Associazione Italiana Strumentisti

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BUTTERFLY VALVES FOR ON-OFF AND CONTROL DUTIES: OPERATING PRINCIPLE AND PERFORMANCES

Milano, 18 Aprile 2018

Auditorio TECNIMONT

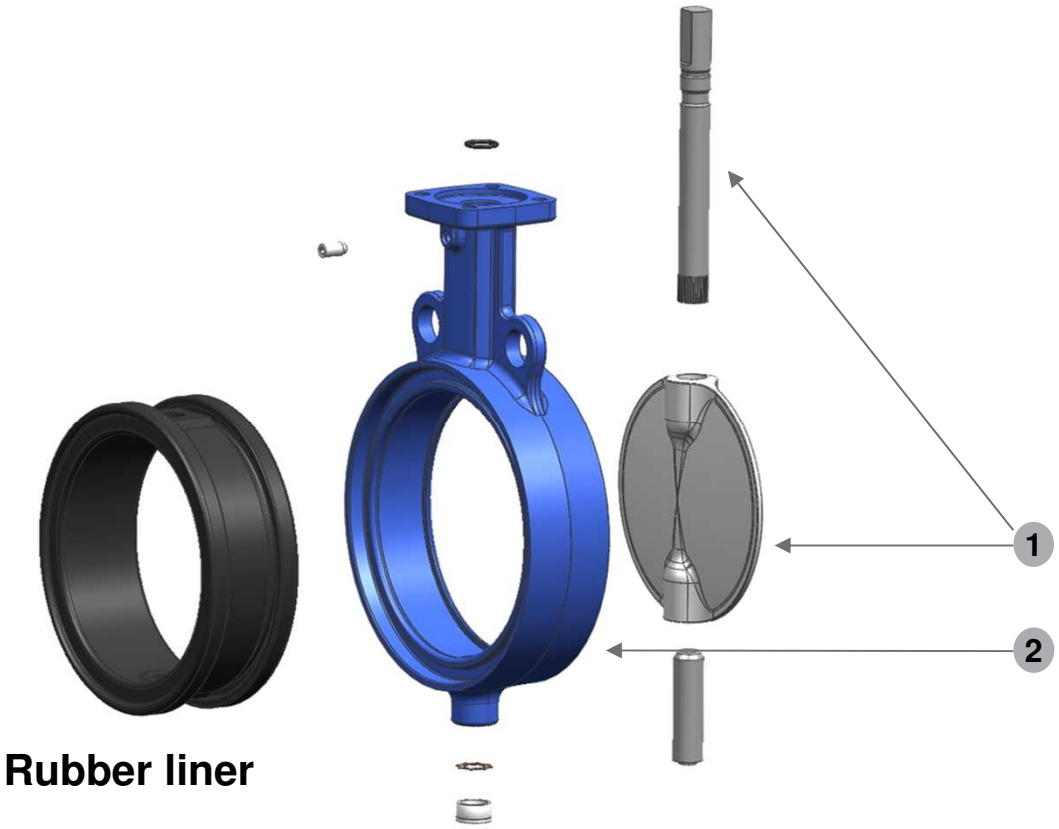
KSB

CENTERED & OFFSET DISC BUTTERFLY VALVE CONCEPT

- CDBV Concepts
  - Tightness Concepts
  - Regulation Concepts
- Offset concepts
  - Tightness Concepts
  - Regulation Concepts

CENTERED DISC BUTTERFLY VALVE CONCEPT

Concept



Rubber liner

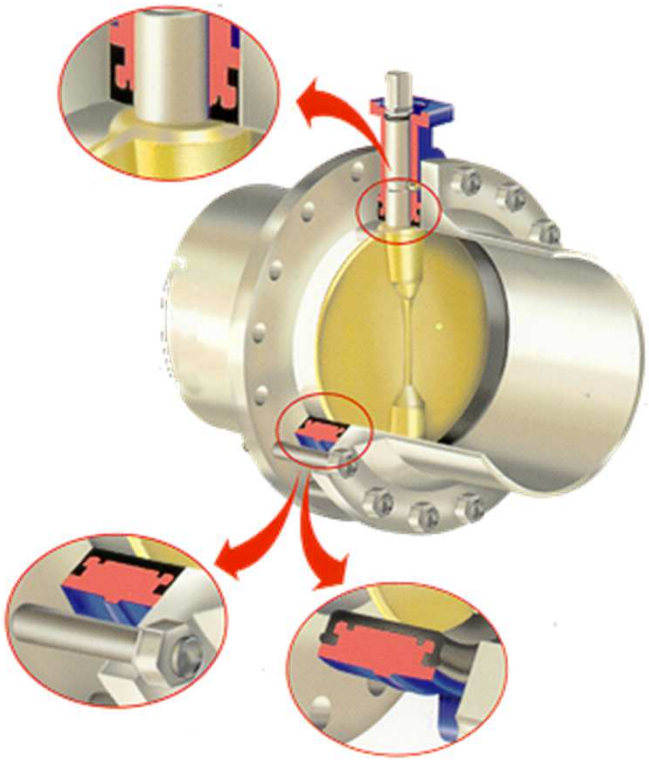
Concept of centered disc butterfly valves

The sealing surface of the disc is spherically shaped.

The disc is centered in the rubber liner.

1 Two-piece shaft and disc

2 Single-piece body



Concept

Sealing

- 3 sealing areas:
- Seat/disc interface
- Shaft passages
- Flanges

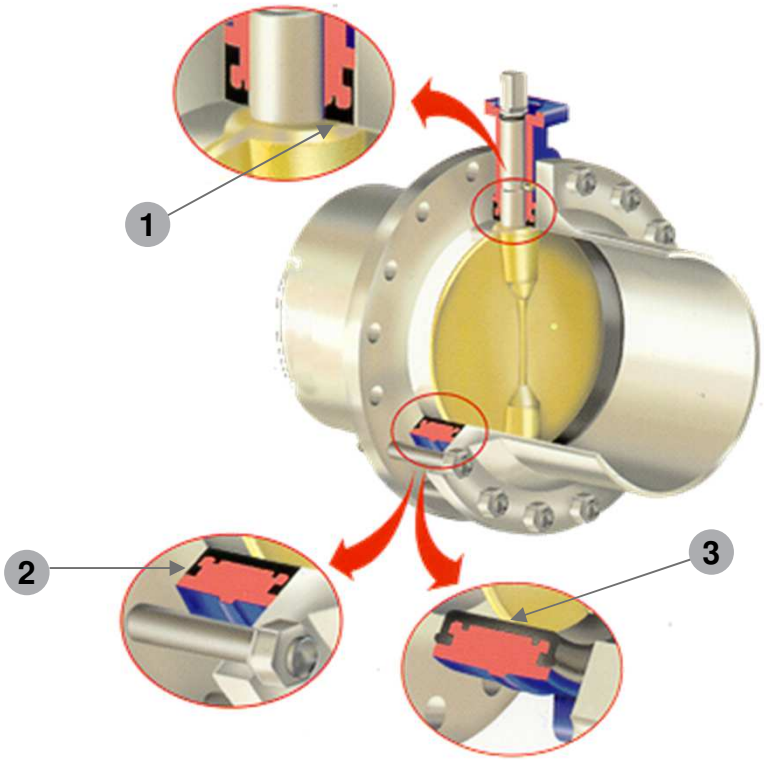
Choice of material is simple

- Only 2 pieces in contact with the fluid handled:
- Disc
- Rubber liner

Installation

- No gasket at the flanges

Sealing Concept



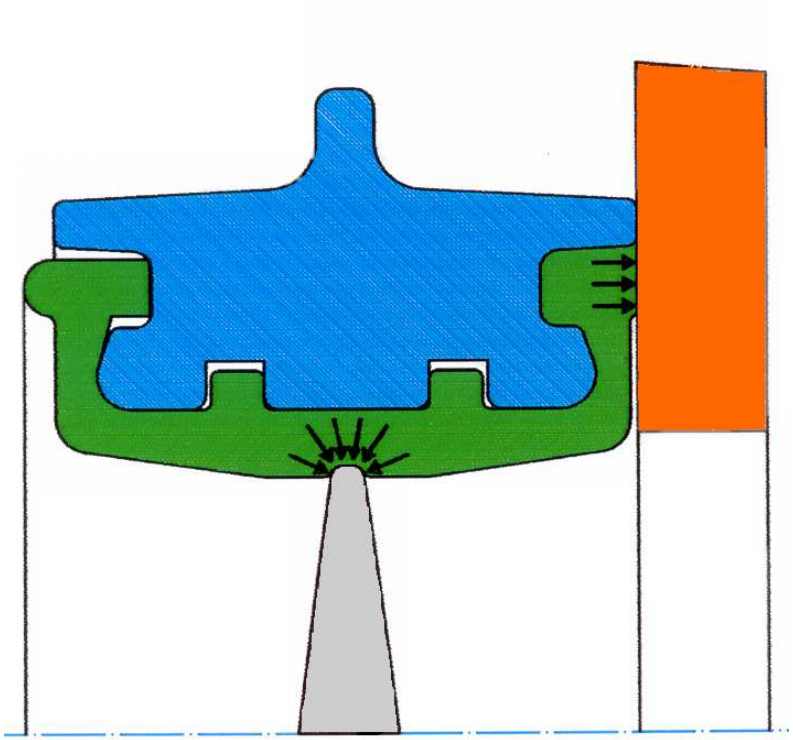
1. At the shaft passage between the disc and the rubber liner (spherically shaped sealing surface).

2. At the flanges between the rubber liner and the pipe flanges.

3. At the seat/disc interface between the spherically machined valve disc and the rubber liner

Concept

Sealing



The level of tightness depends on contact pressure between the rubber and the disc.

The contact pressure is the result of :

the penetration depth of the disc in the rubber liner and

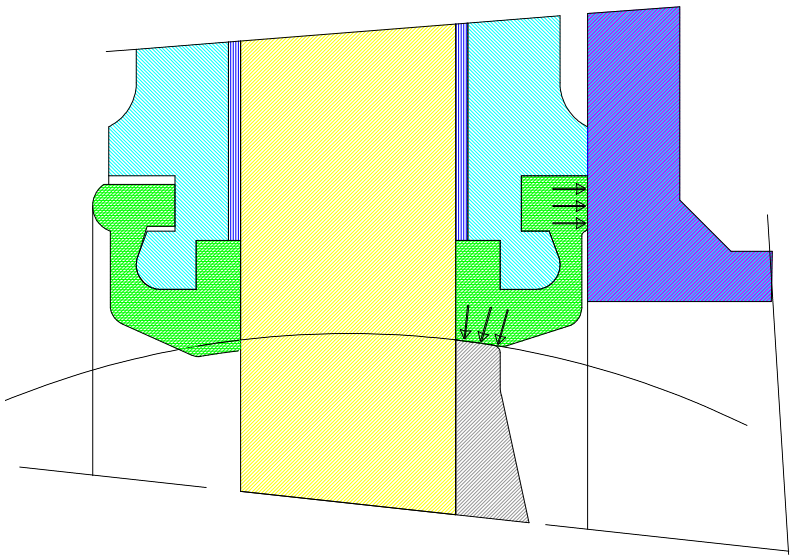
the mechanical properties of the rubber

- **Seat/disc interface**
  The spherical contact between the disc and the rubber liner is uninterrupted and permanent.
  Compression of the rubber ensures reliable shut-off.

