



High Performance Fluid Handling

GESTRA Control Valves with ZK Radial Stage Nozzle®
for Power Station and Plant Engineering



Engineering steam performance



ZK Control Valves for Power-Station and Plant Engineering

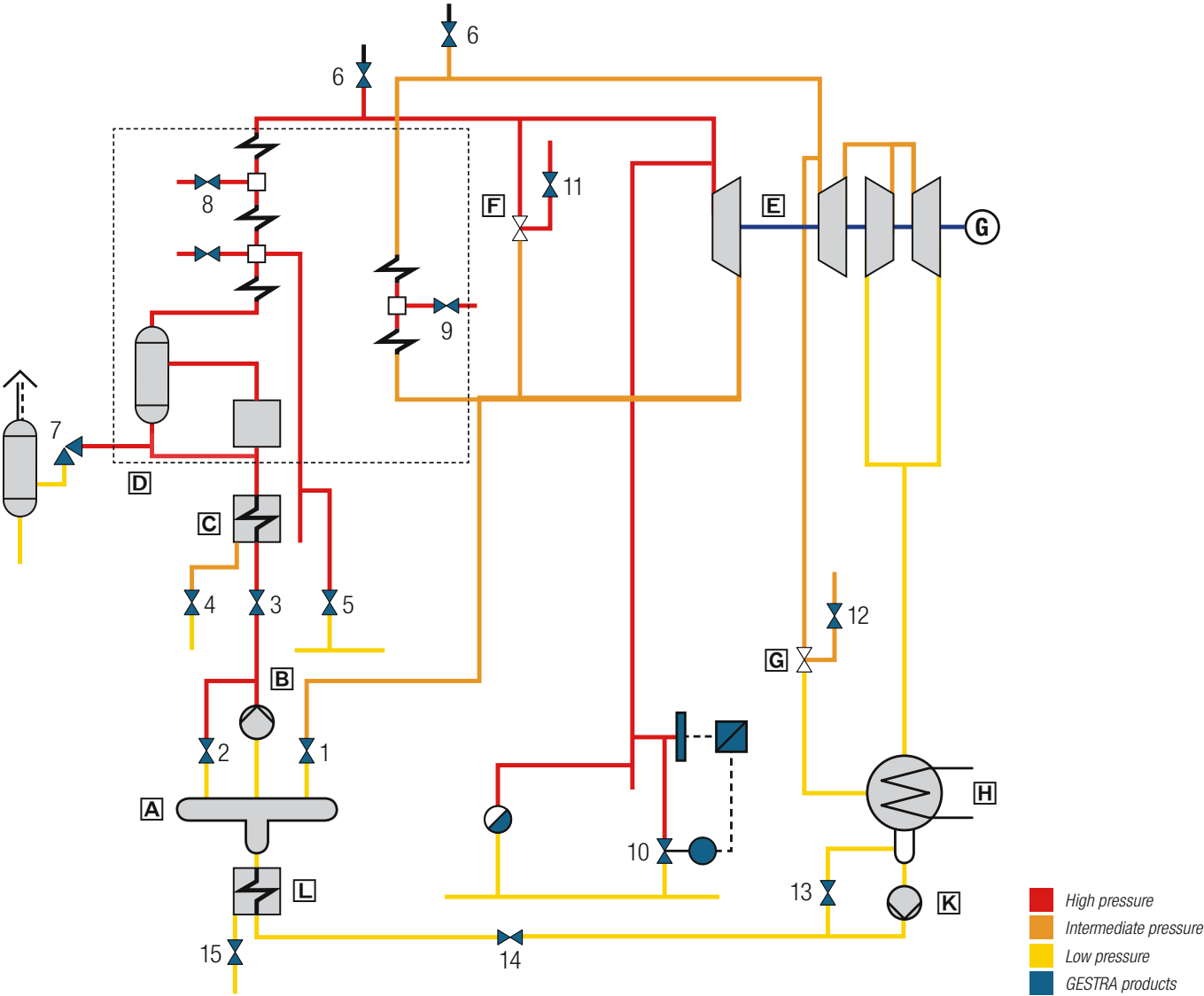
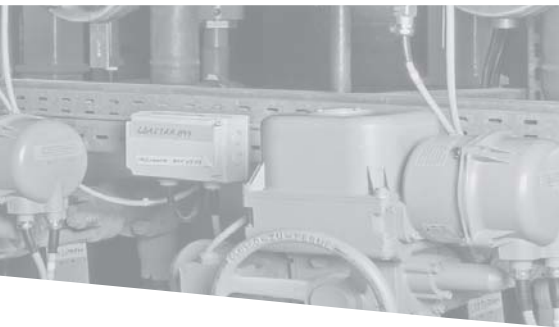
Overview

For many years now, GESTRA control valves of the type ZK have given proof of their reliability under extreme operating conditions. Long experience and know-how form the sound basis for a generation of efficient and tight-closing control valves for applications in power stations. Thanks to the easy maintenance and repair of the valves as well as the extremely high wear resistance afforded by the design, reliable operation is achieved together with a long service life.

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Application	p [bar]	t [°C]	ZK valve type
A Feedwater tank			
1 Heating steam valve	~ 60	~ 400	29, 610
B Main feedwater pump			
2 Feedwater leak-off valve	to 560	~ 220	313, 213
3 Feedwater control valve	to 560	~ 220	610, 613
C H.P. preheater			
4 Condensate drain control valve	20–60	~ 300	29, 210, 610
D Boiler plant			
5 Boiler drain valve	to 280	~ 620	313, 213
Soot-blower warm-up valve	~ 50	300–350	29, 210
Soot-blower steam valve	to 280	550	313
Boiler circulation control valve	180–280	~ 250	313, 613
6 Boiler vent valve	to 280	~ 620	313, 613
7 Start-up pot drain valve	180–280	~ 450	613
8 H.P. spray attemperator valve	~ 280	~ 220	313
9 I.P. spray attemperator valve	~ 50	~ 220	29, 210
E Turbine plant			
10 Live steam drainage	to 280	~ 620	313, 213
I.P. drainage	~ 60	~ 620	29, 210, 313
L.P. drainage	< 20	~ 460	29
F H.P. bypass station			
11 Spray injection valve	to 300	~ 220	313, 213
G I.P. bypass station			
12 Spray injection valve	to 250	~ 220	29, 210
H Condenser			
K Condensate pump			
13 Condensate leak-off valve	10–25	~ 30	29, 610
14 Condensate control valve	10–25	~ 30	29, 610
L L.P. preheater			
15 Condensate drain valve	~ 0.4–5	~ 30	29, 610





Applications of the ZK Control Valves

ZK control valves are suited for various fundamental applications in industry and power stations:

- ▶ **Leak-off control (recirculation)**
- ▶ **Drainage and warm-up**
- ▶ **Level control**
- ▶ **Injection cooling**
- ▶ **Steam control**

GESTRA offers:

- ▶ **Complete solutions**
- ▶ **Subsystems with definite interfaces**

The ZK control valve consists of a valve body and the ZK RADIAL STAGE NOZZLE® with valve plug integrated into the body to act as the control unit.

The ZK RADIAL STAGE NOZZLE® ensures a rapid and reliable adaptation to the prevailing operating conditions.

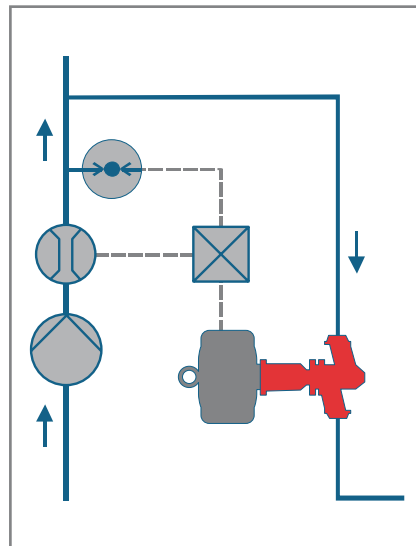
If the operating conditions in the plant are changed, the control valve can be adapted to the new situation by repositioning or exchanging the radial stage nozzle. There is no need to remove the valve from the line for this purpose!

The high standard of GESTRA power station equipment is confirmed by a large number of references.

1. Leak-Off Control (recirculation)

GESTRA leak-off controls for feedwater and condensate pumps represent complete systems for on/off or modulating control.

