6.20.1. Butterfly valve styles

Butterfly valves contain a concentrically or eccentrically oriented disc which can be rotated in a normally sandwich-like housing or body. The angle of rotation is usually 90 degrees for ON-OFF service; for continuous control applications the aperture angle is normally limited to only 60 degrees. Because of the ease of manufacture and the cost-saving construction butterfly valves are - particularly at big nominal sizes and low pressure differentials - a more economical alternative to standard control valves.

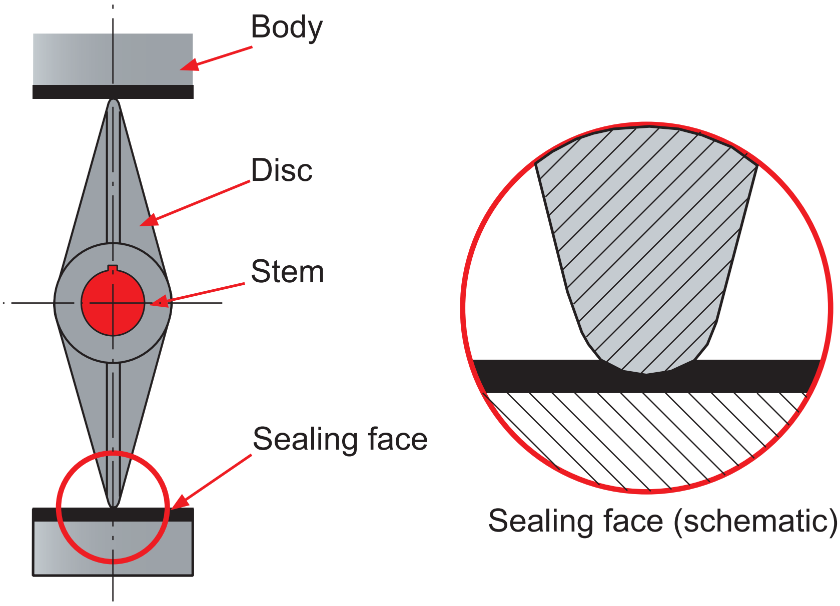


Figure 6.20.1.-1: Sealing structure of centered seal butterfly valve (schematic)

As for other control valve styles, for butterfly valves there are numerous body constructions, disk designs and seating technologies. The housing or valve body can be flange less, flanged or with welded ends for connection to the piping system.

There is also a large variety in the manner of the disc movement (concentric, single or double eccentric, and triple eccentric) and also in the disk orientation in the closed position. Most common is the flange less, wafer type valve body with an aligned disc.

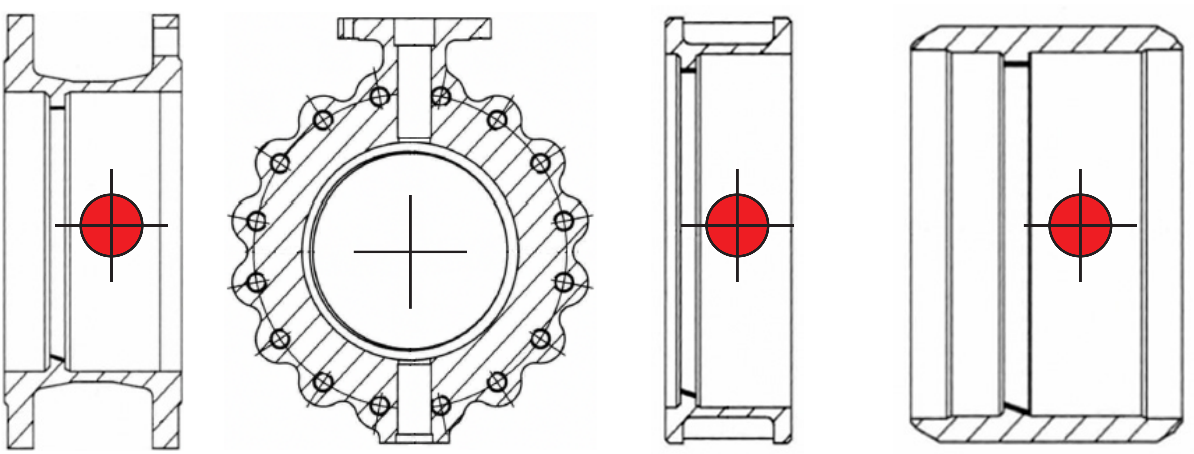


Figure 6.20.1.-2: Butterfly valve styles

This type is used mainly for simple control tasks where a certain level of leakage is acceptable. The seat leakage is naturally determined by the gap width between the disc or disc and the wafer body, which is necessary for faultless operation at low and high temperatures. Since standard butterfly valves with an aligned disk do not touch any seat in the valve body, a travel stop within the actuator is required to avoid over-stroking of the disc.

A somewhat lower leakage can be achieved with a canted disc or by means of two centric sealing ridges which are welded into the wafer body. Five of the many variations available are schematically illustrated in Figure 6.20.1.-3. Some disks are equipped with metallic or elastic piston rings to achieve lower leakage rates.

Some have EPDM (Ethylene Propylene Diene Monomer), or PTFE (Polytetrafluoroethylene) rings - either in the valve body or at the disc - to achieve tight shut-off at temperatures below 200 °C. The valve body is also frequently lined completely with synthetic rubber or PTFE, and thus the sealing surface to both counter flanges is thereby achieved. The outer stainless steel disc surface is rounded in such cases and is pressed, at the closed position, into the soft lining material causing a small radial deformation Figure 6.20.1.-1. Another design relies on a profile ring of synthetic rubber as the sealing element.

