SCHROEDAHL

A subsidiary of CIRCOR International Inc.

Series DK

Type DKV and DKM

Desuperheaters to control the temperature of superheated steam (or gas)

Introduction

Desuperheating (cooling) the steam can simply be achieved by injecting water into the steam flow. When injected, the water is evaporated by means of the desuperheater nozzles. Thereby, the water absorbs heat and consequently the temperature of steam is reduced. The desuperheater type DKV is designed so that even at low injection water quantities an efficient spray of very fine droplets (mist) is obtained.

The nozzles in the sprayhead are designed to give the injection water a high velocity and a radial rotating movement under all conditions. The result is a fine pressure atomization and very quick evaporation (see fig. 2).

Fig. 1: from left DKV, DKM

Features

Features of the DKV desuperheater:

- Optimum characteristics for accurate temperature control available.
- High operating temperature (ASME 650 °C; DIN EN 600 °C)
- Large allowable delta p water/steam pressure difference of up to 100 bar (1450 psi).
- Excellent atomizing characteristics at a delta p water/steam of 5 bar (72.5 psi) and at steam velocity of 10 m/s possible. The field of application starts at steam velocities of 5 m/s and a rate of overheating to the saturation of 3°C. More favorable conditions will improve the effectiveness of the desuperheater.
- Excellent control accuracy for the whole control range.
- Tight shut-off. No leakage in closed position and thus no emptying of the cooling water lines possible.
- No additional control valve required.
- High operation reliability. Due to simple parts, minimal wear.

Fig. 2

Principal of operation | Materials

Principal of operation

The temperature sensor (fig. 5) transmits a signal through the control system to the actuator (positioner) and positions the control piston according to the valve characteristic (fig. 3). The cooling fluid is now admitted to the injection nozzle and is accelareated at the nozzle insert. The cooling fluid is injected as a very fine water spray cone; the small droplets are quickly evaported and absorbed by the independent steam (hot gas). Our high quality atomization of the cooling liquid is the basis of a good mixing fromcooling fluid and steam at all load conditions. The position of the valve seat, just before the spray head, provides a tight shut-off in the closed position, so that dripping is prevented (the piston is lapped into the seat!). The small number of moving parts results in a reliable operation of the valve.

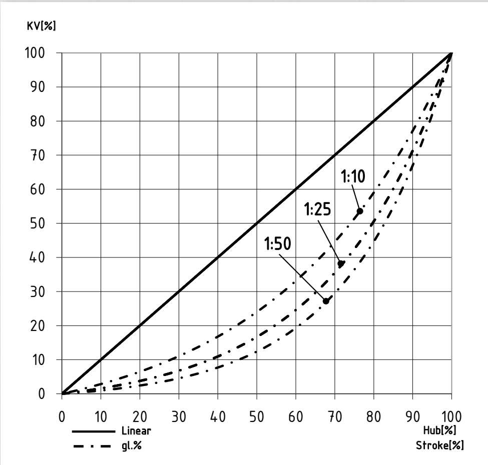


Fig. 3

Materials, size and classes

1.0460/A105
1.5415
1.7335/A182F12Cl.2
1.7383/A182F22Cl.3
1.4903/A182F91

The body material is selected according to temperature and pressure conditions of steam and water. Internal parts are various stainless steel (min 13% chrome).

Type DKV

The DKV desuperheater is available in a standard body size with a max. pressure rating of PN 400 (Class 2500).

Type DKM

The mini desuperheater can be used in steam piping from the nominal diameter DN 50/NPS 2 and is able to precisely inject extremely small amounts of cooling water.

Table 1: Connections

<table>
<tr><th>Type</th><th>Inlet flanges</th><th>Mounting flanges</th><th>Mounting flange internal pipe-diameter</th></tr>
<tr><td rowspan="2">DKV</td><td>DN 25 to 65 / NPS 1 to 2½</td><td>DN 80 / NPS 3</td><td rowspan="2">76 mm</td></tr>
<tr><td colspan="2">PN 16 to 400 / Class 150 to 2500</td></tr>
<tr><td rowspan="2">DKM</td><td>DN 15 to 40 / NPS ½ - 1½</td><td>DN 50 / NPS 2</td><td rowspan="2">43 mm</td></tr>
<tr><td colspan="2">PN 16 to 400 / Class 150 to 2500</td></tr>
</table>

Installation | Instrumentation | Actuator

Installation

The desuperheater can be installed on a stub on the steam pipe (see fig. 8, 9). A minimum height between the flange and the steam piping should be observed (see fig. 7). Water is injected in the same direction as the steam flow. The desuperheater can be installed in vertical as well as horizontal position. The spray nozzle orientation, in regard to the water flange position, can be selected according fig. 4.

