6.22 Rotary plug valves

This valve construction - simply called „the rotary valve“ - summarizes different valve styles under a generic term. All of them have one thing in common: a turning valve shaft for adjustments in valve opening. The form of the obturator varies between a simple drilled-through cylinder and a complicated eccentrically positioned plug with a spherical segment surface. To this category also belong armature types which are described as „cock“ valves with a cylindrical or conical plug and a special opening cross-section whose profile is authoritative for the flow characteristics of the valve.

The so-called cock valve, with tapered plug, has been in use for more than 2000 years and was utilized in earlier days - carved out of wood - to tap wine. With the development of new, high corrosion resistant materials like PTFE or PFA which are frequently used for the lining of inferior metallic valve bodies, these well-known constructions have had a renaissance. This principle is used, however, principally for ON-OFF services and only seldom for continuous control applications.

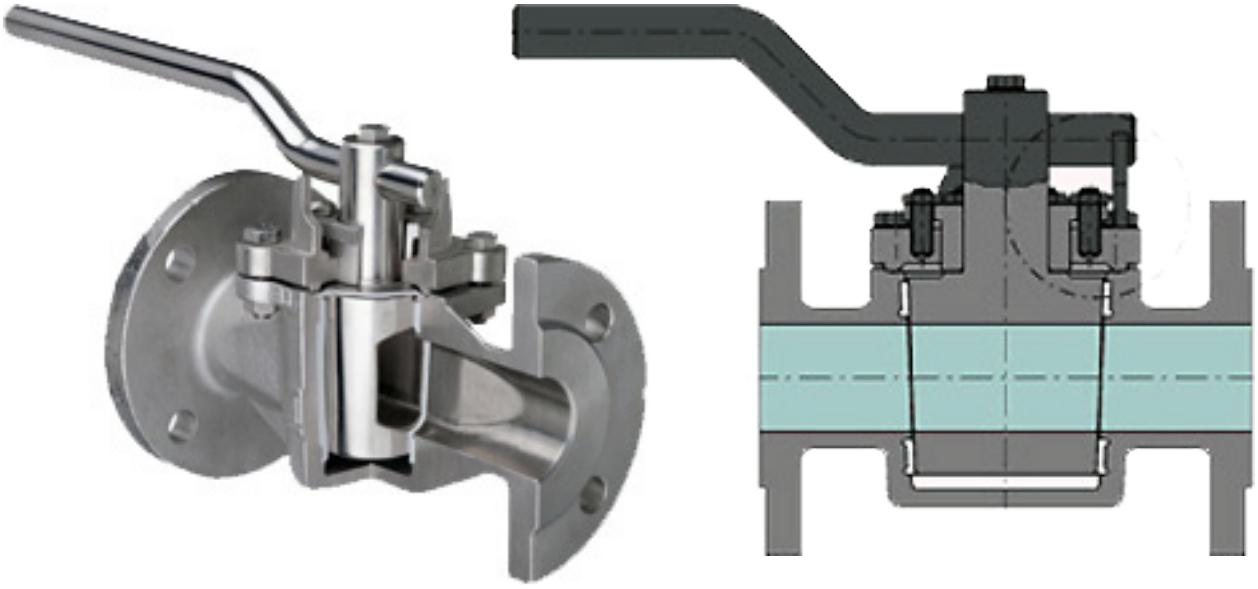


Figure 6.22.-1: Manually operated cock valve with tapered plug

This valve consists of a body with a straight flow path, a bonnet which gives access to the tapered plug which contains normally a round or rectangular opening. If the plug opening is positioned crossways to the flow direction, the valve is closed. Full opening is reached by a turn of 90 degrees by means of a manually actuated lever or by a pneumatic or electric actuator. In the full open position the pressure loss is correspondingly low; this is always desired for a pure ON-OFF service. Tight shut-off can be reached by an exact fit between the tapered plug and the conical bore hole of the valve body and by a high surface finish of these parts.

The tapered plug has, in addition, the advantage that adjustment is possible by pressing the tapered socket, with the help of the bonnet, further into the conical bore hole. Most cock valves used today have a PTFE or PFA lining, which enable a high tight shut-off quality at comparatively low torques. This also avoids seizing between plug and body, if the medium does not provide self lubrication. A special PTFE disk mounted on the top surface of the plug reduces the friction force and provides, at the same time, an excellent sealing at the plug shaft Figure 6.22.-1.