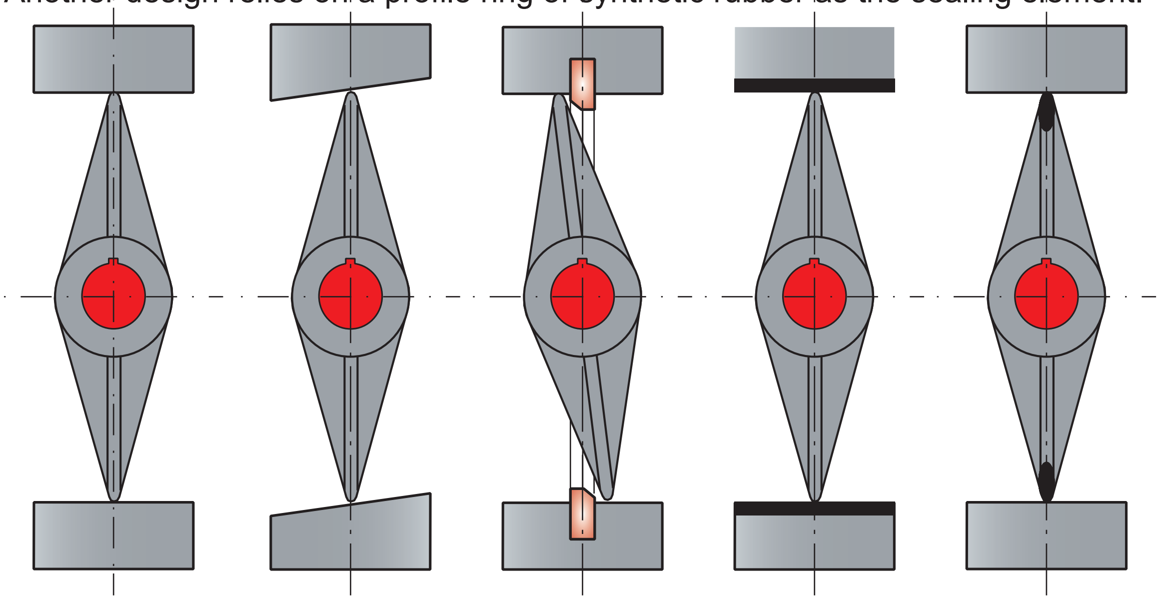
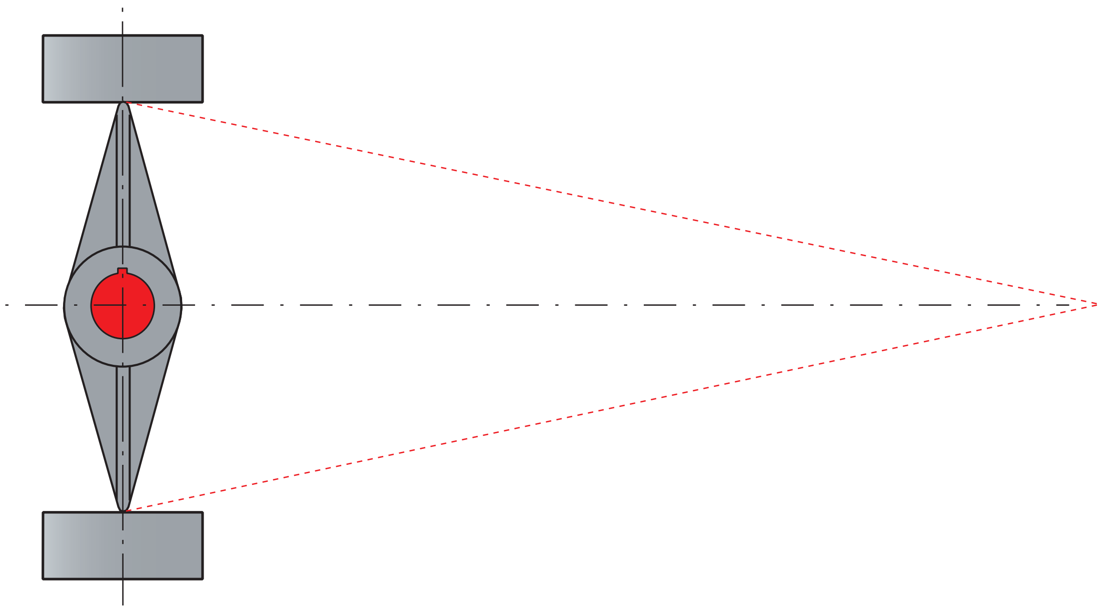


Figure 6.20.1.-3: Butterfly valve designs with a choice of different disk orientations (schematic). Butterfly valve with synthetic rubber lining and clamped sealing ring of synthetic rubber (right)

This is fastened to the disc with the help of a metallic clamping ring. The additional closing (or opening) torque is in both cases exceptionally high. This is caused by the relatively high friction between the steel vane and the synthetic rubber sealing element when the disk is opening or closing.

Therefore special butterfly valves have been developed enabling low friction and hysteresis. One of these special butterfly valves uses, for example, a synthetic rubber tube as the sealing element. This tube can be inflated by low air pressure when the disk has reached the closed position. One disadvantage of butterfly valves with tight shut-off capabilities by means of elastic rubber sealing elements, is the limited applicability with respect to pressure, temperature and resistance of most elastomers to aggressive fluids.

