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**Pipes and Fittings of PP-R/PP-RCT
for hot and cold water as well as for heating installations**

DIN EN ISO 15874	Plastic piping systems for hot and cold water installations Polypropylene (PP)
DIN 8077	Polypropylene (PP) pipes Dimensions
DIN 8078	Polypropylene (PP) pipes General quality requirements
DVGW W 534, W 542 W 544	Pipe joints Compound pipes for drinking water installations Plastic pipes for drinking water installations
DVS 2207 Part 11	Welding of thermoplastic Heated tool welding of pipes, piping parts and panels made of PP
DVS 2208 Part 1	Welding of thermoplastics Machines and devices for heated tool welding of pipes, piping parts and panels
KTW Recommendation	Physiological harmlessness According to the recommendations of the German health authority
VOB Partl C DIN 18381	German construction contract procedures (VOB) – part C: General technical specifications in construction contracts (ATV)- Installation of gas, water and drainage pipework inside buildings
DIN EN 10226 Part 1	Wittworth pipe threads for pipes and fittings Parallel female thread and tapered male thread
DIN 16928	Pipe joints and piping parts installation General regulations



Starting at the day of installation of the PP-R / PP-RCT piping system PN 20 we grant a warranty of 10 years. This product liability includes personal and physical damages, installation costs and costs for disassembly up to 30 Mio EURO per damage event. This will be confirmed by issuing the warranty certificate related to the project.

		<h2 style="text-align: center;">Warranty Certificate No.</h2>	
<p>Bänninger Kunststoff-Produkte GmbH • Bänningerstr. 1 • D-35447 Reiskirchen/Germany • Phone + 49 640889-0 • Fax + 49 6408 6756</p>			
<p>For your security we have covered a product liability insurance with a reputed German insurance company. Compliance with the existing DIN standards, our planning and working instructions as well as professional installation by an approved skilled company are compulsory for any indemnification.</p> <p>In case of any damage – provided that the damage has verifiably been caused by manufacturing resp. material faults – you will be indemnified up to the below mentioned amounts:</p>		<p>This is to confirm that the used Bänninger products have been installed professionally according to the DIN standards and the planning and working instructions.</p>	
<p>1. Product liability: € 30.000.000,-- for personal damages and physical damages at buildings and machinery</p> <p>2. Costs for installation and disassembly: € 1.000.000,-- without any consequential charges</p> <p>3. Damages caused to the environment: € 10.000.000,-- caused by products influencing soil, air or water</p>		<p>Full address _____</p>	
<p>The warranty starts on the day of installation and will end 10 years after the production date of the installed Bänninger products.</p> <p>This certificate is valid after the performing company has confirmed the professional installation with their signature and stamp and Bänninger has countersigned it.</p> <p>Please fill in the warranty certificate after installation has been completed and send it to Bänninger Kunststoff-Produkte GmbH, Bänningerstrasse 1, 35447 Reiskirchen, Germany. Bänninger will countersign the certificate and return it to you.</p>		<p>Name of constructor resp. project _____</p> <p>Installed material: PP-R/PP-RCT <input type="checkbox"/> approx. _____ meters of pipe</p> <p>Installed material: PE <input type="checkbox"/></p> <p>Installed material: PVC-U <input type="checkbox"/></p> <p>Assigned purpose: _____ (e.g. residential house, hotel etc.)</p> <p>Installation has been carried out and completed by us on: _____</p>	
<p>Received at Bänninger</p>		<p>Policy-Nº: 13294786-01018113 13294786-01031133</p> <p>Handled by: _____ Date: _____</p> <p>Back to: <input type="checkbox"/> Sender <input type="checkbox"/> Constructor <input type="checkbox"/> Installation Company</p>	
<p>Reiskirchen, _____</p> <p>(No legal right can be derived from this warranty certificate.)</p>		<p>Delivery / commissioning date: _____</p> <p>Full address: _____</p> <p>Stamp installation company _____</p> <p>Mandatory signature _____</p>	
		04/12	

Material:

PP-R (Polypropylene Random-Co-polymerisate) of high molecular weight and stabilized to high temperature. The material corresponds to KTW-recommendation of the German Board of Health.

Jointing:

Welding joints

Socket-welding by heating-elements according to DVS (German Welding Inst.) specifications: leaflet 2207, part 11, section 3.2. Tools and devices for socket-welding by heating-elements according to DVS leaflet 2208, part 1, section 5, schedule 2, type A.

Threaded joints:

The threaded joint of adaptor pipe-fittings correspond to the requirements of DIN EN 10226 Part 1 resp. ISO 7, i. e. cylindrical female thread, conical male thread. Male threads for connecting back-nuts correspond to the requirements of DIN-ISO 228, part 1.

Dimensions:

Pipes: According to DIN 8077 (Pipes of polypropylene PP).
Fittings: According to DIN EN ISO 15874, (Pipe connections and fittings for polypropylene PP) injection moulded fittings, z-dimensions tolerance ± 3 mm, we reserve the right to modify dimensions without previous notice.

Quality:

Pipes: according to DIN 8078 for PP-R (polypropylene PP pipes). General quality standards, test.
Fittings: according to DIN EN ISO 15874
(Pipe connections and fittings for polypropylene PP pressure pipeline.)
General quality standards, test.

Operating pressure:

For cold water at 20° C: up to 20 bar¹⁾
for hot water at 70° C: up to 10 bar¹⁾
for heating at 70° C: up to 3 bar.
The regulations and guide-lines-dealing with the different fields of application are to be observed.

Chemical Resistance:

Detailed information on the chemical resistance of polypropylene pipes and pipelines is available in annex 1 to DIN 8078. Please note the explanations on page 1 of annex.

Orders:

When ordering, kindly always state the dimensions and the order number in addition to the designation of the piece required.
Example: Elbow 90°, d 32, No. 8090

Marking:

The fittings are marked as follows:
Example: **B+R**, d, PP-R, P

Signs and Symbols:

d =nominal size = pipe diameter
R =male thread-conical
Rp =female thread-cylindric
Rc =female thread-conical
G =male thread-cylindric
Stp=standard packing
® =registered trade mark
AL =number of screw holes

Utilization

The system of tubing of PP-R, as described in this catalogue, has primarily been developed for application in the sanitary field for cold and hot water.

This system can be applied as well in the industrial section.

Tubes and fittings are dimensioned in a way to assure, according to actual results of long-term tests a utilisation of at least 50 years, based on max. 10 bar and a constant temperature of 70 degrees Celsius.

For hot water piping, made according to DIN 1988, the tube row 6 (PN 20) according to DIN 8077 is valid, for dimensions according to table 1.

Tubes are available in lengths of 4 m.

Plastic pipes and fittings of PP-R generally have all advantages which have been registered in all sections of industry and of installation technics. Most of all the excellent resistance of corrosion gives proof of an extensively long utilization of installation tubing in the building technic, without risk of damages known from metallic materials.

Therefore PP-R as installation-material represents an excellent choice for piping of cold and hot water.

Properties	Measuring technique	Unit	PP - R Value	PP - RCT Value
Melting index MFR 190/5 MFR 230/2,16	ISO / R 1133	g/10 min. g/10 min.	0,5 0,24 - 0,36	0,5 0,24 - 0,36
Density	ISO / R 1183	g/cm ³	0,895	0,905
Melting range	polarizing microscope	0°C 0°F	140 - 150 289 - 302	140 - 150 284 - 302
Yield stress Tensile strength Tensile expansion	ISO / R 527 feed speed Test bar	N/mm ² N/mm ² %	21 40 600	25 45 300
Bending stress at 3,5% Marginal fibre expansion	ISO 178 test specimen 5.1	N/mm ²	20	23
Modulus of elasticity	ISO 178	N/mm ²	800	900
Mechanical properties following impact bending test at 0° C	DIN 8078		no fracture	no fracture
Expansion coefficient	VDE 0304 Part 1 § 4	K ⁻¹	1,5 x 10 ⁻⁴	1,5 x 10 ⁻⁴
Thermal conductivity at 20° C/58° F	DIN 52612	W/m K	0,24	0,24
Specific heat at 20° C/68° F	adiabatic calorimeter	kJ/kg K	2,0	2,0
Pipe friction factor	--		0,007	0,007

	Conc. %	TEMPERATURE				Conc. %	TEMPERATURE		
		20°C	60°C	100°C			20°C	60°C	100°C
Acetone	TR	+	+		Ethyl acetate	TR	+	•	–
Alum	GL	+	+		Butyl acetate	TR	•	–	–
Alum of all kinds, hydr.	all	+	+		Ether				
Formic acid		+	•		Ethyl benzene	TR	•	–	–
	85	+	•	–	Ethyl chloride	TR	–	–	–
	10	+	+	•					
Ammonia, gaseous	TR	+	+		Pine needle oil	H	+	•	
Ammonia, hydr.	conc.	+	+		Hydrofluoric acid solution	40	+	+	
Ammoniumacetate	GL	+	+		Formaldehyde, hydr.	40	+	+	
Ammonium carbonate	GL	+	+		Antifreezing solution (motor vehicles)	H	+	+	+
Ammonium chloride	GL	+	+		Fruit juices	H	+	+	+
Ammonium nitrate	GL	+	+	+					
Ammonium phosphate	GL	+	+	+	Glycerine	TR	+	+	+
Ammonium sulphate	GL	+	+	+					
Amyl alcohol, pure	TR	+	+	+	Urea, hydr.	GL	+	+	
Aniline	TR	•	•		Fuel oil	H	+	•	
Apple juice	H	+	+	+	Heptane	TR	+	•	–
					Hexane	TR	+	•	
Batterie acid		+	+						
Barium salts	GL	+	+	+	Iso-octane	TR	+	•	–
Benzaldehyde	GL	+	+						
Benzine	H	•	–	–	Jodine salution	H	+	•	
Benzoic acid	GL	+	+						
Benzene	TR	•	–	–	Caustic potash solution	50	+	+	+
Succinic acid, hydr.	GL	+	+		(potassium hydroxide)				
Beer	H	+	+	+	Potassium carbonate (Potash)	GL	+	+	
Bleaching solution	20	•	•	–	Potassium chlorate	GL	+	+	
Borax	L	+	+		Potassium chloride	GL	+	+	
Boric acid	GL	+	+	+	Bichromate of potash	GL	+	+	
Bromine, liquid	TR	–	–	–	Potassium iodide	GL	+	+	
Bromine, vapours	all	•	–	–	Potassium nitrate, hydr.	GL	+	+	
Bromine water	GL	•	–	–	Potassium permanganate	GL	+	–	
Butane gas	TR	+	+		Potassium persulphate	GL	+	+	
Butyl acetate					Coconut oil	TR	+		
					Cresol	90	+	+	
Calcium chloride	GL	+	+	+					
Calcium nitrate	GL	+	+		LANOLIN®	H	+	•	
Corn oil	TR	+	•		Linseed oil	H	+	+	+
Chlor, liquid	TR	–	–	–	Lactic acid	90	+	+	
Chlorine, gaseous wet	1	–	–	–					
Chlorobenzene	TR	•			Magnesium salts	GL	+	+	
Chloride of lime	all	+	+		Menthol	TR	+	•	
Chloroform	TR	•	–	–	Methanol	TR	+	+	
Chlorosulphonic acid	TR	–	–	–	Methylene chloride	TR	•	–	–
Chlorine water	GL	•	–	–	Methyl ethyl ketone	TR	+	•	
Hydrogen chloride, gaseous	TR	+	+		Milk	H	+	+	+
Chromic sulphuric acid		–	–	–	Motor oil (motor vehicles)	TR	+	•	
Cyclohexane	TR	+			Nickle salts, hydr.	GL	+	+	
Cyclohexanol	TR	+	•						
Cyclohexanone	TR	•	–	–	Sodium carbonate	50	+	+	•
					Sodium chlorate	GL	+	+	
Dekahydronaphtaline	TR	•	–	–	Sodium chloride	VL	+	+	+
Dibutyl phthalate	TR	•	–	–	Sodium chlorite, hydr.	2 – 20	+	•	–
Diesel oil	H	+	•		Sodium hydrochlorite, hydr.	10	+		
Diethylether	TR	+	•		Sodium nitrate	GL	+	+	
1,4-Dioxane	TR	•	•		Sodium nitrite	G	+	+	
					Sodium phosphate	GL	+	+	+
Peanut oil	TR	+	+		Sodium sulphate	GL	+	+	
Vinegar	H	+	+	+	Sodium sulphide	GL	+	+	
Acetic acid (glacial acetic acid)	TR	+	•	–	Sodium sulphite	40	+	+	+
Acetic acid, hydr.	50	+	+	•	Sodium thiosulphate	GL	+	+	
Acetic acid anhydride	TR	+			Caustic soda solution	up to 60	+	+	+