- **At the flanges**
  Compression of the rubber ensures permanent and reliable sealing.

Concept

Sealing



- **At the shaft passages**
  The uninterrupted spherical shape of the disc and the spherical shape at the shaft passage of the liner ensure uninterrupted, permanent contact. Compression of the rubber ensures permanent and reliable sealing.

The shafts are never in contact with the fluid because sealing is effected at the spherical shape between the disc and the rubber liner.

KV values (m^3/h)

α° / DN	20°	30°	40°	50°	60°	70°	80°	90°
20	–	1,0	4	8	11	19	27	32
25	–	1,5	5	10	15	24	32	36
32	–	1,5	5	11	16	27	35	40
40	–	2,5	8	15	21	33	43	50
50	1,2	8	13	22	38	50	65	85
65	2	9	22	42	77	115	170	215
80	8	24	50	95	150	240	330	420
100	13	28	65	130	180	340	550	800
125	26	65	130	230	350	530	870	1010
150	35	90	200	360	640	900	1350	2100
150	29	85	185	320	500	650	970	1150
200	43	180	350	580	1000	1600	3000	4000
250	125	360	660	1100	1800	3100	5300	6400
300	200	550	1000	1600	2600	5000	7500	8500
350	350	780	1400	2400	4000	8000	10800	11500
400	490	1050	1800	3100	5500	11000	12000	14500
500	520	1100	2200	3500	6200	12000	15100	21000
600	750	1400	2800	5100	8800	14000	22000	29300
700	770	1755	3260	5980	10600	17100	25300	36000
800	1200	2260	4550	8230	12900	20300	29300	44600
900	1540	2280	6030	10500	17600	29200	42150	59000
1000	2200	3970	8300	14480	24000	37100	60300	81500
1100	4120	6600	11600	16590	28200	44800	61400	86300
1200	5050	7900	13800	19700	33500	53300	73050	102650

Concept

Regulation performances

- Regulation is possible but with some limits

➢ Up to 15°/20° opening, regulation is not recommended

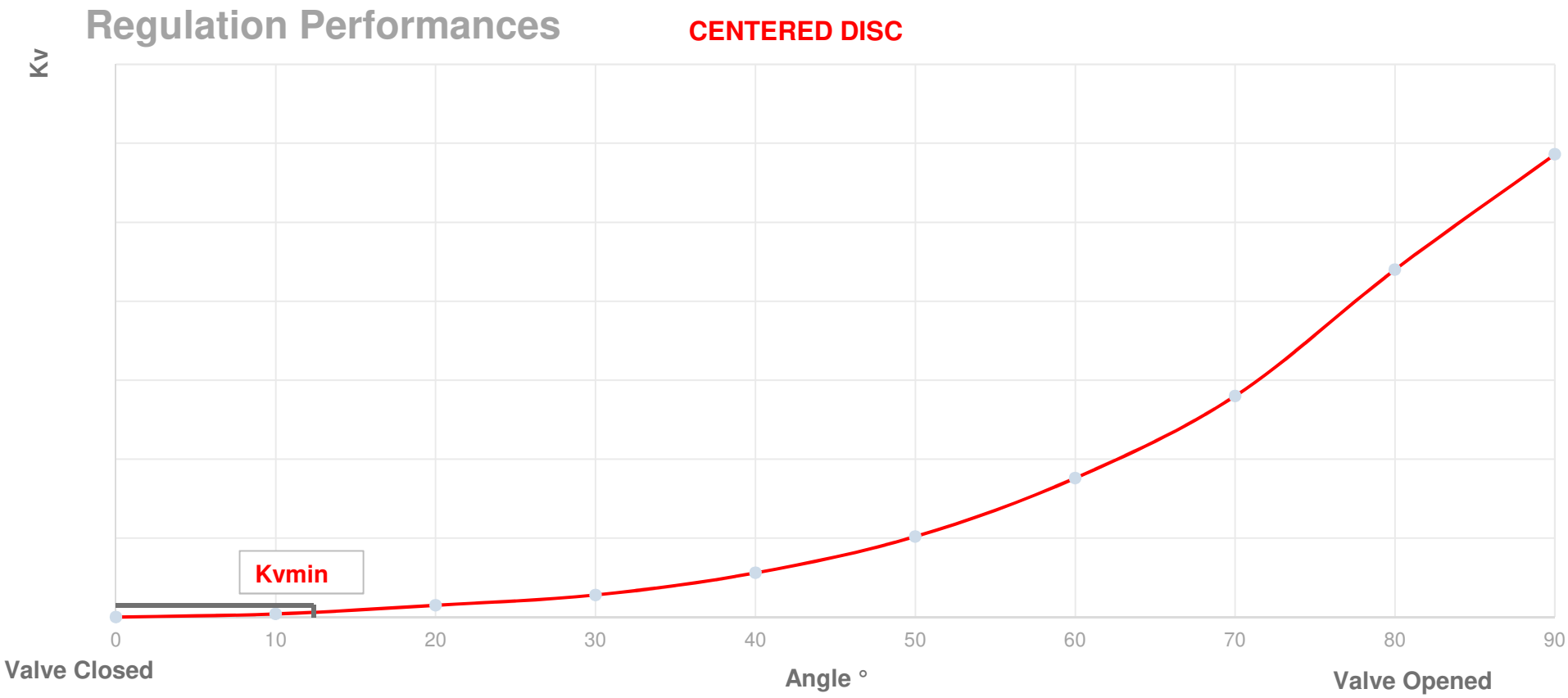
➢ Last 10° flow rate modification decrease

➢ Disc position is limited by some fixed position.

Concept

Regulation performances

- The curve is not linear - Regulation can‘t be precise



OFFSET DISC BUTTERFLY VALVE CONCEPT

OFFSET DISC BUTTERFLY VALV CONCEPT

When use an Offset Disc Butterfly Valve ?

•Exceeding conditions for which a Centred Disc Butterfly Valve may be used:

- **pressure:** **> 20 bar**
  vacuum / low pressure steam
- **temperature** **> +110°C** (over heated water, …)
  < -10°C (cryogenics applications,…)