We recommend installing a hat shaped sieve in front of the radiator with a mesh of 0.1mm and a wire diameter of 0.063 mm

Minimum requirement for the nominal diameter of the steam piping:

Table 2: Min. D-dimension

Type	Stroke (mm)	D min.
DKV	32	DN 150 / NPS 6
	55	DN 200 / NPS 8
	80	
DKM	10	DN 50 / NPS 2

The minimum distance – Ls – (see fig. 5) required between the desuperheater and the sensing element depends on service conditions (see fig. 6).

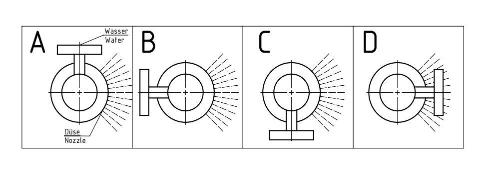


Fig. 4: Water connection flange options

Instrumentation

A temperature sensing element transmits the steam temperature to a temperature controller. This controller sends a signal (electric or pneumatic) to the actuator, which results in an upward or downward repositioning of the desuperheater stem and control piston. Thus, the injection water quantity and subsequently the steam temperature are controlled.

Actuator

The desuperheater can be fitted with all electric, pneumatic or electric/hydraulic actuators. For manual operations the valve can be fitted with a hand wheel.

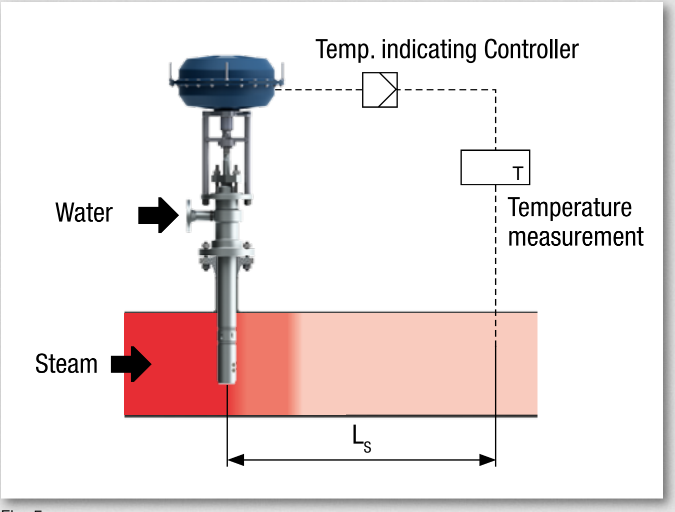


Fig. 5

Sizing and selection

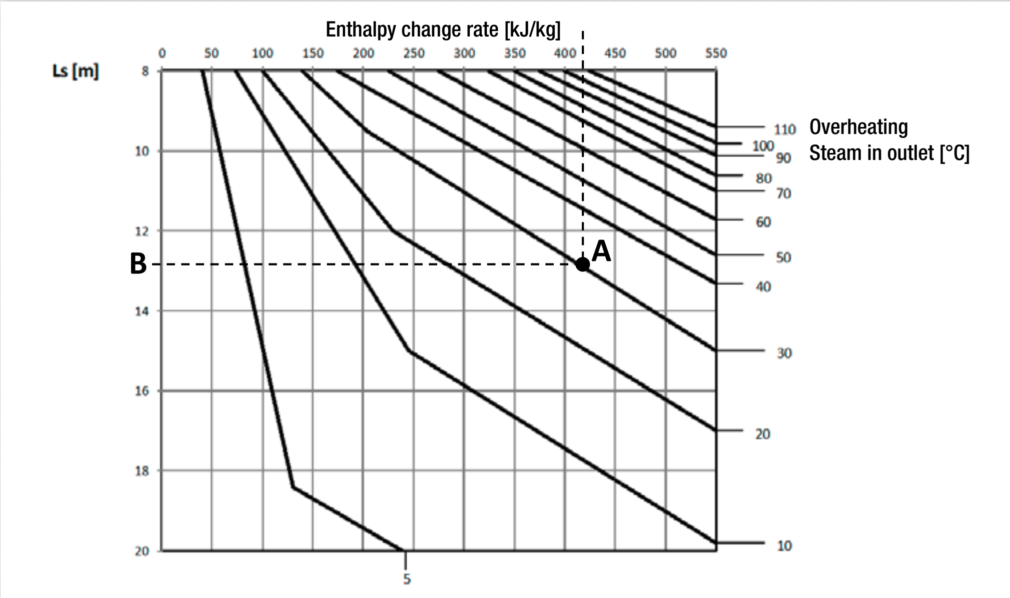


Fig. 6: Distance between desuperheater and temperature sensor

*Above values are for DN 300 pipe sizes, for other pipe sizes multiply distance by 0.06 $\sqrt{D}$ (D = pipe dia.)