	Conc. %	TEMPERATURE		
		20°C	60°C	100°C
Oleum	TR	–	–	–
Olive oil	TR	+	+	•
Oleic acid	GL	+	•	–
Oxalic	GL	+	+	•
Ozone	0,5 ppm	+	•	
Paraffin	H	+	+	
Paraffin oil	TR	+	•	–
Perchloroethylene				
Petroleum ether	TR	+	•	
Petroleum	TR	+	•	
Peppermint oil	TR	+		
Phenol (hydr. phase)	5	+	+	
Phosphoric acid	85	+	+	+
Photographic developer	H	+	+	
Propane, gaseous	TR	+	•	
Pyridine	TR	•	•	
Mercury	TR	+	+	
Mercury salts	GL	+	+	
Castor oil	TR	+	+	
Nitric acid, hydr.	10	+	•	–
Hydrochloric acid, hydr.	up to 20	+	+	
	20 – 36	+	•	
Sulphur dioxide	TR	+	+	
Carbonum disulphide	TR	–	–	–
Sulphuric acid, hydr.	80-TR	•	–	
	10 – 80	+	+	
	10	+	+	+
Hydrogen sulphide	TR	+	+	
Sea water	H	+	+	+
Silver salts	GL	+	+	
Silicone oil	TR	+	+	+
Sodium carbonate (soda)	50	+	+	•
Soybean oil	TR	+	•	
Starch solution, hydr.	all	+	+	
Turpentine oil	TR	–	–	–
Turpentine substitute	TR	+	•	–
Tetrachloroethane	TR	•	–	–
Tetrachloroethylene (Perchloroethylen)	TR	•	•	
Carbon Tetrachloride	TR	–	–	–
Tetrahydrofurane	TR	•	–	–
Tetrahydronaphtalene (Tetralin)	TR	–	–	–
Toluene	TR	•	–	–
Transformer oil	TR	•	–	
Trichloroethylene	TR	–	–	–
Petroleum jelly	TR	+	•	
Detergent	VL	+	+	
Water	H	+	+	+
Hydrogen peroxide, hydr.	30	+	•	
Tricresyl phosphate	TR	+	•	
Trioctyl phosphate	TR	+		
Wine	H	+	+	
Tartaric acid, hydr.	10	+	+	

	Conc. %	TEMPERATURE		
		20°C	60°C	100°C
Xylene	TR	•	–	–
Zinc salts, hydr.	GL	+	+	
Stannous chloride	GL	+	+	
Citric acid, hydr.	VL	+	+	+
Sugar sirup	H	+	+	

Signs and symbols:

VL = moderate loosening, mass-part ≤ 10%

L = moderate loosening, mass-part > 10%

GL = Saturated (with 20°C), hydrous solution

TR = medium rate flow is minimum-technical pure

H = usual in trade composition

+ = resistant

• = limited resistant

– = inconstant

Application areas for fittings and pipes made of PP-R and PP-RCT according to DIN 8077

Cold water pipelines:

Continuous operation temperature up to 20°C
Continuous operation pressure up to 20 bar

Warm water pipelines:

Continuous operation temperature up to 70°C
Continuous operation pressure up to 10 bar

Heating pipelines:

Continuous operation temperature up to 70°C
Continuous operation pressure up to 3 bar
(Installation pressure according to DIN EN 12828)

Temperature °C	Operating years					
	1	5	10	25	50	100
Max. Operating pressure (bar) according to DIN 8077						

Field of application: Drinking water and sanitary installation

G 8160 B

PP-RCT Pressure Pipe

20° C/1,6 MPa, 60° C/0,8 MPa

20	16,6	16,0	15,8	15,5	15,3	15,1
40	12,3	11,9	11,7	11,5	11,3	11,1
60	8,9	8,6	8,4	8,2	8,1	–
70	7,5	7,2	7,0	6,9	6,8	–
80	6,2	6,0	5,9	5,7	–	–
95	4,7	4,4	4,3	–	–	–

G 8200 B

PP-RCT Pressure Pipe

20° C/2,0 MPa, 70° C/1,0 MPa

20	26,3	25,4	25,1	24,6	24,3	24,0
40	19,6	18,9	18,6	18,2	17,9	17,6
60	14,2	13,6	13,4	13,1	12,8	–
70	11,9	11,4	11,2	10,9	10,7	–
80	9,9	9,5	9,3	9,1	–	–
95	7,4	7,1	6,9	–	–	–

G 8200

PP-R Pressure Pipe

20° C/2,0 MPa, 70° C/1,0 MPa

20	29,9	28,1	27,4	26,4	25,7	25,0
40	21,6	20,2	19,6	18,8	18,3	17,8
60	15,4	14,3	13,9	13,3	12,9	–
70	12,9	12,0	11,6	10,0	8,5	–
80	10,8	9,6	8,1	6,5	–	–
95	7,6	5,2	4,3	–	–	–

G 8215 B

PP-RCT Stabi composite pipe

20° C/2,0 MPa, 70° C/1,0 MPa

20	25,0	24,2	23,9	23,5	23,1	22,8
40	18,6	18,0	17,7	17,3	17,1	16,8
60	13,5	13,0	12,7	12,4	12,2	–
70	11,3	10,9	10,7	10,4	10,2	–
80	9,5	9,0	8,9	8,6	–	–
95	7,1	6,7	6,6	–	–	–

Application areas for fittings and pipes made of PP-R and PP-RCT according to DIN 8077

Cold water pipelines:

Continuous operation temperature up to 20°C
Continuous operation pressure up to 20 bar

Warm water pipelines:

Continuous operation temperature up to 70°C
Continuous operation pressure up to 10 bar

Heating pipelines:

Continuous operation temperature up to 70°C
Continuous operation pressure up to 3 bar
(Installation pressure according to DIN EN 12828)

Temperature °C	Operating years					
	1	5	10	25	50	100
Max. Operating pressure (bar) according to DIN 8077						

Field of application: Drinking water and sanitary installation

G 8200 FW PP-RCT Fiber composite pipe Watertec 20° C/2,0 MPa, 70° C/1,0 MPa	20	25,0	24,2	23,9	23,5	23,1	22,8
	40	18,6	18,0	17,7	17,3	17,1	16,8
	60	13,5	13,0	12,7	12,4	12,2	–
	70	11,3	10,9	10,7	10,4	10,2	–
	80	9,5	9,0	8,9	8,6	–	–
	95	7,1	6,7	6,6	–	–	–

G 8200 FW PP-RCT Fiber composite pipe Watertec 20° C/1,6 MPa, 70° C/0,8 MPa	20	19,9	19,3	19,0	18,6	18,4	18,1
	40	14,8	14,3	14,1	13,8	13,6	13,3
	60	10,7	10,3	10,1	9,9	9,7	–
	70	9,0	8,6	8,5	8,3	8,1	–
	80	7,5	7,2	7,0	6,9	–	–
	95	5,6	5,3	5,2	–	–	–

Field of application:

Air conditioning, Industrial plants, Drinking water and sanitary installation

G 8160 FC PP-RCT Fiber composite pipe Climatec 20° C/1,6 MPa, 70° C/0,8 MPa	20	19,9	19,3	19,0	18,6	18,4	18,1
	40	14,8	14,3	14,1	13,8	13,6	13,3
	60	10,7	10,3	10,1	9,9	9,7	–
	70	9,0	8,6	8,5	8,3	8,1	–
	80	7,5	7,2	7,0	6,9	–	–
	95	5,6	5,3	5,2	–	–	–

G 8160 FC PP-RCT Fiber composite pipe Climatec 20° C/1,0 MPa, 70° C/0,5 MPa	20	12,5	12,1	12,0	11,7	11,6	11,4
	40	9,3	9,0	8,8	8,7	8,5	8,4
	60	6,7	6,5	6,4	6,2	6,1	–
	70	5,7	5,4	5,3	5,2	5,1	–
	80	4,7	4,5	4,4	4,3	–	–
	95	3,5	3,3	3,3	–	–	–

Classification of operating conditions according to DIN EN ISO 15874-1

The selection of a particular application class according to the following table should be agreed among the contracting parties.

For each application class allowable operating pressure p_D of 4 bar²⁾, 6 bar, 8 bar or 10 bar applies, depending on the application.

Application class	Calculation-temperature T_D °C	Service life ^b at T_D Years	T_{max} °C	Service life at T_{max} Year(s)	T_{mal} °C	Service life at T_{mal} h	Typical application area	PP-R pipe system SDR 6	PP-RCT pipe system SDR 7,4
1 ^a	60	49	80	1	95	100	Warm water supply (60°C)	10 bar	10 bar
2 ^a	70	49	80	1	95	100	Warm water supply (70°C)	8 bar	10 bar
4 ^b	20 Followed by 40 Followed by 60 Followed by (see next column)	2,5 20 25 (see next column)	70 Followed by (see next column)	2,5 (see next column)	100	100	Floor heating and Low temperature radiator connections	10 bar	10 bar
5 ^b	20 Followed by 60 Followed by 80 Followed by (see next column)	14 25 10 (see next column)	90 Followed by (see next column)	1 (see next column)	100	100	High temperature radiator connections	6 bar	8 bar

^a Pertinent to the national regulations either application class 1 or application class 2 may be selected.

^b If there is more than one operational temperature for one application area, the corresponding service life time should be summed (for example the temperature collective for class 5 for a period of 50 years consists of:

- 20°C over 14 years followed by
- 60°C over 25 years followed by
- 80°C over 10 years followed by
- 90°C over 1 year followed by
- 100°C over 100 h)

Explanation:

The column T_{mal} gives the highest allowed temperature (for example at disruption of the controlling), max 100° C
The column **Service life at T_{mal}** shows that this breakdown temperature allows a max period of 100 h (over 50 years) whereas single breakdown segments should not exceed 3 hours.

REMARK:

This norm does not apply when higher values are assigned to T_D , T_{max} and T_{mal} than those quoted on the table.