•Moderate and high corrosion when C.D.B.V. is not accepted by the customer

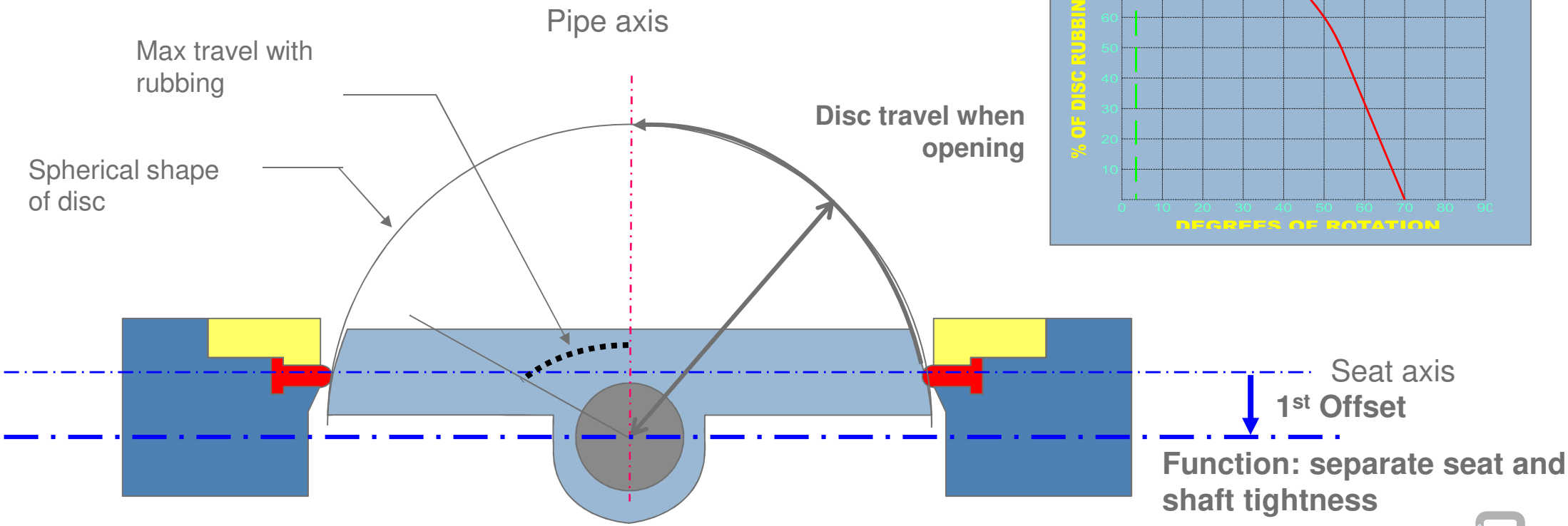
•Fire-Safe applications

Offset concepts

Single Offset

Seat rubs against the disc with full contact pressure during entire travel

→ short lasting service and high operating torque

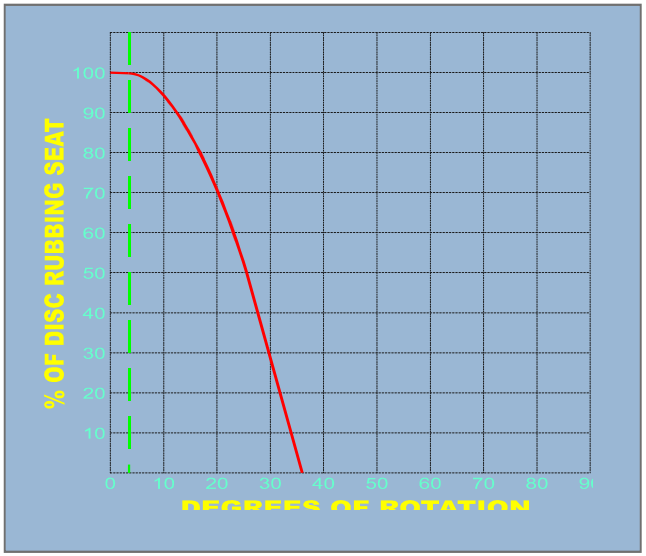


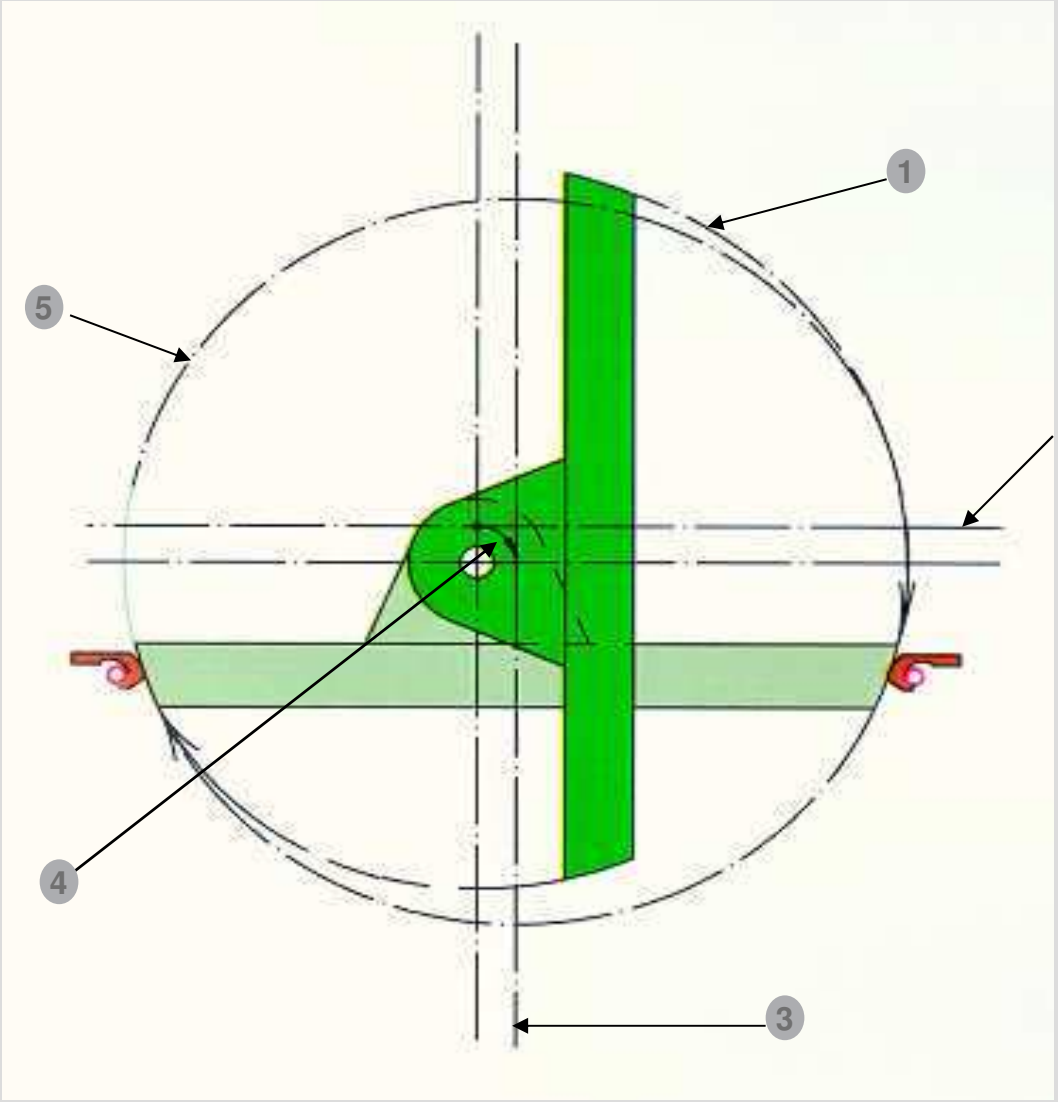
Function: separate seat and shaft tightness

Offset concepts

Double Offset

Seat leaves disc quickly, rubbing pressure reduces as soon as disc starts to open. It ensures a long lasting service and maintains tight shut-off characteristics



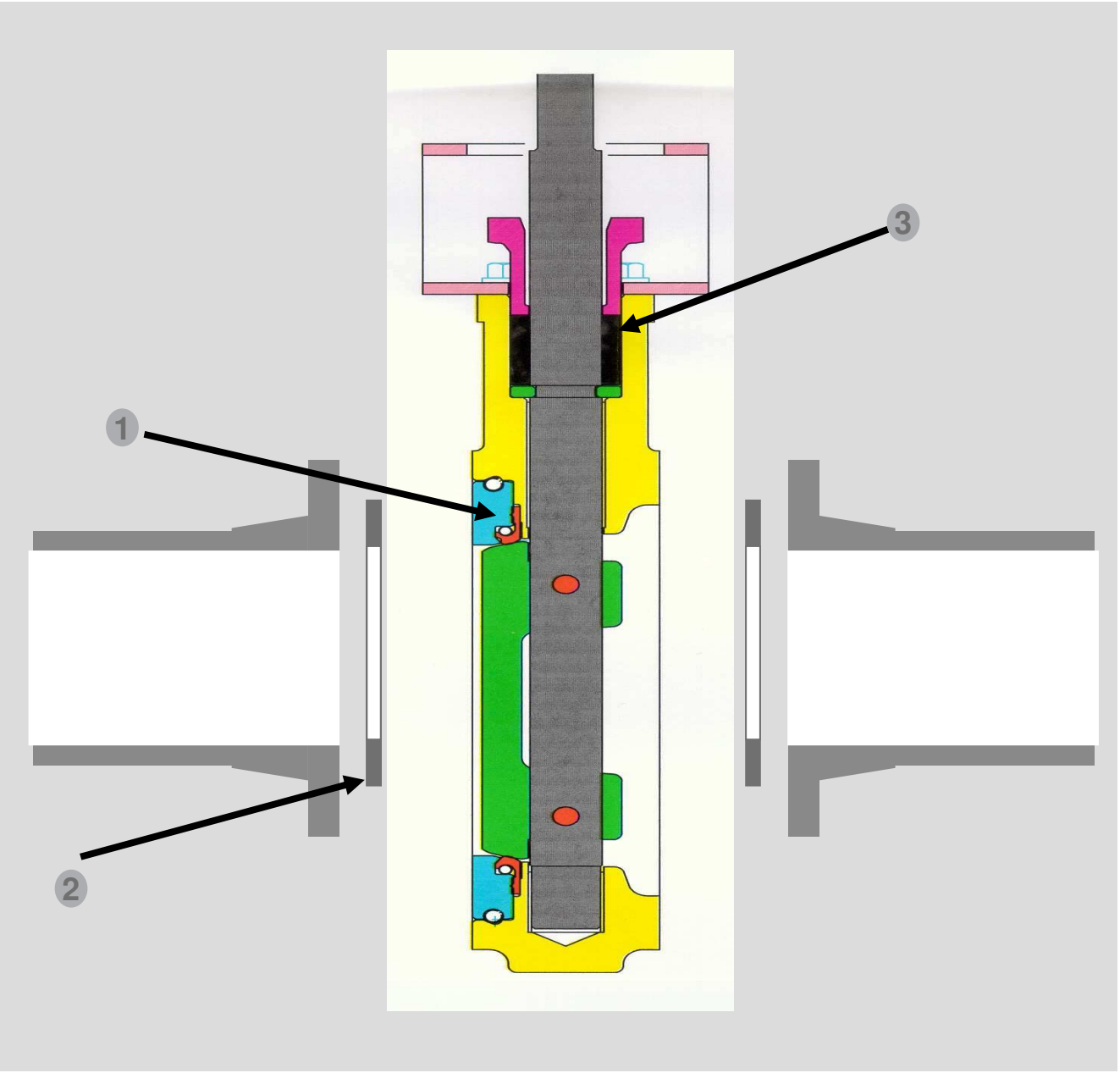


OFFSET DISC BUTTERFLY VALVE CONCEPT

Offset concepts

Double Offset

1. Travel of disc toward closure
2. Axis of disc in open position
3. Axis of disc in closed position
   Axis of pipe
4. Travel arc of spherical center
5. Spherical diameter of disc closed



OFFSET DISC BUTTERFLY VALVE CONCEPT

Tightness concepts

Three independent locations

All the main parts are in contact with the fluid: body, disc, shaft, seat , flange, …

1. **Upstream / Dowstream**
   Uninterrupted seat

2. **With flange pipes**
   ordinary or spiral gaskets
   (recommended for high temperature)

3. **Shaft passage**

   Gasket holder

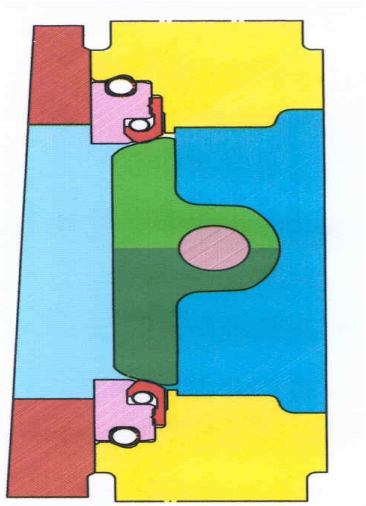
   Packing

OFFSET DISC BUTTERFLY VALVE CONCEPT

Pressure application

Preferred directions of application of the pressure

Pressure disc side



Pressure shaft side

+ In close position, shaft passage is not submitted to pressure

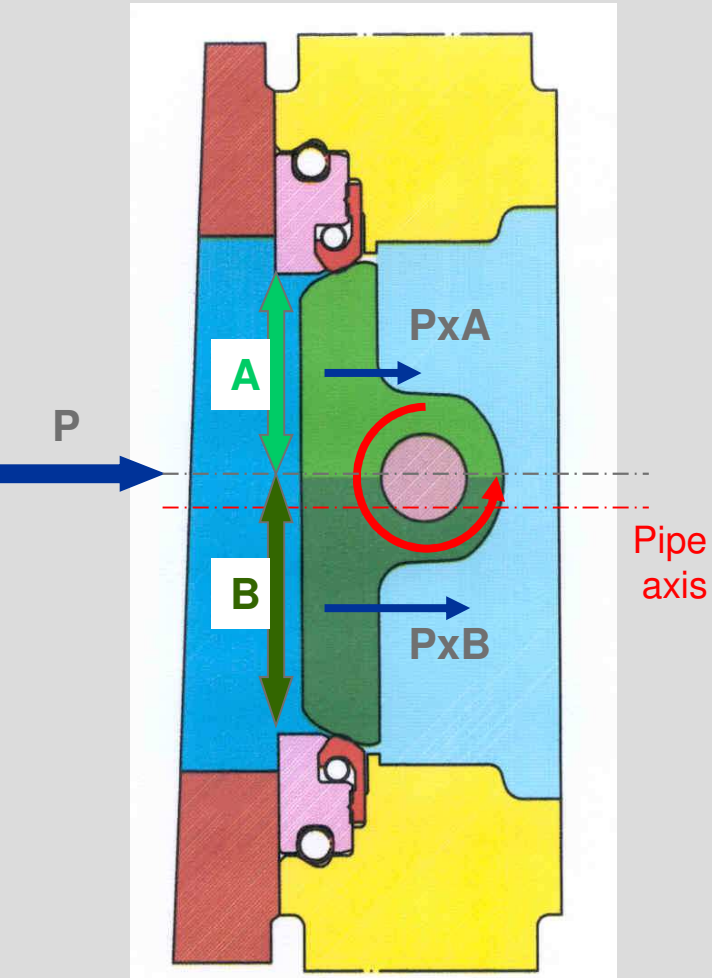
Pressure tends to open valve

+ No supplementary torque due to disc setting too deeply into seat

+ Pressure applies disc on seat → improved upstream/dowstream tightness

Pressure tends to close valve → safety

- higher opening torque



Example: Pressure disc side

OFFSET DISC BUTTERFLY VALVE CONCEPT

Pressure application

Influence of the pressure on an offset disc

Due to the offset between the pipe axis and the disc axis, the surfaces under pressure are not symmetrical about the rotation axis of the disc: B > A.