Butterfly bearing of the disc
Centric

Centric between the shaft centre line and the disc centre line.
Single eccentric

The first eccentric is the offset ① between the shaft centre line and the disc trunnion centre line.

Figure 6.20.1.-4: Centric and eccentric bearing of the butterfly disc (schematic)

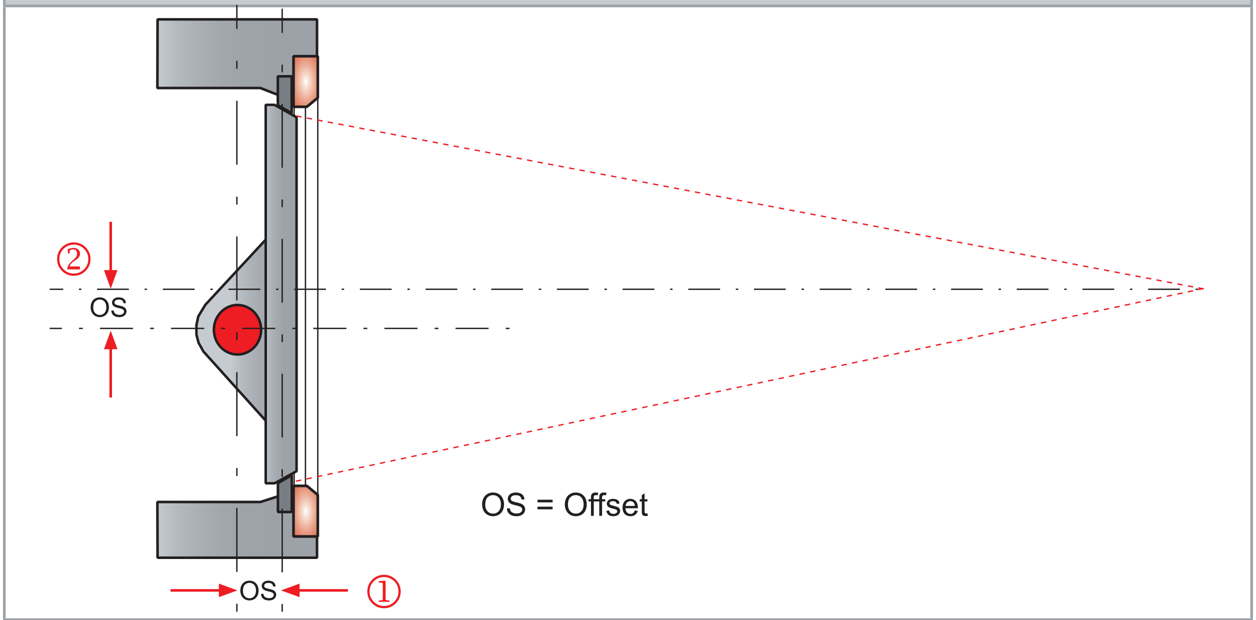
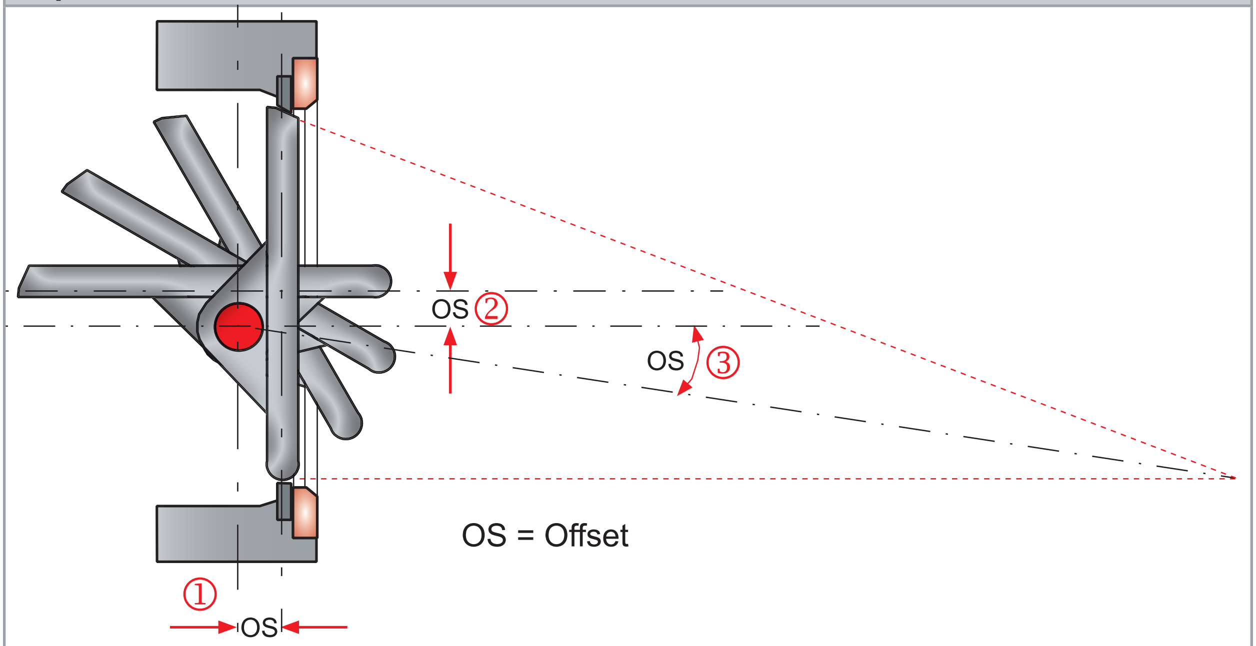
Butterfly bearing of the disc
Double eccentric

First eccentric is the offset ① between the shaft centre line and the disc trunnion centre line. Second eccentric is the offset (OS) ② between the body centre line and the disc centre line.
Triple eccentric

First eccentric is the offset ① between the shaft centre line and the disc trunnion centre line. Second eccentric is the offset ② between the body centre line and the disc centre line. The third and the most important is the eccentric in the sealing ③ (multiple) itself such that if you draw a imaginary contour line between the sealing shape versus the body centre.