²⁾ 1 bar = 10^5 N/m² = 0,1 MPa

Allowed operating pressures

for warm and hot water pipelines made of PP-R and PP-RCT

			PP-R	PP-RCT		
Time-Temperature collective	Temperature	Operating period (Years)	Allowed operating pressures • Nominal pressure			
			SDR 6 ¹⁾ (bar)	SDR 7,4 (bar)	SDR 9 (bar)	SDR11 (bar)
Continuous temperature 70°C including 30 days per year with ➡	75°C	5	14,12	13,30	10,50	8,40
		10	13,66	13,00	10,30	8,20
		25	11,69	12,70	10,10	8,00
		45	10,13	12,50	9,90	7,90
	80°C	5	13,80	12,20	9,70	7,70
		10	13,36	12,00	9,50	7,50
		25	11,04	11,70	9,30	7,30
		42,5	9,70	11,50	9,10	7,20
	85°C	5	13,28	11,10	8,80	7,00
		10	12,53	10,90	8,70	6,90
		25	10,03	10,60	8,40	6,70
		37,5	9,09	10,50	8,30	6,60
	90°C	5	12,57	10,10	8,00	6,40
		10	10,94	9,90	7,90	6,20
		25	8,76	9,60	7,60	6,10
		35	8,07	9,50	7,60	6,00
Continuous temperature 70°C including 60 days per year with ➡	75°C	5	14,06	13,10	10,40	8,20
		10	13,32	12,80	10,20	8,10
		25	11,30	12,50	9,90	7,90
		45	9,83	12,30	9,80	7,80
	80°C	5	13,09	12,00	9,50	7,50
		10	12,44	11,70	9,30	7,40
		25	10,52	11,50	9,10	7,20
		40	9,31	11,30	9,00	7,10
	85°C	5	11,96	10,90	8,70	6,90
		10	11,33	10,40	8,30	6,60
		25	9,04	10,40	8,30	6,60
		35	8,32	10,30	8,20	6,50
	90°C	5	10,79	9,90	7,90	6,20
		10	9,66	9,70	7,70	6,10
		25	7,71	9,40	7,50	5,90
		30	7,39	9,40	7,40	5,90
Continuous temperature 70°C including 90 days per year with ➡	75°C	5	13,85	13,00	10,30	8,20
		10	13,40	12,70	10,10	8,00
		25	11,13	12,40	9,80	7,80
		45	9,65	12,20	9,70	7,70
	80°C	5	13,19	11,80	9,40	7,50
		10	12,32	11,60	9,20	7,30
		25	8,86	11,30	9,00	7,10
		37,5	8,94	11,20	8,90	7,00
	85°C	5	12,36	10,80	8,60	6,80
		10	10,52	10,60	8,40	6,60
		25	8,42	10,30	8,20	6,50
		32,5	7,90	10,20	8,10	6,40
	90°C	5	10,40	9,80	7,80	6,20
		10	8,79	9,60	7,60	6,00
		25	7,03	9,30	7,40	5,90

¹⁾ SDR = Standard Dimension Ratio = diameter / wall thickness

Allowed operating pressures

for warm and hot water pipelines made of PP-R and PP-RCT

			PP-R	PP-RCT		
Time-Temperature collective	Tempe- rature	Operating period (Years)	Allowed operating pressures • Nominal pressure			
			SDR 6 ¹⁾ (bar)	SDR 7,4 (bar)	SDR 9 (bar)	SDR11 (bar)
Continuous temperature 70°C including 120 days per year with ➔	75°C	5		12,90	10,20	8,10
		10		12,60	10,00	7,90
		25		12,30	9,70	7,70
		45		12,10	9,60	7,60
	80°C	5		11,70	9,30	7,40
		10		11,50	9,10	7,20
		25		11,20	8,90	7,10
		35		11,10	8,80	7,00
	85°C	5		10,70	8,50	6,70
		10		10,50	8,30	6,60
		25		10,20	8,10	6,40
		30		10,10	8,00	6,40
	90°C	5		9,70	7,70	6,10
		10		9,50	7,50	6,00
		25		9,20	7,30	5,80
	Continuous temperature 70°C including 150 days per year with ➔	75°C	5		12,80	10,10
10				12,50	10,00	7,90
25				12,20	9,70	7,70
40				12,10	9,60	7,60
80°C		5		11,70	9,30	7,30
		10		11,40	9,10	7,20
		25		11,20	8,90	7,00
		35		11,10	8,80	7,00
85°C		5		10,60	8,40	6,70
		10		10,40	8,20	6,50
		25		10,10	8,00	6,40
90°C		5		9,60	7,60	6,00
		10		9,40	7,50	5,90
		20		9,30	7,30	5,80

Allowed operating pressures

for warm and hot water pipelines made of PP-R and PP-RCT

			PP-R	PP-RCT		
Time-Temperature collective	Temperature	Operating period (Years)	Allowed operating pressures • Nominal pressure			
			SDR 6 ¹⁾ (bar)	SDR 7,4 (bar)	SDR 9 (bar)	SDR11 (bar)
Continuous temperature 70°C including 180 days per year with ➔	75°C	5		12,70	10,10	8,00
		10		12,50	9,90	7,90
		25		12,20	9,70	7,70
		45		12,00	9,50	7,60
	80°C	5		11,60	9,20	7,30
		10		11,40	9,00	7,20
		25		11,10	8,80	7,00
		30		11,00	8,80	6,90
	85°C	5		10,50	8,40	6,60
		10		10,30	8,20	6,50
		25		10,10	8,00	6,30
	90°C	5		9,60	7,60	6,00
		10		9,40	7,40	5,90
		18		9,20	7,30	5,80
Continuous temperature 70°C including 210 days per year with ➔	75°C	5		12,70	10,10	8,00
		10		12,40	9,90	7,80
		25		12,10	9,60	7,60
		40		12,00	9,50	7,50
	80°C	5		11,60	9,20	7,30
		10		11,30	9,00	7,10
		25		11,10	8,80	7,00
		30		11,00	8,70	6,90
	85°C	5		10,50	8,30	6,60
		10		10,30	8,20	6,50
		25		10,00	8,00	6,30
	90°C	5		9,50	7,60	6,00
		10		9,30	7,40	5,90
		15		9,20	7,30	5,80

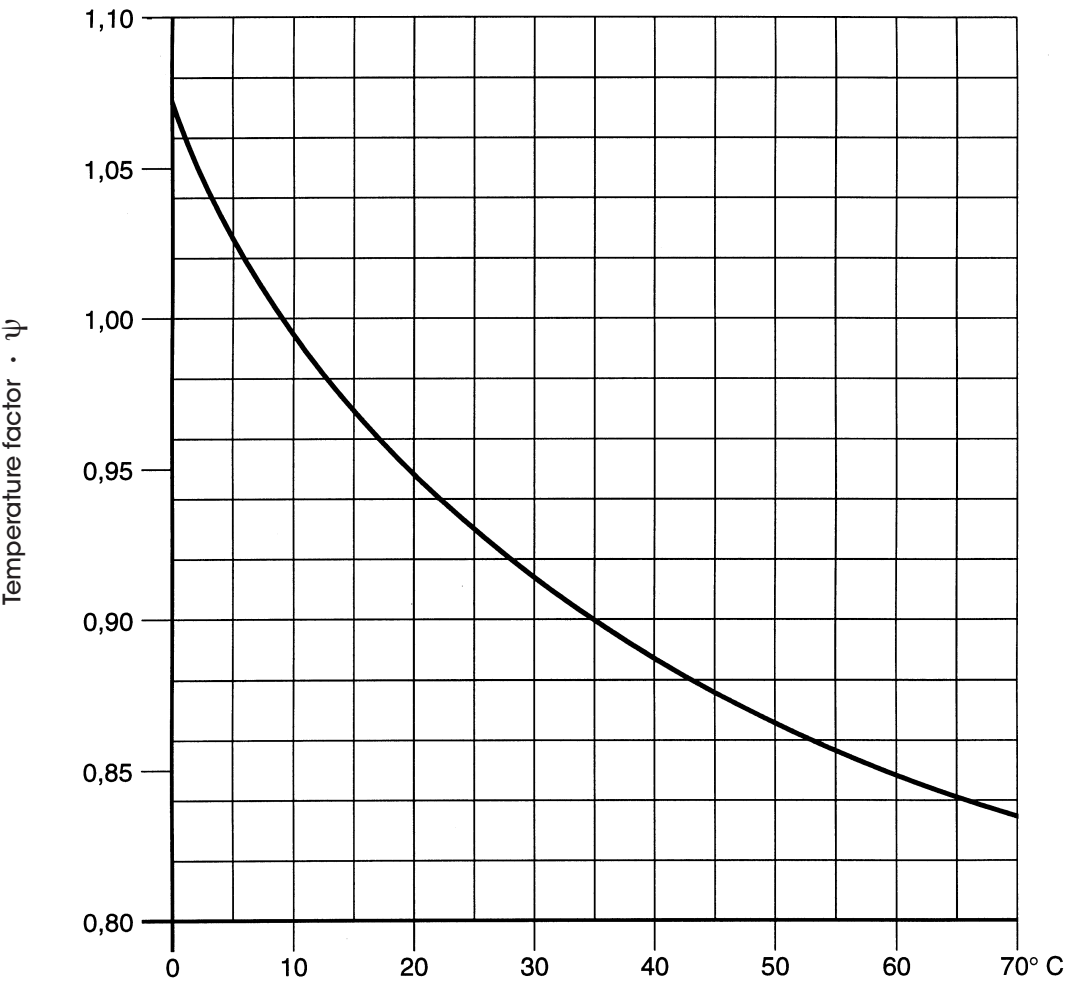


Fig. 2: Temperature of the flow medium

For the individual fitting resistance values given in the chart below (fig. 3) can be applied by approximation.
The individual joint resistance values can be determined altogether.
As a standard value add an extra of 3% to 5% to the overall pressure drop.

Outside pipe diameter d m m	16 20 25	32 40 63	50 63	≥63
Fitting Type	Drag coefficient ζ			
	1,5	1,0	0,6	0,5
	2,0	1,7	1,1	0,8
	0,3			
	1,5			
	0,5			
	1,0			

Fig. 3: Pressure drop in fittings

Reference values for the minimum flow pressures and calculated flows for generally used drinking water service points

Minimum flow pressure $P_{\min FI}$ bar	Type of drinking water service points		Calculated flow for outlet of		
			Mixed water		Either cold or hot water
			Volume flow cold l/s	Volume flow hot l/s	Volume flow l/s
0.5	outlet valve without air whirler DN 15 DN 20 DN 25 with air whirler DN 10 DN 15		-	-	0.30
0.5			-	-	0.50
0.5			-	-	1.00
1.0			-	-	0.15
1.0			-	-	0.15
1.0	shower heads for clinsing showers	DN 15	0.10	0.10	0.20
1.2	Pressure rinser in acc.to DIN 3265 part 1	DN 15	-	-	0.70
1.2	Pressure rinser in acc.to DIN 3265 part 1	DN 20	-	-	1.00
0.4	Pressure rinser in acc.to DIN 3265 part 1	DN 25	-	-	1.00
1.0	Pressure rinser for urinals	DN 15	-	-	0.30
0.5	corner valve for urinals	DN 15	-	-	0.30
1.0	household dishwasher	DN 15	-	-	0.15
1.0	household washing machine	DN 15	-	-	0.25
1.0	mixer for showers DN 15 bath tubs DN 15 kitchen sinks DN 15 wash-stands DN 15 bidet DN 15		0.15	0.15	-
1.0			0.15	0.15	-
1.0			0.07	0.07	-
1.0			0.07	0.07	-
1.0			0.07	0.07	-
1.0	mixer	DN 20	0.30	0.30	-
0.5	flushing box acc.to DIN 19542	DN 15	-	-	0.13
1.0	heater for drinking water for supply of service point (incl. fitting for mixed outlet) electric water boiler DN 15 electric hot water tank and boiler with nominal contents 5 – 15 l DN 15 with nominal contents 30 – 150 l DN 15		-	-	0.10*
1.1**			-	-	0.10
1.2**			-	-	0.20
1.5	electric flow water heater with hydraulic test, without flow limitation nominal capacity 12 kW 18 kW 21 kW 24 kW		-	-	0.06
1.9			-	-	0.08
2.1			-	-	0.09
2.4			-	-	0.10
1.0	gas flow water heater	12 kW	-	-	0.10

* with fully opened throttle valve – ** values under unfavourable conditions (shower)

Note: Service points which are not included in the table and devices of similar kind with larger flow of fittings than indicated are to be taken into account according to the recommendations of the producer as far as determination of pipe diameter is concerned

Thermoplastic plastics PP-R pipes are exposed to thermal expansion. The linear extension of such pipes is higher than with steel pipes. This fact must be all means be taken into consideration in the laying process. Already in the pipe arrangement planning stage each possibility should therefore be utilized fully to compensate all extension processes within a pipe section.

The linear thermal expansion coefficient for PP-R and PP-RCT pipes is:

$$\alpha = 0,15 \frac{\text{mm}}{\text{mK}}$$

Polypropylene pipes mechanically stabilized by an aluminium coating on the pipe periphery (Stabi-Rohr/Stabi-Pipe) have a reduced thermal expansion coefficient. The aluminium coating prevents linear extension at about 4/5.

The linear thermal expansion coefficient for PP-R Stabi-Pipes can by approximation assumed as:

$$\alpha = 0,03 \frac{\text{mm}}{\text{mK}}$$

The linear thermal expansion coefficient for PP-RCT Fibre-Pipes is:

$$\alpha = 0,035 \frac{\text{mm}}{\text{mK}}$$

Δl = Linear extension in (mm)
 α = Thermal expansion coefficient in $\left(\frac{\text{mm}}{\text{m K}}\right)$
 L = Pipe length (m)
 Δt = Temperature difference (K)

The linear deformation of a pipe is thus calculated according to the following formula:

$$\Delta l = \alpha \cdot L \cdot \Delta t \quad (\text{mm})$$

The calculation of the linear deformation is based on the laying temperature. The following example gives you an idea of how to calculate.