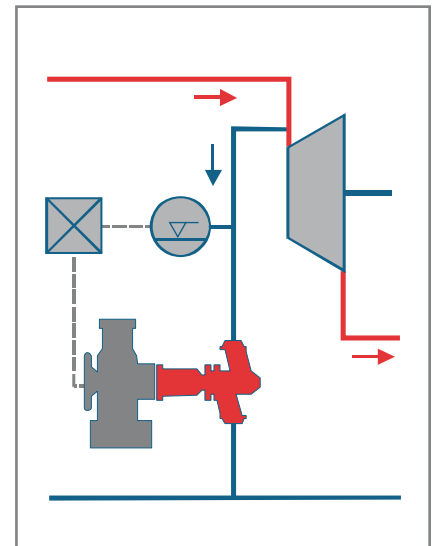
The control valve with ZK RADIAL STAGE NOZZLE®, the actuator with quick-opening function, and the control unit are optimally adapted to the operating conditions prevailing in each case.

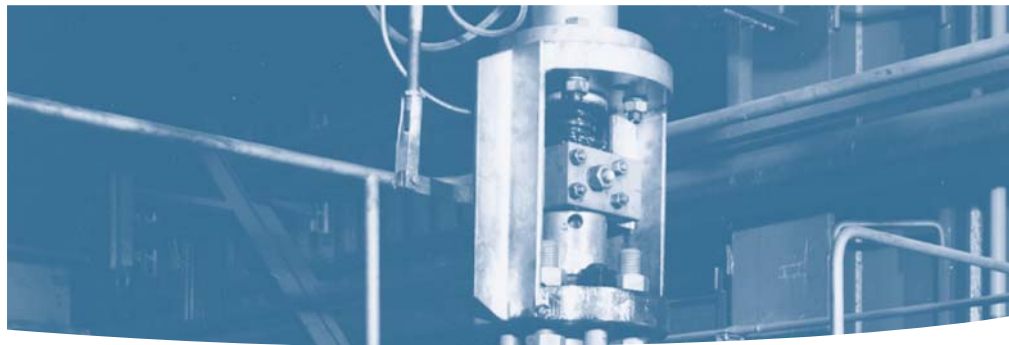
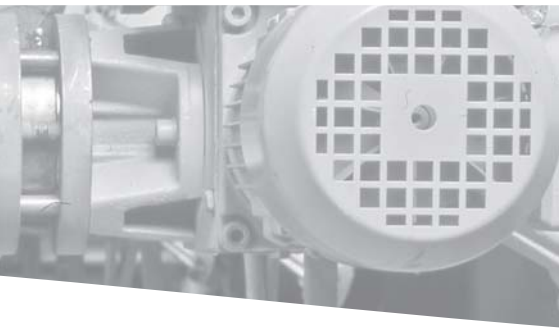


2. Drainage and Warm-Up

The control valve with ZK RADIAL STAGE NOZZLE®, actuator, level electrode and control unit together constitute a complete system which can be perfectly adapted to the operating conditions.

Even condensate flowrates with extreme fluctuations are discharged by this system without any problems. Specific warming-up of certain parts of the plant can be achieved with the aid of a temperature acquisition system.

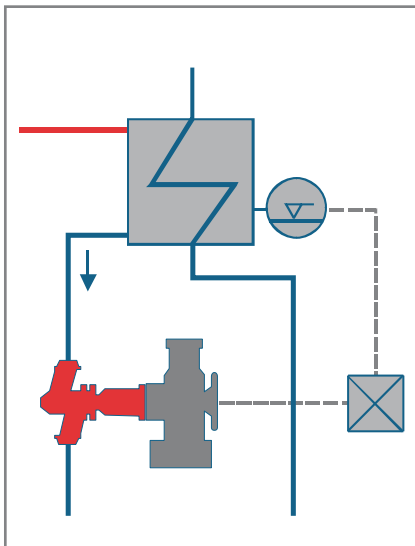




3. Level Control

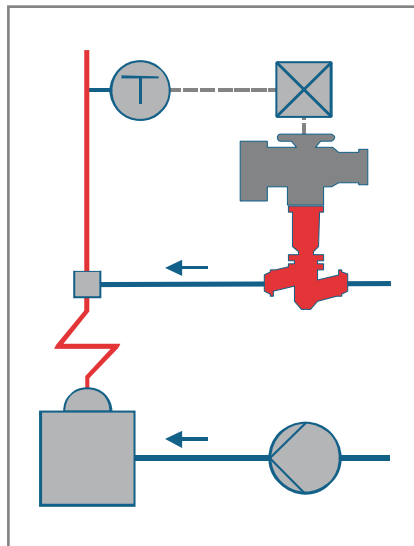
With the aid of the ZK control valve, level control systems can be realized under difficult technical conditions. The GESTRA level control system consists of a control valve with ZK RADIAL STAGE NOZZLE®, an actuator, a level electrode and a control unit.

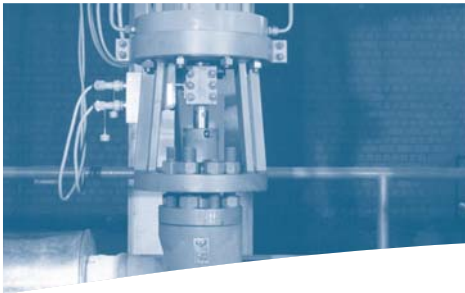
The high-pressure probes NRG 211 and NRG 111 offer new possibilities for extreme temperatures and pressure ratings. Reliable operation of the system is ensured by the long life of the radial stage nozzle.



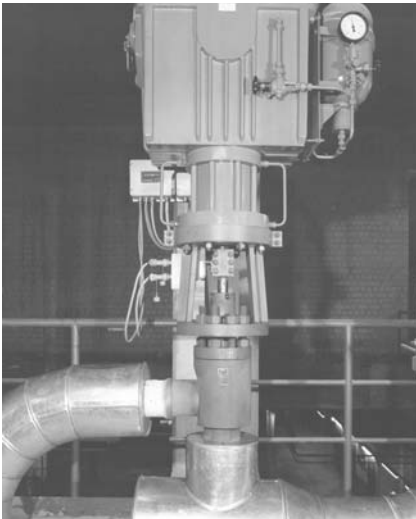
4. Injection Cooling

GESTRA injection cooling systems are offered as complete systems consisting of an injection-cooling valve with radial stage nozzle, an actuator, a temperature acquisition system, and the control unit. Injection cooling valves have to cope with high differential pressures, whilst ensuring extreme wear resistance and good regulating characteristics. The radial stage nozzle meets these high requirements and provides a perfect adaptation of the valve characteristic to the desired regulating characteristic. Thanks to the absolutely tight closure, thermal shock damage is prevented in injection coolers and combined steam pressure reducing and desuperheating valves.





Application Examples of the ZK Control Valves



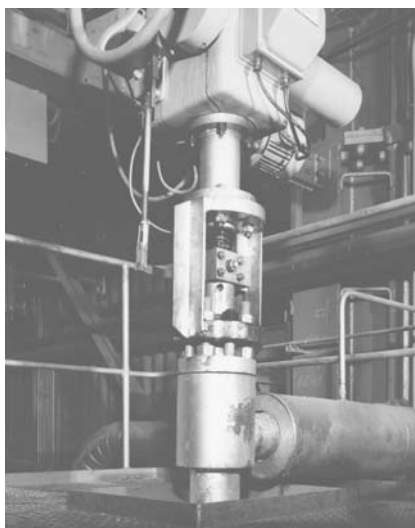
Leak-off valve ZK 213 with compact electro-hydraulic actuator