When a pressure is applied, the force due to the pressure on the surface B is higher than the force generated on the surface A.

This differential of force tends to drive the disc and to open the valve ➔ unseating of the valve.

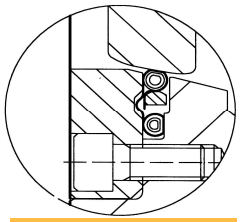
The holding in position of the valve is only achieved by the actuator.

Before maintenance, please verify that there is no pressure or differential of pressure here and there of the disc, before to dismantle the actuator

OFFSET DISC BUTTERFLY VALVE CONCEPT

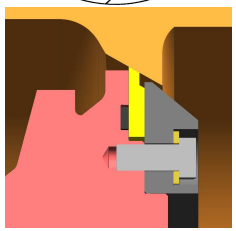
Fire-Safe concepts

Different designs for the Fire-Safe construction



Metallic seat

Agreement according to BS 6755 – Part 2



Metallic seat

Agreement according to EN ISO 10497

Tightness is maintained throughout fire

Answers the needs of many oil companies

No limit for fluid temperature

(- 250° C to 380°C)

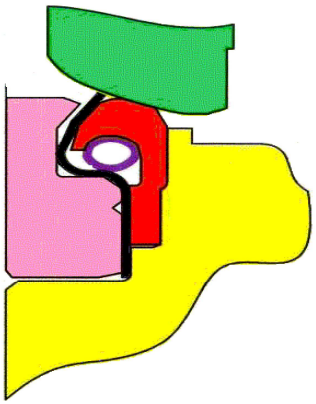
Absolute tightness is difficult to achieve even more to maintain

More expensive (disc edge has to be hardened)

Need for larger actuators

PTFE seat backed by metallic disc

Agreement according to API 607



Absolutely tight

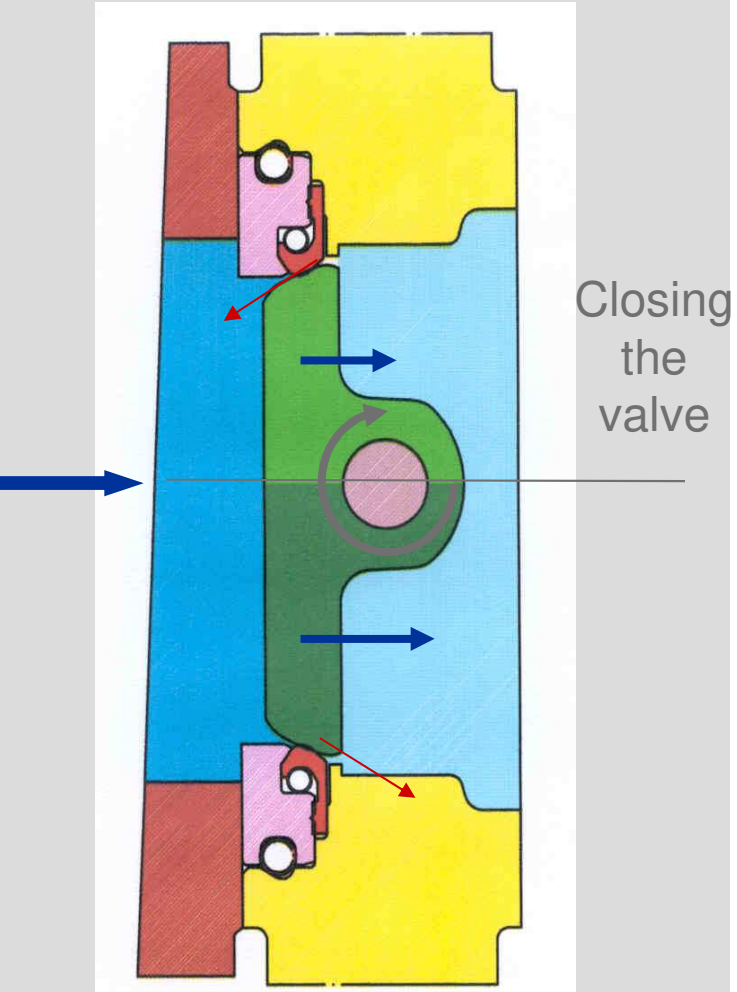
Cheaper

Lower torques → smaller actuation

Tightness is less guaranteed after fire

Fluid temperature limited to - 50°C +250°C

Pressure disc side



Closing the valve

OFFSET DISC BUTTERFLY VALVE CONCEPT

Operating torques

When the pressure is disc side,

in non preferential flow

The pressure of the fluid tends to open the valve and reduce the upstream / downstream tightness

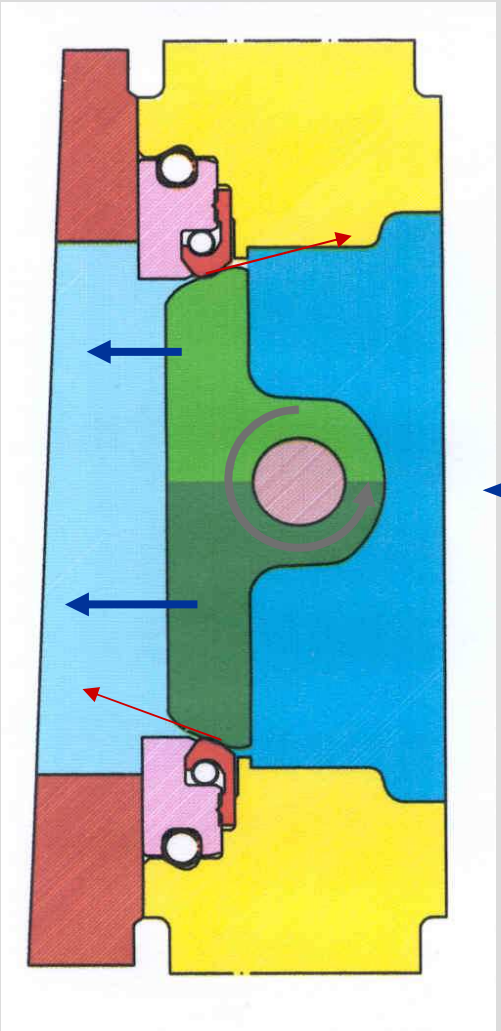
2 cases:

- To keep the valve closed and ensure upstream / downstream tightness, a powerful actuator is necessary to stop the offset torque due to the fluid from opening the valve.

- The opening of the valve is facilitated by the pressure, therefore a powerful actuator is not necessary since the offset torque facilitates this action.

➢ Please refer to the corresponding actuator type described in the Actuator selection document.

Pressure shaft side



Opening of the valve

OFFSET DISC BUTTERFLY VALVE CONCEPT

Operating torques

When the pressure is shaft side,

in preferential flow

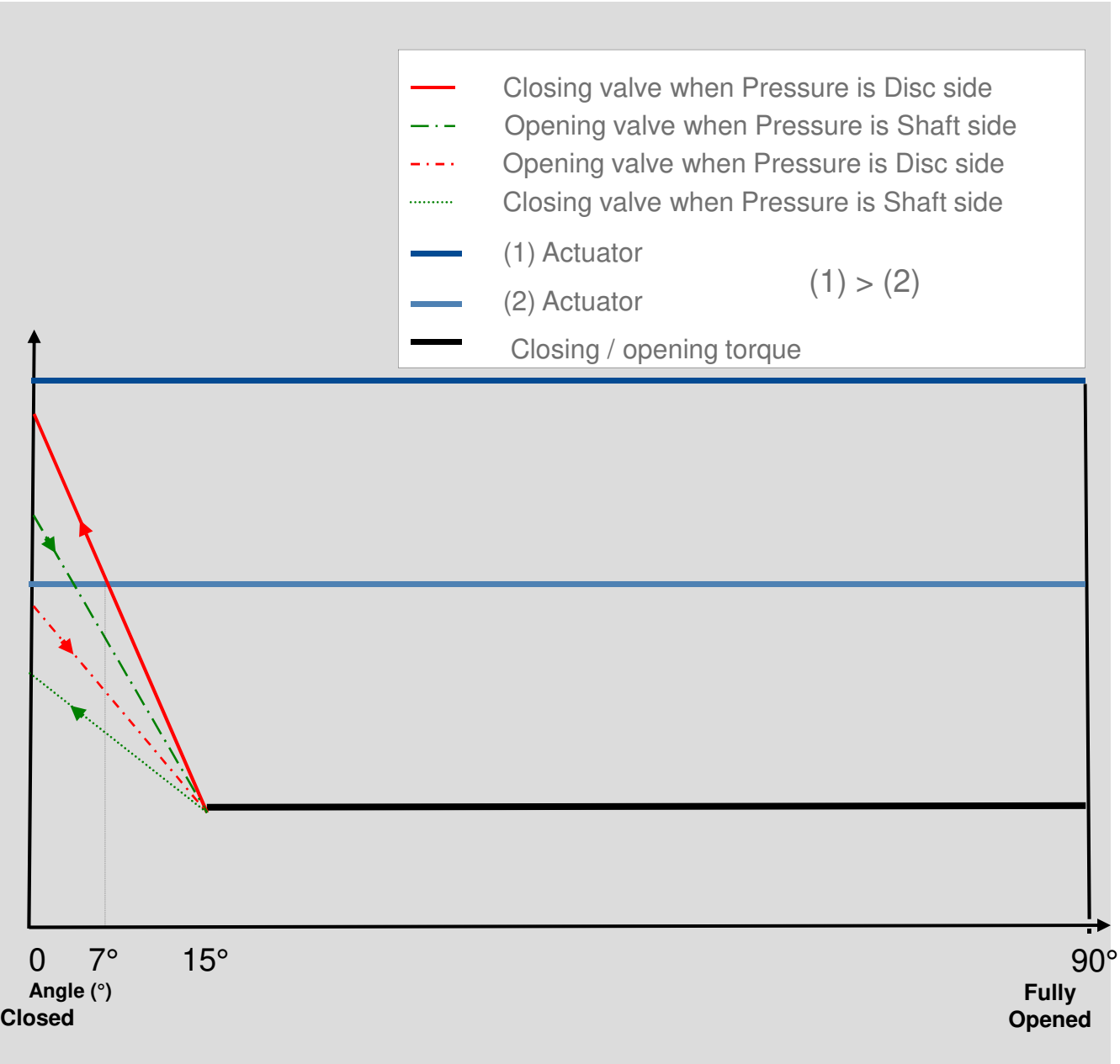
The pressure of the fluid tends to close the valve and keep the upstream / downstream tightness

2 cases:

- To keep the valve closed, a powerful actuator is not necessary since the offset torque facilitates this action

- For the opening of the valve, a powerful actuator is necessary to stop the offset torque from closing the valve

➢ Please refer to the corresponding actuator type described in the Actuator selection document



OFFSET DISC BUTTERFLY VALVE CONCEPT

Operating torques

When valve is used with differential pressure exceeding 10 bars, you may have to select a larger actuator

Ex: Case study:

The pressure is disc side

We want to close the valve by using actuator2

What happens?