Example for a pipe length of 8m:

1. Lowest pipe wall temperature $+ 9^{\circ}\text{C}$ (cold-water pipe)

Difference 7 K

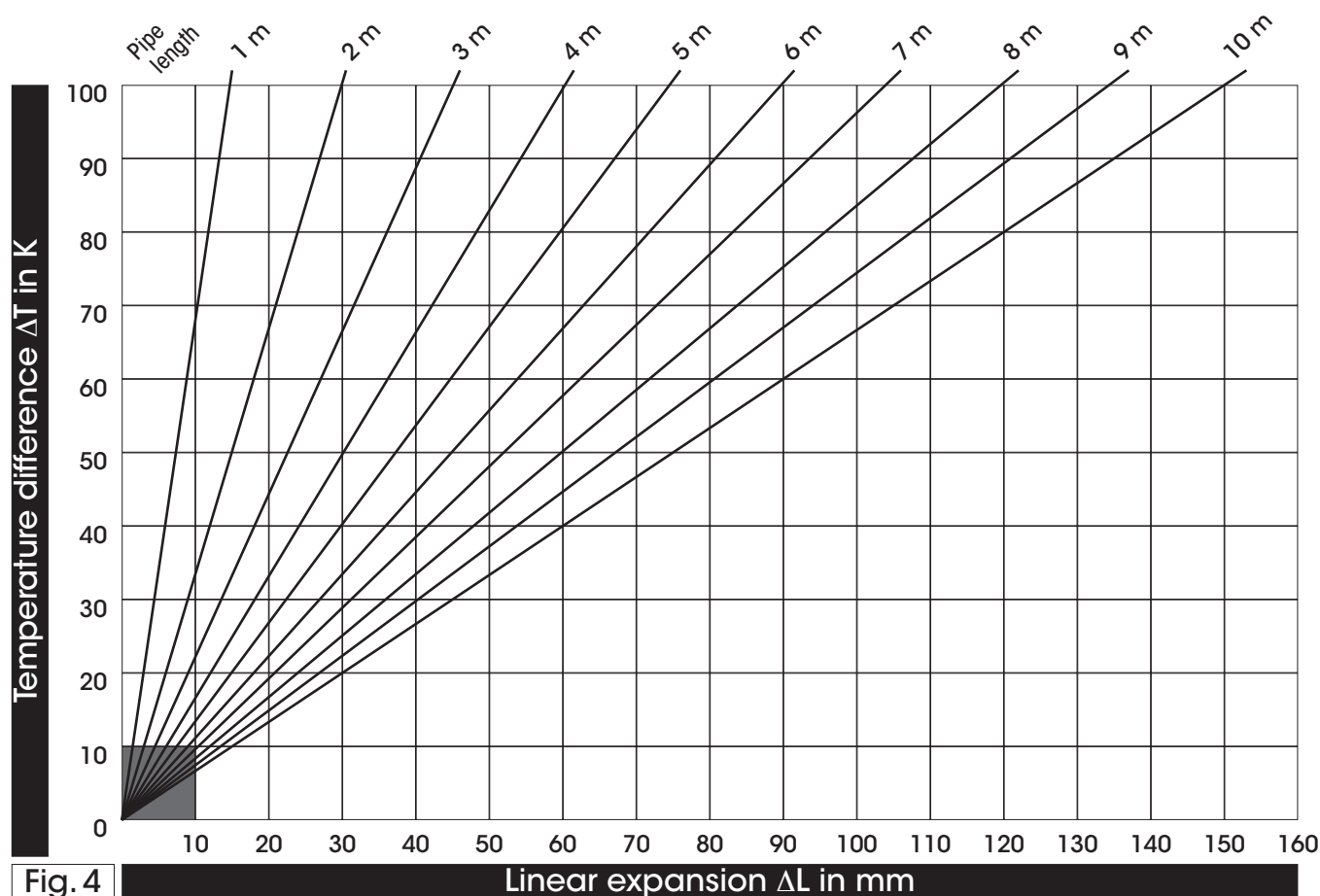
2. Laying temperature $+ 16^{\circ}\text{C}$

Difference 54 K

3. Highest pipe wall temperature $+ 70^{\circ}\text{C}$ (hot-water pipe)

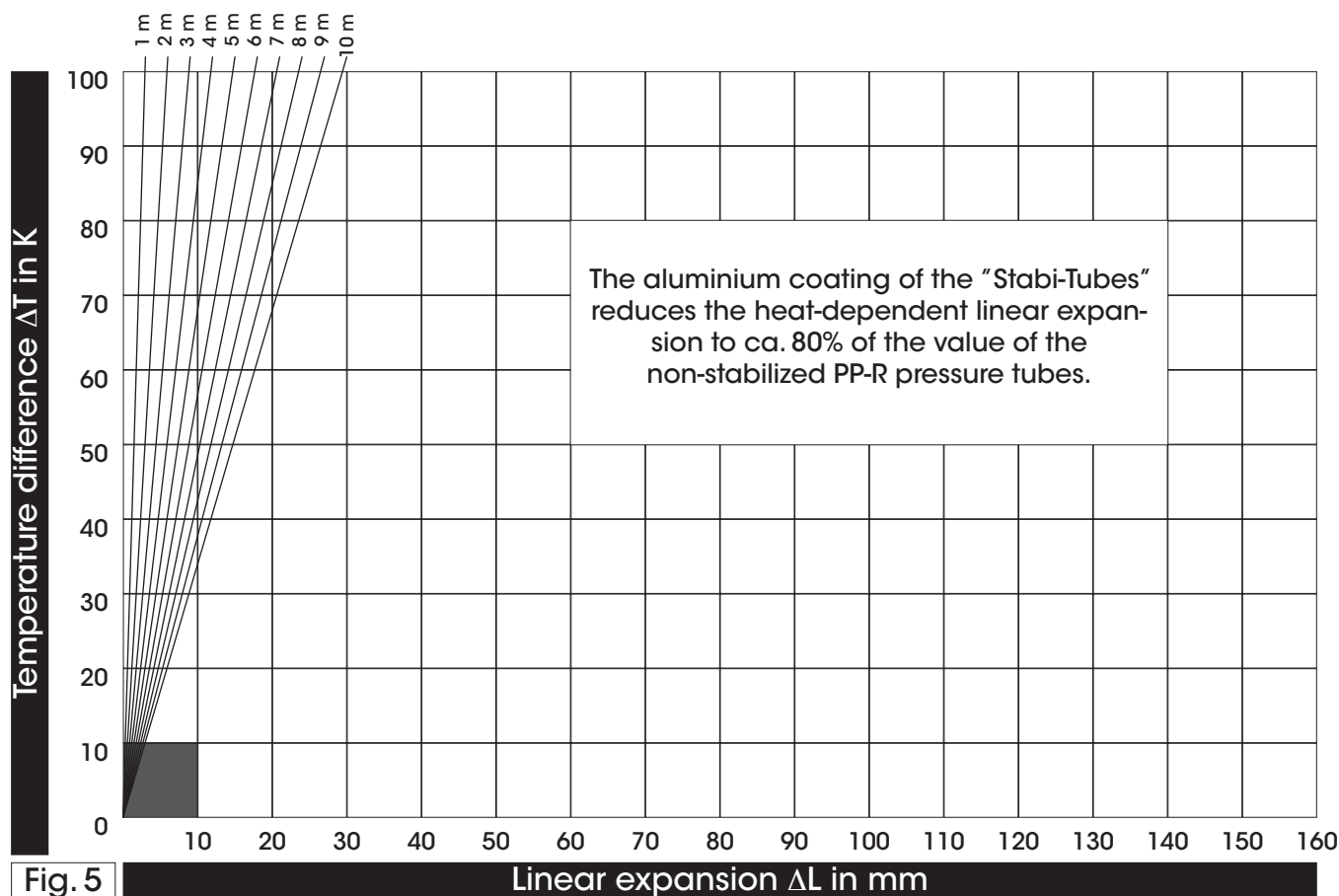
To 1. Shortening of the pipe: $8 \text{ m} \cdot 7 \cdot 0,03 = 1,68 \text{ mm}$

To 3. Extension of the pipe: $8 \text{ m} \cdot 54 \cdot 0,03 = 12,96 \text{ mm}$



Pipe length	Temperature difference ΔT in K									
	10	20	30	40	50	60	70	80	90	100
0,1 m	0,15	0,30	0,45	0,60	0,75	0,90	1,05	1,20	1,35	1,50
0,2 m	0,30	0,60	0,90	1,20	1,50	1,80	2,10	2,40	2,70	3,00
0,3 m	0,45	0,90	1,35	1,80	2,25	2,70	3,15	3,60	4,05	4,50
0,4 m	0,60	1,20	1,80	2,40	3,00	3,60	4,20	4,80	5,40	6,00
0,5 m	0,75	1,50	2,25	3,00	3,75	4,50	5,25	6,00	6,75	7,50
0,6 m	0,90	1,80	2,70	3,60	4,50	5,40	6,30	7,20	8,10	9,00
0,7 m	1,05	2,10	3,15	4,20	5,25	6,30	7,35	8,40	9,45	10,50
0,8 m	1,20	2,40	3,60	4,80	6,00	7,20	8,40	9,60	10,80	12,00
0,9 m	1,35	2,70	4,05	5,40	6,75	8,10	9,45	10,80	12,15	13,50
1,0 m	1,50	3,00	4,50	6,00	7,50	9,00	10,50	12,00	13,50	15,00
2,0 m	3,00	6,00	9,00	12,00	15,00	18,00	21,00	24,00	27,00	30,00
3,0 m	4,50	9,00	13,50	18,00	22,50	27,00	31,50	36,00	40,50	45,00
4,0 m	6,00	12,00	18,00	24,00	30,00	36,00	42,00	48,00	54,00	60,00
5,0 m	7,50	15,00	22,50	30,00	37,50	45,00	52,50	60,00	67,50	75,00
6,0 m	9,00	18,00	27,00	36,00	45,00	54,00	63,00	72,00	81,00	90,00
7,0 m	10,50	21,00	31,50	42,00	52,50	63,00	73,50	84,00	94,50	105,00
8,0 m	12,00	24,00	36,00	48,00	60,00	72,00	84,00	96,00	108,00	120,00
9,0 m	13,50	27,00	40,50	54,00	67,50	81,00	94,50	108,00	121,50	135,00
10,0 m	15,00	30,00	45,00	60,00	75,00	90,00	105,00	120,00	135,00	150,00

Fig. 4a Linear expansion ΔL in mm



Pipe length	Temperature difference ΔT in K									
	10	20	30	40	50	60	70	80	90	100
0,1 m	0,03	0,06	0,09	0,12	0,15	0,18	0,21	0,24	0,27	0,30
0,2 m	0,06	0,12	0,18	0,24	0,30	0,36	0,42	0,48	0,54	0,60
0,3 m	0,09	0,18	0,27	0,36	0,45	0,54	0,63	0,72	0,81	0,90
0,4 m	0,12	0,24	0,36	0,48	0,60	0,72	0,84	0,96	1,08	1,20
0,5 m	0,15	0,30	0,45	0,60	0,75	0,90	1,05	1,20	1,35	1,50
0,6 m	0,18	0,36	0,54	0,72	0,90	1,08	1,28	1,44	1,62	1,80
0,7 m	0,21	0,42	0,63	0,84	1,05	1,26	1,47	1,68	1,89	2,10
0,8 m	0,24	0,48	0,72	0,96	1,20	1,44	1,68	1,92	2,16	2,40
0,9 m	0,27	0,54	0,81	1,08	1,35	1,62	1,89	2,16	2,43	2,70
1,0 m	0,30	0,60	0,90	1,20	1,50	1,80	2,10	2,40	2,70	3,00
2,0 m	0,60	1,20	1,80	2,40	3,00	3,60	4,20	4,80	5,40	6,00
3,0 m	0,90	1,80	2,70	3,60	4,50	5,40	6,30	7,20	8,10	9,00
4,0 m	1,20	2,40	3,60	4,80	6,00	7,20	8,40	9,60	10,80	12,00
5,0 m	1,50	3,00	4,50	6,00	7,50	9,00	10,50	12,00	13,50	15,00
6,0 m	1,80	3,60	5,40	7,20	9,00	10,80	12,80	14,40	16,20	18,00
7,0 m	2,10	4,20	6,43	8,40	10,50	12,60	14,70	16,80	18,90	21,00
8,0 m	2,40	4,80	7,20	9,60	12,00	14,40	16,80	19,20	21,60	24,00
9,0 m	2,70	5,40	8,10	10,80	13,50	16,20	18,90	21,60	24,30	27,00
10,0 m	3,00	6,00	9,00	12,00	15,00	18,00	21,00	24,00	27,00	30,00