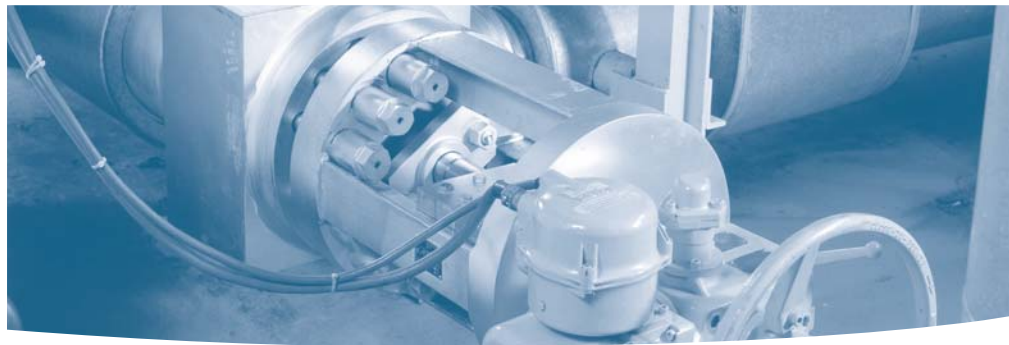
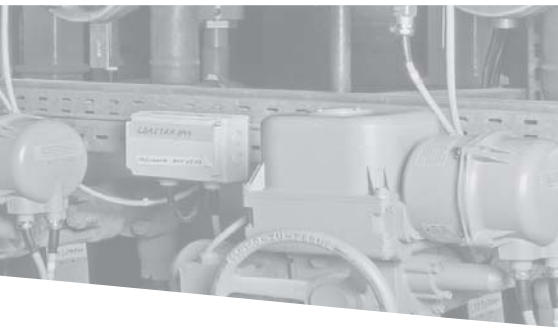
Drain control station using ZK 29 valves with electrical actuator



H.P. preheater in a nuclear power station equipped with a condensate drain control valve type ZK 29



ZK 213 as spray injection valve in a high-pressure bypass station



The ZK RADIAL STAGE NOZZLE®

Operating Principle

Patented both in Germany and abroad, the ZK RADIAL STAGE NOZZLE® consists of several sleeves with a large number of radial orifices. The orifices are arranged in parallel, but are shifted from sleeve to sleeve so that they partly overlap, forming nozzles mounted in series with intermediate flash chambers.

The flow through the radial stage nozzle is determined by the valve plug. Depending on its position, the individual stage nozzles are either partially or completely set free. The valve plug and the seat together form the shut-off unit of the radial stage nozzle. Due to the successive expansion in the flash chambers, the pressure differential across the cross-sectional flow area of the valve is reduced to a minimum.

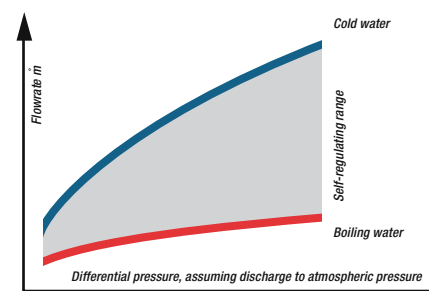
Various stage nozzles and valve plugs are available to account for the pressure drop in a particular application. For extremely high pressure gradients, control valves with tandem shut-off are applied.

Due to the special design of the ZK RADIAL STAGE NOZZLE®, the sound level is reduced to a minimum. As a result of the expansion through a multitude of individual nozzles, the sound level is normally below 85 dB(A) within the entire control range of the valve.

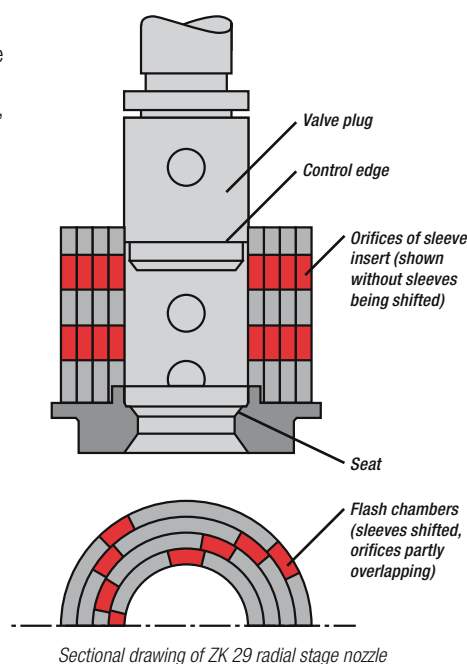
Automatic Control

For drainage purposes, the valve can alternatively be used as a hand control valve. In this case, the radial stage nozzle not only acts as a throttling unit, but also provides the function of thermodynamic control.

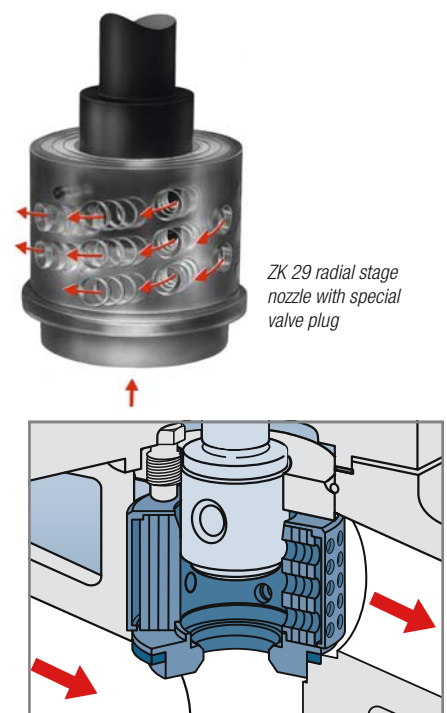
For this purpose, the control valve is adjusted manually once to the working point. From this time on, the condensate flowrate is determined by the thermal state of the condensate in the nozzle system (cold condensate / boiling hot condensate) without any further modification of the cross-sectional area. The valve is therefore also suitable for varying operational conditions.



Regulating characteristic of the ZK RADIAL STAGE NOZZLE®



Sectional drawing of ZK 29 radial stage nozzle



ZK 29 radial stage nozzle with special valve plug

Valve plug of ZK 29 in control position



The ZK RADIAL STAGE NOZZLE®

Technical Properties

ZK control valves are designed to meet the highest operational requirements. They offer a number of special features in comparison with conventional control valves.

► Extreme wear resistance

The successive expansion of the fluid in the throttling sleeves of the radial stage nozzle produces a considerable reduction in pressure drop across the cross-sectional flow area. Special design details at the seating surfaces ensure safe and reliable valve operation. In addition, the mass flow is split up into many partial flows.

► Leakage rates

The following leakage rates apply, depending on the valve type:
 FCI 70-2-2003, at least class V (test procedure B) and class VI (test procedure C) and EN 12266-1, leakage rate A

► Variable valve characteristics

For the ZK control valves, stage nozzles are available with linear or equal-percentage characteristics. A subsequent change is possible by repositioning throttling sleeves (orifices) or by exchanging the complete nozzle insert.

► Easy installation and inspection

The entire nozzle insert, including seat, can be completely dismantled without the need for any specialist work and without removing the valve body from the line.

► Tandem shut-off

Control valves for an extremely high pressure gradient are provided with a tandem shut-off (dual seat). In this way, the ZK control valve combines the functions of a conventional shut-off valve and a control valve, even for very high pressures.

► Low sound level

The continuous reduction of the flow velocity in the radial stage nozzle ensures a low sound level, usually a maximum of 85 dB(A) within the valve's control range. For differential pressures up to Δp_{\max} 100 bar, the sound level is even below 80 dB(A).

► Different capacity ranges

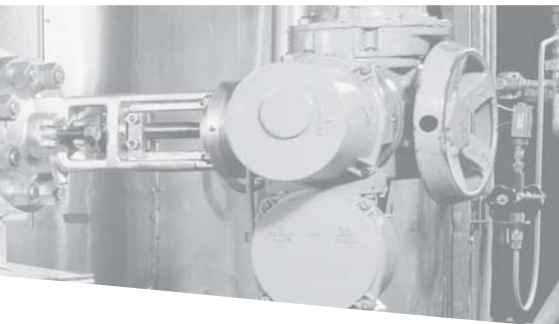
The k_{vs} values can be adapted to the operating conditions by repositioning or exchanging the radial stage nozzle. Intermediate lift positions of the valve plug can thus be avoided.

The complete ZK product range offers k_{vs} values from 0.5 m³/h to 969 m³/h.

By exchanging the internals, it is possible to adjust ZK control valves to account for changes in differential pressure.

► Actuators

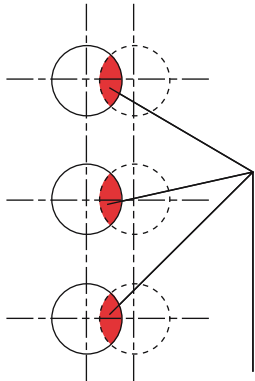
ZK control valves can be used with most types of actuators available on the market.