Figure 6.20.1.-5: Double and Triple eccentric (schematic)

Butterfly valves have been steadily improved within the last decades and many new designs have been developed. There are available, for example, butterfly valves with considerably reduced torques under dynamic conditions. This is achieved by a special design of the disk profile. Other versions use vanes with „teeth" which work at low openings like a flow distributor and thereby reduce the generated noise. The greatest progress, however, has been achieved in the development of the so-called "high-performance" butterfly valves. These constructions utilize, as a rule, the double eccentric and triple eccentric design principle and are fitted with a metallic sealing element, which make them also therefore suitable for high pressures and temperatures. A typical example of a high performance butterfly valve of the new generation is shown in Figure 6.20.1.-8 as a triple eccentric, high performance butterfly valve with metallic sealing element suitable for high static pressures and temperatures.

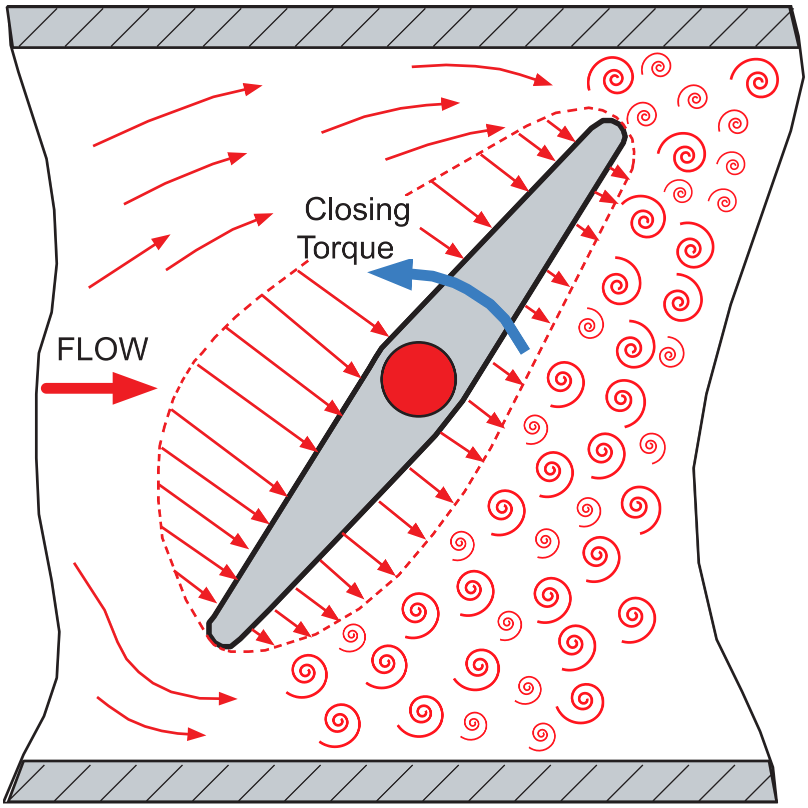


Figure 6.20.1.-6: *Dynamic torque*

Particularly advantageous are the high rangeability and the metal to metal leak rate class V at the closed position which competes favorably with the single seated standard valve in case of larger sizes and/or high shut down pressures. The geometry of the disk movement is quite complicated. These valves require therefore a sealing element that provides a minimum of elasticity, and beyond this, it must allow small movements in the radial direction without allowing any leakage between the disk and the sealing ring. Through these features the sealing ring can adapt itself to the seat during closing and thus makes tight shut-off possible. The sealing ring consists usually of an exotic material with a high strength at elevated temperatures and an excellent corrosion resistance against common industrial fluids.

A typical dynamic torque curve of a concentric butterfly valve is shown in Figure 6.20.1.-7. This behavior should be considered, particularly in connection with a pneumatic actuator.

