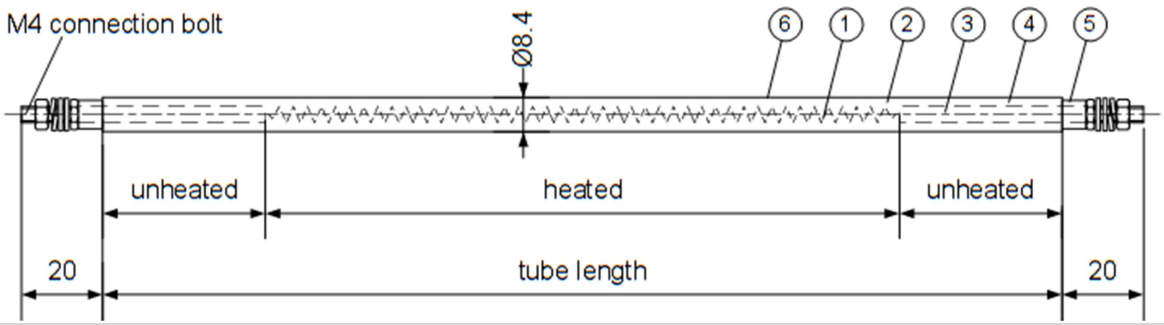
9.1 High-power tubular heating element Ø 8,4

Application	For heating up: **Water** in kettles, boilers, heat exchangers, rinsing and degreasing baths, double jackets for indirect heating, etc. **Oil** for hardening-, hydraulic- or lubrication systems, in gear boxes, oil tanks, etc. **Other fluids** like tar, paraffin, tetrachloroethylene, diphyl, glycerin, phosphat ester, melting of tin or lead **Solid media** like heating plates, machine parts, rollers, tanks, etc. (built-in or pressing-on), aluminium parts (cast-in). **Air** in air heaters or circulating air ovens, in heating cabinets and drying furnaces as radiant heating elements. Further applications please see catalogue page 9.6
Technical advantages	High degree of operational reliability, dielectric strength, protection against contact and humidity, resistant against external influences and high temperatures, good heat transmission and heat conductivity, low heat storage, easy malleable, stable, vibration resistant and long life expectancy.
Design	Heating element consists of a coiled heating wire with welded-on connection bolts, centrically embedded in highly compressed insulating material, protected by a bendeable metal tube. Tube ends are sealed by ceramical lock bushings.



① Heating wire NiCr 30 20 or NiCr 80 20

② Insulating made of magnesium oxid with high electrical insulation capacity and good thermal conductivity.

③ Connection bolts M4 made of stainless-steel are part of the unheated zone of the tubular heating element. Following length of connection bolts are available from stock:

30 mm	120 mm	250 mm	450 mm	700 mm
50 mm	150 mm	270 mm	500 mm	750 mm
65 mm	175 mm	300 mm	550 mm	800 mm
80 mm	200 mm	350 mm	600 mm	850 mm
100 mm	220 mm	400 mm	650 mm	1000 mm

other lengths are also available

④ Tube ends are sealed with silicone (up to 180°C) or synthetic resin (up to 130°C).

⑤ Ceramic lock bushing

⑥ Tube jacket, see next page (9.2)

9.2 High-power tubular heating element Ø 8,4

⑥ Tube jacket material depends of the use of the heating element (see page 9.6), following materials are available:

Material	Material-designation	Mat.-no.	Technical advantages
Steel	ST 34-2	1.0108	max. surface temp. 400°C
chrome-nickel steel	AISI 321 (X6CrNiTi18-10)	1.4541	max. surface temp. 750°C
chrome-nickel steel	AISI 316Ti (X6 CrNiMoTi17-12-2)	1.4571	corrosion resistance
chrome-nickel steel	AISI 317LMN (X2CrNiMoN17-13-5)	1.4439	corrosion resistance
chrome-nickel steel	AISI 309 (X15CrNiSi20-12)	1.4828	max. surface temp. 850°C
chrome-nickel steel	alloy 800 (X10NiCrAlTi)	1.4876	corrosion and temp. resistance
special material	alloy 825 (NiCr21Mo)	2.4858	high degree of corrosion resistance
titanium	Ti Gr. 2	3.7035	high degree of corrosion resistance

Tolerances
Diameter 8.4 mm ± 0.1 mm,
length ± 2%, tighter tolerances on request
power +5% / -10°C, tighter tolerances on request

Stamp
Stamp on each tubular heating element: month, HELIOS, year, voltage and power

Weight
Depends on tube jacket material approx. 240 – 270 g/m

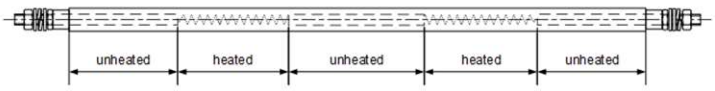
Testing
Routine testing according to DIN EN 60335-1

Manufacturing limits
min. length 300 mm,
max. length 6300 mm, 7000 mm (stainless-steel mat.-no. 1.4541 (AISI 321), 1.4571 (AISI 316Ti), 1.4828 (AISI 309), 2.4858 (alloy 825))
max. voltage 690 V
min. resistance 3 Ω/m, max. resistance 500 Ω/m

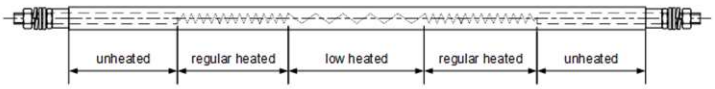
max. Power	4000 W at 230 V and max. 4 m heated length
max. Power	3000 W at 230 V and max. 5 m heated length
max. Power	2000 W at 230 V and max. 6 m heated length
min. Power	100 W at 230 V and min. 1 m heated length
min. Power	200 W at 230 V and min. 0,5 m heated length
min. Power	400 W at 230 V and min. 0,25 m heated length