Changing the valve characteristics using the ZK 29 as an example



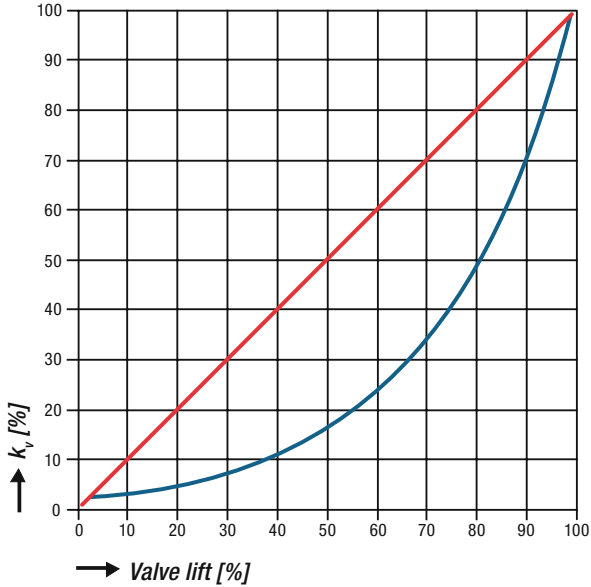
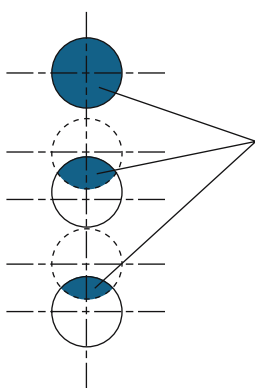
Position of the sleeves for linear characteristic



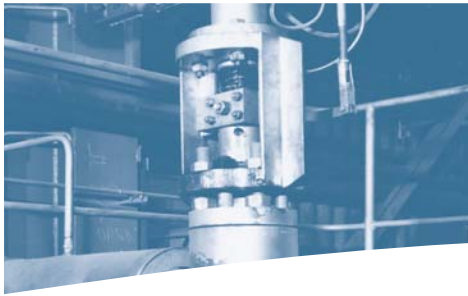
Cross-sectional flow area



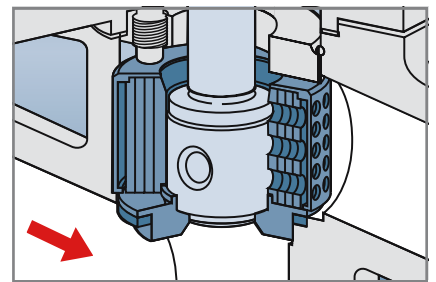
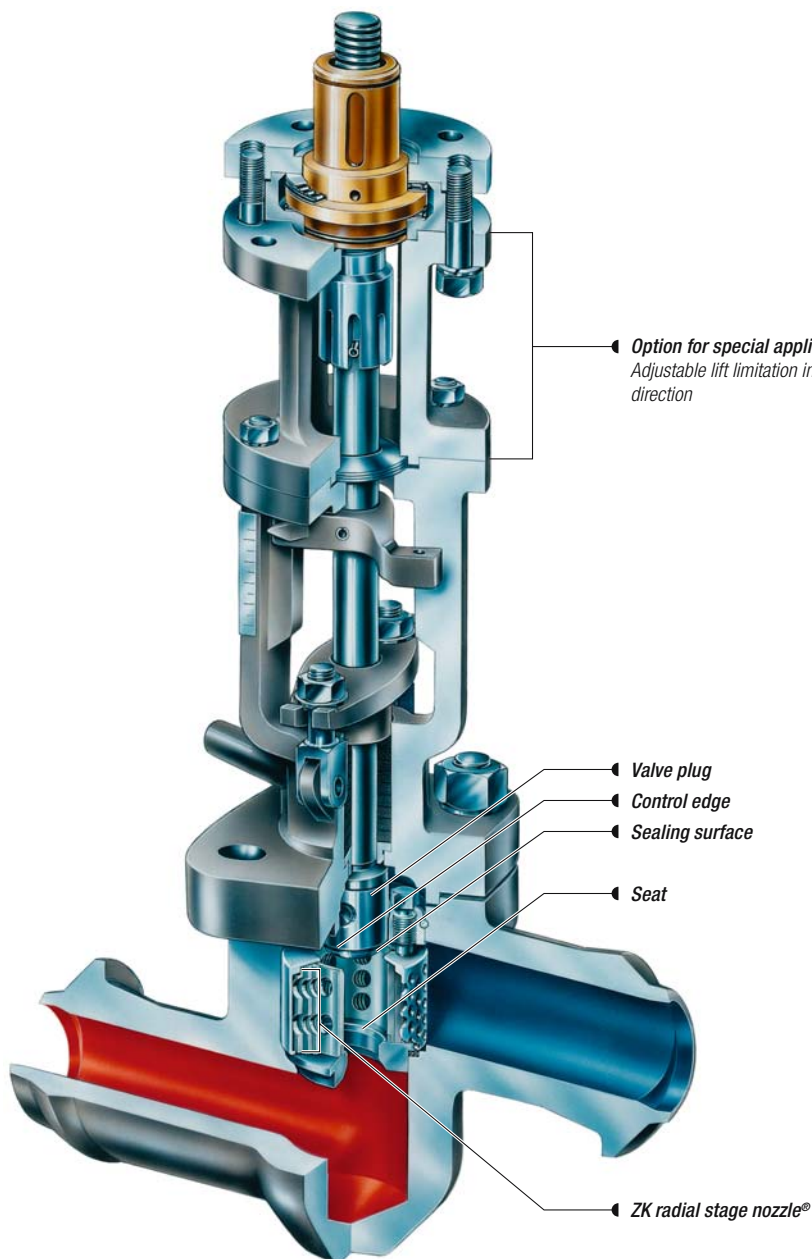
Position of the sleeves for equal-percentage characteristic



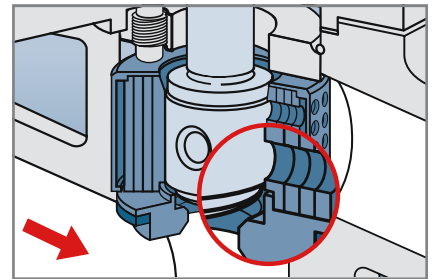
Linear characteristic Equal-percentage characteristic



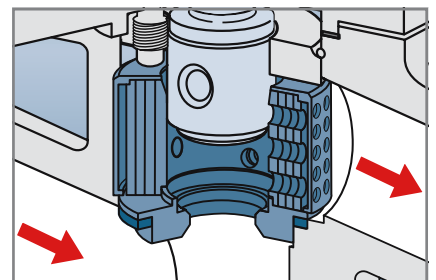
Control Valve ZK 29, Valve Plug in Open Position



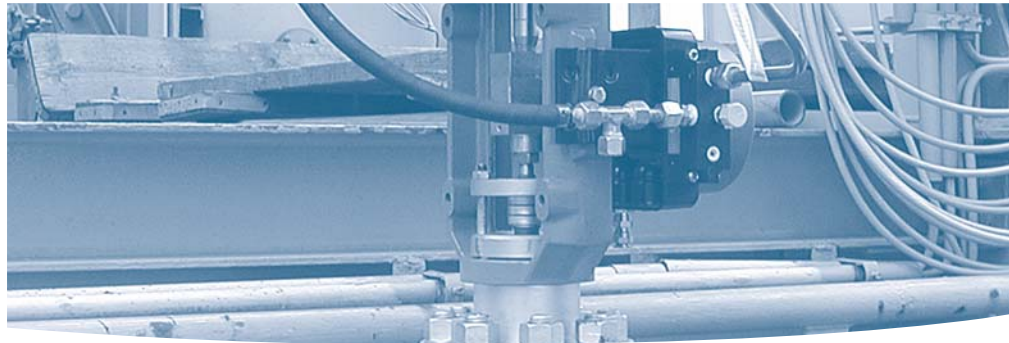
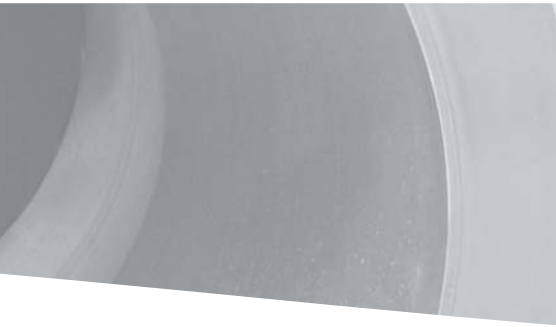
ZK 29: Valve plug in closed position



ZK 29: Valve plug no longer in closed position; control edge does not yet set free any orifices



ZK 29: Valve plug in control position



Control Valve ZK 29

PN 160
 Δp_{\max} 100 bar (1450 psi)
 k_{vs} 0.7 – 130 m³/h

With its permissible differential pressure of 100 bar, the ZK 29 control valve covers a large range of k_{vs} values.