A cock valve for pure control tasks is not the best choice although some of these rotary plug valves have a triangular hole or a special profile instead of a simple bore to achieve a better rangeability.

Cock valves with a PTFE/PFA bushing or lining have natural application limits. Without the application of modern synthetic fluorine materials high friction and above all the unwanted „stick-slip“ effect in combination with pneumatic diaphragm actuators might occur. Under these circumstances a fine control is almost impossible.

There is, in addition, another disadvantage of cock valves with metal to metal contact: the valve can be stuck in the same way as a ball valve, especially if it has not been moved for a long time.

Often corrosion or a sticking fluid are the causes of this malfunction. Another problem is caused by the often differing expansion coefficients of valve body and plug.

This limits the temperature range at which a high tight shut-off quality can be guaranteed. The manufacturing of this construction is simpler than for ball valves and this reflects lower costs and/or lower retail prices.

They are used in a wide range of severe and highly demanding services - ideal for corrosive, scaling, adhering, inflammable, or erosive flow media. These valves show excellent performance in traditional ball and gate valve applications, and they offer a cost-efficient solution for tight shutoff and throttling of gases, vapors, slurries, etc.

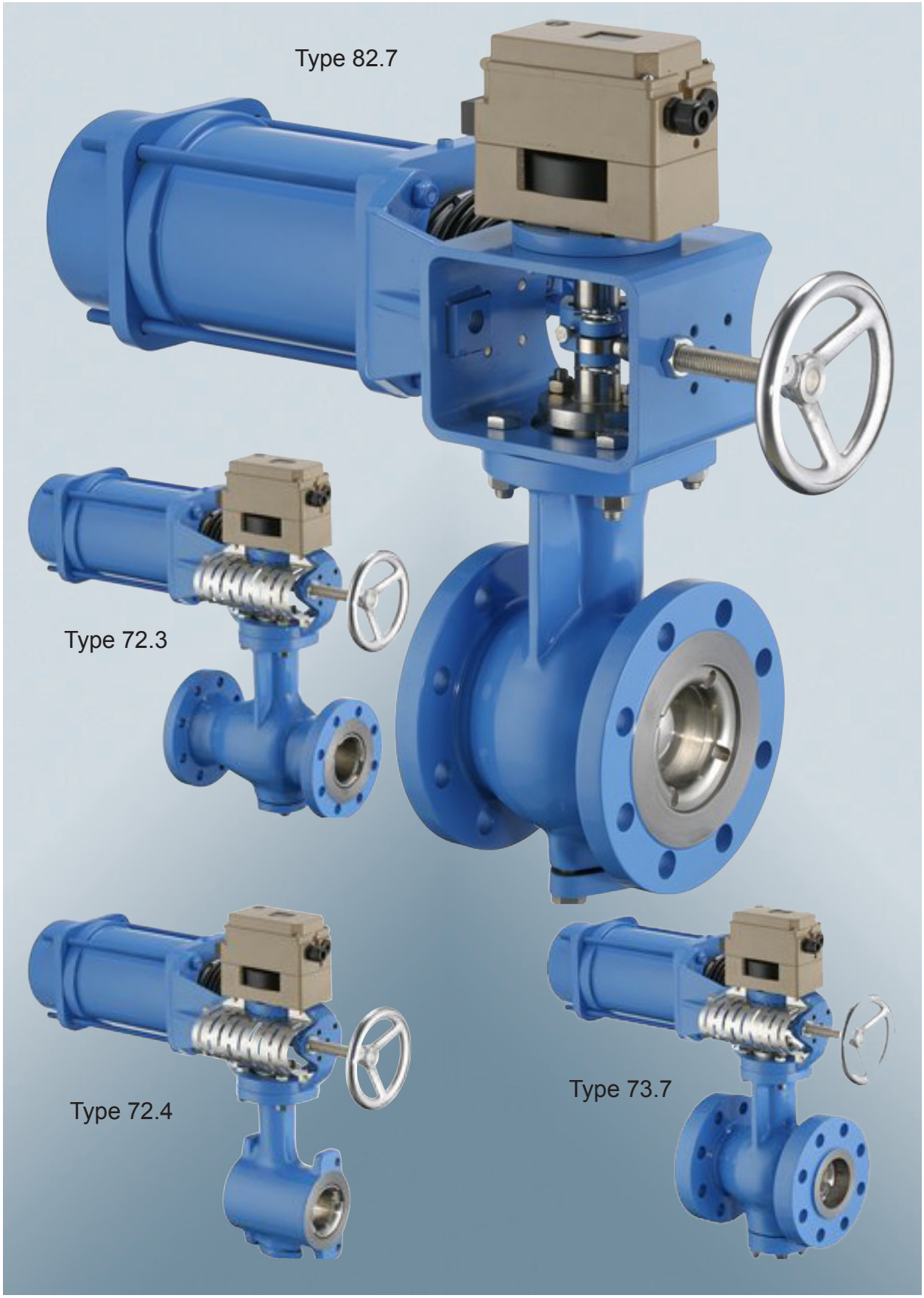
Figure 6.22.-2: AZ - Armaturen[1] with SAMSON Positioner