Example:

Enthalpy change between inlet- and outlet steam = 420 kJ/kg. Temperature of outlet steam is 30°C above saturation temperature. Draw a vertical line from 420 kJ/kg until it intersects with the 30°C superheat line graph (point A). The required minimum distance of the temperature sensor from the desuperheater can be read from point B in the ordinate axis on the graph; the value shown in the example is Ls≈13 m.

Sizing and selection

Data required for sizing and selection:

G_S = steam flow (kg/hr or lbs/hr)
P = steam pressure (bar/psi)
T_1 = temperature inlet steam (°C/°F)
T_2 = temperature outlet steam (°C/°F)
p_W = cooling water pressure (bar/psi)
T_W = cooling water temperature (°C/°F)
D_X = diameter of steam piping
X = DKV = 150 mm
DKM = 100 mm

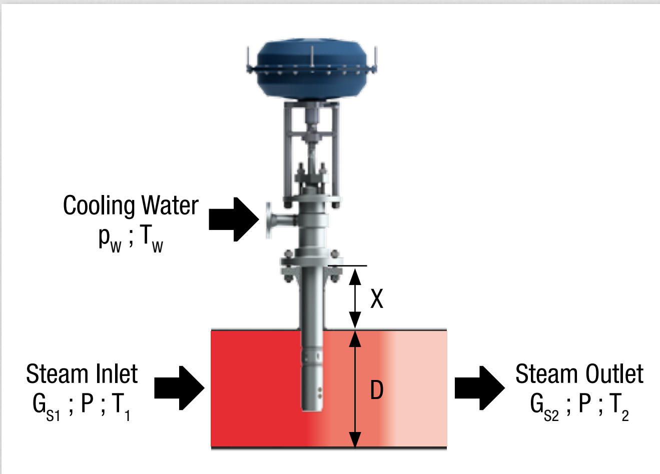


Fig. 7: D = diameter of steam piping

Design values

Table 3: Max. K_V and (C_V)– value

Type	Stroke (mm)	Linear	1:10	1:25	1:50
DKV	32	5.5 (6.4)	4.0 (4.6)	3.5 (4.1)	3.2 (3.7)
	55	8.0 (9.3)	5.8 (6.7)	5.2 (6.0)	4.7 (5.4)
	80	10.0 (11.6)	7.3 (8.4)	6.5 (7.5)	5.9 (6.8)
DKM	10	1 (1.2)			

K_V (C_V) - values of the standard sprayheads
*Max. K_V (C_V) value

Calculation

Calculation of the injection water quantity

$$G_W = G_S \times \frac{h_1 - h_2}{h_2 - h_W} \text{ (k/hr)}$$

$$Q_W = \frac{G_W}{S.G. \times 1000}$$

Calculation of the K_V (C_V)

$$K_V = Q_W \sqrt{\frac{S.G.}{\Delta p}}$$

$$C_V = 1.1561 \times K_V$$

- Select K_V (C_V) and corresponding stroke of the valve from table 3.
- Check max. stroke versus steam pipe diameter in table 2.

Example

G_S = 100,000 kg/hr
T_1 = 430 °C
T_2 = 330 °C
S.G. = 0.885
p = 50 bar (a)
T_W = 190 °C
p_W = 140 bar (a)

From steamtable find enthalpy at inlet (h_1) and outlet (h_2) conditions.

$$G_W = 100{,}000 \times \frac{3270.4 - 3016.1}{3016.1 - 813.6} = 11546 \text{ kg/hr}$$

$$Q_W = \frac{11546}{0.885 \times 1000} = 13 \text{ m}^3\text{/hr}$$

$$\Delta p = 140 - 50 = 90 \text{ bar}$$

$$K_V = 13 \sqrt{\frac{0.885}{90}} = 1.29; \; K_V \text{ (selected)} = 1.5$$

Nomenclature

K_V (C_V) = valve flow coefficient (m³/h resp. gal/min)
S.G. = specific gravity injection water (kg/dm3)
G_S = steam flow (kg/hr resp. lbs/hr)
Q_W = injection water quantity (m³/hr or gpm)
G_W = injection water quantity (kg/hr or lbs/hr)
h_1 = enthalpy inlet steam (kJ/kg)
h_2 = enthalpy outlet steam (kJ/kg)
h_W = enthalpy injection water (kJ/kg)
Δp = p_W - p