The valve plug and seat of a control valve are as a rule subjected to very high flow velocities during the opening and closing processes. To reduce this effect, the valve plug of the ZK control valve is provided with a special control edge above the seating surface.

At the beginning of the opening process, the plug lifts off the seat, yet the flow admitted is very low. Only once a certain lift has been reached, and

hence a large annular channel has been opened between the seat of the valve and the sealing surface of the plug, are the annular rings of the radial stage nozzle set free one after the other by the control edge.

During the closing process, the flow is first considerably reduced by the control edge and then the sealing surface of the plug reaches the seat to close the valve completely.

The ZK 29 offers the possibility of adjusting for various k_{vs} values and characteristics at a later time, by rotating the stage nozzle.

Connections	Butt-weld ends, socket-weld ends, flanged ends (EN, ASME)
Actuators	Electric (rotary, linear or lever actuator), pneumatic, handwheel
Body material	DN 25-50: 13 CrMo 4 4 (1.7335) DN 80-150: GS-17 CrMo 5 5 (1.7357) <i>Other butt-weld ends and body materials on request</i>

Control Valve ZK 210

PN 250
 Δp_{\max} 100 bar (1450 psi)
 k_{vs} 0.7 – 28 m³/h
 Δp_{\max} 180 bar (2610 psi)
 k_{vs} 0.5 – 5 m³/h

The control valve ZK 210 supplements the valve type ZK 29 primarily by extending the pressure rating to PN 250.

An additional radial stage nozzle arranged downstream makes it possible to overcome pressure differentials Δp_{\max} of up to 180 bar, thus closing

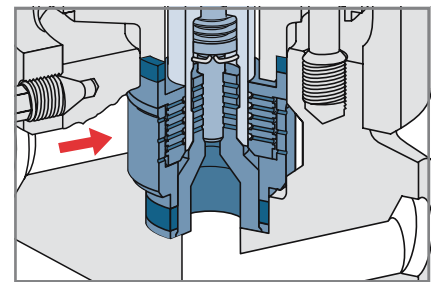
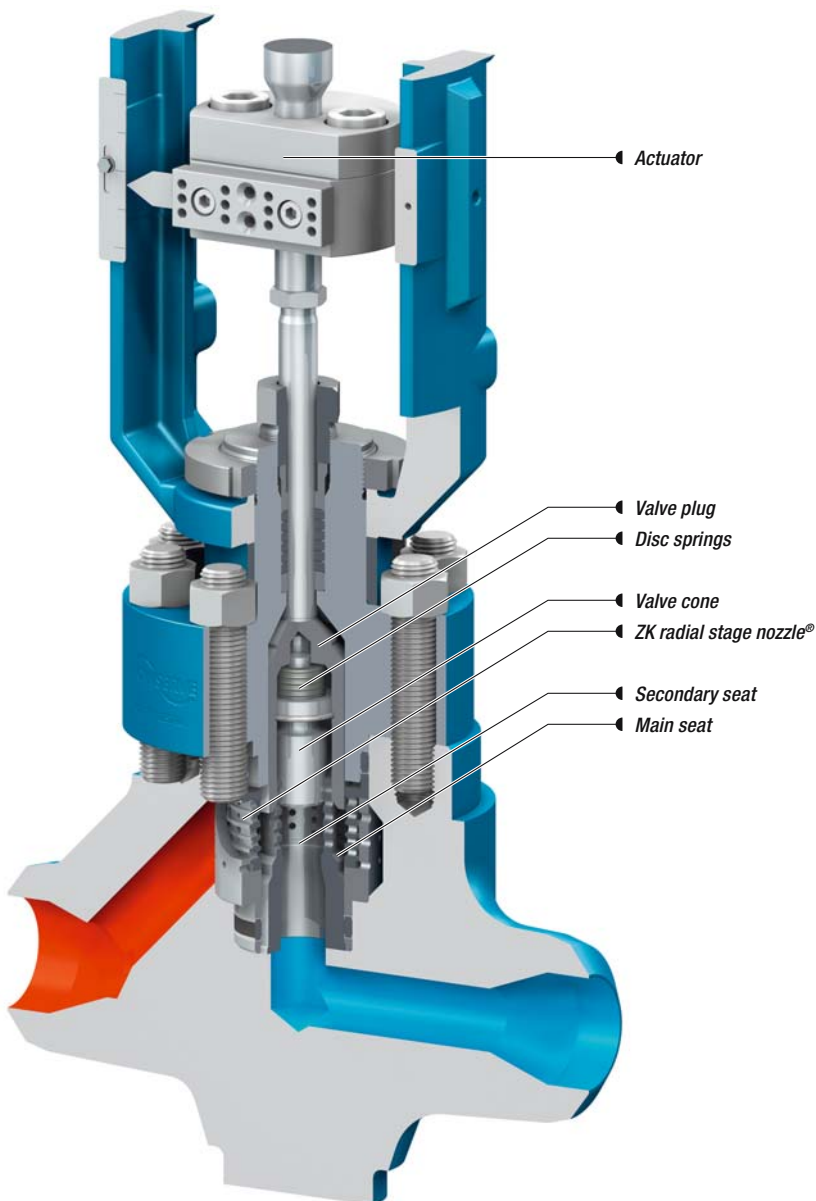
the gap to the existing high-pressure types. In comparison to the ZK 29, the required actuator forces are lower.

By exchanging the internals, pressure differentials of $\Delta p_{\max} = 100$ bar or $\Delta p_{\max} = 180$ bar can be

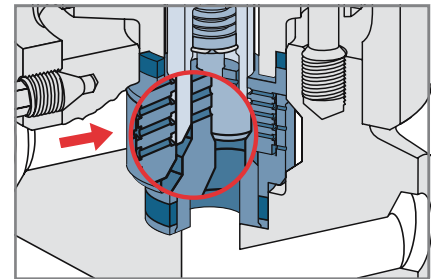
achieved. The ZK 210 offers the possibility of adjusting for various k_{vs} values and characteristics at a later time, by rotating the stage nozzle.

Connections	Butt-weld ends, socket-weld ends, flanged ends (EN, ASME)
Actuators	Electric (rotary or linear actuator), pneumatic, handwheel
Body material	13 CrMo 4 4 (1.7335) <i>Other butt-weld ends and body materials on request</i>

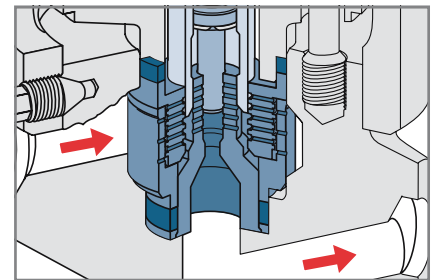
Control Valve ZK 313 with Tandem Shut-Off



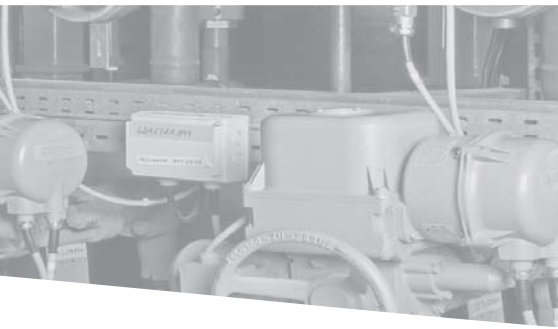
ZK 313: Valve plug in closed position



ZK 313: Valve plug no longer in closed position; valve cone still in closed position, control edge does not yet set free any orifices



ZK 313: Valve plug in control position



Control Valve ZK 313

PN 630 & Class 2500

Δp_{\max} 40 bar

k_{vs} 20 – 46 m³/h

Δp_{\max} 300 bar

k_{vs} 1 – 17 m³/h

Δp_{\max} 370 bar

k_{vs} 4.5 – 9.5 m³/h

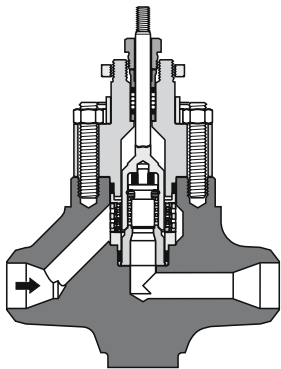
The control valve ZK 313 is also available as an ASME version as per ASME B 16.34. Due to the tandem shut-off, it combines the function of a conventional isolating valve and control valve, and offers long service lifetimes. The leakage rates are in accordance with the highest EN and FCI classifications.