The cock valve can be used for the following media:

- Liquids, especially aggressive, crystallizing and polymerizing
- Liquids with particles
- 2- phase liquids, e.g. crude oil
- Solids
- Liquid gas (LPG)
- Gas

1 http://www.az-armaturen.de

Rotary plug valves



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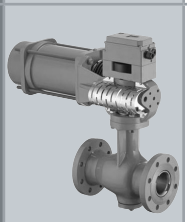
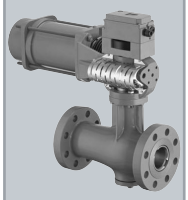
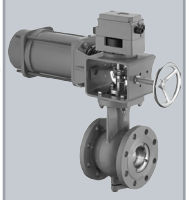
Rotary Plug Valves Double eccentric control valve for process engineering and industrial applications						
Type		72.3	72.4	73.3	73.7	82.7
Standard version	DIN	✓	✓	✓	✓	
	ANSI	✓	✓		✓	✓
Temperature		-100 to 400 °C -148 to 752 °F	-100 to 400 °C -148 to 752 °F	-100 to 400 °C -148 to 752 °F	-100 to 400 °C -148 to 752 °F	-100 to 400 °C -148 to 752 °F
Nominal sizes	DN	25 to 500	25 to 300	25 to 250	25 to 500	
	NPS	1 to 20	1 to 12		1 to 20	1 to 10
Nominal pressure	PN	10 to 40	10 to 40	63/100/160	63/100/160	
	Class	150 and 300	150 and 300		600 and 900	150 and 300
Characteristic (using cam disk or positioner characteristic)		On-Off, Equal-percentage or linear	On-Off, Equal-percentage or linear	On-Off, Equal-percentage or linear	On-Off, Equal-percentage or linear	On-Off, Equal-percentage or linear
Sealing		Metal, soft or ceramic	Metal, soft or ceramic	Metal, soft or ceramic	Metal	Metal, soft
Body		Cast/carbon steel or Stainless cast/carbon steel	Cast/carbon steel or Stainless cast/carbon steel	Cast/carbon steel or Stainless cast/carbon steel	Cast/carbon steel or Stainless cast/carbon steel	Cast/carbon steel or Stainless cast/carbon steel
Leakage rate		IV VI (soft)	IV VI (soft)	IV	IV	IV VI (soft)
Opening angle		75°	75°	75°	75°	75°
Body style		Flange	Sandwich	Flange	Flange	Flange
Hand-lever or Gear-operated actuators		On request	On request	On request	On request	On request
Pneumatic and electric actuators		✓	✓	✓	✓	✓
Valve pictures						
Face to face dimensions		Acc. to EN 558-1 and 558-2				
Connection / Flanges		DIN EN 1591-1/DIN 2500, ASME B16.5				
Fail-safe position		Fail-safe position with pneumatic or electric actuators see the associated technical data sheet.				
Accessories		Accessories are available on request for customer specifications				
Technical data and accessories		For all further data, accessories, and industry codes see the associated technical data sheet.				