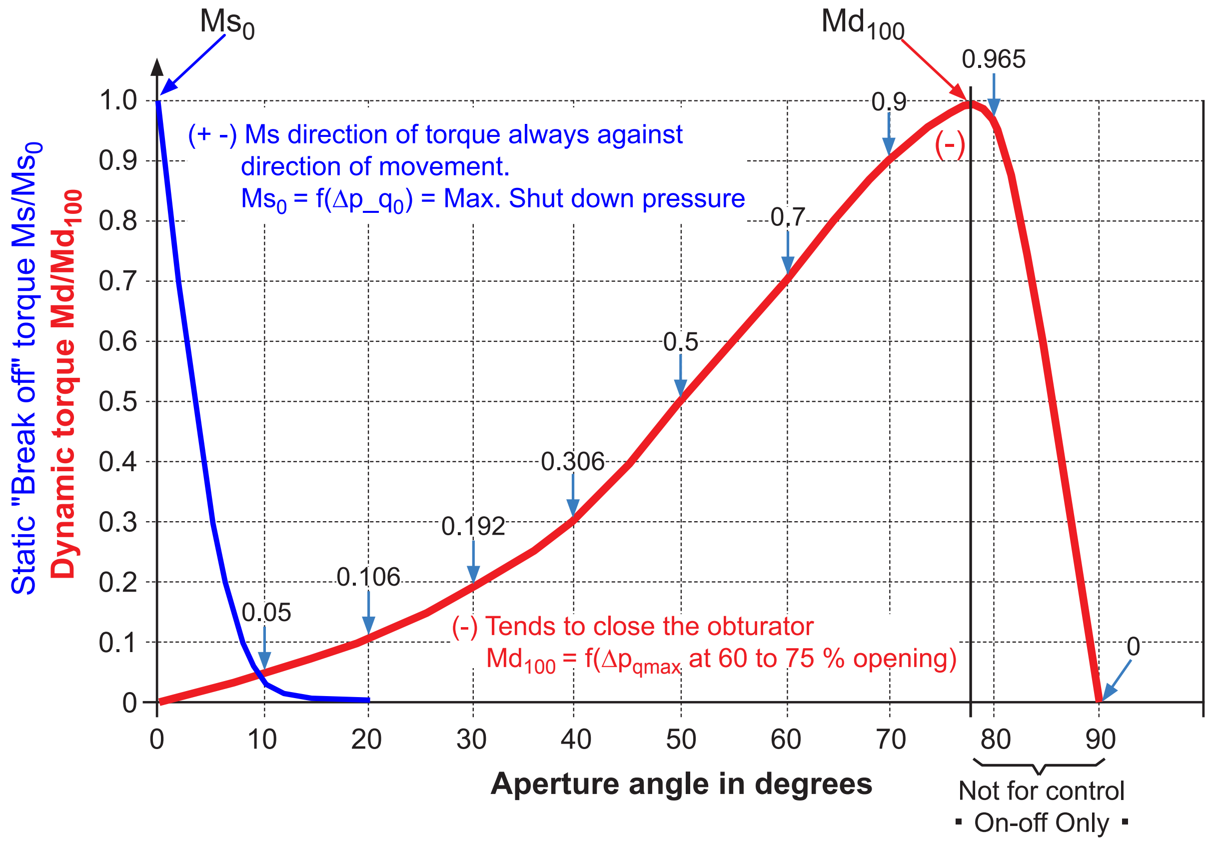


Figure 6.20.1.-7: Typical torque requirements for a centric butterfly valve under dynamic operating conditions

The dynamic torque in contradiction to the static "break off" torque is in the closed position almost, zero and increases steadily up to an opening angle of approx. 75 degrees and reaches a maximum at this point. At higher aperture angles the torque decreases rapidly and can even reach negative values. This might give bistable control with a trend to either close or open the valve depending on its current position. This undesirable behavior must be taken into account at the actuator selection to avoid instability problems. To overcome this disadvantage, special low torque constructions have been developed. These types use specially shaped vanes to reduce the dynamic torque and to permit opening angles above 75 degrees, in order to increase valve capacity and to allow the use of smaller valve actuators.

Actuator sizing must take care of both kind of torques. In most of applications the static "break off" torque is dominating the actuator size, because the differential pressure decrease in direction of maximum flow.

In case of applications with moderate constant differential pressure like level controls, pump recycling, pressure let down and anti-surge control the dynamic torque will demand to a larger actuator size than the static torque. In this case actuator sizing becomes sophisticated and need special care to size for the closed - and for the open position at the highest dynamic torque. Parameters are: actuator size, spring range and air supply and the safe position air to close or air to open.

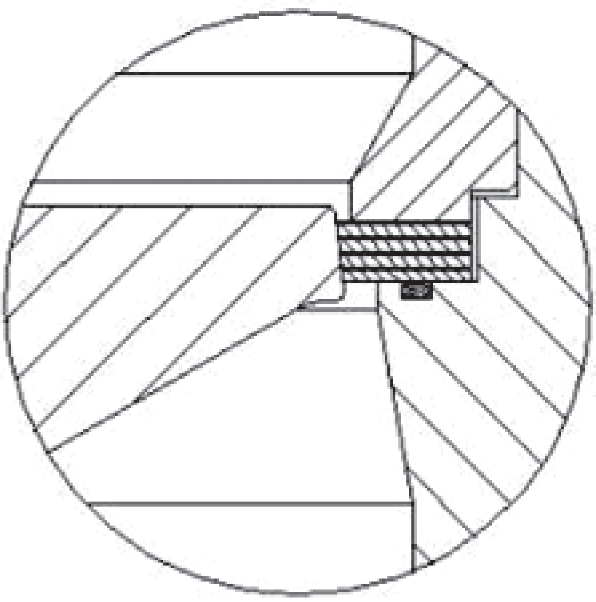
Triple Eccentric Butterfly

Triple Eccentric Butterfly
Type LTR 43

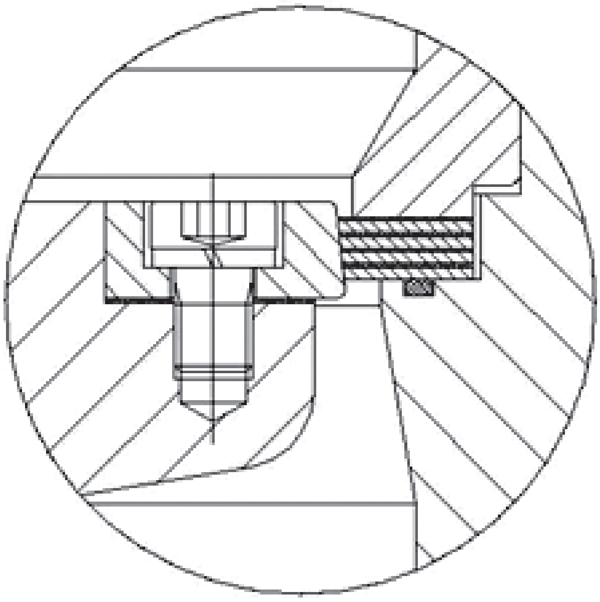
Size: NPS 3 to 120
Pressure: ANSI Class 150 to 2500