At the beginning of the opening process, first the valve plug is lifted off the main seat, but the valve

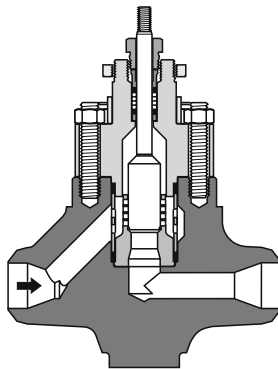
cone follows only after a certain lift. At the moment of closing and at the beginning of opening, the flow velocity at the valve seat is therefore zero, which means that wire drawing is prevented. Through the use of the steel type 1.4903 / A 182 F91 and special seat materials, the ZK 313 permits a maximum temperature of 620 °C. The ZK 313 valve with additional nozzle can be used for differential pressures up to Δp_{\max} 370 bar.

Connections	Butt-weld ends, socket-weld ends (EN, ASME)
Actuators	Electric (rotary, linear or lever actuator), hydraulic, pneumatic, handwheel
Body material	16 Mo 3 (1.5415), A 182 F1 10 CrMo 9 10 (1.7383), A 182 F 22 X10 CrMoVNb 9 1 (1.4903), A 182 F 91

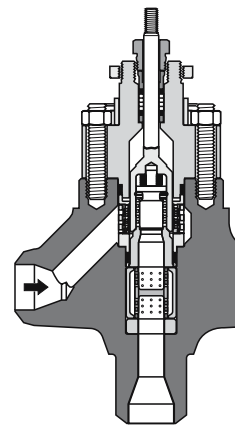
Nozzle Versions for ZK 313



Standard nozzle Δp_{\max} 300 bar / 4350 psi



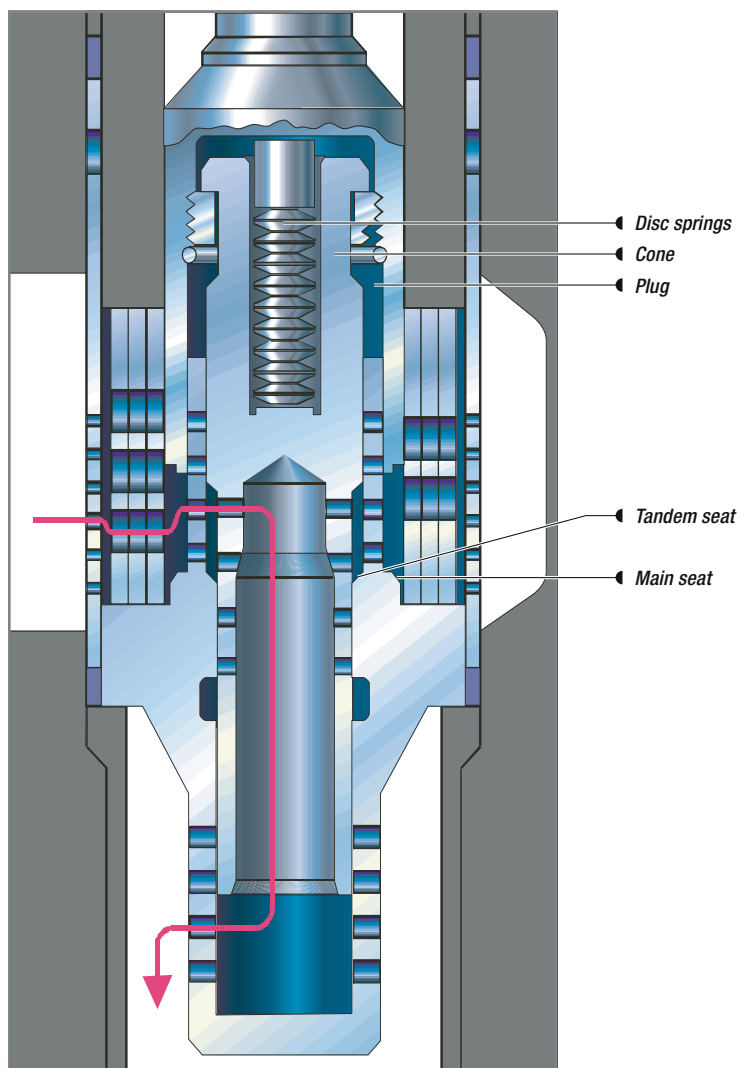
Special nozzle Δp_{\max} 40 bar / 580 psi
(without tandem seat)



Special nozzle Δp_{\max} 370 bar / 5365 psi
(only angle-type design)



GESTRA System Solutions ZK 213

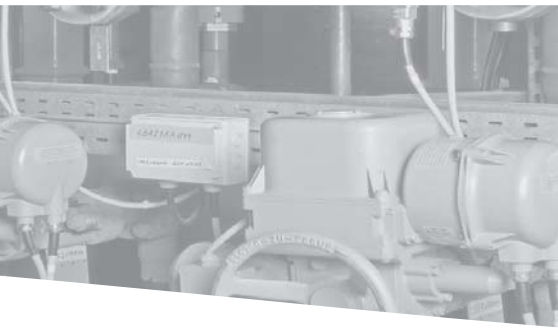


Leak-off control consisting of:

- ▶ ZK 213-E4/40 DN 200 with 6-stage nozzle and tandem seat
- ▶ Hydraulic actuator with opening spring
- ▶ Control cabinet with SIEMENS S7 PLC
- ▶ GESTRA software with stored characteristic for leak-off valves



ZK 213 with tandem shut-off $\Delta p_{max} 560 \text{ bar (8120 psi)}$



Control Valve ZK 213

Δp_{\max} 300 bar (4350 psi)
 k_{vs} 10 – 90 m³/h
 Δp_{\max} 560 bar (8120 psi)
 k_{vs} 10 – 70 m³/h

The tandem shut-off of the control valve type ZK 213 ensures stable and low-wear operation as a control and shut-off valve for a pressure drop of Δp_{\max} 300 bar or Δp_{\max} 560 bar.

For this control valve, the maximum differential pressures of Δp_{\max} 300 bar or Δp_{\max} 560 bar depend

on the design. A subsequent change is possible by exchanging the internals. The two additional throttling elements fitted in the high-pressure version provide effective protection against wear. Due to the tandem shut-off, it combines the functions of a conventional isolating valve and control valve, and offers long serv-

ice lifetimes. The leakage rates are in accordance with the highest EN and FCI classifications.