Connection code

Table 4: Connection code

Type	Actuator code	Water connection / Size code	Pressure rating
DKV DKM	P = Pneumatic R = Electric O = Hydraulic M = Manual drive	03 = DN 15 (NPS ½) 05 = DN 25 (NPS 1) 07 = DN 40 (NPS 1½) 08 = DN 50 (NPS 2) 09 = DN 65 (NPS 2½)	3 = PN 25 / Class 150 4 = PN 40 5 = PN 64 / Class 300 6 = PN 100 / Class 600 7 = PN 160 / Class 900 8 = PN 250 / Class 1500 9 = PN 320 0 = PN 400 / Class 2500
Connection code	**Design values code**	**Value mounting flange code**	**Housing material code**
B = British Standard F = DIN EN G = GOST J = JIS U = ASME S = Special	PX = equal % 1:50 PX = equal % 1:25 PX = equal % 1:10 LH = Linear	08 = DN 50 (NPS 2) 10 = DN 80 (NPS 3) 11 = DN 100 (NPS 4)	1 = 1.0460/A105 2 = 1.5415 3 = 1.7335/A182F12Cl.2 4 = 1.7383/A182F22Cl.3 5 = 1.4903/A182F91 0 = Special

Example:

DKVP057/107U-PL-1 = Valve Type DKV; suitable for pneumatic actuator; water connection 1”/900 lbs; mounting flange 3”/900 lbs; flanges ASME; parabolic 1:10 characteristic; body material acc. DIN 1.5415.

Dimension

Table 5: Dimension A

<table>
<tr><th rowspan="2">Type</th><th rowspan="2">DN/NPS</th><th colspan="5">PN/Class</th></tr>
<tr><th>63/300</th><th>100/600</th><th>160/900</th><th>250/1500</th><th>400/2500</th></tr>
<tr><td rowspan="2">DKV</td><td>≤40 / 1½</td><td colspan="2">150 mm</td><td colspan="2">175 mm</td><td>250 mm</td></tr>
<tr><td>>40 / 1½</td><td colspan="2">175 mm</td><td colspan="2">225 mm</td><td>300 mm</td></tr>
<tr><td rowspan="2">DKM</td><td>≤25 / 1</td><td colspan="2" rowspan="2">135 mm</td><td colspan="3">160 mm</td></tr>
<tr><td>>25 / 1</td><td colspan="3">185 mm</td></tr>
</table>