➢The valve will be easily opened because actuator 2 is well designed, powerful enough and the pressure also facilitates this action.

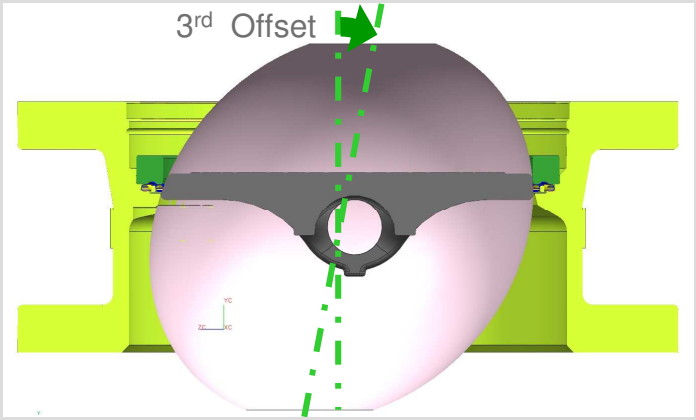
➢For the closing, the valve will be blocked at 7° because actuator 2 is not powerful enough. A more powerful actuator will be necessary to close the valve (actuator 1)

TRIPLE OFFSET BUTTERFLY VALVE CONCEPT

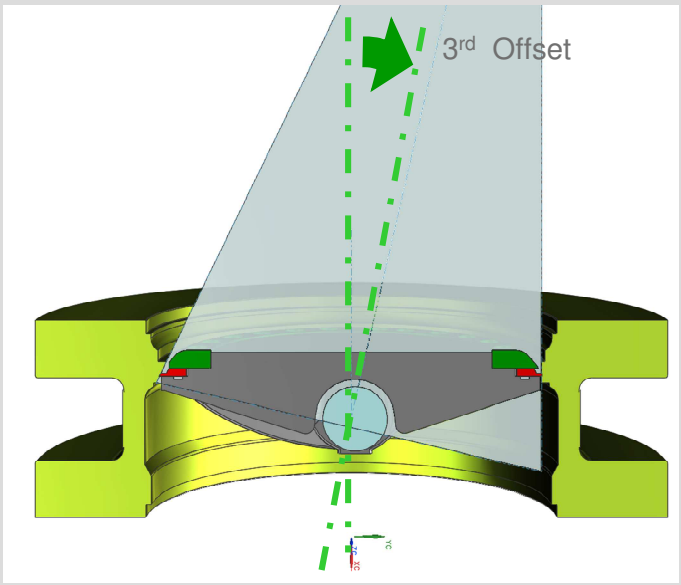
Offset concepts

Triple offset

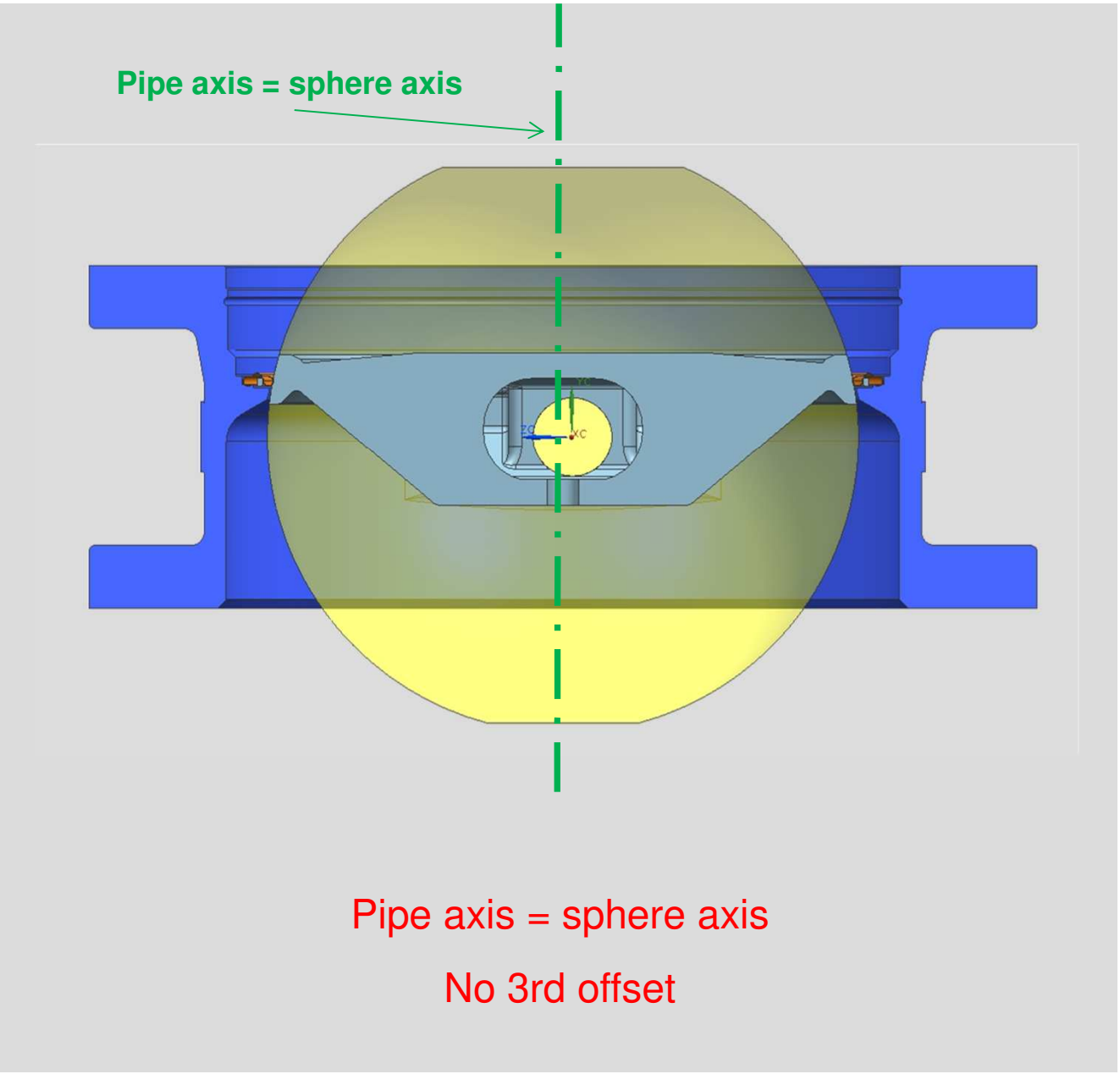
TRISPHERICAL CONCEPT
(Only at KSB)



TRICONICAL CONCEPT
(Idem competitors)



At KSB, we have two ways to do the triple offset disc design

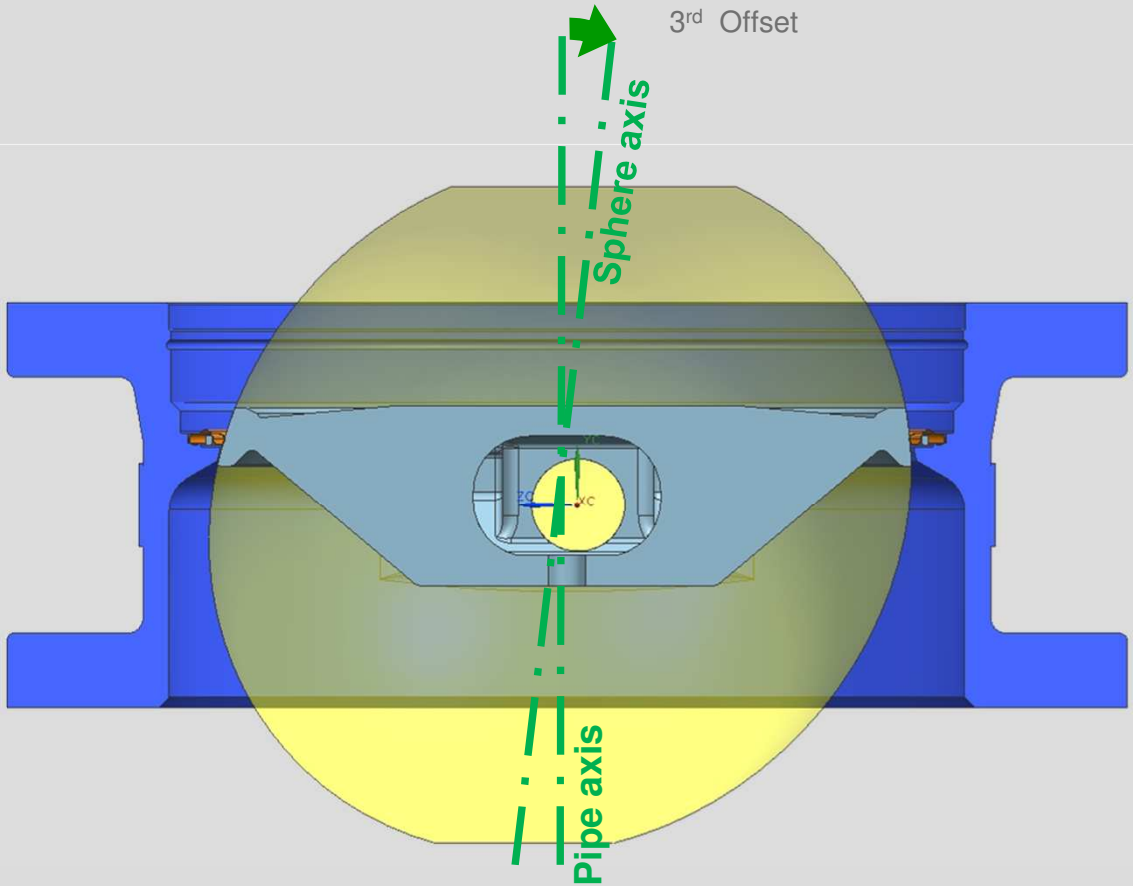


Offset concepts

TRISPHERICAL Concept

Triple Offset

Initial shape = sphere



Sphere axis is inclined of specific angle from pipe axis

This is the 3rd offset

Offset concepts

TRISPHERICAL Concept

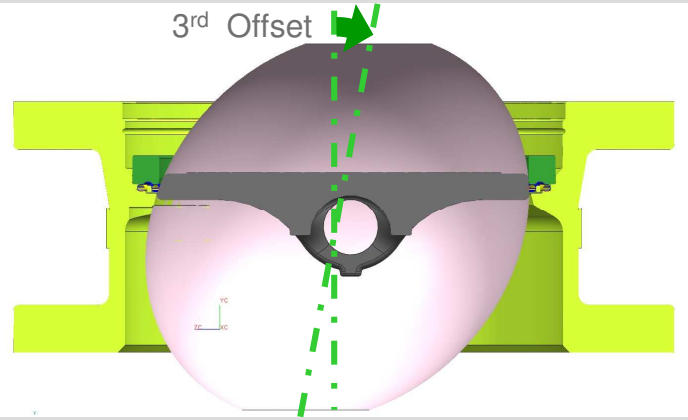
Triple Offset

The "TRISPHERICAL" shape of sealing surfaces is obtained by shifted circles from initial sphere.