Connections	Butt-weld ends (EN, ASME)
Actuators	Electric (rotary, linear or lever actuator), hydraulic
Body material	16 Mo 3 (1.5415)
	15 NiCuMoNb 5 (1.6368, WB 36)

ZK 213 internals when new

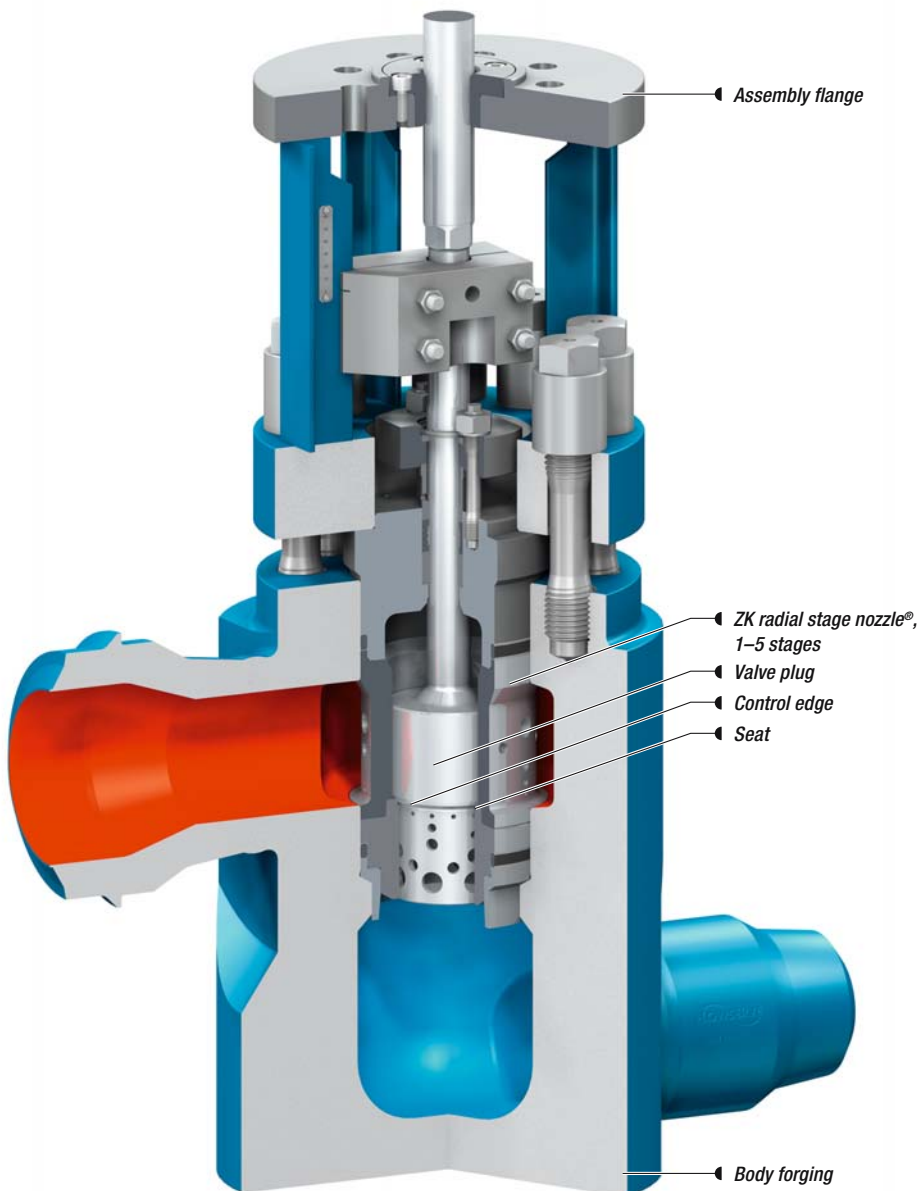


Internals of a leak-off valve ZK 213, DN 100, after 13 years of operation with $p_1 = 374$ bar (5420 psi), $p_2 = 11$ bar (159.5 psi), $t = 172$ °C, $\dot{m} = 35$ kg/s



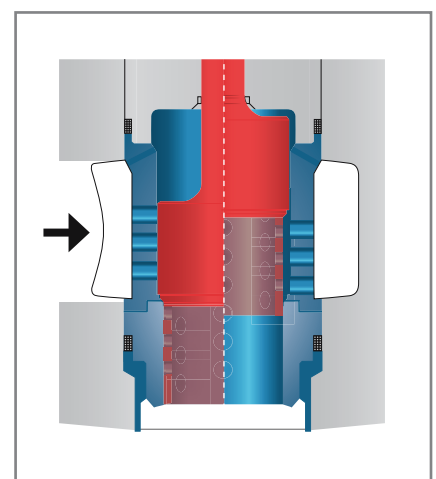
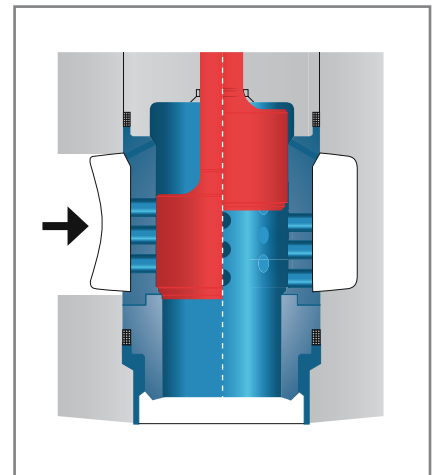


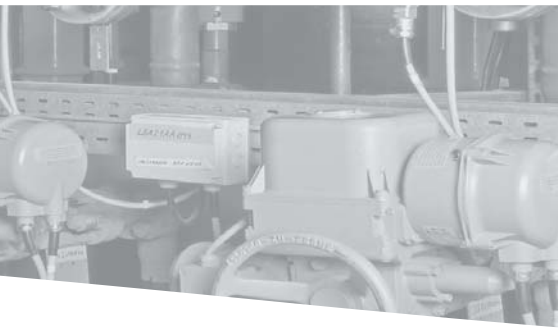
Control Valve ZK 610 and ZK 613



Modular System of the ZK Radial Stage Nozzle® for ZK 610, ZK 613

The multi-stage pressure drop is adapted precisely to suit the operating conditions.





Control Valve ZK 610, ZK 613

ZK610, PN 250
ZK613, PN 630

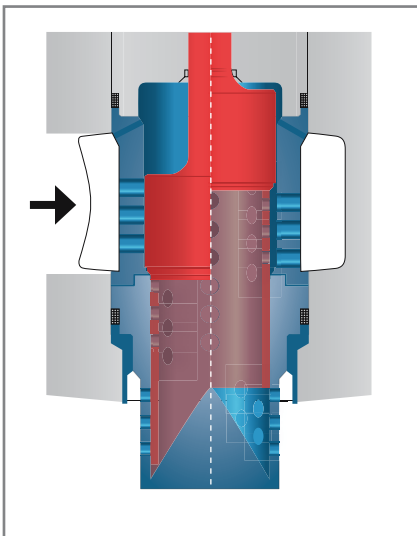
Δp_{\max} 40 bar – Δp_{\max} 250 bar (3625 psi)
 k_{vs} 13 – 969 m³/h

The control valve types ZK 610 and ZK 613 round off the ZK valve range with large k_{vs} values. Thanks to the modular design, it is possible to adapt the throttling units optimally to the operating conditions. In addition, leakage-free pressure balancing can be used to reduce the actuating forces.

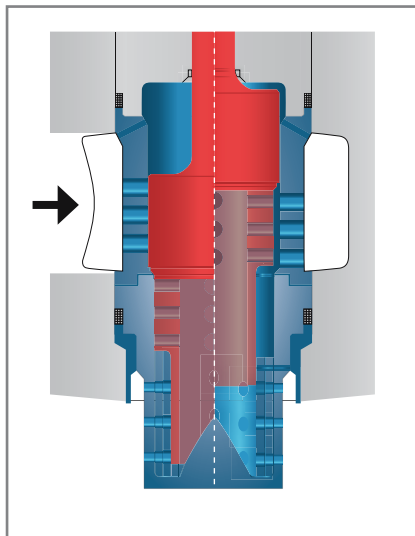
As for the ZK 29, the seating surfaces are protected against high flow velocities by means of a control edge at the valve plug. This design measure achieves the highest leakage-rate classifications

according to EN and FCI with long service lifetimes. The entire ZK radial stage nozzle® including seat is easy to exchange, ensuring the highest level of availability.

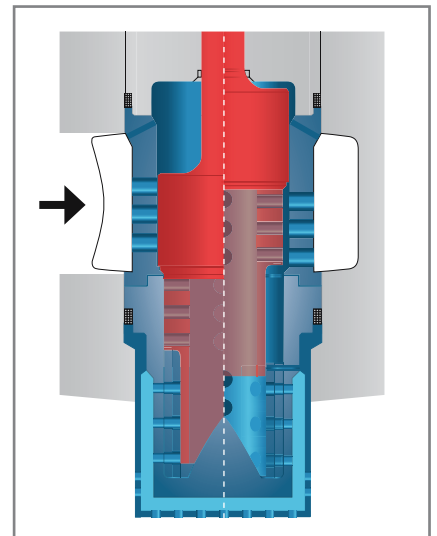
Connections	Butt-weld ends (EN, ASME)
Actuators	Electric (rotary or linear actuator), hydraulic, pneumatic
Body material	C22.8 (1,0460)
	16 Mo 3 (1,5415)
	10 CrMo 9 10 (1.7380)
	<i>Other body materials on request</i>



3-stage expansion



4-stage expansion



5-stage expansion



GESTRA Stands for Quality

Quality is our Strength

For GESTRA, the concept of "Quality" not only includes the product itself, but applies equally to planning, handling and service. It is our aim to recognize and eliminate the sources of potential errors during all phases of order processing by means of comprehensive internal strategies. The ideal basis for this is a quality management system in accordance with EN ISO 9000. Of the three possible levels, our quality assurance system

achieved certification according to EN ISO 9001. The high quality standard of GESTRA products has been confirmed time and time again through a large number of recognized type-approvals issued by TÜV (German Technical Supervisory Association), Germanischer Lloyd, Lloyd's Register of Shipping and many other classification societies. The company thus also fulfils the conditions of the new Pressure Equipment Directive.