Special design

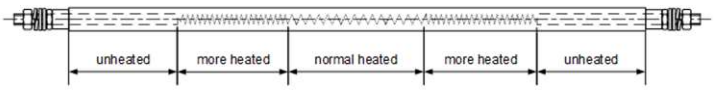
unheated sections



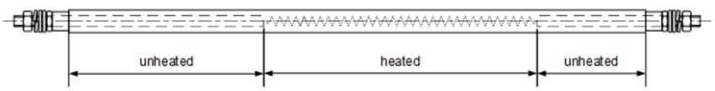
low heated sections



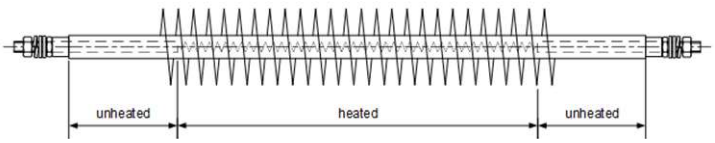
more heated sections



different length of unheated zones from the end of the tube



finned-tube heating element Ø 28 mm, see page 9.11 and 9.12



9.3 High-power tubular heating element Ø 8,4

Design Determination of the heated tube length depending on power and the permitted surface load (9.6):

Diagram 1 **Example:**
Power 2000 W, surface load 1.5 W/cm², heated tube length 5.1 m

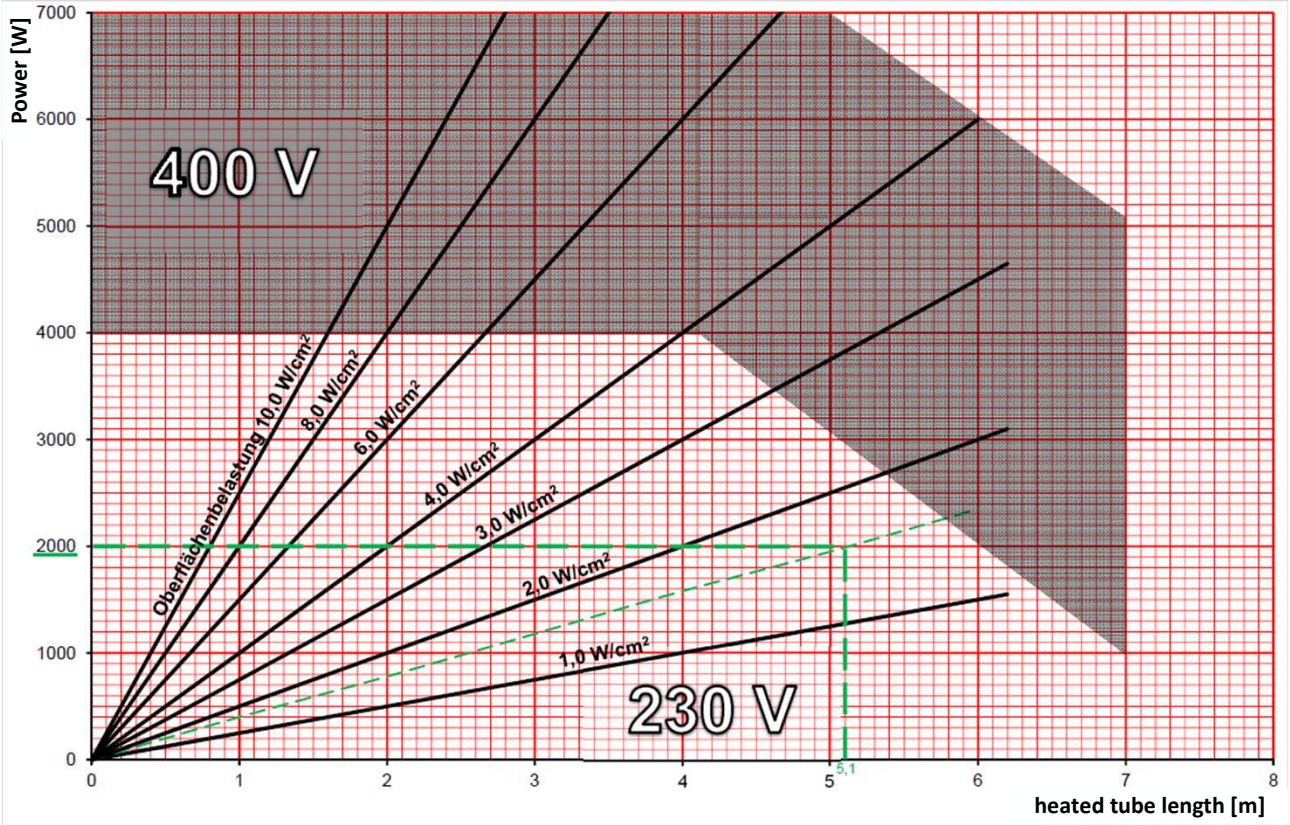
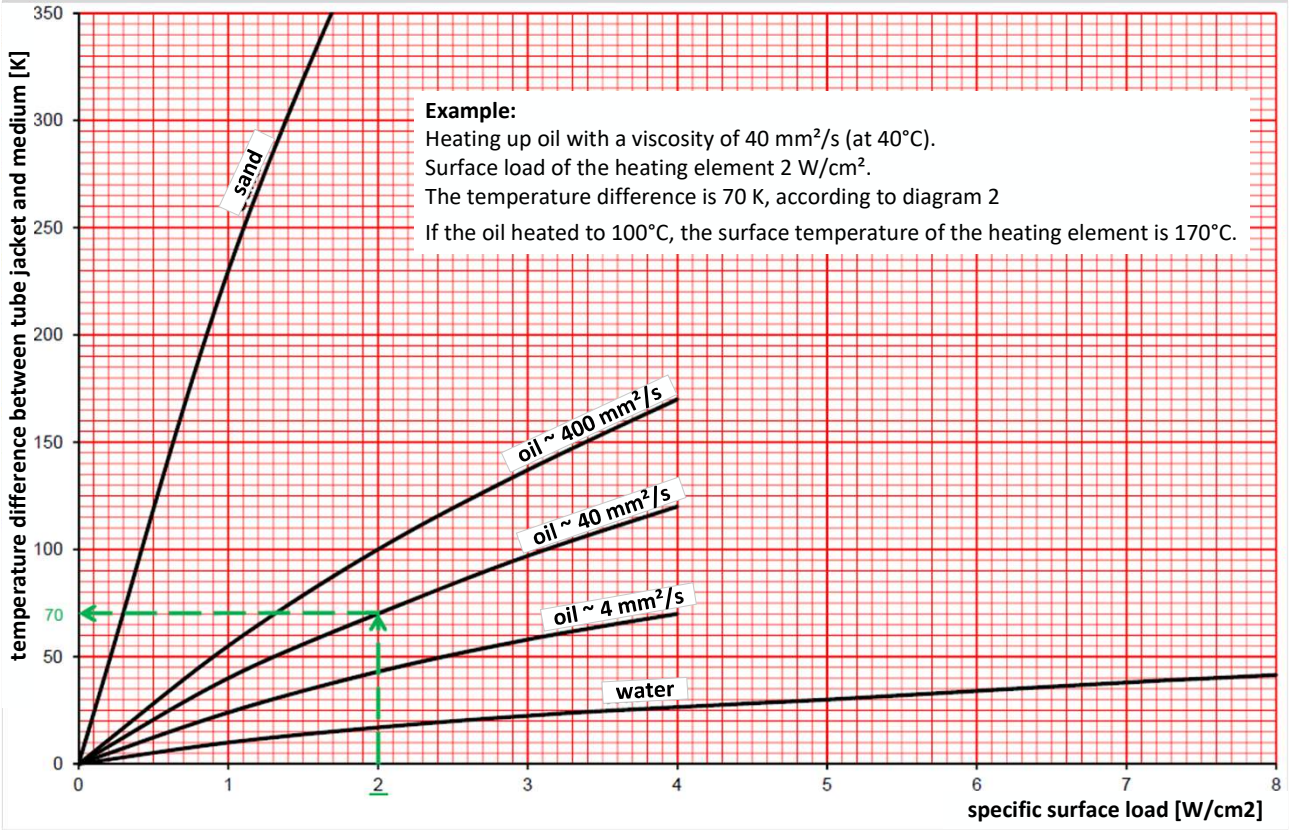