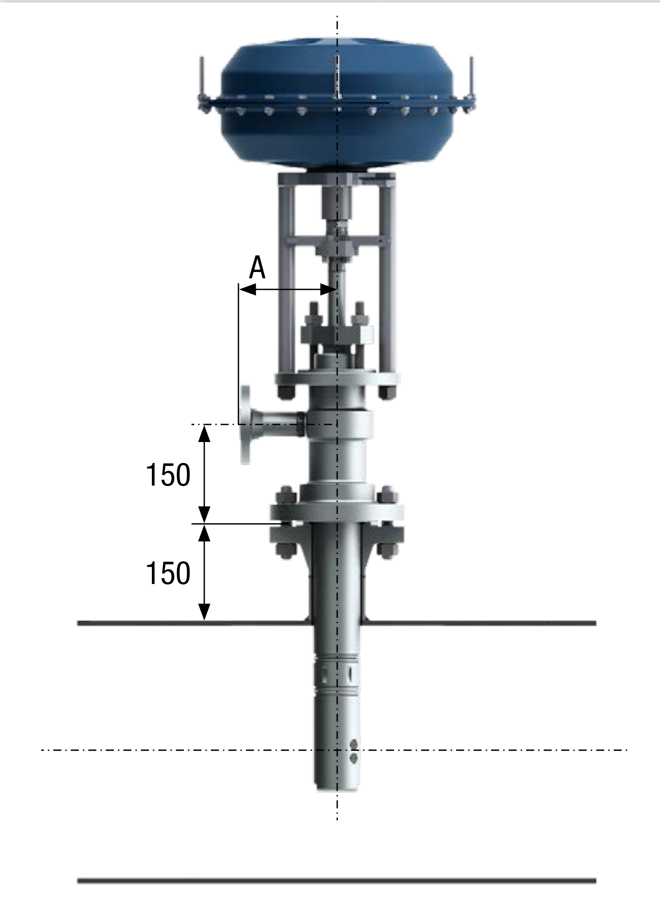


Fig. 8: DKV

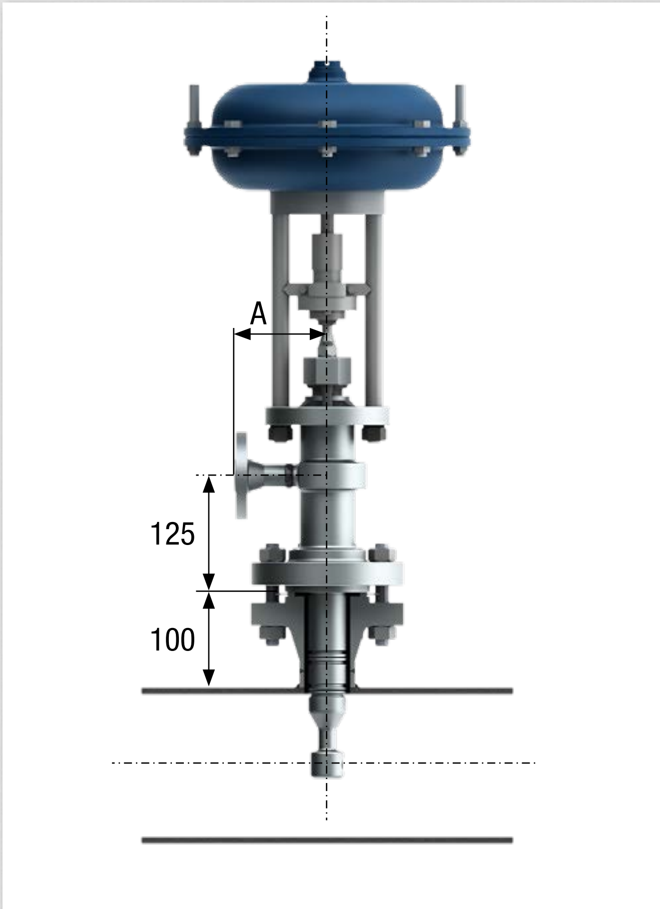


Fig. 9: DKM

Type DKV

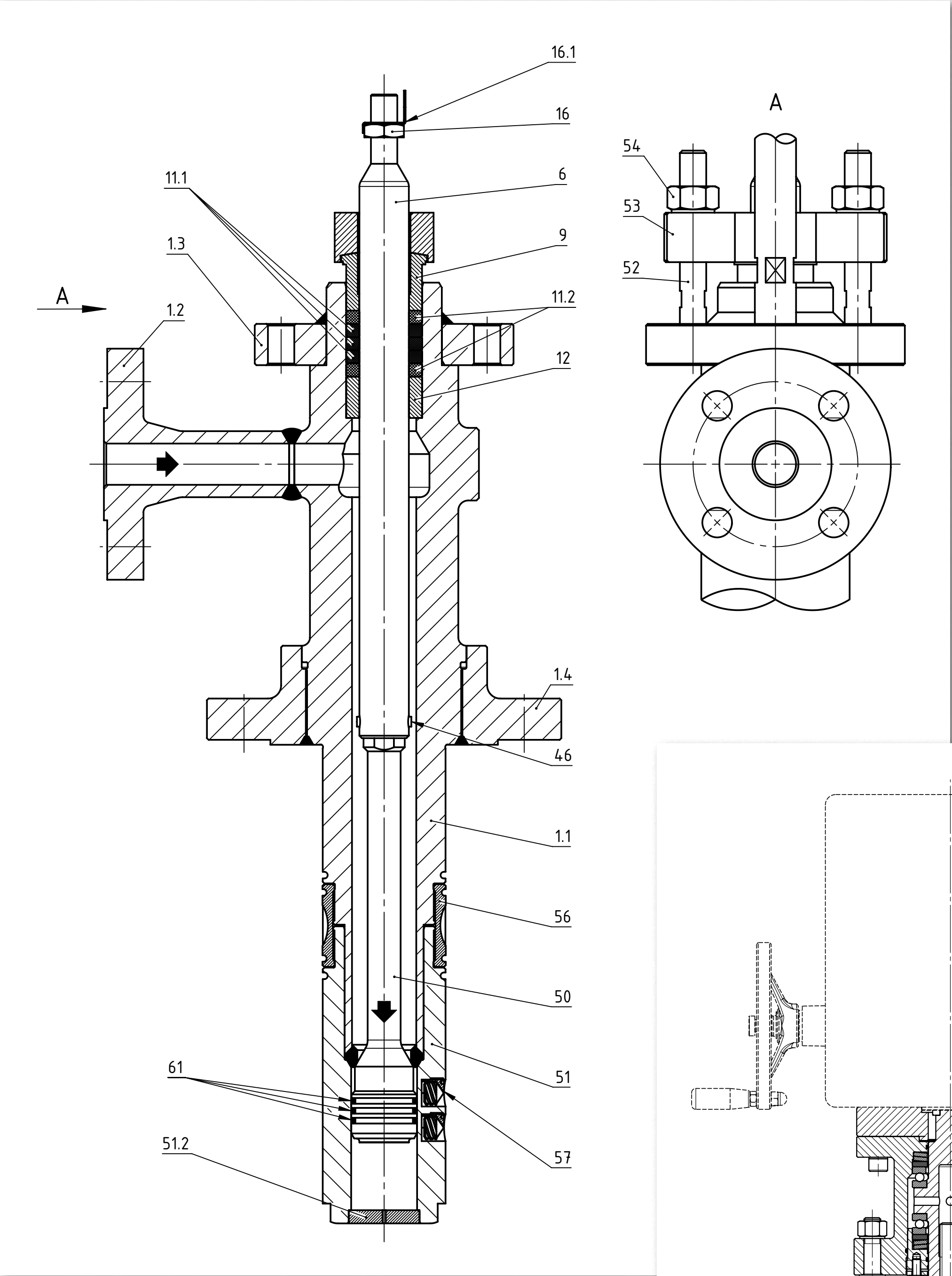


Fig. 10: Type DKV

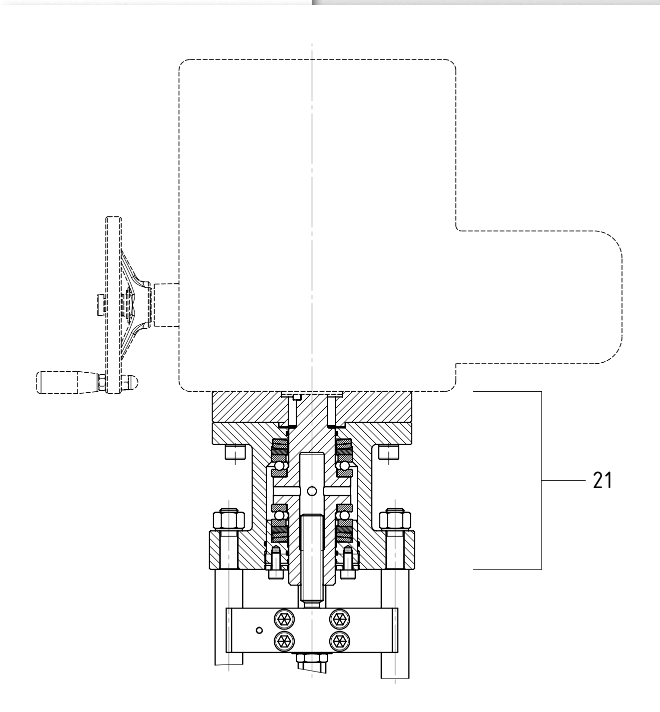


Fig. 11: Gearbox (electric actuator)

Parts and materials

Table 6: Parts and materials list (Fig. 10)

Pos.	Qty.	Description	Material
1	1	Housing (assy.)	*1
1.1	1	Housing	*1
1.2	1	Flange	*1
1.3	1	Flange	*1
1.4	1	Flange	*1
6	1	Stem	1.4057/A276 (431)
9	1	Packing Follower	1.4122
11.1	3	Packing Ring	GRAFIT
11.2	2	Packing Ring	GRAFIT
12	1	Bottom Ring	1.4122
16	1	Hexagon Nut	4
16.1	1	Safety Plate	A4
46	1	Pin	1.4301/A182F304H
50	1	Control Piston	1.4122
51	1	Spray Head	1.4006/AISI410
51.2	1	Bottom Plate	1.4006/AISI410
52	2	Stud Bolt	1.7709, 1.4923
53	1	Packing Gland	*1
54	2	Hexagon Nut	1.7218, 1.4923
56	1	Tighten Ring Nut	1.4006/AISI410
57	*2	Nozzle	1.4301, 1.4313
61	3	Piston Ring	1.4923, Stellite 6

*1 Material - see table: Housing material
*2 stroke 32 = 6, stroke 55 = 9, stroke 80 = 12

Table 7: Additional parts and materials (Fig. 11)