Extract from our List of References

Loy Yang B Power Station	Australia
Collie Power Station	Australia
Energy Brix Australia	Australia
AUSTRIAN ENERGY	Austria
Electrabel	Belgium
JP Elektroprivreda	Bosnia
Tractebel	Brazil
Becancour Power Plant	Canada
Methanex	Chile
BASF YPC Project Nanjing	China
Waigaoqiao	China
INA Raffinerie	Croatia
ČEZ	Czechia
Škoda	Czechia
Elsam	Denmark
Teollisuuden Voima Oy	Finnland
EDF	France
ALSTOM	Germany
BASF	Germany
Bayer	Germany
BEWAG	Germany
Clariant	Germany
E.ON	Germany
EnBW	Germany
Hitachi Power Europe	Germany
KSB Pumpen	Germany
RWE Power AG	Germany
SIEMENS PG	Germany
STEAG	Germany
Sulzer Pumpen	Germany
SWB	Germany
Vattenfall	Germany
Volkswagen	Germany
Weller Pumpen	Germany
BHEL	India
Tjiwi Kimia	Indonesia
Ansaldo	Italy
ENEL	Italy
Incheon Power Plant	Korea
Panglima Power	Malaysia
EPZ	Netherlands
Elektrownia Kozenice	Poland
Ribatejo Power Plant	Portugal
AL Shuweihat	Saudi Arabia
Eskom	South Africa
Campo de Gibraltar	Spain
Kernkraftwerk Trillo	Spain
Sagunto	Spain
C4 ENERGI AB	Sweden
SSAB	Sweden
Kernkraftwerk Leibstadt	Switzerland
Kuo Kuang Power	Taiwan
British Energy	UK
Alabama Power	USA
Ameren UE	USA
Con Edison	USA
Electric Energy	USA
TVA	USA
Phu My	Vietnam

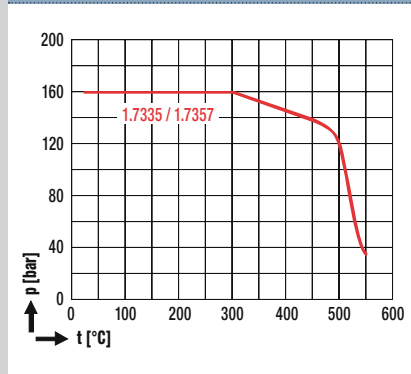
On request, we will gladly provide references for other countries and customers.

Overview of the Product Range

k_{vs} values [m³/h] (Linear Characteristics, Design, Pressure/Temperature Ratings)

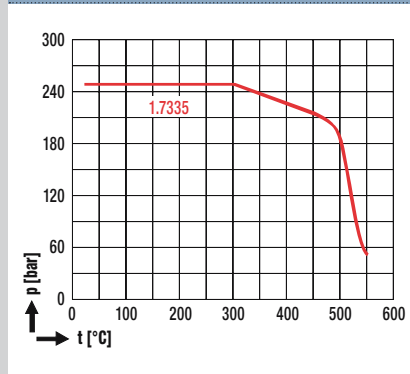
ZK 29			
DN	Δp 100 bar		
25	0.7	1.4	2
50	3	6	9
65			
80	9	18	28
100	15	30	45
125			
150	44	88	130
200			
250			
300			
350			
400			

Straight-through / angle



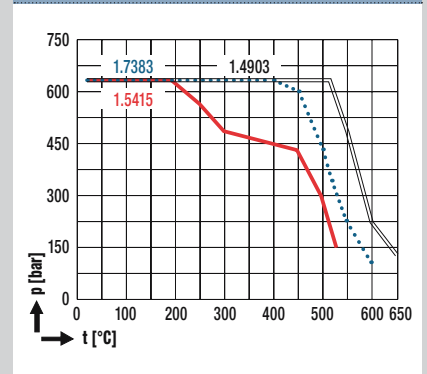
ZK 210				
DN	Δp 100 bar		Δp 180 bar	
25	0.7	1.4	2	0.5
50	3.5	6.3	7.7	2
65				
80	9.5	18	28	5
100				
125				
150				
200				
250				
300				
350				
400				

Straight-through / angle



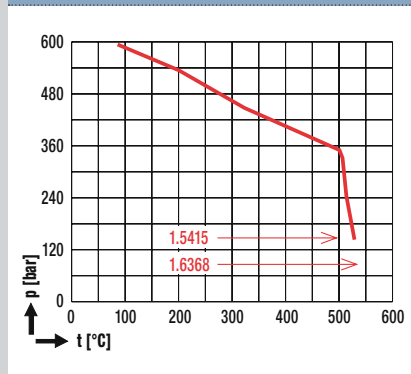
ZK 313											
DN	Δp 300 bar								Δp 370 bar		
25	1	1.5	2.3	3.6	5.5	8	11	13	4.5	9.5	
50	1	1.5	2.3	3.6	5.5	8	11	13	4.5	9.5	
65	1	1.5	2.3	3.6	5.5	8	11	13	4.5	9.5	
80							11	14.5	17	4.5	9.5
100							11	14.5	17	4.5	9.5
125							11	14.5	17	4.5	9.5
150											
200											
250											
300											
350											
400											

Straight-through / angle



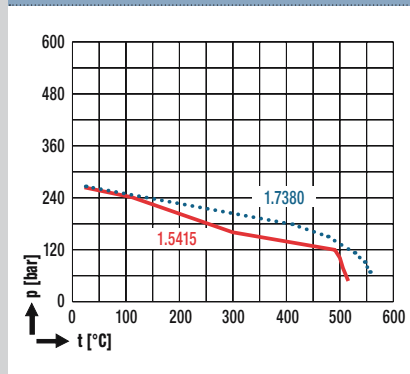
ZK 213, sizes 1-5											
DN	Δp 300 bar					Δp 560 bar					
	Bg.	1	2	3	4	5	1	2	3	4	5
50											
65											
80	15					10					
100	15	26				10	20				
125	15	26	39			10	20	30			
150		26	39	60			20	30	46		
200			39	60	90			30	46	70	
250				60	90				46	70	
300					90					70	
350											
400											

Angle / Z-pattern

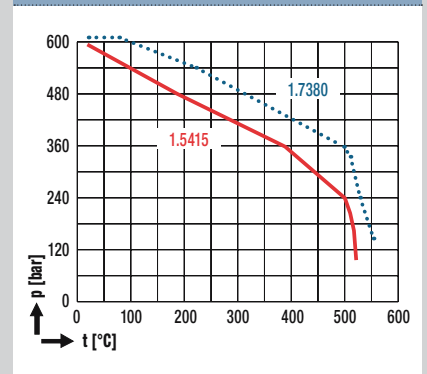


ZK 610 und ZK 613					
DN	Δp 40 bar	Δp 80 bar	Δp 120 bar	Δp 150 bar	$\Delta p > 150$ bar
25					
50					
65					
80					
100	44 - 98	38 - 54	33 - 47	14 - 19	13 - 18
125	71 - 154	61 - 85	51 - 74	22 - 31	20 - 29
150	112 - 243	95 - 134	81 - 117	35 - 48	32 - 46
200	177 - 385	150 - 212	128 - 185	55 - 76	50 - 73
250	281 - 611	238 - 336	216 - 294	86 - 121	78 - 116
300	446 - 969	378 - 533	322 - 465	137 - 191	125 - 184
350					
400					

ZK 610 Angle / Z-pattern



ZK 613 Angle / Z-pattern



Adaptation of nominal sizes is possible

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Engineering steam performance