- Wafer, Lug, Double Flanged or Butt weld ends
- Metal or soft seated
- Tight acc. to ANSI B16.104 Class VI
- Seat Itt - Laminated / 316SS - Graphite
- Fire safe design acc. to API / BS 6755
- Packing acc. to TA-Luft

Figure 6.20.1.-8: Leusch Control Butterfly Valve Type LTR 43, triple eccentric, NPS 24 ANSI Class 900 with return actuator



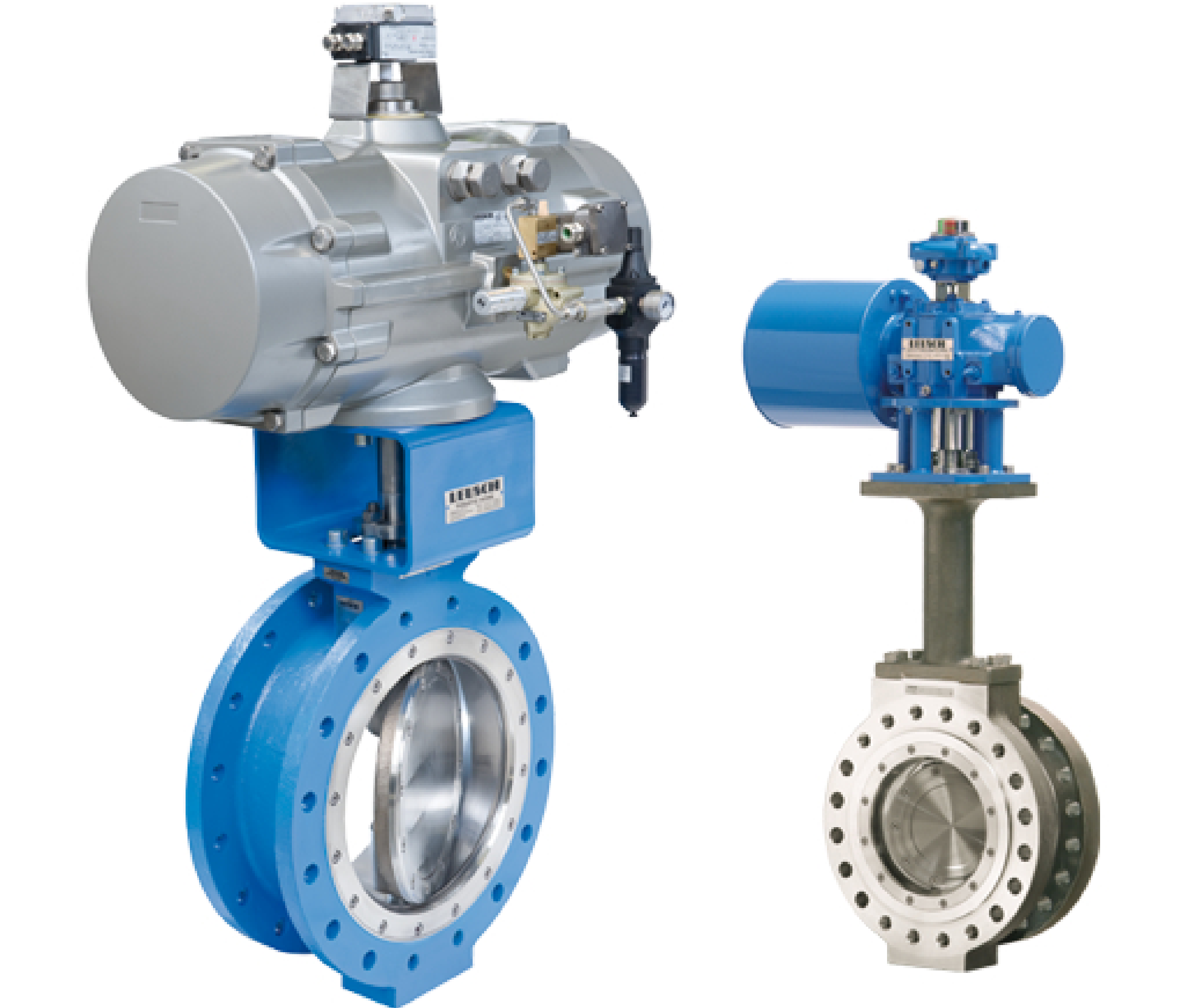
Solid disc



Screwed seatring

Figure 6.20.1.-9: Leusch line gasket between Disc / Seatring and Seat. Seat and Seatring changeable.

Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard



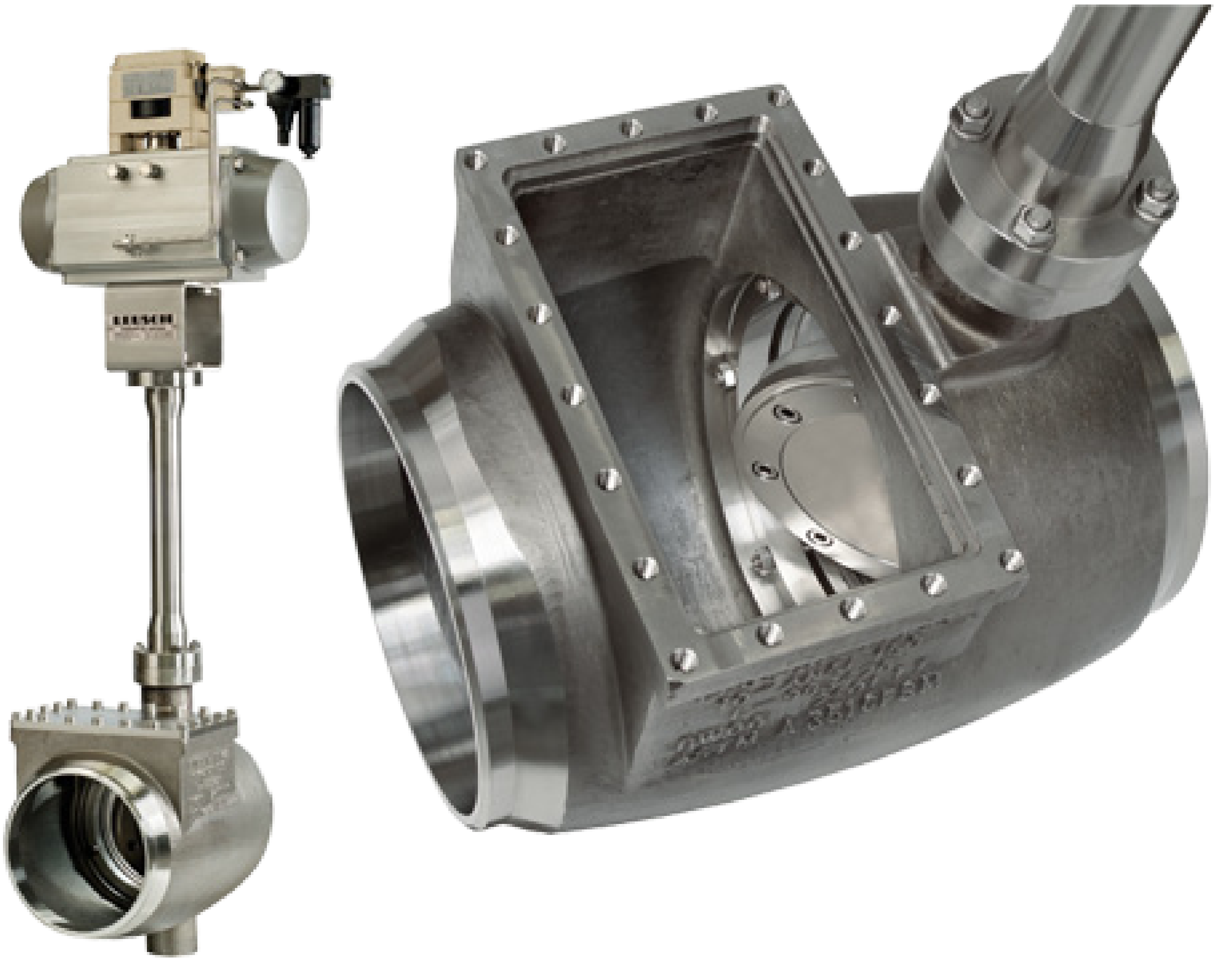
Style	Wafer, lug, double flanged or butt weld ends			
Application	Chemical Industry, Refineries, Pulp and Paper Industry, Sea water desalination plants, Waste water treatment, Gas extraction and transport, Ship building, Offshore technology etc.			
Valve data	NPS	Nominal pressure	C_V value	Body material
	3 to 100	PN 6 to 420 ANSI Class 150 to 2500	Series LTR 43	C-Steel, Stainless steel, Titanium, Hastelloy, Inconel, Monel, Duplex, SMO, Bronze etc..
	Metal or soft seated ▪ Leakage Class VI to ANSI FCI 70-2 / IEC 60534-4 ▪ Seat Itt Laminated 316SS/Graphite or special material ▪ Designed to ANSI B16.34 and API 609			
Special features	Packing acc. to TA-Luft ▪ Low Noise / Anti Cavitation trim ▪ Heating jacket ▪ Anti surge design ▪ ESD-Application ▪ Outer bearing, inner packing ▪ Cryogenic or high temperature service			

Figure 6.20.1.-10: Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard

Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard	
	
Style	Butterfly Valve ▪ Flanged type
Application	LNG, LPG, and GTL Plants Industrial gases and cryogenic applications
Valve data	16" ANSI Class 900
	■ Type LTR 43, flanged type ■ With extension for Cryogenic-Service (-196°C) ■ Metal seated, Leakage Class VI ■ With spring return Actuator incl. Damping system ■ Stroking time: < 0,5 sec.