Diagram 2 Determination of the temperature difference between tube jacket and medium as a function of the surface load of the heating element for different stationary media.



Example:
Heating up oil with a viscosity of 40 mm²/s (at 40°C).
Surface load of the heating element 2 W/cm².
The temperature difference is 70 K, according to diagram 2
If the oil heated to 100°C, the surface temperature of the heating element is 170°C.

9.4 High-power tubular heating element Ø 8,4

Diagram 3 Determination of the surface temperature of the tube jacket depending on the surface load and air temperature at **stationary** air.

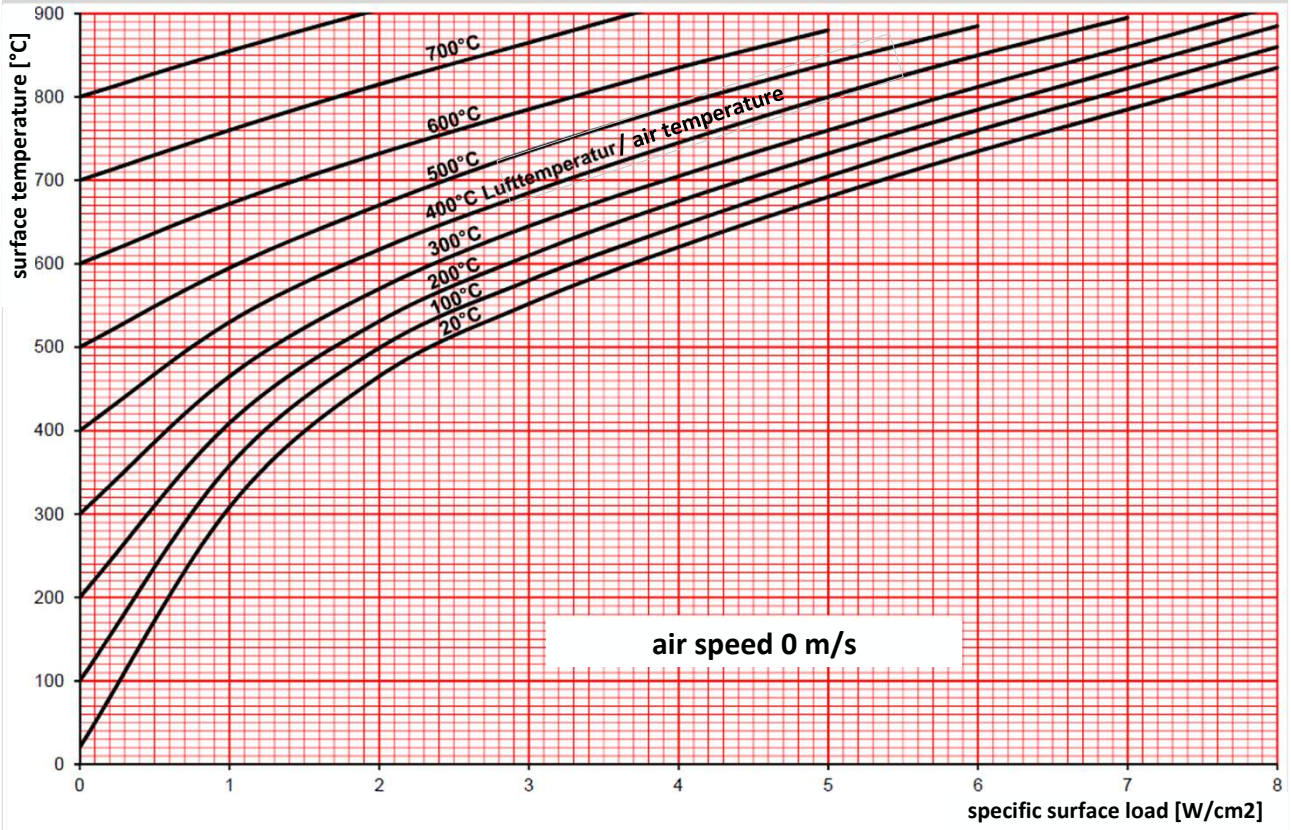
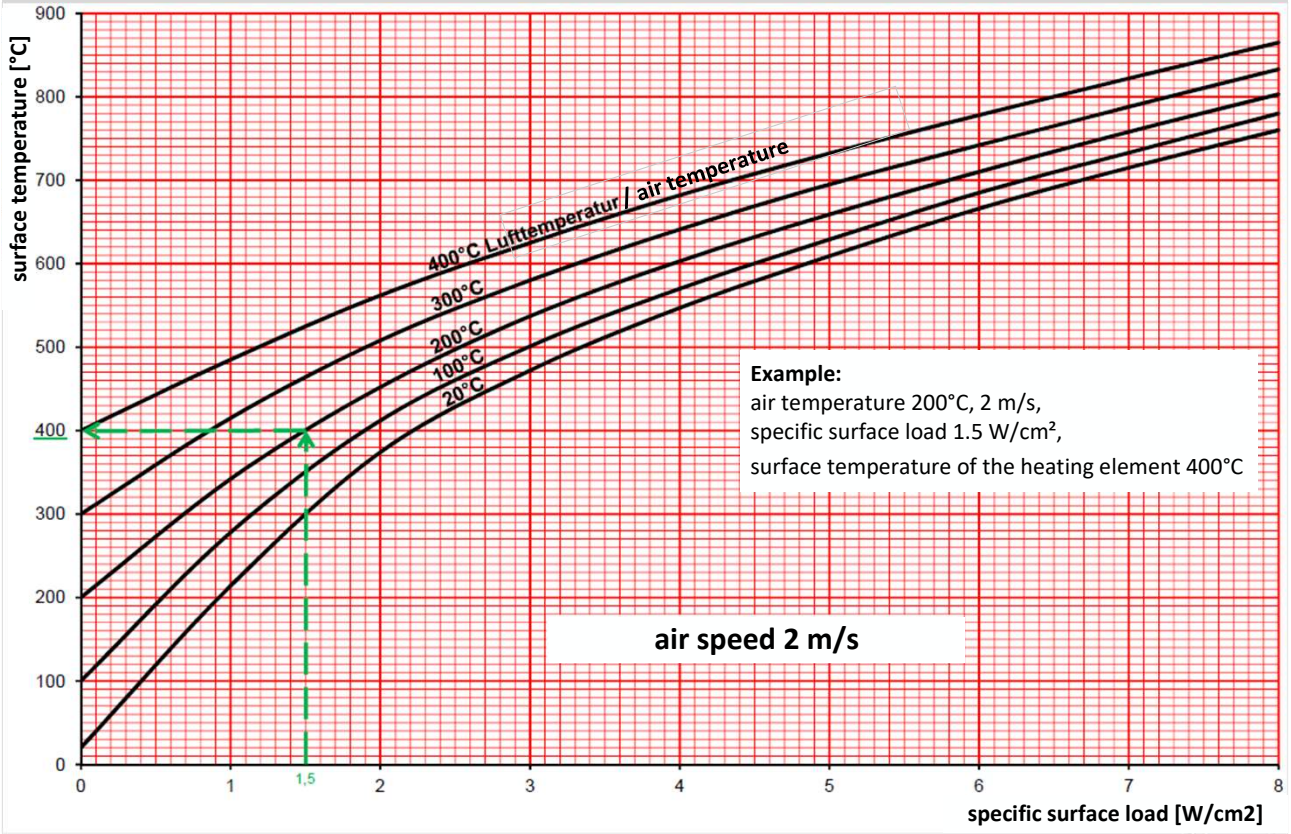


Diagram 4 Determination of the surface temperature of the tube jacket depending on the surface load and air temperature at **air speed of 2 m/s.**



9.5 High-power tubular heating element Ø 8,4

Diagram 5 Determination of the surface temperature of the tube jacket depending on the surface load and air temperature at **air speed of 5 m/s.**