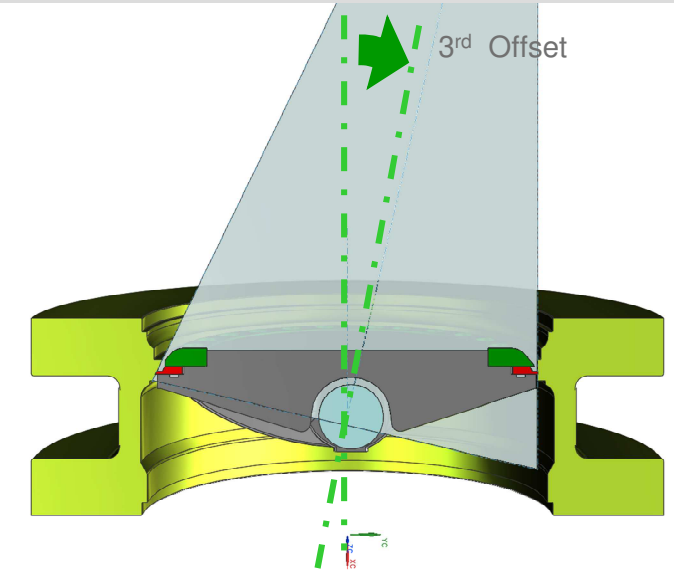
Offset concepts

Triple offset

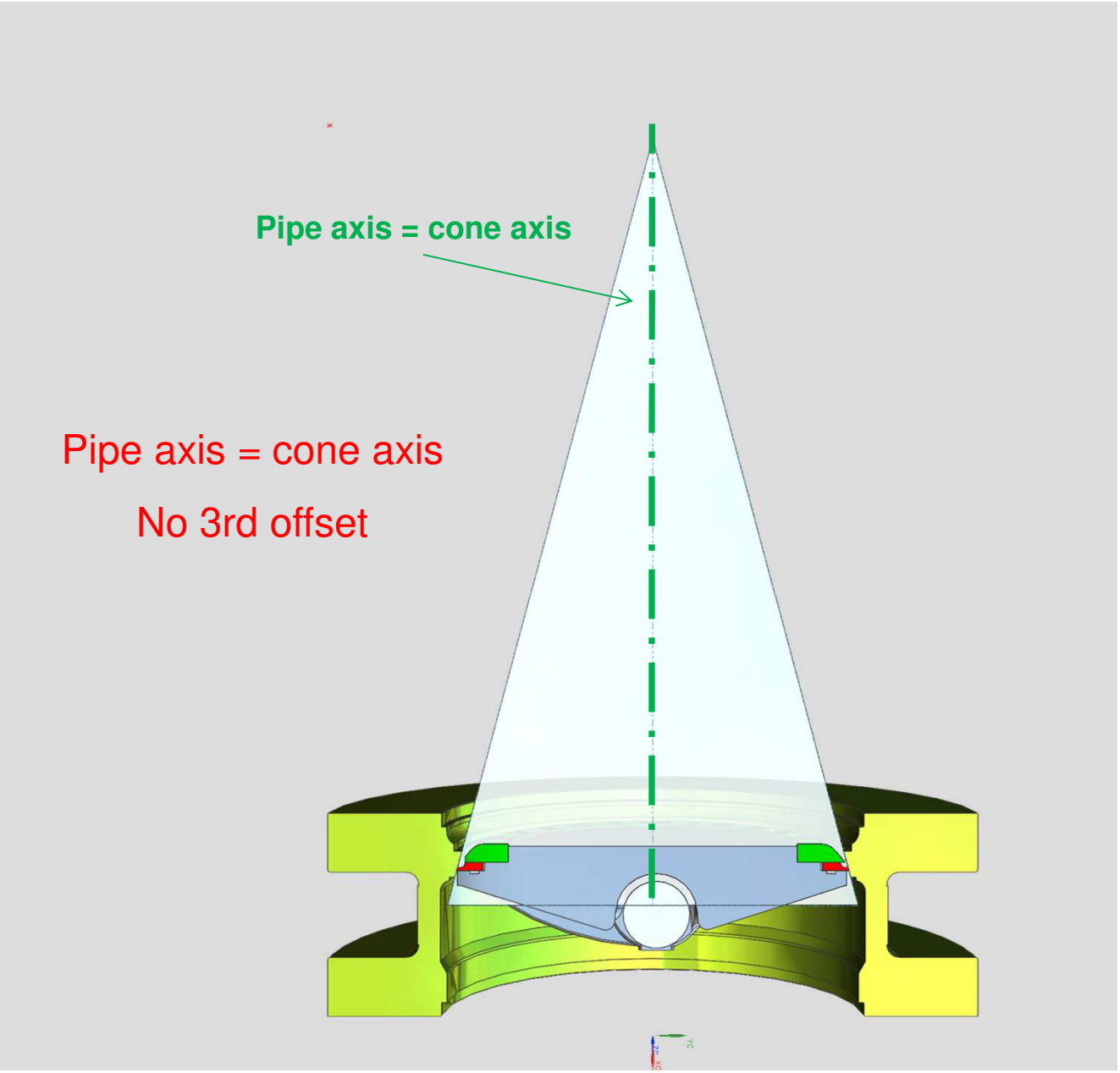
TRISPHERICAL CONCEPT
(Only at KSB)



TRICONICAL CONCEPT
(Idem competitors)