Table 6.22.-3: Rotary Plug Valves industrial applications

Rotary Plug Valves Control valve for control systems subject to the special safety requirements applicable for gas supply.						
Type		72.3 AT DVGW	72.4 AT DVGW	72.3 MN DVGW	72.4 MN DVGW	Special models
Standard version	DIN	✓	✓	✓	✓	
	ANSI	✓	✓	✓	✓	
Temperature		-20 to 150 °C -4 to 302 °F	-20 to 150 °C -4 to 302 °F	-20 to 150 °C -4 to 302 °F	-20 to 150 °C -4 to 302 °F	
Nominal sizes	DN	25 to 200	25 to 200	25 to 200	25 to 200	
	NPS	1 to 8	1 to 8	1 to 8	1 to 8	
Nominal pressure	PN	10 to 40	10 to 40	10 to 40	10 to 40	
	Class	150 and 300	150 and 300	150 and 300	150 and 300	
Characteristic (using cam disk or positioner characteristic)		On-Off, Equal-percentage or linear	On-Off, Equal-percentage or linear	On-Off, Equal-percentage or linear	On-Off, Equal-percentage or linear	
Sealing		Soft	Soft	Soft	Soft	
Body		Cast/carbon steel or Stainless cast/carbon steel	Cast/carbon steel or Stainless cast/carbon steel	Cast/carbon steel or Stainless cast/carbon steel	Cast/carbon steel or Stainless cast/carbon steel	
Leakage rate		VI (soft)	VI (soft)	VI (soft)	VI (soft)	
Opening angle		75°	75°	75°	75°	
Body style		Flange	Sandwich	Flange	Sandwich	
Hand-lever or Gear-operated actuators		On request	On request	On request	On request	On request
Pneumatic and electric actuators		✓	✓	✓	✓	
Valve pictures						
Face to face dimensions		Acc. to EN 558-1 and 558-2				
Connection / Flanges		DIN EN 1591-1/DIN 2500, ASME B16.5				
Fail-safe position		Fail-safe position with pneumatic or electric actuators see the associated technical data sheet.				
Accessories		Accessories are available on request for customer specifications				
Technical data and accessories		For all further data, accessories, and industry codes see the associated technical data sheet.				

Table 6.22.-4: Rotary Plug Valves for gas supply, DVGW certified

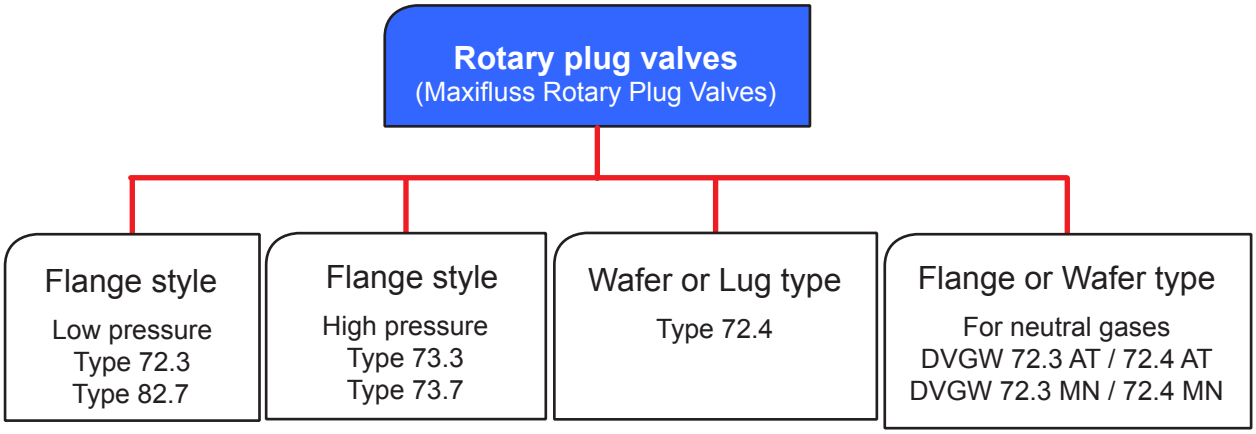


Figure 6.22.-5: Overview Rotary plug valves

This valve construction has gained great approvals since the eighties. The forerunner of this development was Masoneilan's "Camflex"-valve. In the meantime almost all important manufacturers of control valves have introduced a similar valve type and extended thereby their product range. Of advantage are: high rangeability, good controllability at low friction and an tight shut-off feature at a comparatively low actuator thrust.

The eccentric rotary plug valve is an attempt to combine the advantages of standard valves (low friction, good rangeability) with ball valves (high C_V-values, compact dimensions). The original idea was a flange less valve which could be installed into any piping system regardless of the very many flange standards. In the meantime, however, also short comings have come to light in spite of the advantages of a flange less version: there are dangers of leakages at high pressures and temperatures. This led, for example, to the recommendation in refineries and petrochemical plants to use preferably control valves with flanges for combustible liquids and gases, in order to reduce the risk of a fire.