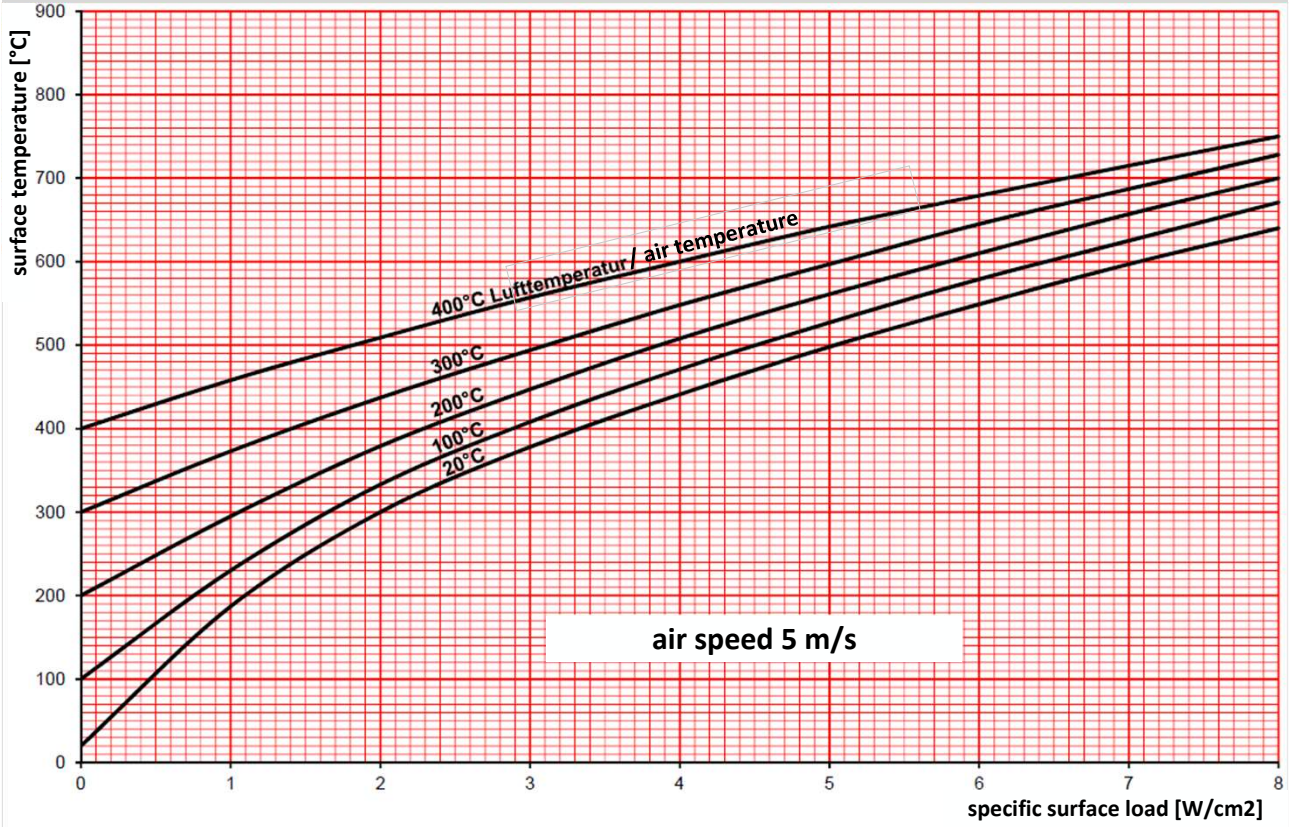
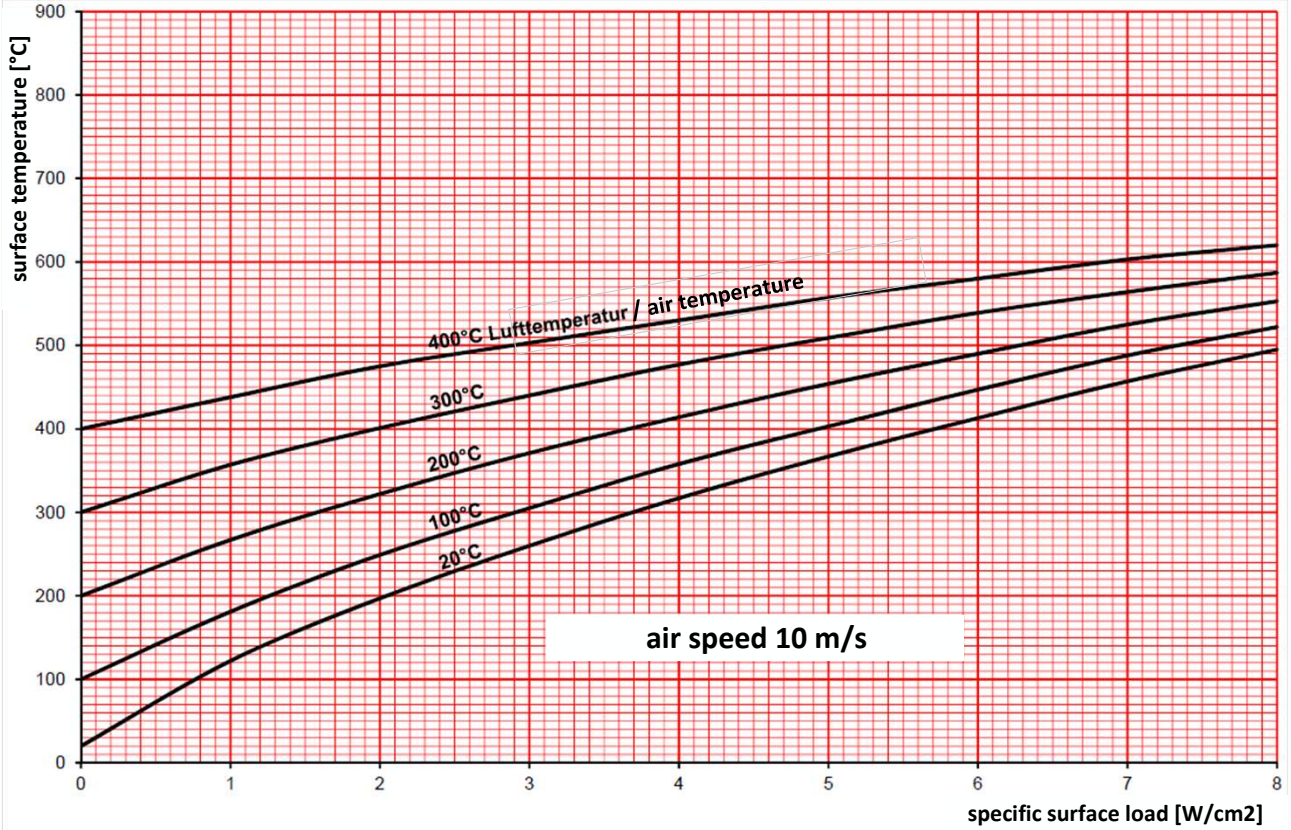