Fig. 5a Linear expansion ΔL in mm

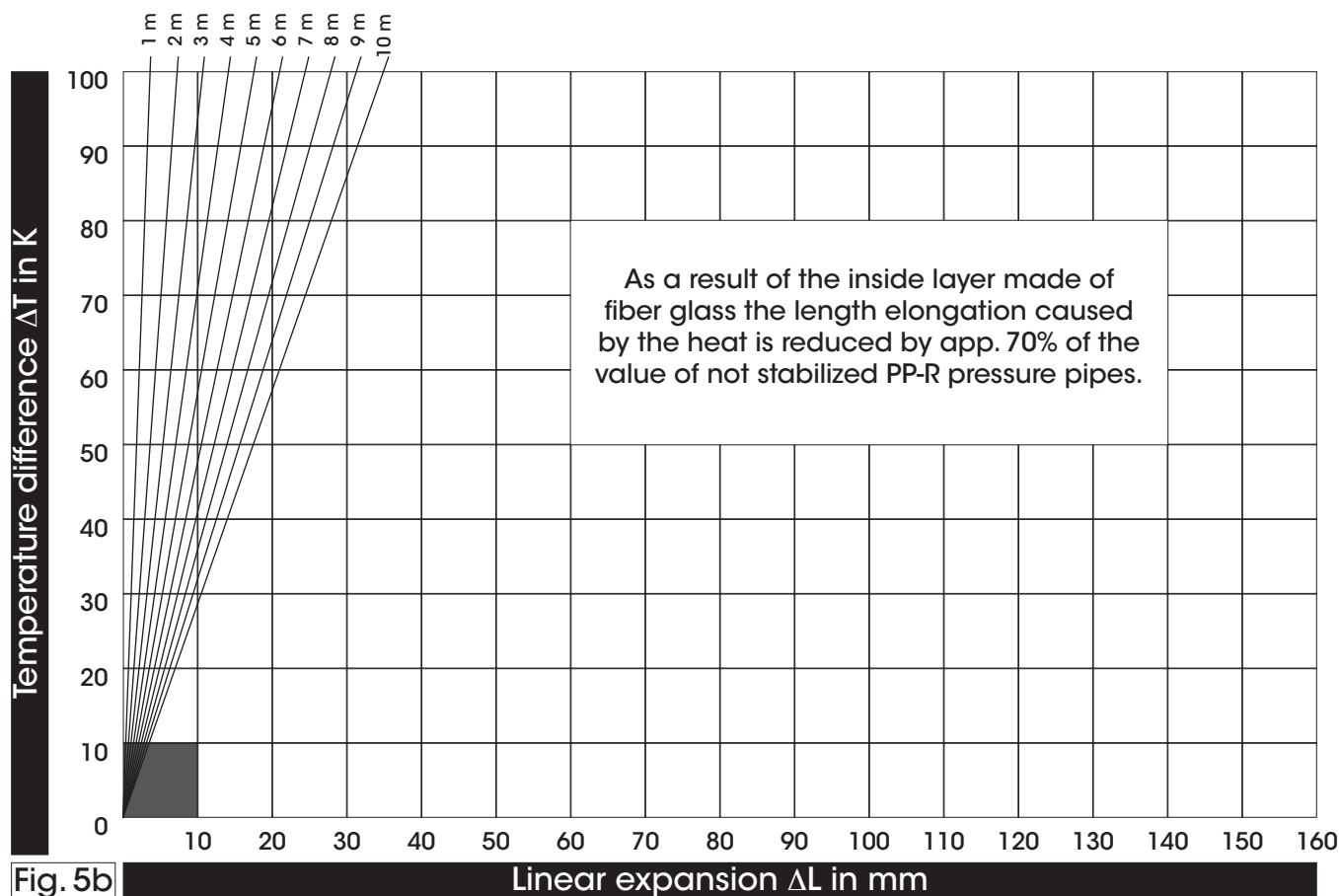


Fig. 5b

Linear expansion ΔL in mm

Pipe length	Temperature difference ΔT in K									
	10	20	30	40	50	60	70	80	90	100
0,1 m	0,04	0,07	0,11	0,14	0,18	0,21	0,25	0,28	0,32	0,35
0,2 m	0,07	0,14	0,21	0,28	0,35	0,42	0,49	0,56	0,63	0,70
0,3 m	0,11	0,21	0,32	0,42	0,53	0,63	0,74	0,84	0,95	1,05
0,4 m	0,14	0,28	0,42	0,56	0,70	0,84	0,98	1,12	1,26	1,40
0,5 m	0,18	0,35	0,53	0,70	0,88	1,05	1,23	1,40	1,58	1,75
0,6 m	0,21	0,42	0,63	0,84	1,05	1,26	1,47	1,68	1,89	2,10
0,7 m	0,25	0,49	0,74	0,98	1,23	1,47	1,72	1,96	2,21	2,45
0,8 m	0,28	0,56	0,84	1,12	1,40	1,68	1,96	2,24	2,52	2,80
0,9 m	0,32	0,63	0,95	1,26	1,58	1,89	2,21	2,52	2,84	3,15
1,0 m	0,35	0,70	1,05	1,40	1,75	2,10	2,45	2,80	3,15	3,50
2,0 m	0,70	1,40	2,10	2,80	3,50	4,20	4,90	5,60	6,30	7,00
3,0 m	1,05	2,10	3,15	4,20	5,25	6,30	7,35	8,40	9,45	10,50
4,0 m	1,40	2,80	4,20	5,60	7,00	8,40	9,80	11,20	12,60	14,00
5,0 m	1,75	3,50	5,25	7,00	8,75	10,50	12,25	14,00	15,75	17,50
6,0 m	2,10	4,20	6,30	8,40	10,50	12,60	14,70	16,80	18,90	21,00
7,0 m	2,45	4,90	7,35	9,80	12,25	14,70	17,15	19,60	22,05	24,50
8,0 m	2,80	5,60	8,40	11,20	14,00	16,80	19,60	22,40	25,20	28,00
9,0 m	3,15	6,30	9,45	12,60	15,75	18,90	22,05	25,20	28,35	31,50
10,0 m	3,50	7,00	10,50	14,00	17,50	21,00	24,50	28,00	31,50	35,00

Fig. 5c

Linear expansion ΔL in mm

Mostly the linear extension of a PP-R / PP-RCT pipe line can be compensated by changing the direction. Attention has to be paid to the fact that the pipeline can easily move in axial direction. In case linear extension compensation of a changed direction is not possible installation of an expansion bend is necessary. An axial compensation is mostly not suitable and uneconomical.

For spring deflexion of a pipeline the size of the bending limb has to be considered which is calculated with the adjoining formula.

Figures 6 and 7 show the mode of action of a change of length and its compensation. The correct choice of the fixed points with regard to the necessary bending limbs L_s has to be considered.

$$L_s = C \cdot \sqrt{d \cdot \Delta L} \quad (\text{mm})$$

L_s = Length of bending limb (mm)

d = Outside pipe diameter (mm)

ΔL = Linear deformation (mm)

C = Material-dependent constant for PP-R = 15

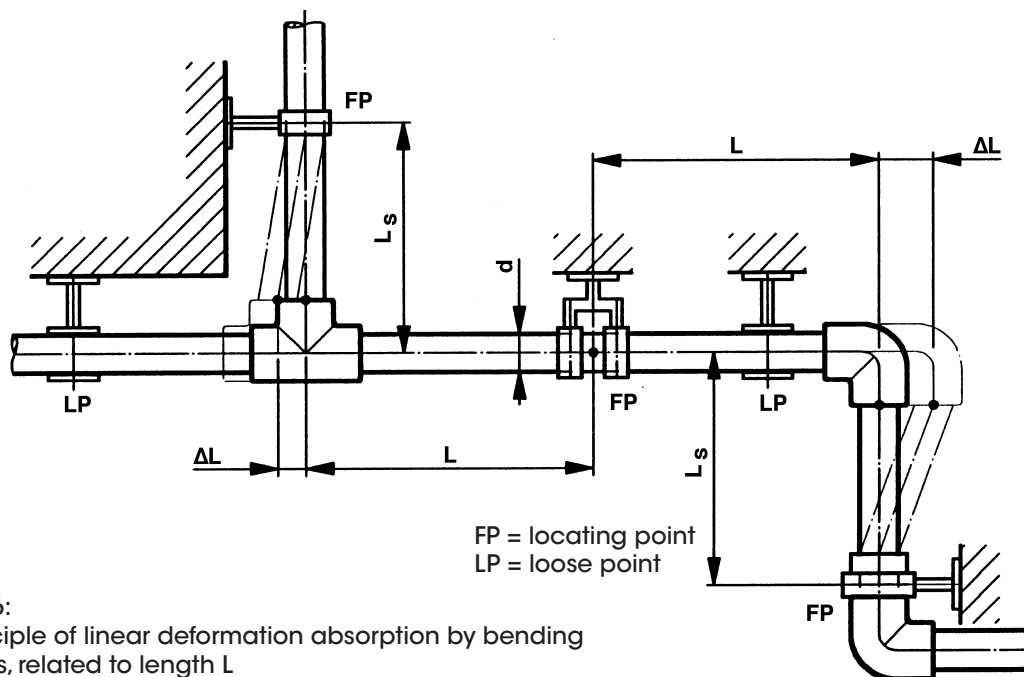


Fig. 6:
Principle of linear deformation absorption by bending limbs, related to length L

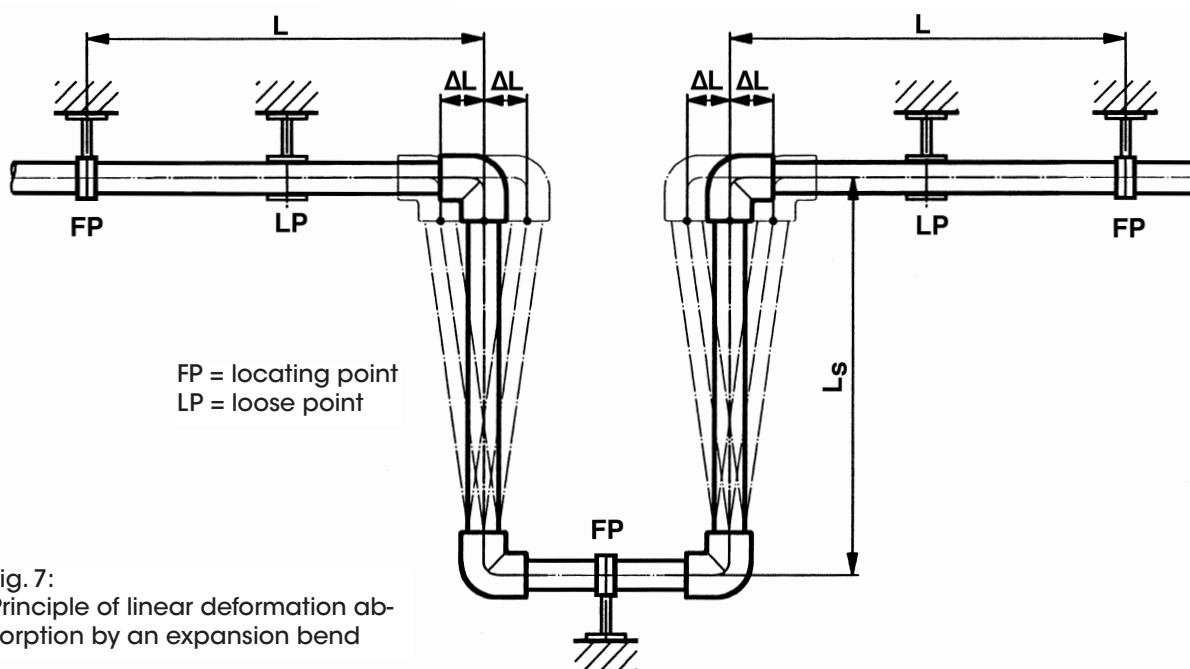


Fig. 7:
Principle of linear deformation absorption by an expansion bend

Expansion bends can easily be made right at the site. Beside the required pipe length 4 elbows (8090) or 4 pipe bends (8002a) are needed. To construct an expansion bend, the bending limb L_s is calculated in dependence on the linear deformation ΔL . As standard value, the L_s value given in the Fig. 8 diagram can be used. Spacing B_{min} should be at least 210 mm..