Pos.	Qty.	Description	Material
21	1	Gearbox	various

Type DKM

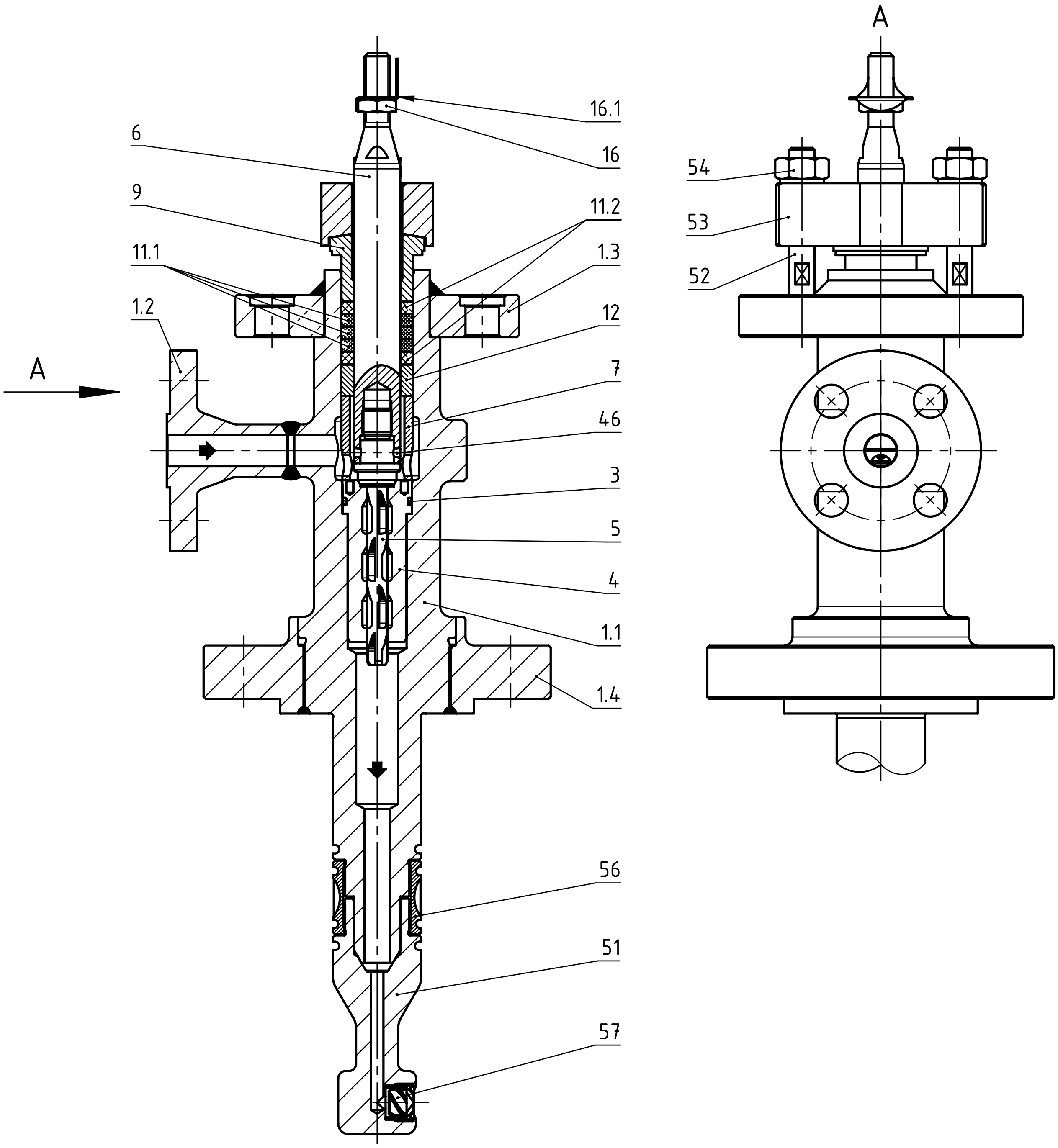


Fig. 12: Type DKM

Parts and materials

Table 8: Parts and materials list DKM (Fig. 12)

Pos.	Qty.	Description	Material
1	1	Housing (assy.)	*1
1.1	1	Housing	*1
1.2	1	Flange	*1
1.3	1	Flange	*1
1.4	1	Flange	*1
3	1	O-Ring	EPDM
4	1	Cascade Connector	1.4122
5	1	Valve Body	1.4122
6	1	Stem	1.4057/A276(431)
7	1	Spacer Ring	1.4122
9	1	Packing Follower	1.4122
11.1	3	Packing Ring	GRAFIT
11.2	2	Packing Ring	GRAFIT
12	1	Bottom Ring	1.4122
16	1	Hexagon Nut	4
16.1	1	Safety Plate	A4
46	1	Pin	1.4301/A182F304H
51	1	Spray Head	1.4006/AISI410
52	2	Stud Bolt	1.7709, 1.4923
53	1	Packing Gland	*1
54	2	Hexagon Nut	1.7218, 1.4923
56	1	Tighten Ring Nut	1.4006/AISI410
57	1	Nozzle	1.4301, 1.4313