Diagram 6 Determination of the surface temperature of the tube jacket depending on the surface load and air temperature at **air speed of 10 m/s.**



9.6 High-power tubular heating element Ø 8,4

Chart for determination of maximum surface load and tube material of high-power tubular heating elements for different applications.

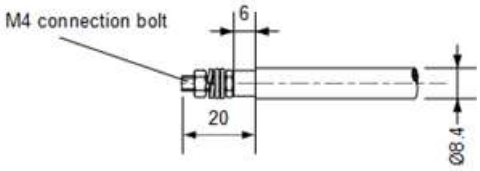
Medium / application	max. medium temperature [°C]	max. specific surface load [W/cm²]	Heating element material						
			Steel	AISI 321 (1.4541)	AISI 316Ti (1.4571)	AISI 904LMN(1.4439)	AISI 309 (1.4828)	alloy 825 (2.4858)	Titanium
Water									
Tap water (soft)	60	5 - 8						X	
Tap water (hard)	60	3 - 5						X	
Water (circulation)	100	10			X			X	
Water (deionized)	100	10			X	X			
Water (vaporization)	100	5			X			X	
Aquerous fluids									
Iron-III-chlorid 20°C	50	5							X
Bases (aqueous)	100	4	X		X			X	X
Milk	50	1			X				
Caustic soda	100	2						X	X
Acids (aqueous)	100	2			X			X	
Seawater	100	5						X	X
Suds (moved)	100	8			X			X	
Oil									
Thermal oil	300	5	X						
Hydraulic oil	40	1.5	X						
Lubricating oil (gear box)	40	1	X						
Heavy fuel oil	100	1.5	X						
Other fluids									
Lead bath	500	4		X	X				
Diphyl	350	1.5	X		X				
Frying oil	200	4			X				
Glycerin	110	3	X						
Carbon dioxide (fluid)	20	3	X						
Phosphate ester	40	1	X						
Molten salt	400	2			X				
Lubricating grease	40	0.5	X						
Tar	150	1	X	X					
Water glycol mixture	130	3			X				
Wax	60	1	X						
Solid media									
Aluminium (cast-in)	300	8		X					
Charcoal (to ignite)	600	3.5					X		
Metal (pressed-on)	300	2 - 4		X			X		
Metal (pressed-in groove)	300	6		X					
Sawdust (to ignite)	600	3.5					X	X	
Sand	200	1.5		X			X		
Roller	300	2.5		X			X		
Air									
Defrost heating element		1		X					
Grill (BBQ) heating element		4					X		
Air (stationary)	750	diagram 3		X			X		
Air (moved)	750	diagram 4-6		X			X		
Radiant heating element		3 - 5					X		

alloy 800 (1.4876)

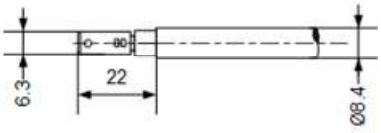
9.7 High-power tubular heating element Ø 8,4

Connection options

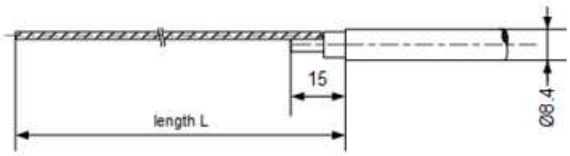
Connection bolts M 4 made of stainless steel (special design M 3)



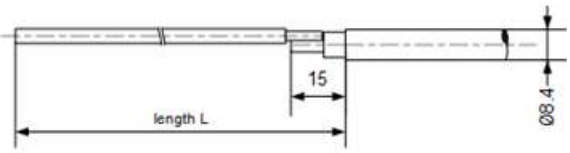
Flat plug acc. to DIN 46244, plug width 6.3 mm



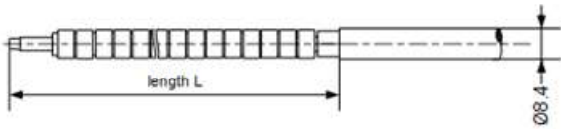
Nickel wire tack welded
(up to 600°C ambient air temperature)
1 mm², 2 mm²



glass fibre insulated nickel wire, tack welded
(up to 400°C ambient air temperature)
1.5 mm², 2.5 mm², 4.0 mm²

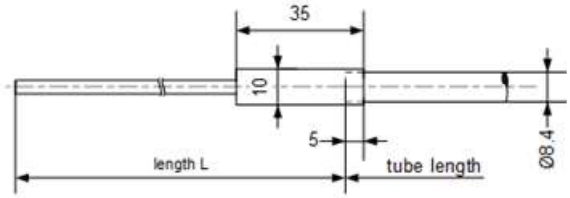


pearl insulated nickel wire, tack welded
(up tp 600°C ambient air temperature)
1 mm², 2 mm²