Fig. 7a:
Expansion bend, made of PP-R pipe and 90° elbow

- d = Outer diameter of pipe
- L = Length of pipe
- ΔL = Linear elongation of pipe (longitudinal)
- L_s = Length of bending shank
- B_{min} = Width of bending shank
- BS = Safety distance (min. 150 mm)

Calculation of expansion bend:

$$B_{min} = 2 \times \Delta L + BS$$

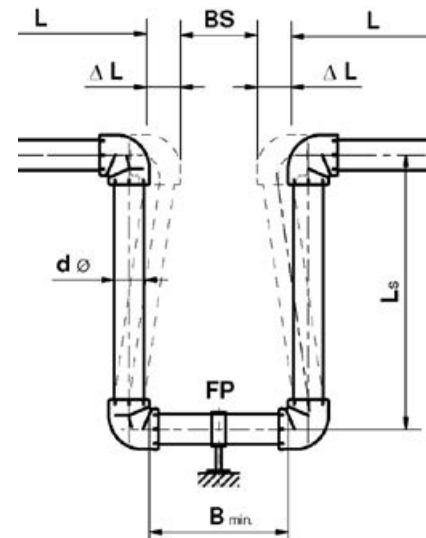
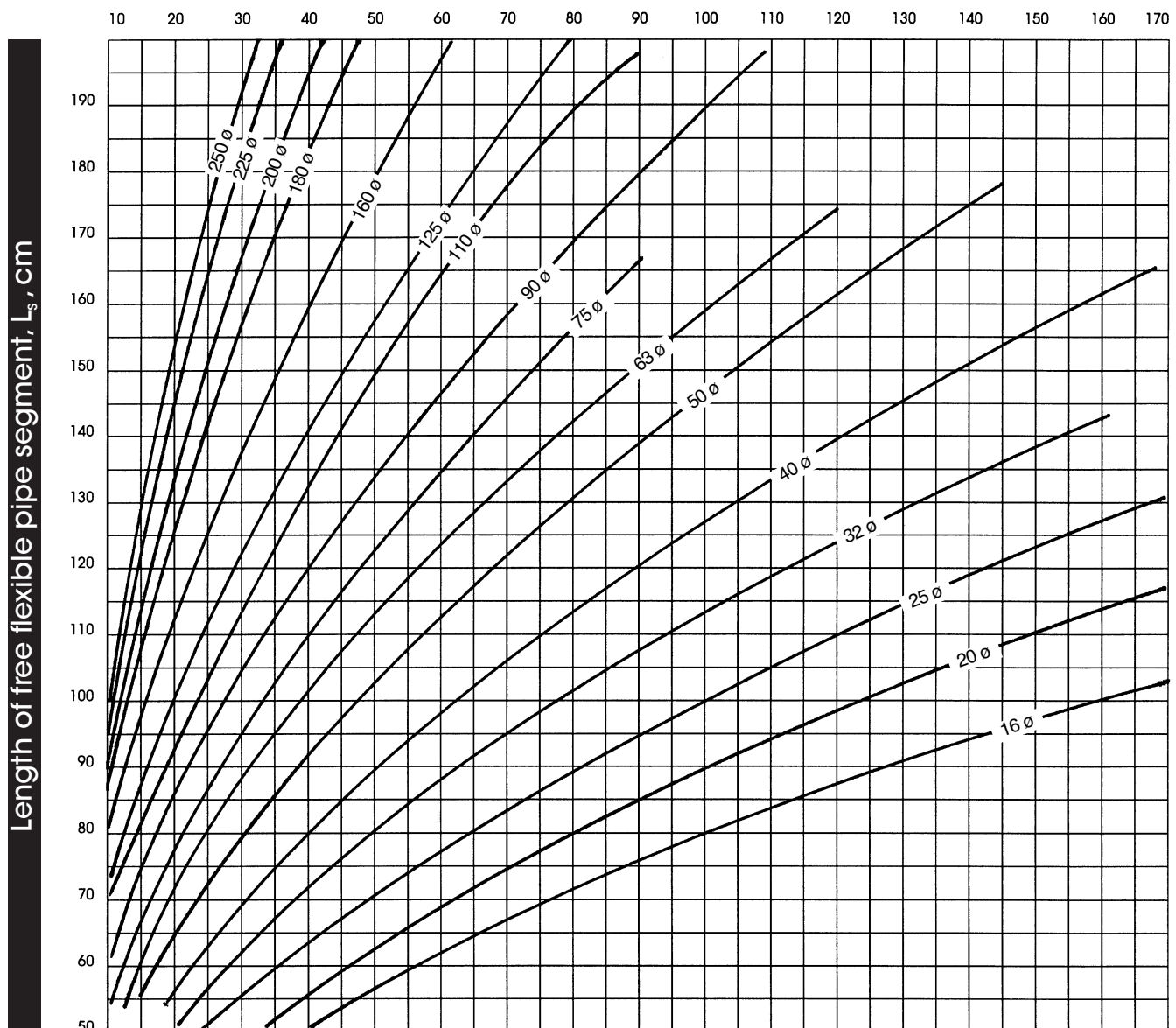


Fig. 8

Linear expansion ΔL , in mm



Example for in-wall piping

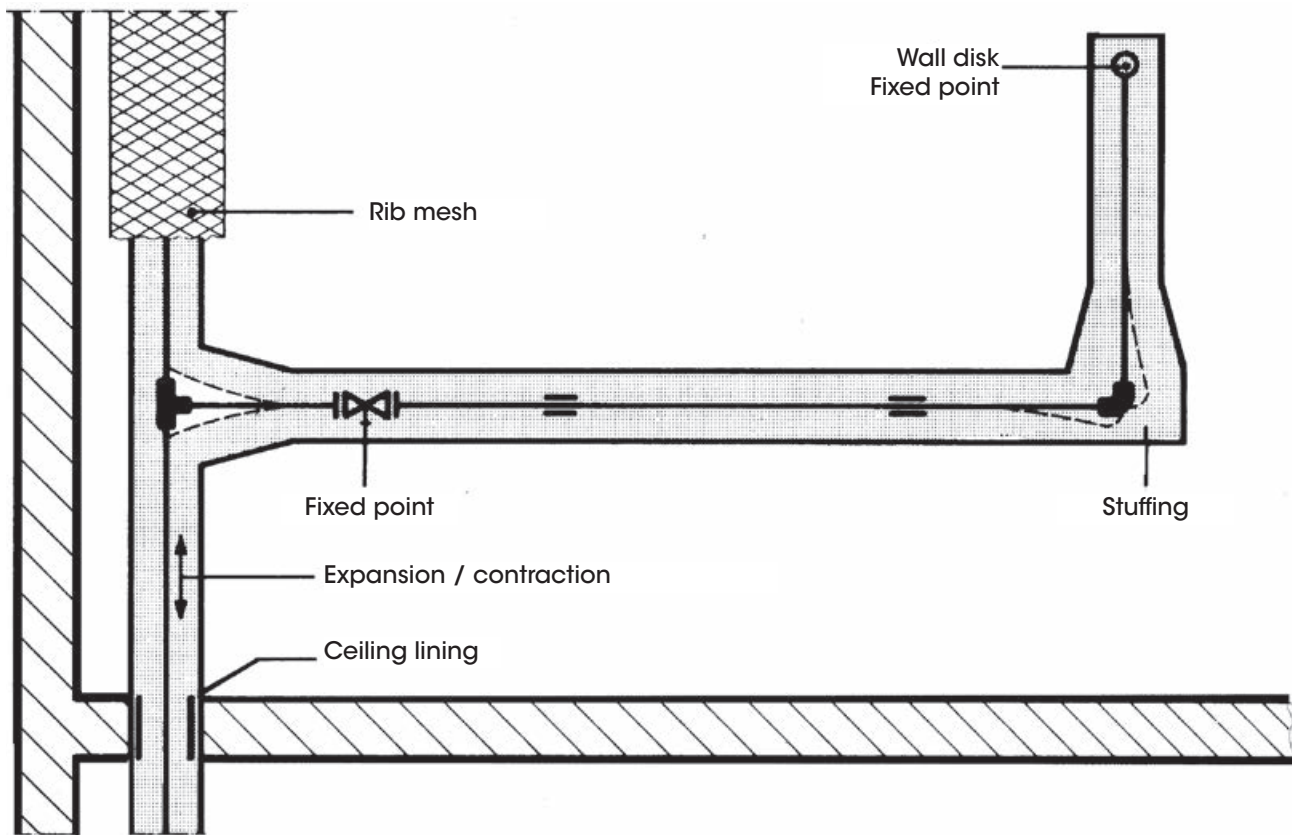


Fig. 9

Installation in Sanitary Installation Shaft:

Risers in pipe shafts have to be installed in such a way that the diverting pipeline can adjust the longitudinal expansion of the risers.

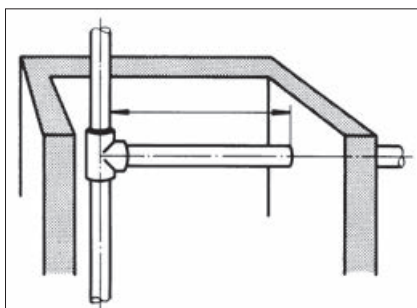


Fig. 1
Best positioning in the pipe shaft.

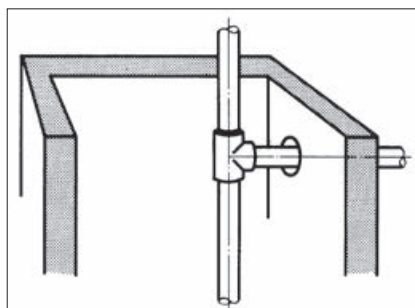


Fig. 2
Sufficient dimensioning of the casing pipe for the diverting pipeline.

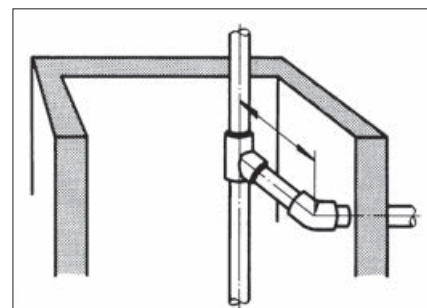


Fig. 3
Installation of a spring leg.