Figure 6.20.1.-11: Butterfly Valve ▪ Flanged type

Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard



Style	"Top Entry“ Design ▪ Low Temperature
Application	LNG, LPG, and GTL Plants Industrial gases and cryogenic applications
Valve data	■ Type LTR 43, with butt weld ends ■ In-line servicing / easy maintenance ■ With extension for Cryogenic-Service (-196°C) ■ Metal seated ■ With spring return Actuator, AFC ■ And E/P Positioner Type 3730-3 (HART)

Figure 6.20.1.-12: Top Entry“ Design ▪ Low Temperature

Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard	
	
Style	**Control Butterfly Valve ▪ Low Temperature**
Application	LNG, LPG, and GTL Plants Industrial gases and cryogenic applications
Valve data	■ Type LTR 43, with butt weld ends ■ with extension for Cryogenic-Service (-196°C) ■ incl. “Cold Box“ flange

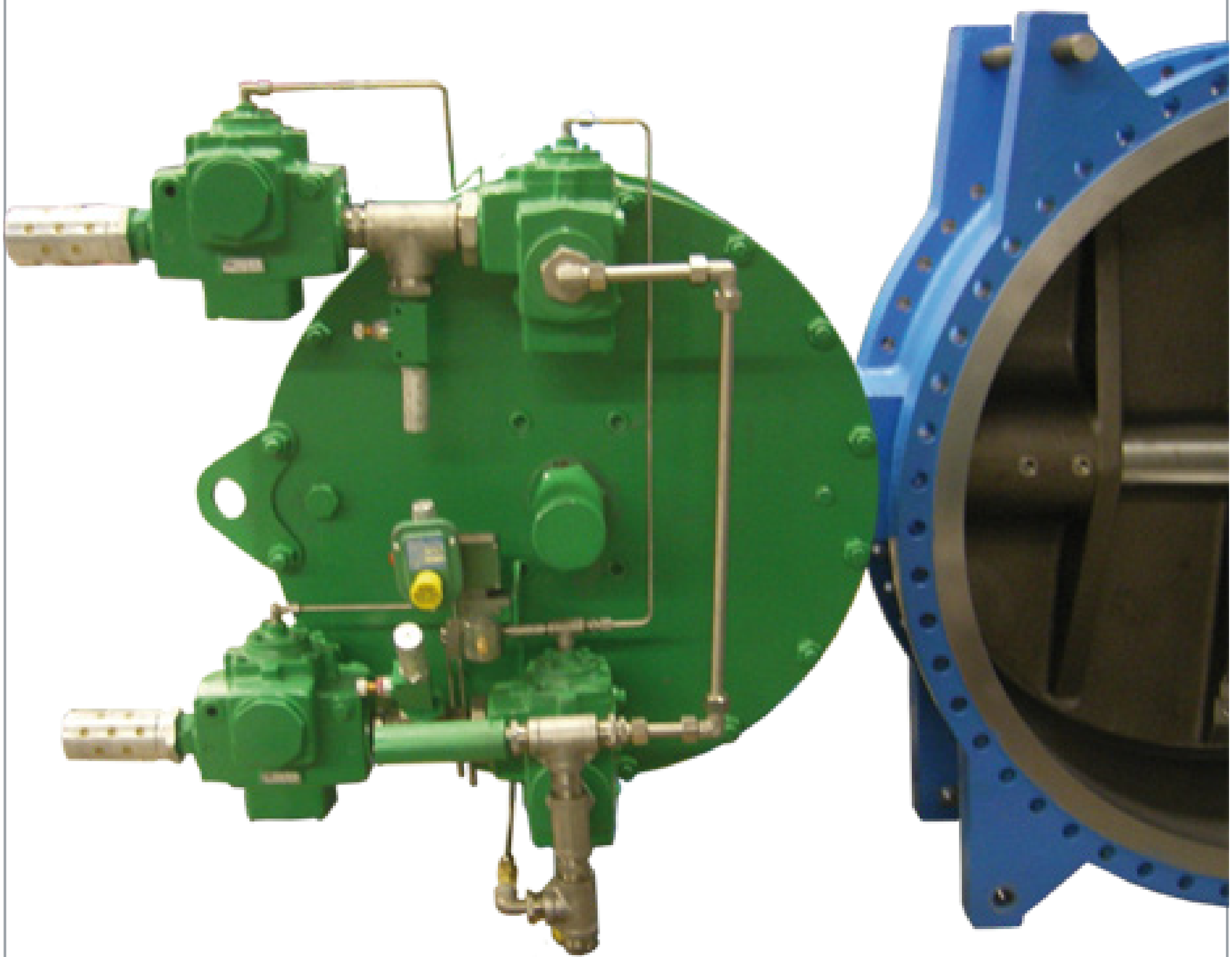
Figure 6.20.1.-13: Control Butterfly Valve ▪ Low Temperature

Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard

Style	Special Butterfly Valve ▪ Anti-surge
Application	Anti-surge control designed to cover even the most complex tasks such as variable molecular weight, fast closing discharge valves or increasing suction temperature during recycling. A typical application is Anti-Surge control for axial turbo compressors.
Valve data	24" ANSI Class 300
	■ Type LTR 43, flanged type ■ With Low Noise for start up flow ■ With outer bearing and inner packing ■ With single acting Actuator, AFO ■ And E/P Positioner 3731 (EExd)

Figure 6.20.1.-14: Special Butterfly Valve for "Anti-Surge"

Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard



Style	Special Butterfly
Application	Shut-off Valve
Valve data	54" ANSI Class 150
	■ Type LTR 43, flanged type ■ Metal seated, Leakage Class VI ■ With spring return Actuator incl. Damping System ■ Stroking time: < 1 sec.

Figure 6.20.1.-15: Special Butterfly Shut-off Valve

Triple Eccentric Control and Shut-off Butterfly Valve LTR 43, Standard

Style	Special Butterfly Valve
Application	Fire safe ▪ ESD
Valve data	NPS 44, ANSI Class 300
	■ Type LTR 43, lug type ■ Metal seated, Fire safe ■ With spring return Actuator, AFC ■ And ESD Positioner SAMSON Type 3730 ■ (Partial stroke test)

Figure 6.20.1.-16: Special Butterfly Valve for Fire safe ESD