Since flange less rotary valves are clamped between the pipe flanges by means of 4 to 12 long overhung bolts, these would be directly exposed to the flames, in case of a fire. The highly stressed bolts would, under this circumstance, expand and increase thereby the leakage. Although the same problem exists for all flange less valves, the danger of a leakage is diminished for a short sandwich style body, due to a great number of short bolts as in, for example, a butterfly valve with wafer type body.

6.22.1. What is a rotary plug valve and what are its advantages?

The VETEC rotary plug valve is an outstanding combination of a segmented ball valve, butterfly valve, and the classic control valve and unifies all their advantages such as free passage, no dead space, high gland nut insularity, control over high pressure difference, compact design and very good control properties. Rotary plug valves have a variety of critical applications that can only be covered by conventional control valves with difficulty.

The advantage

One of the main advantages of the rotary plug valve is its free passage. Due to the flow restrictor which moves crossways to the flow, the media current does not have to be diverted through the housing wall. This confers a special advantage on abrasive or adhesive media.

Typically rotary plug valves features – technical / economical / environmental
■ High shut down pressures with low break off torque
■ Free flow path
■ No dead spaces
■ Compact design at larger sizes compared to globe valves
■ 2-3 times more of C_v-capacity compared to globe valves and similar C_v values by reducing the seat only.
■ High Cv turn down ratio 200:1 of the natural linear modified characteristic
■ Smaller DN / NPS compared to globe valves for the same application are possible
■ Rotary action prevents transport of toxic products through packing
■ O-ring seals guarantee Clean Air Act approval
■ Flow direction is various
■ FTC is useful for: ▪ Gas/steam applications ▪ Cavitation or flashing ▪ Decreased actuator sizing
■ Smaller actuators ➔ less weight, less space and less price

Table 6.22.1.-1: Typically rotary plug valve features – technical / economical / environmental

The bearing

The axle's bearing in connection with the plug and the housing is arranged double eccentric and causes the plug to lift up immediately and smoothly from the seat when rotating the plug shaft. The valve does not fire open and therefore displays stable control action even for small opening angles.

Double eccentric principle

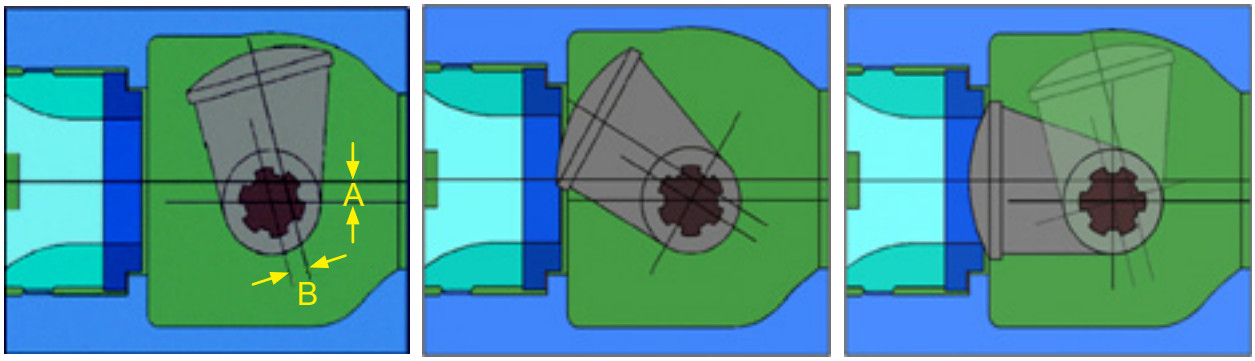


Figure 6.22.1.-2: Sectional diagram: Plug movement with double eccentric bearing

Double eccentric principle	
Shaft offset „A“	Valve body◄►Shaft centre
Shaft offset „B“	Shaft centre◄►Ball segment centre
Opening	75°

Table 6.22.1.-3: Double eccentric principle

6.22.2. What is typical for rotary plug valves

Rotary plug valves are characterized by high C_{v100} values which are up to 200 % larger than for globe valves of a similar nominal size. By opting for a rotary plug valve, you can use smaller valve nominal sizes and thereby avail of cheaper solutions.

Rotary plug valves display firm geometry of the flow restrictor, whereby the valve's natural curve is set. Conversion to an ideally linear or ideally equal percentage curve is conducted via a position regulator, either with suitable cam disks or via a software curve in the case of modern regulators. The incoming signal is transformed accordingly via the so-called signal curve so that this produces the desired total curve by superimposing with the natural curve. Signal characteristics will not improve controllability anyway and should handle with care special in quick acting control loops.