The kind and number of pipe fixings depends among other things on the pipe size and linear expansion. Locating points shall divide the pipes into individual pipe sections allowing expansion or contraction. The guidance of such sections is made with loose clips. The clip distances or spans depend on operation conditions, pipe material, and weight of the filled pipe. In practical use the spans given in figures 10, 10a, 11, 11a and 11b proved to be appropriate.

d	Spans L at cm bei T°C						
mm	20°C	30°C	40°C	50°C	60°C	70°C	80°C
16	62	59	55	53	50	48	46
20	73	68	64	61	58	56	54
25	84	79	74	71	67	65	62
32	98	92	87	83	79	76	73
40	111	106	100	96	91	88	84
50	124	118	113	109	105	101	97
63	139	133	127	123	118	115	111
75	152	145	138	134	129	126	121
90	166	159	152	147	141	138	133
110	184	176	168	162	156	152	147
125	208	198	189	183	176	172	166

Fig. 10: Spans for **PP-R** and **PP-RCT** pipes, nos. G 8200B, G 8200

d	Spans L at cm bei T°C				
Ø	20°C	30°C	40°C	50°C	60°C
20	64	60	57	54	51
25	73	69	65	62	59
32	86	81	76	73	69
40	100	94	88	84	80
50	113	108	101	97	92
63	127	121	115	111	107
75	138	132	125	121	117
90	151	144	137	133	128
110	167	159	152	147	142
125	188	180	171	166	160
140	208	199	190	184	177
160	223	213	203	197	189
200	249	238	227	220	212
250	279	266	254	246	237
280	295	282	269	260	251
315	313	299	285	276	266
355	332	317	302	293	282
400	353	337	321	311	300
450	374	357	341	330	318
500	394	377	359	348	335

Fig. 10a: Spans for **PP-RCT**, no. G 8160B

d	Spans L at cm bei T°C						
Ø	20°C	30°C	40°C	50°C	60°C	70°C	80°C
16	60	56	53	51	48	47	44
20	70	66	62	59	56	54	52
25	77	72	68	65	62	60	57
32	90	85	80	76	73	70	67
40	104	98	92	88	84	81	77
50	117	111	106	102	97	94	89
63	131	125	119	116	111	109	104
75	143	137	130	126	121	118	114
90	157	150	143	138	133	130	125
110	173	165	158	153	147	143	138
125	195	187	178	172	166	162	156

Fig. 11: Spans for **PP-RCT Stabi-Pipes**, no. G 8215B

d	Spans L at cm bei T°C						
Ø	20°C	30°C	40°C	50°C	60°C	70°C	80°C
20	70	66	62	59	56	54	52
25	81	76	71	68	65	63	60
32	90	85	80	76	73	70	67
40	104	98	92	88	84	81	77
50	117	111	106	102	97	94	89
63	131	125	119	116	111	109	104
75	143	137	130	126	121	118	114
90	157	150	143	138	133	130	125
110	173	165	158	153	147	143	138
125	195	187	178	172	166	162	156
160	223	213	203	197	189	185	178
200	249	238	227	220	213	206	199
250	279	266	254	246	237	231	223
315	313	299	285	276	266	259	250
355	332	317	302	293	282	275	265
400	353	337	321	311	300	292	282
450	374	357	341	330	318	310	299
500	394	377	359	348	335	327	315

Fig. 11a: Spans for **PP-RCT Fibre pipes Watertec**, no. G 8200FW

d	Spans L at cm bei T°C						
Ø	20°C	30°C	40°C	50°C	60°C	70°C	80°C
20	70	66	62	59	56	54	52
25	81	76	71	68	65	63	60
32	90	85	80	76	73	70	67
40	100	94	88	84	80	77	74
50	113	108	101	97	92	89	85
63	127	121	115	111	107	104	99
75	138	132	125	121	117	114	110
90	151	144	137	133	128	125	121
110	167	159	152	147	142	138	133
125	188	180	171	166	160	156	150
160	205	196	187	181	172	166	159
200	229	219	209	202	195	190	182
250	256	245	233	226	217	212	205
315	288	275	262	254	244	238	230
355	306	292	278	270	260	253	244
400	324	310	295	286	275	268	259
450	344	329	313	303	292	285	275
500	363	346	330	320	308	300	290

Fig. 11b: Spans for **PP-RCT Fibre pipes Climatec**, no. G 8160FC

Piping system pipes often require pipes to be bypassed. Cross over connections (Fig. 12) are highly suitable. Similar to manufacturing expansion bends of Bänninger parts cross over bends can easily be made with 2 elbows 45° (8040) male and female and 1 bend (8002a).

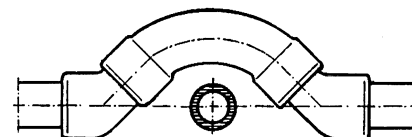


Fig. 12: Cross over connection

For connecting sanitary armatures, shut-off devices or for plastic-metal transition pieces our programme offers the required transition fittings.

The threads are according to DIN EN 10226 Part 1 and ISO 7: cylindrical female thread and conical male thread. All screw connections, threaded pipe sockets or nipples are designed for easy installation with standard wrenches.

Do not use pipe wrenches for threaded plastic parts to imperatively avoid any damage. Also a possible deformation of the parts by using a pipe wrench must be excluded.

The installation of pipes for cold and hot water supply must be done in accordance with the norms of DIN1988.

For ceiling installation the use of galvanized or coated metal shells (Fig. 13) is recommended if necessary. In such case the fixing distances are to be extended accordingly.



Fig. 13: Pipe in shell

Equipotential Bonding

Acrylic bath and shower tubs, also with metal water supply and discharge equipment, do not require any earthing when BÄNNINGER PP-R pipework is used since neither PP-R nor the tubs are conductive. When using metal tubs, an equipotential bonding must be created. For further information see DIN VDE 0100, part 701.

Welding Procedure

The **Bänninger** PP-R/PP-RCT pipe-work is coupled by socket fusion welding. The pipes and fittings are connected longitudinally overlapping. The heating of pipe ends and sockets is done by a heating element with fitted bushes. After the necessary welding temperature is reached the joining process is done. The pipe and socket diameter as well as the respective heated bush diameters are matched to build up the necessary pressure during the joining process.

The heating element is electrically heated. It has to comply with DVS Directive 2208 part 1 in construction and accuracy.

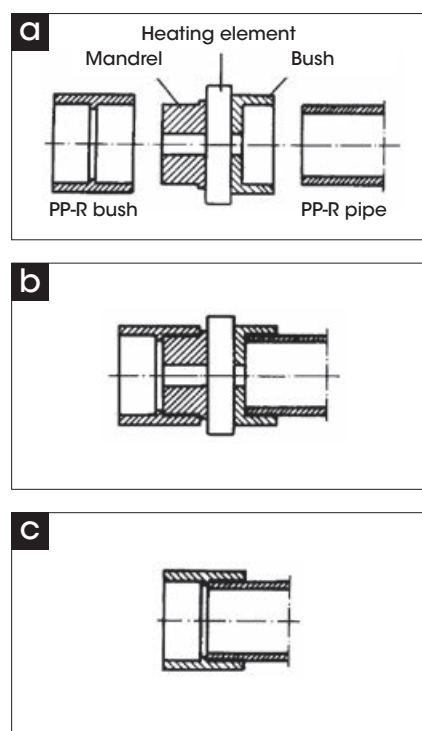
Note on the welding process:
The heating elements (mandrel and bush) must correspond to DVS 2208 part 1, par. 5, table 2, type A (excluding mechanical processing of pipe).

Figures a, b and c schematically show the 3 welding process stages:

a = Welding preparation

b = Warming up

c = Welded joint



Preparations

Cut pipes square into sections. Thoroughly clean both joint faces, the pipe end and socket with spirit and absorbent paper. Mark socket depth on the pipe. Bring the heating element to 260° C. Check the set temperature before the welding process. Temperature tolerance $\pm 10^\circ \text{C}$. The heating element should have an integrated thermometer, otherwise the temperature of the heating element must be controlled by an appropriate measuring device.

Do not start heating the joint parts before the heating temperature has reached 260° C. The mandrel and bush must be clean and have to be cleaned before each following welding process.

1	2	3	4
Pipe outside diameter mm	Heating phase s	Switch s	Cooling min
16	5		
20	5	4	2
25	7		
32	8		
40	12	6	4
50	18		
63	24	8	6
75	30		
90	40	10	8
110	50		
125	60		

Fig. 14
Standard values for socket fusion welding at a room temperature of 20° C. At a room temperature below +5° C the heating phases should be increased by up to 100%.

Welding

Push the pipe and fitting quickly and axially up to the stop of the mandrel and the marked insertion depth respectively and hold them fast without torsion. The heating of the joint faces is done according to the table in fig. 14.

After the end of the heating period pull the pipe and fitting abruptly off the heating element and join them immediately axially aligned and without torsion.

In considering the correct insertion depth (fig. 15). The pipe must be pushed in up to marked insertion depth respectively up to the socket bottom. We recommend to fix the two joint parts again for a certain time (approximately the heating period).

The welded joint must not be stressed mechanically before end of the cooling time.

Pipe Ø d (mm)	Bush depth=Insertion depth (mm)
16	13,0
20	14,5
25	16,0
32	18,0
40	20,5
50	23,5
63	27,5
75	30,0
90	33,0
110	37,0
125	40,0

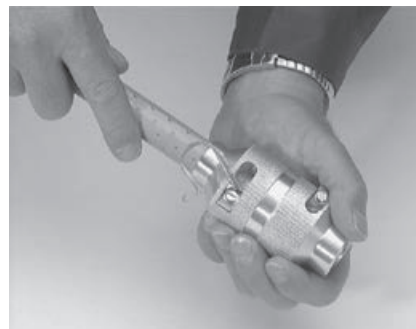
Fig. 15:
Bush depths for PP-R and PP-RCT fittings



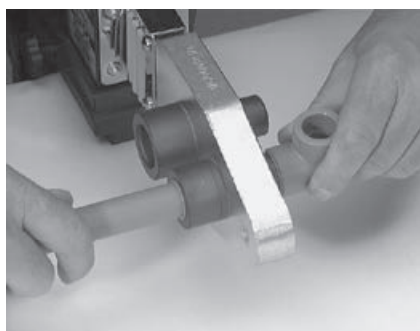
1. Pipes are measured and cut to the required length. Cutting should be rectangular to the pipe axis (90°).



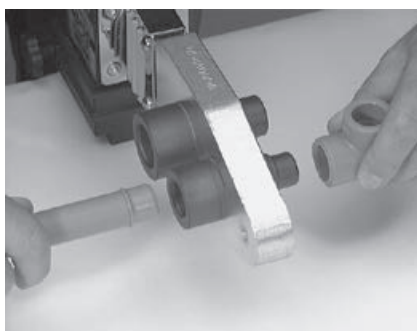
2. Clean the joint area with cleaner. Mark the insert depth of the fitting on the pipe.



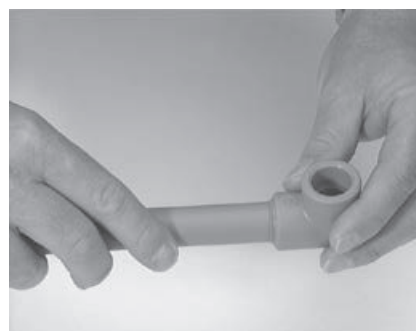
3. When using **Banninger Stabi-Pipes**, the aluminum coating has to be peeled off before welding them. The length of the peeled zone is determined by the peeling device.



4. Pipe and fitting have to be heated simultaneously. Push in parts to be joined axially.



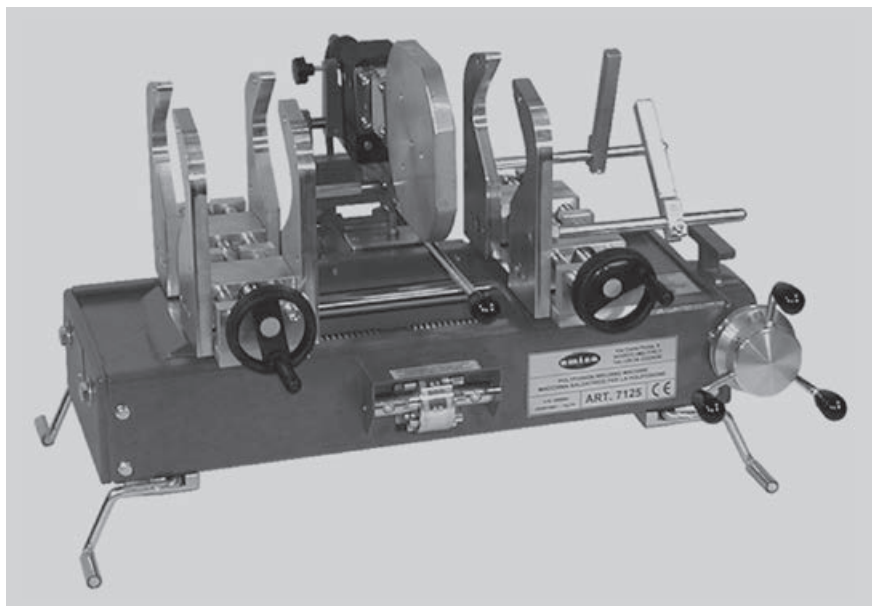
5. At the end of heating period fitting and pipe end from the heating elements have to be pulled off fully and simultaneously.