*1 Material - see table: Housing material

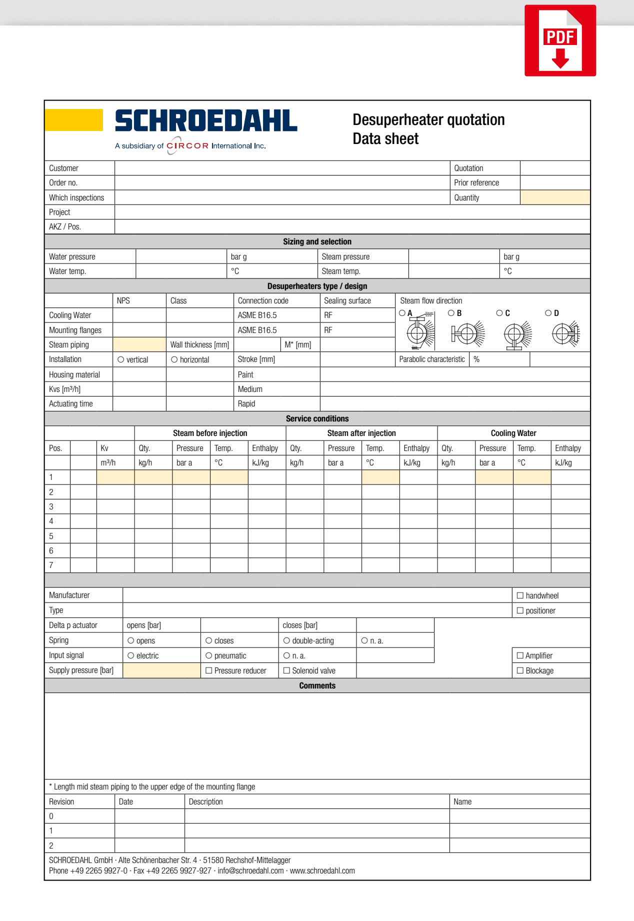
Type DK

The following data are required to prepare a quotation:

- Valve operating- and design data (as per page 6+7)
- Type of actuator and required accessories: e.g. pneumatic actuator, make...; failsafe open; incl. electro/pneumatic positioner + air filter/ reducer station + limit switches, e.g. electric actuator make...
- Installation position:
  Standard: valve stem vertical upward
  Option: valve stem horizontal
- Which inspections / certificates

Standard test are:

- Dimensional Check
- Visual Inspection
- Hydraulic Pressure Test
- Seat Leakage Test
- K_V/C_V-Valve Test
- Functional Test (mechanical)



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Desuperheater quotation
Data sheet

Customer		Quotation	
Order no.		Prior reference	
Which inspections		Quantity	
Project			
AKZ / Pos.			

Sizing and selection

Water pressure		bar g	Steam pressure		bar g
Water temp.		°C	Steam temp.		°C

Desuperheaters type / design

	NPS	Class	Connection code		Sealing surface	Steam flow direction	
Cooling Water			ASME B16.5		RF	○ A ○ B ○ C ○ D	
Mounting flanges			ASME B16.5		RF		
Steam piping		Wall thickness [mm]		M* [mm]			
Installation	○ vertical	○ horizontal	Stroke [mm]			Parabolic characteristic	%
Housing material			Paint				
Kvs [m³/h]			Medium				
Actuating time			Rapid				

Service conditions

			Steam before injection				Steam after injection				Cooling Water			
Pos.		Kv	Qty.	Pressure	Temp.	Enthalpy	Qty.	Pressure	Temp.	Enthalpy	Qty.	Pressure	Temp.	Enthalpy
		m³/h	kg/h	bar a	°C	kJ/kg	kg/h	bar a	°C	kJ/kg	kg/h	bar a	°C	kJ/kg
1														
2														
3														
4														
5														
6														
7														

Manufacturer					☐ handwheel
Type					☐ positioner
Delta p actuator	opens [bar]		closes [bar]		
Spring	○ opens	○ closes	○ double-acting	○ n. a.	
Input signal	○ electric	○ pneumatic	○ n. a.		☐ Amplifier
Supply pressure [bar]		☐ Pressure reducer	☐ Solenoid valve		☐ Blockage

Comments

* Length mid steam piping to the upper edge of the mounting flange

Revision	Date	Description	Name
0			
1			
2			

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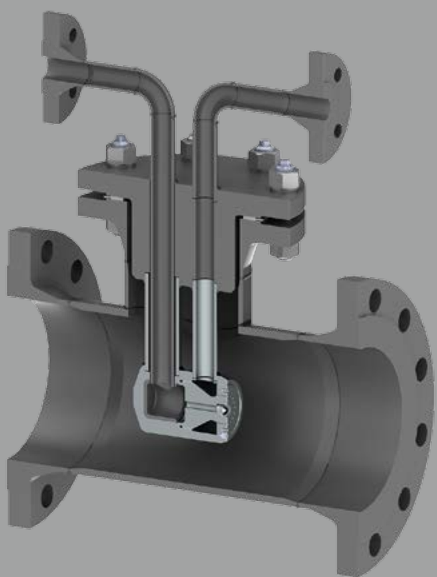
In addition to the DKV and DKM desuperheaters, our range includes the following products for controlling the temperature:

Type DKH

DKH desuperheater with particularly long lance for large steam piping and special requirements.



Type DKT

DKT drive desuperheaters for an extended control range (compared to DKV), very short cooling lines and cooling close to the saturation state.

Type DU

Steam converter-control valve DU for steam cooling while reducing pressure.

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