The high rangeability of the rotary plug valve must be mentioned in connection with the flow curve within acceptable slope variations of the installed flow characteristic and the flow ratio q100/qmin.

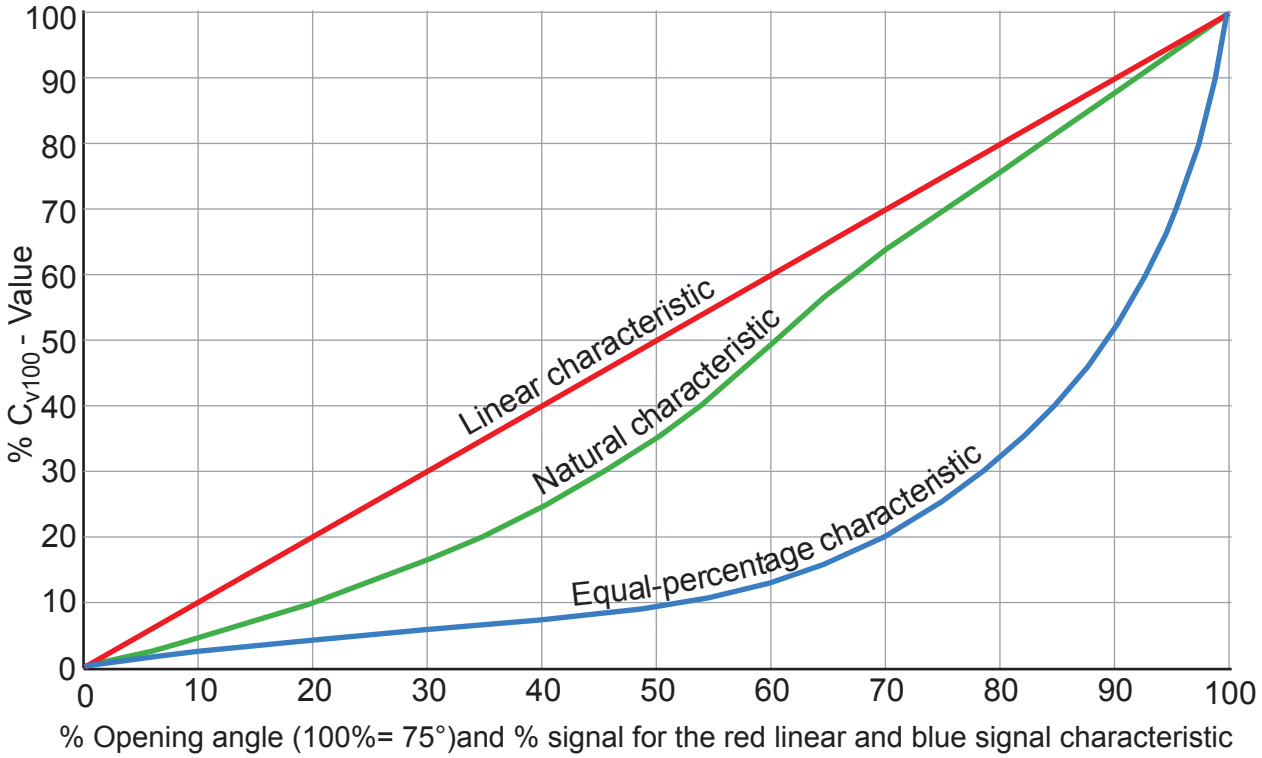


Figure 6.22.2.-1: Rotary plug valves characteristic by using cam disk or positioner

The rangeability defines the ratio of the nominal C_{v100}-value to the smallest controllable flow value where the curve is still within the permitted tolerances. Rotary plug valves attain typical values of 1:200 in comparison with globe valves with range abilities of 1:30 to 1:50. The rotary plug's valves are pre-determined by the design, because the plug does not dip into the seat through the double eccenter, but releases a traceable transverse section for the smallest opening angle. Therefore, in the case of a rotary plug valve, it can be adjusted to zero.

In contrast with the globe valves, rotary plug valves produce a torque through the actuator's linear transmission via a lever which favours the use of smaller actuators with shorter manipulation. This can be seen, most notably, in the case of large nominal sizes. Compared to globe valves, rotary plug valves have a more compact design.