At KSB, we have two ways to do the triple offset disc design



Pipe axis = cone axis

No 3rd offset

Offset concepts

TRICONICAL Concept

Triple Offset

Initial shape = cone

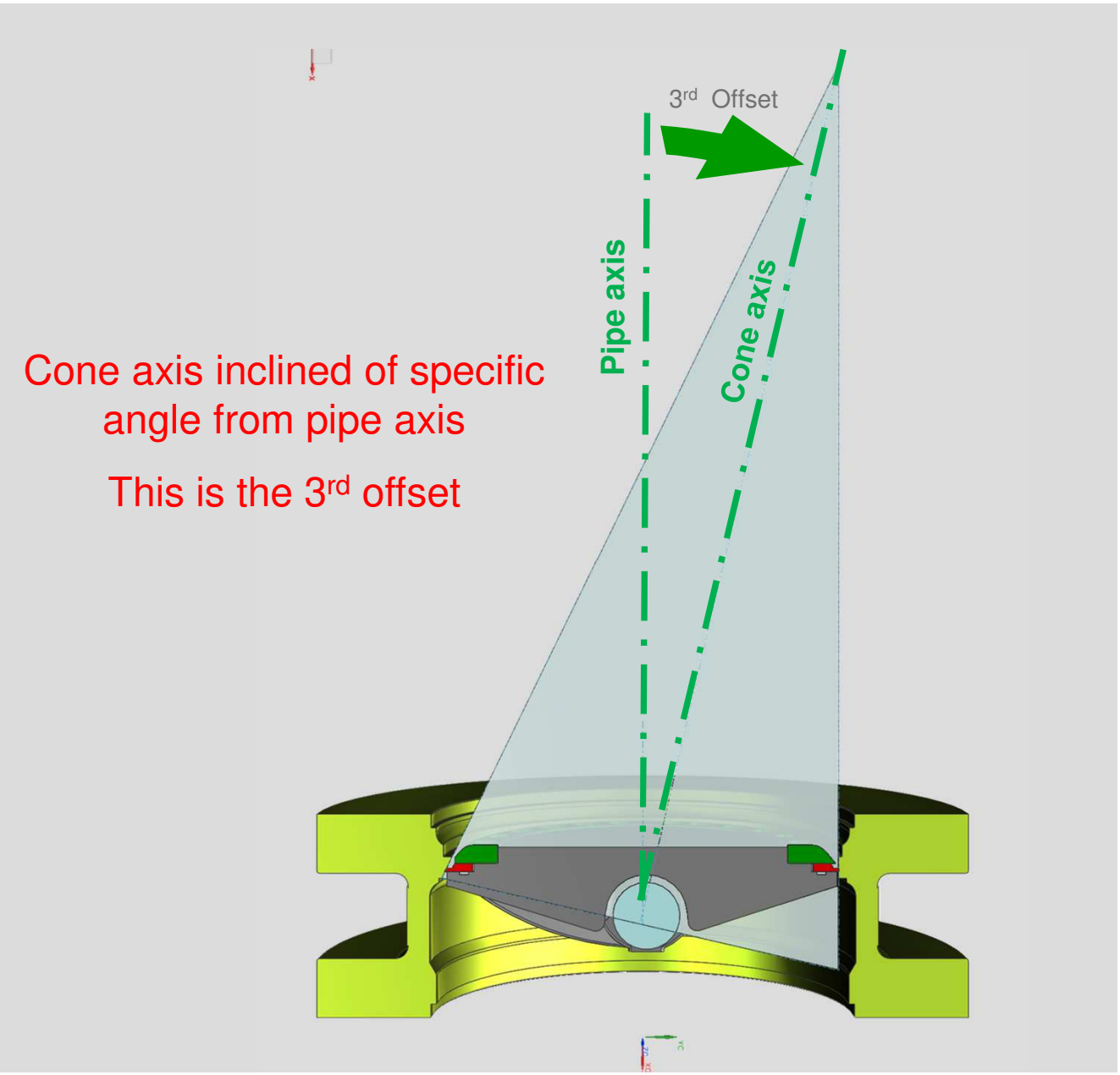
Offset concepts

TRICONICAL Concept

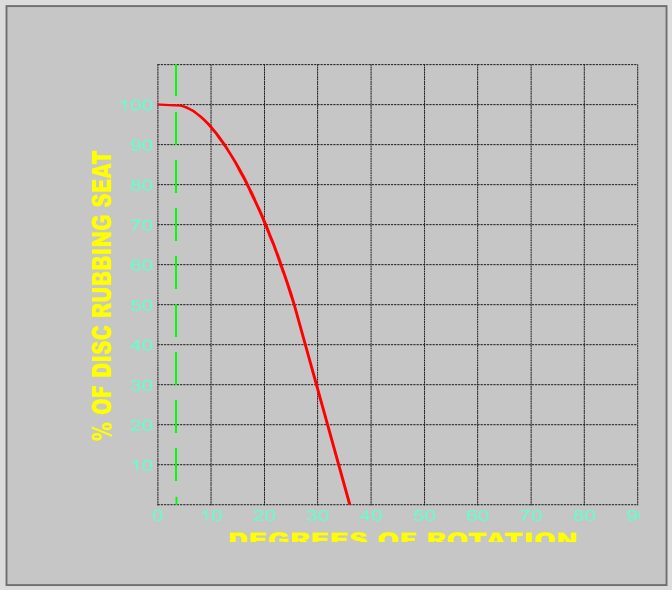
Triple Offset

Cone axis inclined of specific angle from pipe axis

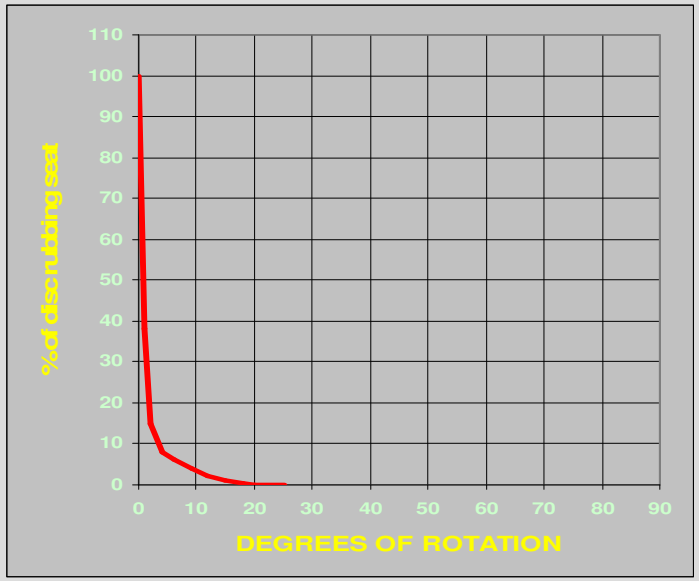
This is the 3rd offset



The “TRICONICAL” shape of sealing surfaces is obtained by inclining a cone of specific angle from pipe axis.



Double offset design



Triple offset design

Disc Rubbing

Triple offset

The triple offset design limits frictions
to the very last 5° closing angle

compared to 30° for double offset design.

➔ increased service life even at high pressure

Tightness concept

Trispherical design tightness concept

Excellent bi-directional tightness with HELICOFLEX® Gasket

Service pressure

P ≤ 25 bar

Before closing

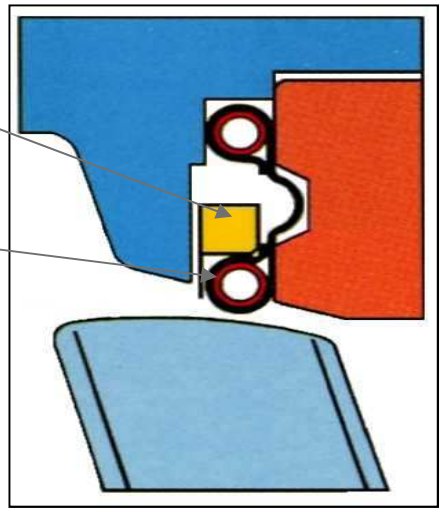
Pressure shaft side

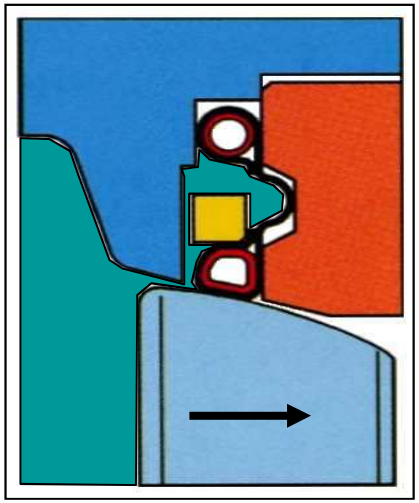
Pressure disc side

Self centering

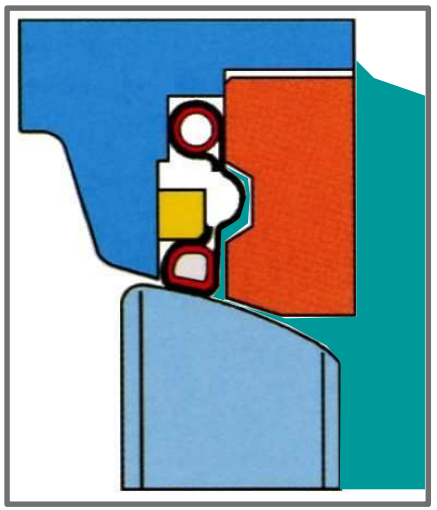
reaction ring

Flexible seat



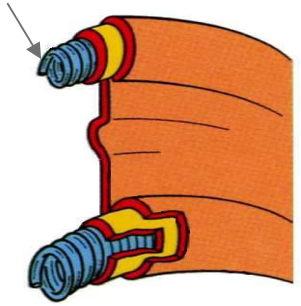


Compression of the metallic seat by the disc



Pressure pushes the seat upwards on the disc → seat compression

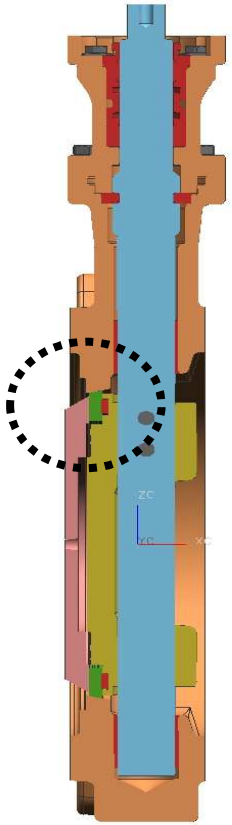
Elastic wire

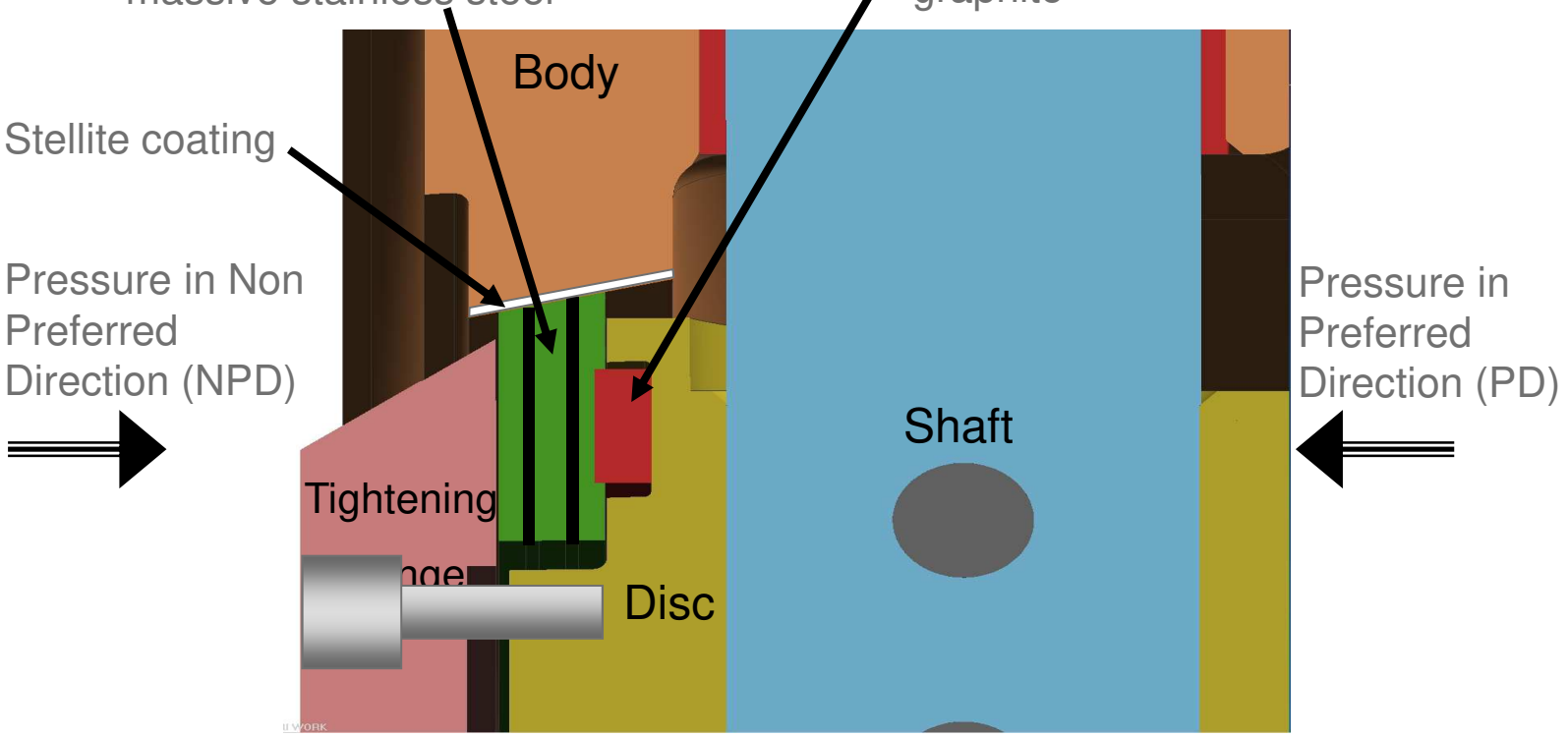


→To guarantee excellent tightness, a valve stopper is implemented on all diameters