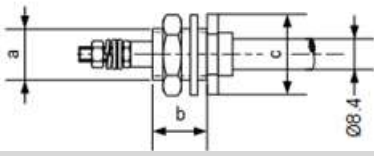
Waterproof connection with PVC special cable, 1 mm²

Other heat-shrink tubing, protective conductor



Mounting and integration

with screw-nipples at each tube end, soldered or pressed,
with nut and gasket

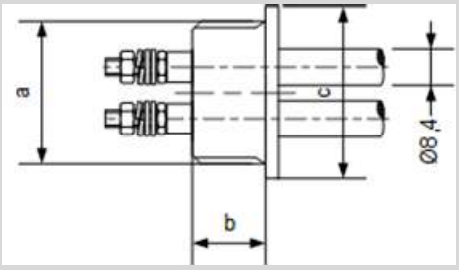


a thread	b length [mm]	c wrench size [mm]	Material mat.-no.	Article-no.
M 14 x 1.5	10	wrench size 19	1.4541 (AISI 321)	0907 0011
M 14 x 1.5	15	wrench size 19	brass	0907 0021
M 14 x 1.5	15	wrench size 19	steel	0907 0031
M 14 x 1.5	15	wrench size 19	1.4541 (AISI 321)	0907 0041
M 14 x 1.5	15	wrench size 19	1.4571 (AISI 316Ti)	0907 0051
M 14 x 1.5	25	wrench size 19	brass	0907 0061
M 14 x 1.5	25	wrench size 19	steel	0907 0071
M 14 x 1.5	25	wrench size 19	1.4541 (AISI 321)	0907 0081
M 14 x 1.5	25	wrench size 19	1.4571 (AISI 316Ti)	0907 0091
M 14 x 1.5	25	wrench size 26	brass	0907 0101
M 14 x 1.5	40	wrench size 19	brass	0907 0111
M 14 x 1.5	40	wrench size 19	steel	0907 0121
M 14 x 1.5	40	wrench size 19	1.4571 (AISI 316Ti)	0907 0131
G ½	10	wrench size 30	brass	0907 0141
G ½	25	wrench size 30	brass	0907 0151
M 14 x 1.5	15	wrench size 19	steel, zinc-coated	0907 0161

9.8 High-power tubular heating element Ø 8,4

Mounting and installation

Screw-nipples hardsoldering (brazing), with nut and IT-gasket

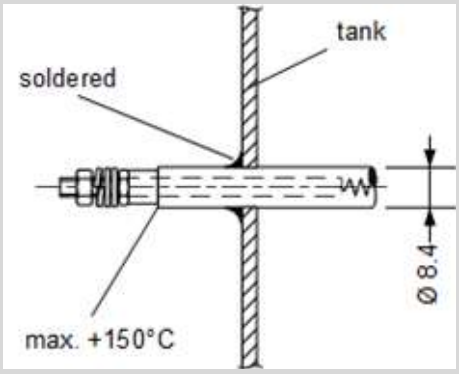


a thread	b length [mm]	c collar [mm] SW (wrench size)	Material mat.-no.	Article-no.
for 2 tube-ends				
M 26 x 1.5	11	Ø 32	brass	0908 0011
M 26 x 1.5	21	Ø 32	brass	0908 0021
M 26 x 2	15	Ø 32	1.4571 (AISI 316Ti)	0908 0031
M 26 x 2	23	Ø 32	1.4571 (AISI 316Ti)	0908 0041
G ¾	25	SW 32	brass	0908 0051
G 1	17	Ø 40	brass	0908 0061
for 4 tube-ends				
G 1	17	Ø 40	brass	0908 0101

Hardsoldering (brazing)

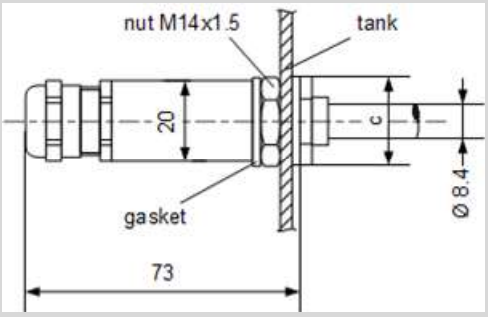
When soldering-in the tubular heating element, the distance from the ceramic lock bushing must be chosen so large that the temperature at this point does not exceed 150°C.

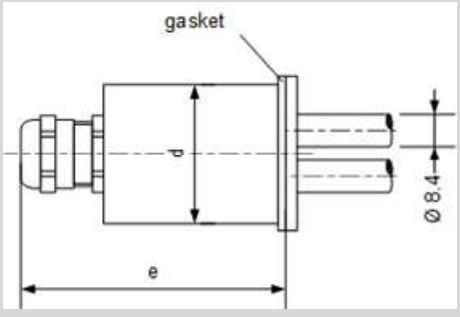
If soldering is carried out closer to the end of the tube, the tubular heater must be ordered with loose ceramic lock bushing and loose fastening material. After soldering, the tubular heating element must be dried out at approx. 150°C and must be sealed with silicone under the lock bushing when warm.



