tr>
<td>2.0</td>
<td>$3,100</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

* All valves are provided with 150# RF connections (Courtesy of Jordan Valve.)
Bibliography