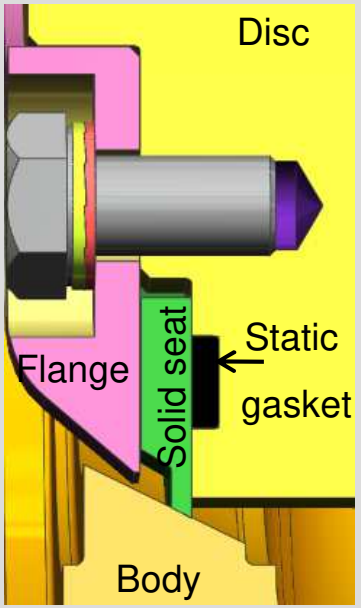
Triconical design tightness concept

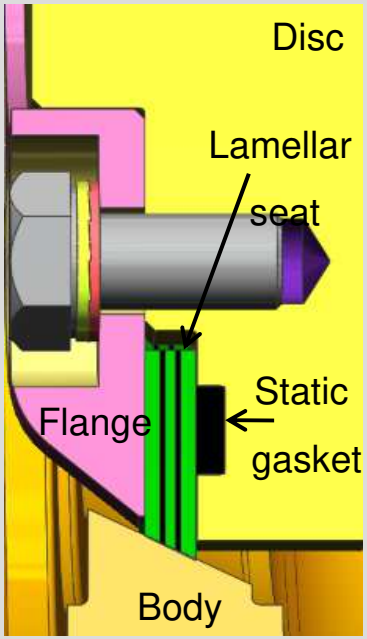
Seat on the disc

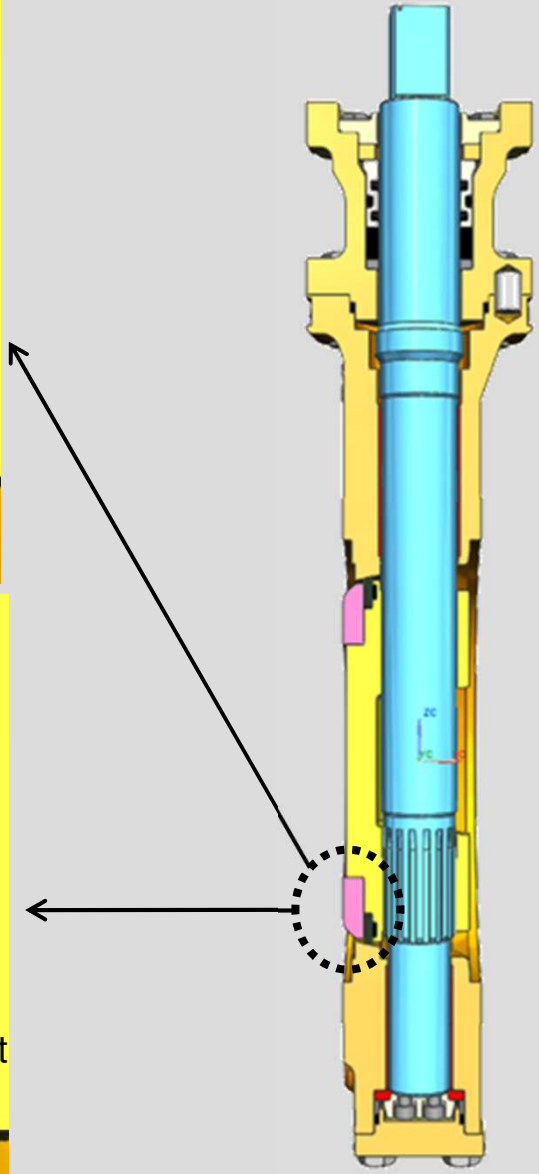




Solid Seat
for cryogenic
applications







Lamellar
Seat for
conventional
applications

Tightness Concept

Triconical

- Implementation of solid gasket allows to guarantee a high tightness performances at high pressure (up to class 900 = 150 bar)
- Triconical valves does not need a stopper in the closed position. The seat is the natural stopper
- Triconical valves are a torque seated valve.
More torque = more tightness.

Customers benefits

Triconical versus Trispherical

“Trispherical” concept

• Implementation of HELICOFLEX® gasket which is a worldwide recognized gasket for its highest tightness performances of the LNG market even at cryogenic temperature and in reverse flow direction

Inconvenient:

(HELICOFLEX® gasket is limited to 25 bar).

“Triconical” concept

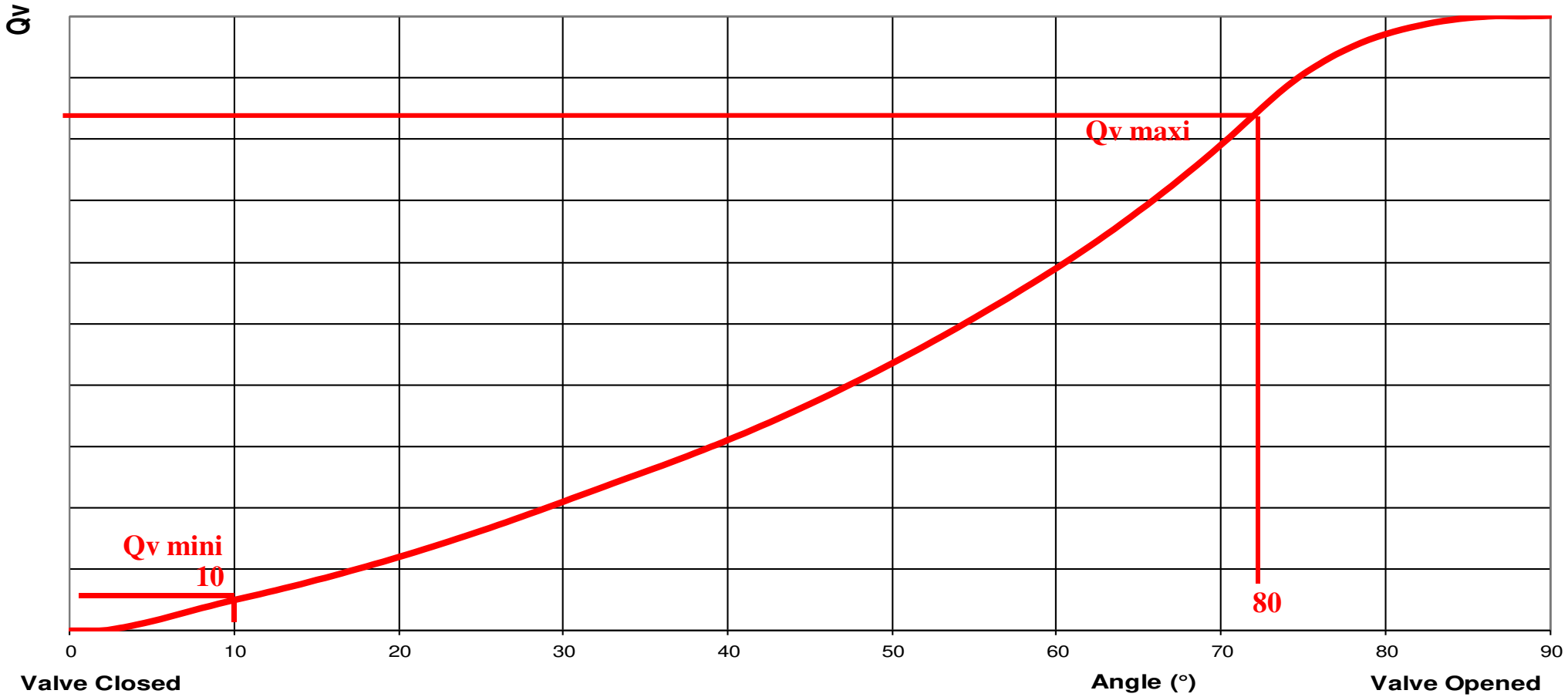
• Implementation of solid gasket allows to guarantee a high tightness performances at high pressure (up to class 900 = 150 bar)

Inconvenient:

Good tightness performances in reverse flow direction are difficult to achieve.

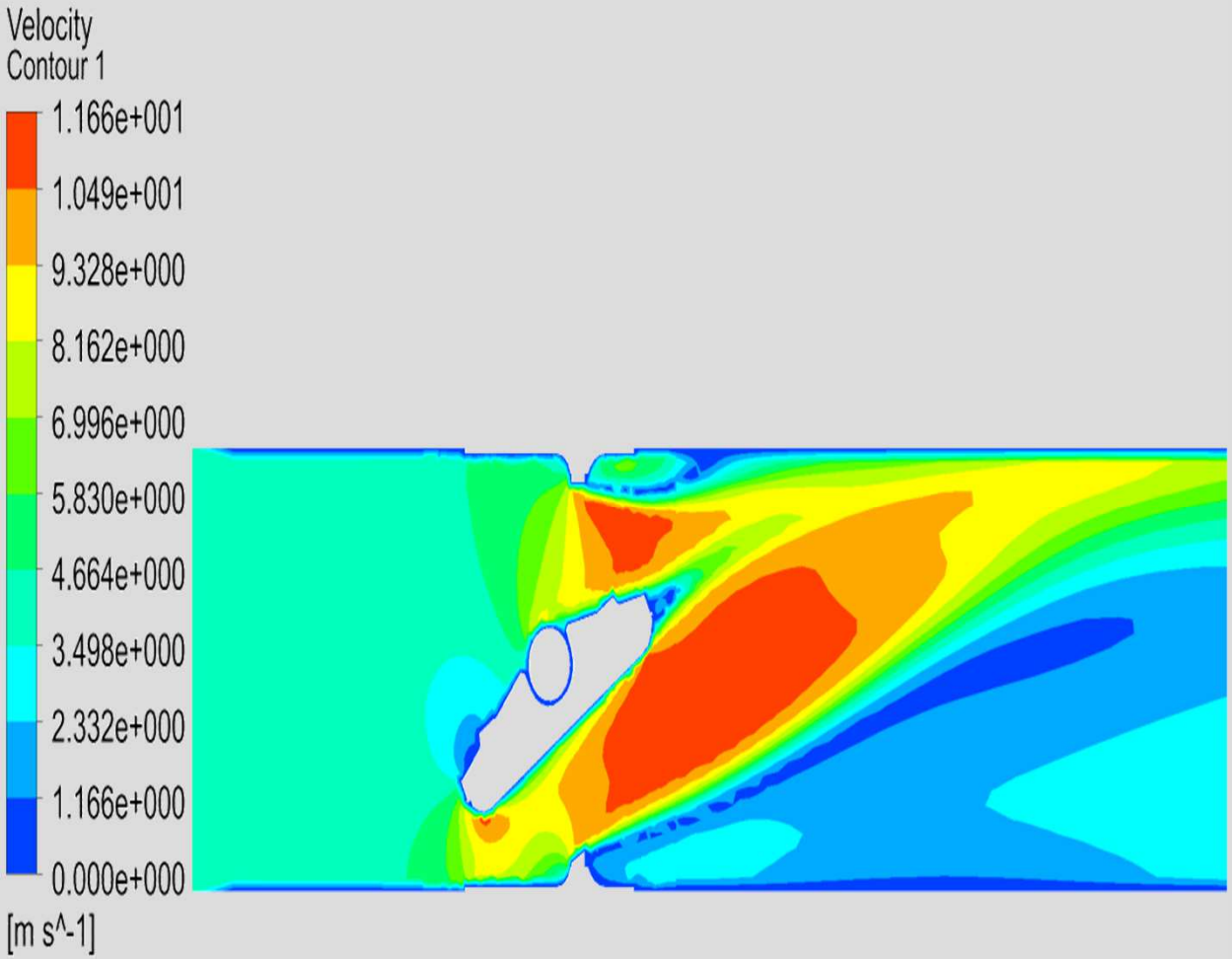
Regulation performances

- The curve is linear - Regulation can be precise



Triple eccentric

Regulation performances



Metallic seat is placed in the body

- → Metallic seat is protected against fluid velocity (abrasion)
- → Good performance in terms of endurance of the disc

THANK YOU FOR YOUR ATTENTION