Additional components

Screw-cap Protection system IP 65, with cable gland M 16 x 1.5





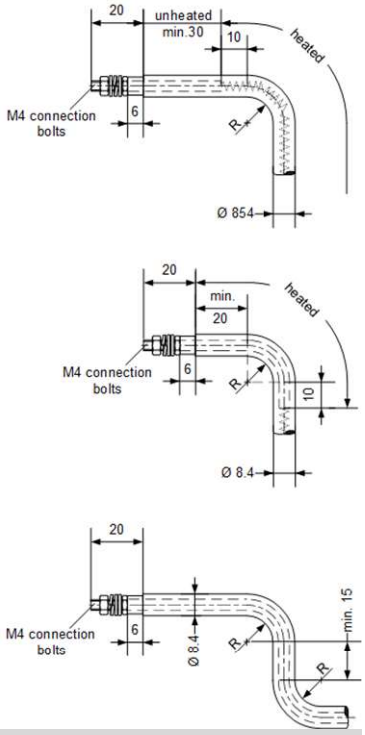
a thread	e length [mm]	d diameter [mm]	Material mat.-no.	Article-no.
M 14 x 1.5	73	Ø 20	brass	
M 26 x 1.5	50	Ø 29	brass	0908 1011
M 26 x 1.5	50	Ø 29	plastic	0908 1021
G ¾	50	Ø 29	brass	0908 1031
G ¾	50	Ø 29	plastic	0908 1041
G 1	60	Ø 36	brass	0908 1051
G 1	60	Ø 36	plastic	0908 1061

9.9 High-power tubular heating element Ø 8,4

Shaping

Tubular heating elements can be formed when cold.
When bending, make sure that the unheated zone ends at least 10 mm in front of the bend or 10 mm behind the bend .
Bends below radius R = 50 mm can only be bent with using a bending tool and profiled bending rolls.
Smallest bending radius is R = 8.5 mm.
This corresponds to a bending roll diameter of 17 mm.

For 180° bends, the bending radius can reduced to R = 2.5 mm, by subsequently compressing the tube legs.

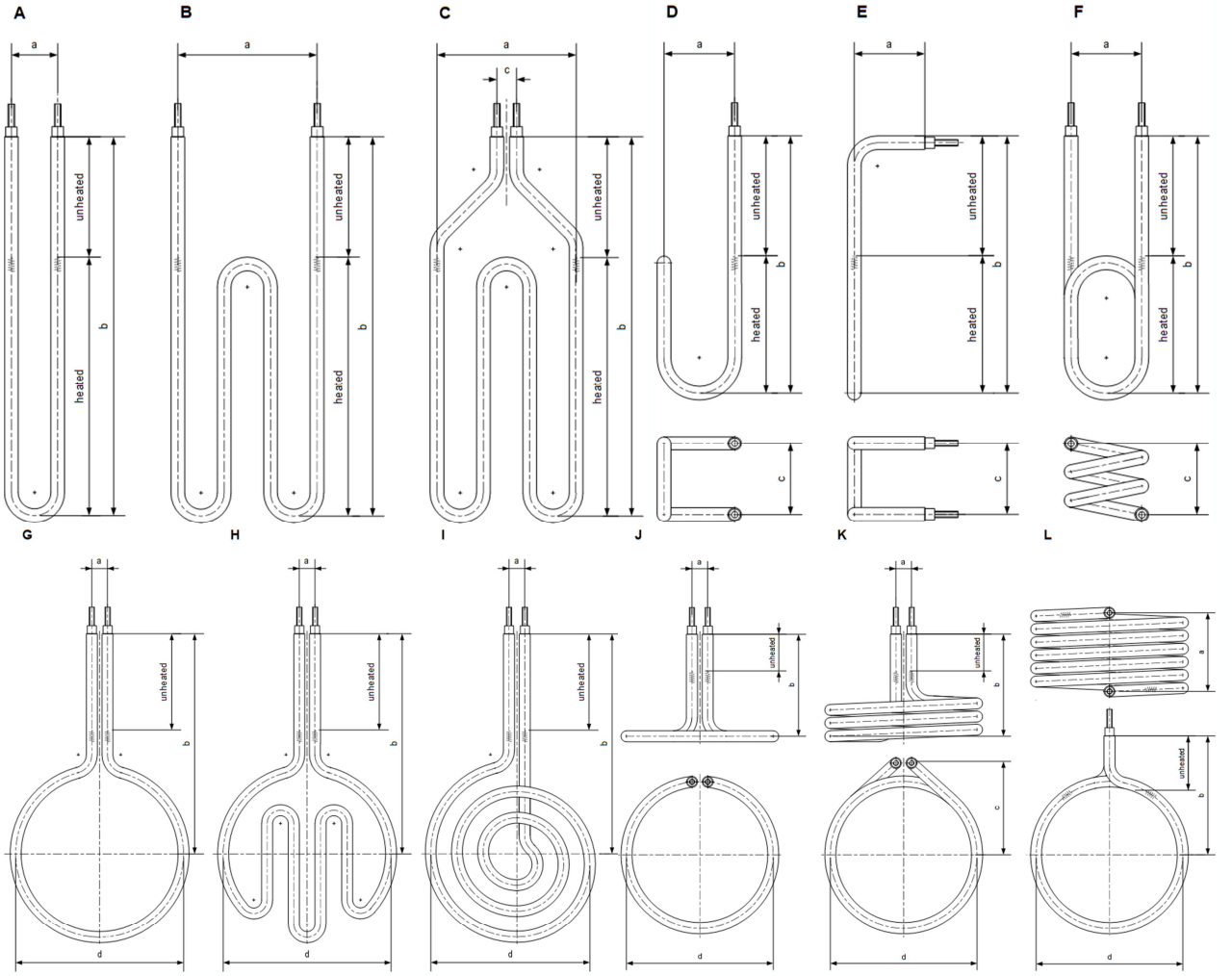


Available bending rolls

Ø 17, 20, 25, 30, 35, 40, 45, 50, 60, 70, 75, 80, 90 and 100 mm

The distance between two bends should be at least 15 mm.

Shaping examples



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