Design of the inner parts

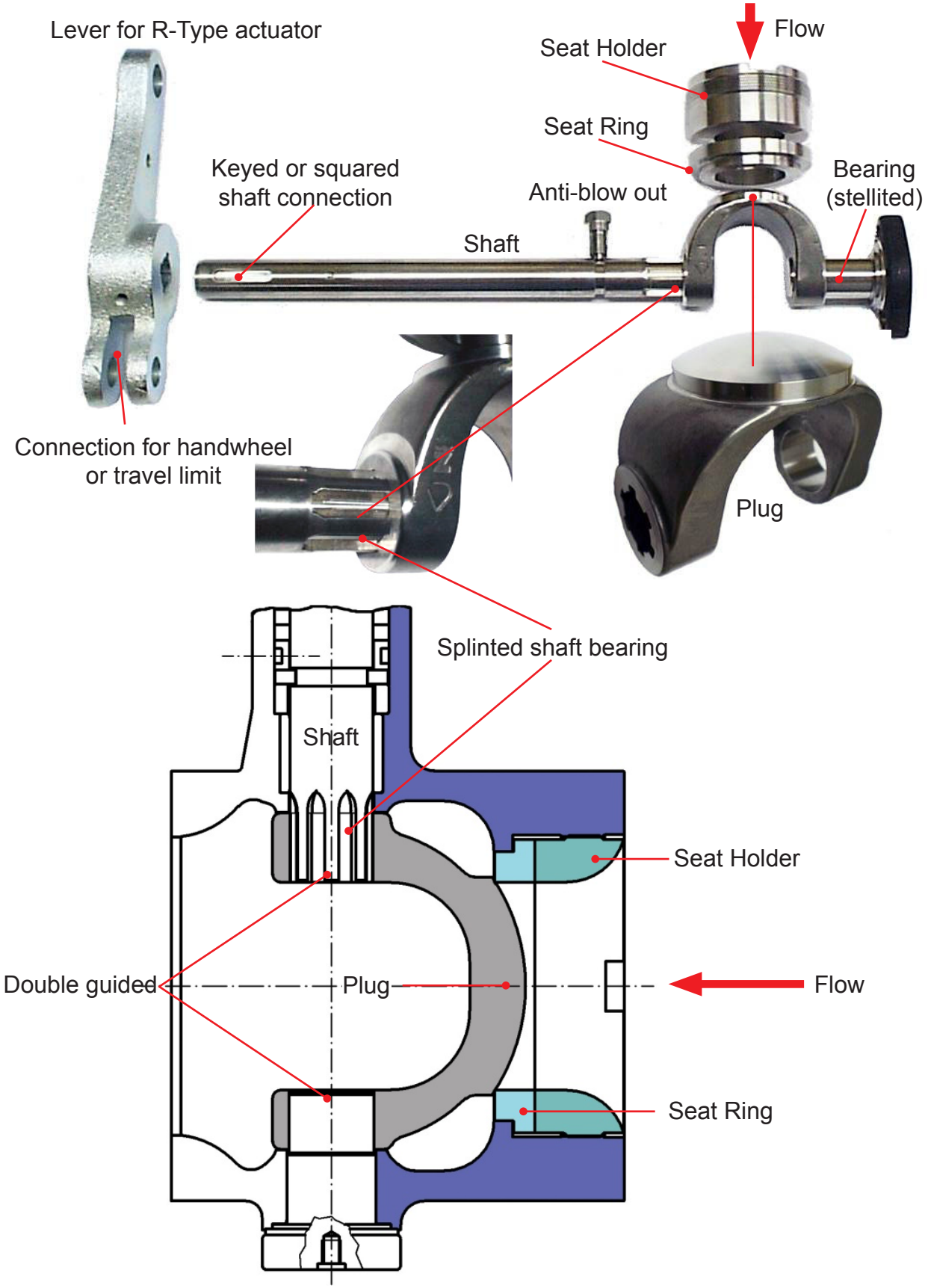


Figure 6.22.2.-2: Design of the inner parts

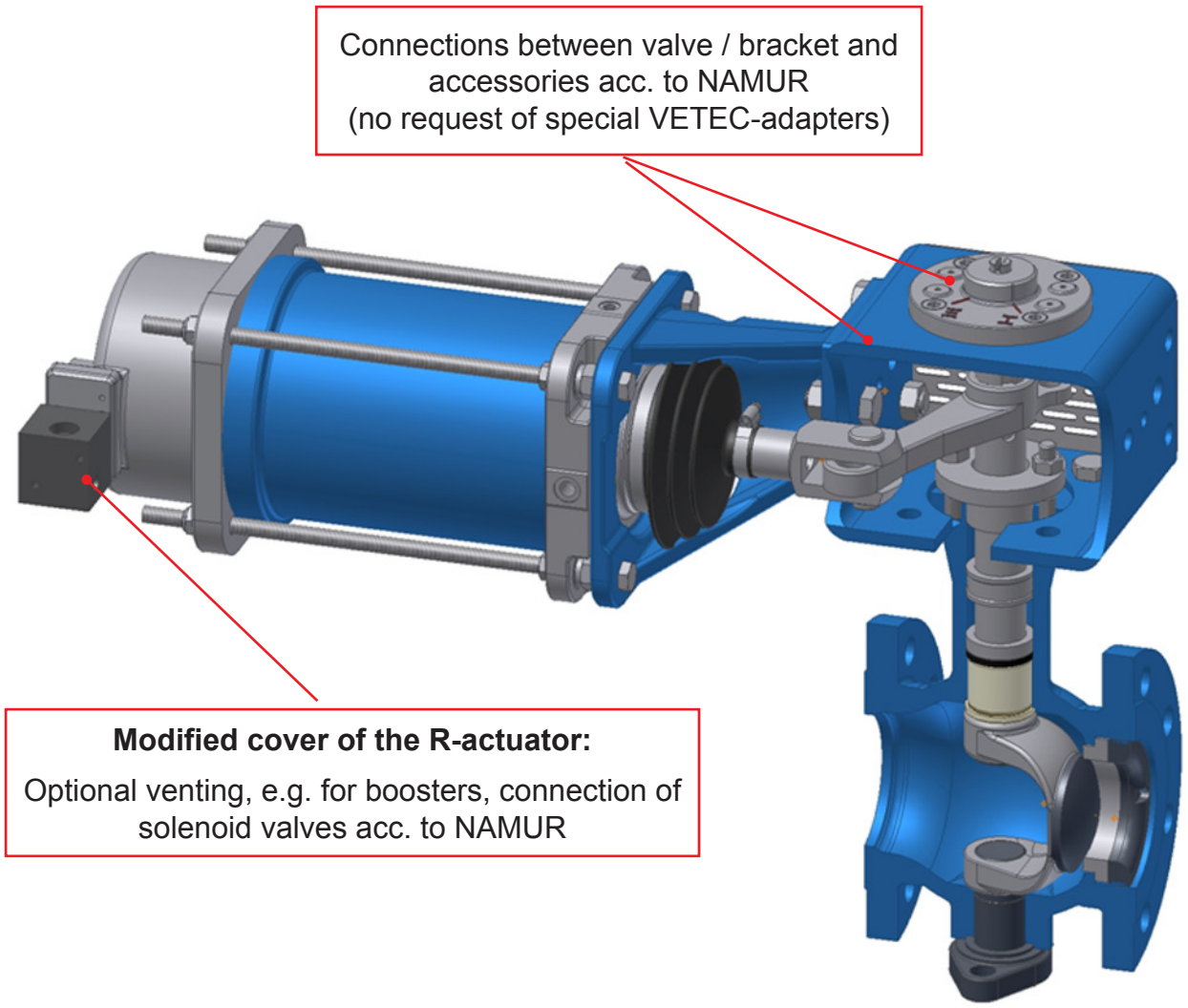


Figure 6.22.2.-3: Rotary plug valve Type 82.7
The new design features improve handling, function and meet international standards, e.g. NAMUR

If one considers this valve philosophy, then one can only be fascinated that this valve, which only has a few options, can be used ways that are similar to a universal valve.

A rotary valve with eccentric plug consists of a body with a straight flow path, a seat ring which is usually adjustable in the radial direction, a fastening ring, and a specially shaped, eccentrically pivoted plug.

This plug can be rotated, by a shaft which sticks radially out of the body, to an angle of rotation of 50 to 75 degrees Table 6.21.1.-1. As a result of the eccentrically positioned valve shaft, the plug with the spherical cup, touches the seat ring only in the closed position. This reduces the friction forces to a minimum and designates this valve type particularly for control services. The size of eccentricity (approx. 10% of nominal size) plays a important part in the closing thrust of the pneumatic or electric actuator. The smaller the eccentricity is, the smaller the actuator thrust be-comes and the higher the differential pressure in the closed position can be.