6. Adapt and join pipe and fitting within the max. allowed period without turning the parts against each other.

Immediately after the cooling time the fused joints can fully work under pressure. The fusion of the joint parts results in a unique longitudinally force-locked joint.

The welding machine No. 8988 is suitable for socket welding of pipes and / or fittings made of PP-R/PP-RCT
d = 125 mm



The socket welding machine No. 8988 consists of:

- Basic unit with movable slides
- Heating element
- Prism clamping jaws
- Socket and mandrels from d = 50 mm to d = 125 mm according to DVS 2208
- Tripod for pipe support
- Metal transport case

Setting of welding machine:

Put the heat reflector into the holder. Mount the appropriate welding tools (socket and mandrel), install the clamping jaws. Switch-on the device and the energy control lamp turns on. The temperature control lamp extinguishes after reaching the operating temperature (260°).



Fig. 1
Set the heat reflector in the holder



Fig. 2
Place the socket and the mandrel on the heat reflector



Fig. 3
Mount the prism clamping jaws

This is how the push-in depth will be precisely determined:

Select the relevant fitting/pipe diameter on the measuring drum which is situated in the middle of the machine base. Adjust the position of the slides; arrows in the middle of the machine base must stand one over the other, also on the hand wheel. Place the fitting into the clamping jaw and seize it with the hand wheel. Lock and seize the stop. Place the pipe axially forwards the fitting into the chunk jaw and position in such a way that it is situated frontally at the fitting. Seize the pipe with the hand wheel.

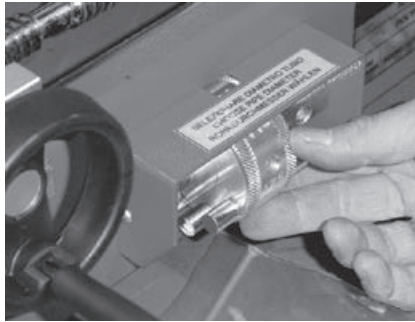


Fig. 4
Select the pipe / fitting diameter

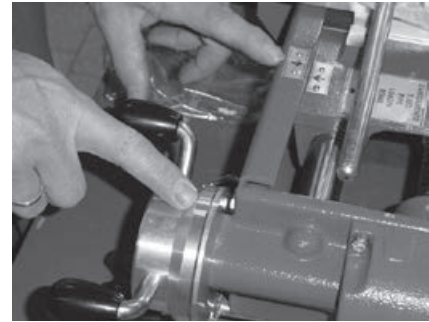


Fig. 5
Adjust the position of the slides



Fig. 6
Place and adjust the fitting in the clamping jaw



Fig. 7
Adjust the stop to hold the fittings

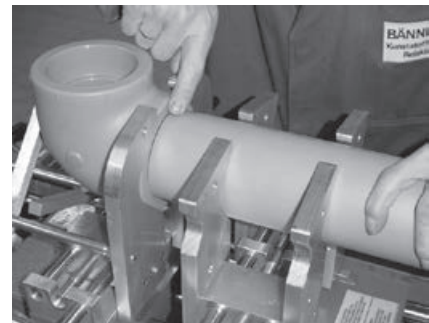


Fig. 8
Lay the pipe axially into the fitting and place in such a way that it is situated frontally to the fitting

Welding

(According to the DVS regulations 2207, part 11)

Before starting the welding process it has to be checked if the welding temperature has been reached. The first welding can be made 5 minutes after the welding temperature is reached. Split apart the machine slides and close down the heating element. Slowly move the machine slides by turning the hand wheel. Align the heating element so that the pipe and the fitting properly fit into the welding tools. Move the slides with constant forward motion up to the point until the stop is reached. The heating timer of the joint surfaces starts only after the stop is reached. After end of the heating time the slides are separated. The heating element shall be brought into idle position as quickly as possible. Move the machine slides with the hand wheel at constant forward motion up to stroke end so that the precise joining depth between the pipe and the fitting is reached. The welding may only be removed from the clamping jaws after the cooling time. Unscrew the clamping jaw with the hand wheel and take off the welded part.

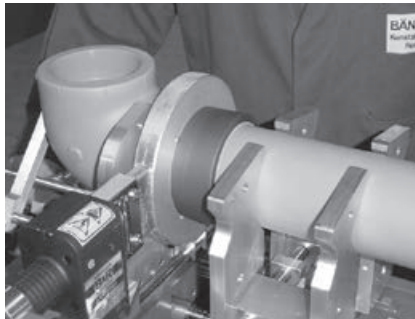


Fig. 9
Move the machine slides with the hand wheel, warmup the pipe and the fitting in the welding tools

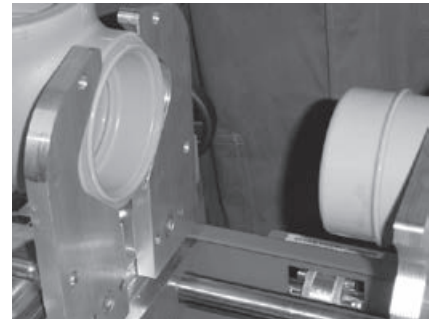


Fig. 10
After the warming time join pipe and fitting

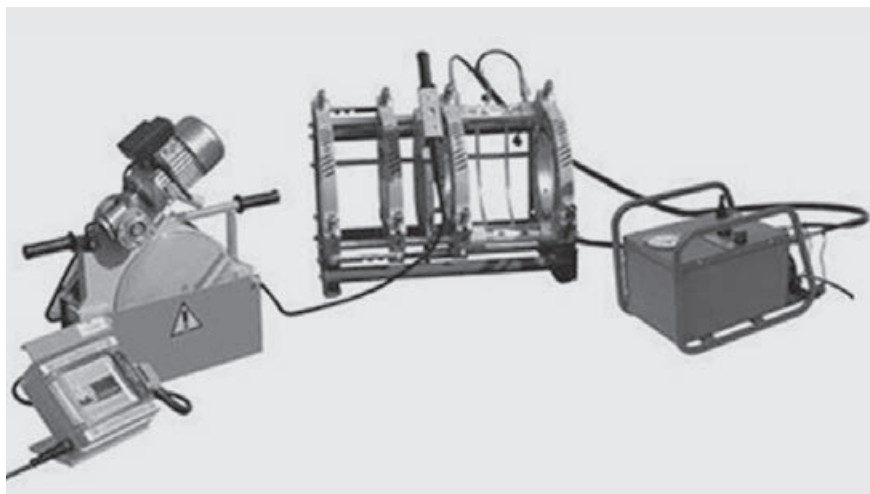


Fig. 11
Move the machine slides up to stroke end



Fig. 12
Remove the welding joint after the end of the cooling time from the clamping jaws

The welding machine part no. 8989 is suitable for butt welding of pipes and/or fittings made of PP-R / PP-RCT from dia = 90 mm up to dia = 500 mm



The butt welding machine with heating element part no. 8989 includes:

- Basic machine with movable slide
- Heating element
- Hydraulic aggregate
- Electrical planing tool
- Flexible hydraulic hoses
- Metal box for electrical heating elements and planing tool.

Parameters for PP-butt welding with heating element at 20° C outside temperature

according to DVS data sheet 2207, part 11

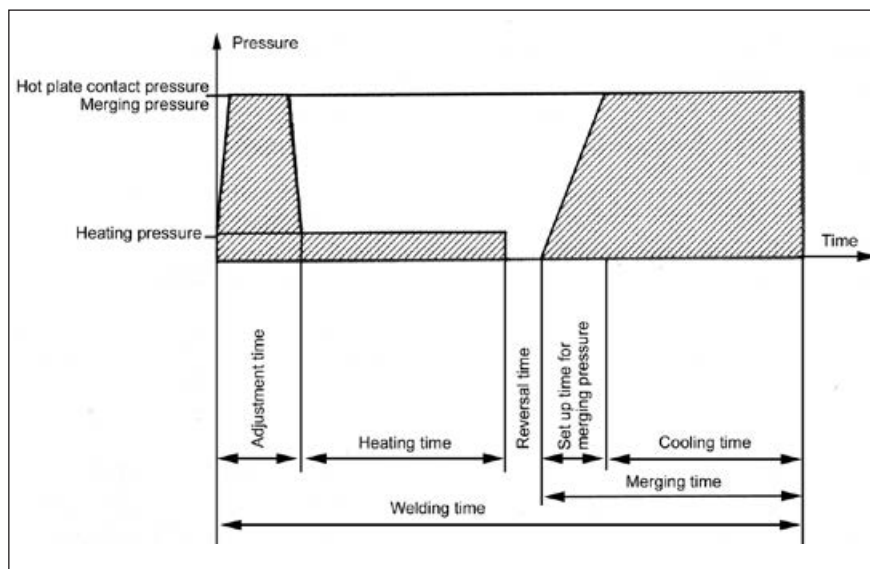


Fig. 1

Preparation before welding

Before start the temperature of the heating element should be controlled. In order to have optimal welding connections, the heating element should be cleaned with a non-fuzzing paper before each welding. The wall thickness of the fittings that shall be welded should be conform in the welding area.

Pipes and fittings have to be aligned axial.

The areas that shall be welded should be planed with a tool, which has to be clean and free of grease. So they should be plane parallel in the plane condition.

The roundness of the pipe has to be ensure either by the clamping device of the welding machine or extra clamps.

Permissible misalignment of wall $0,1 \times \text{wall thickness (s)}$

During butt welding with heating elements the areas to be joined are heated up to the welding temperature by means of the heating element and compressed after the heating element has been removed. Heating temperature $210^{\circ} \text{C} \pm 10^{\circ} \text{C}$ The step-by-step welding procedure is shown in Fig. 1.

Welding Procedure:

During butt welding with heating elements the areas to be joined are adjusted with pressure at the heating element (adjusting with merging pressure) until the specified bead height is reached. Following heating up to welding temperature with reduced pressure ($0,10 \pm 0,01 \text{ N/mm}^2$) and joining with merging pressure after removal of the heating element (Adaption).

Fig. 2 shows the principle of the welding procedure.

After merging a double bead (K) has to exist over the complete perimeter. The bead formation is an orientation for the uniformity of the weldings among each other.

Fig. 3 shows the bead formation during butt welding with heating elements.

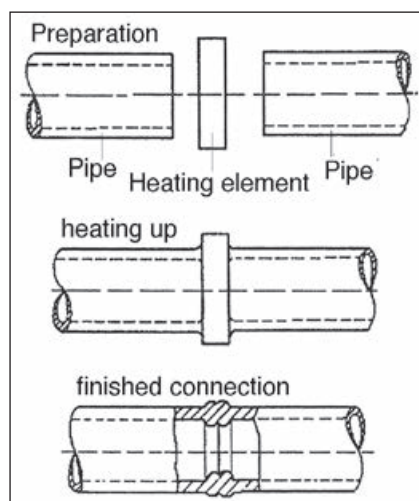


Fig. 2

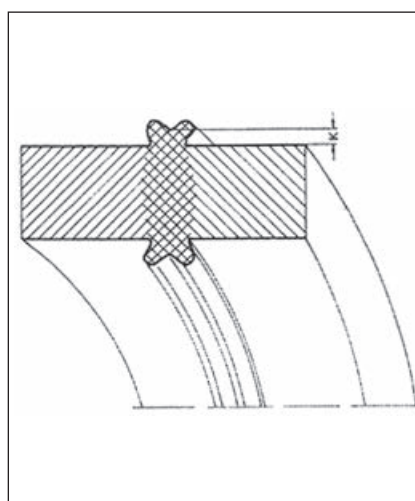


Fig. 3

Application area:

Additional extension of existing pipe systems.
Direct connection of consumer pipe to a supply pipe line.
Alternative for Tees.

Welding preparation:

Heat up the heating element to 260° C.

Control the set temperature prior to the welding process. Temperature difference $\pm 10^{\circ}$ C.

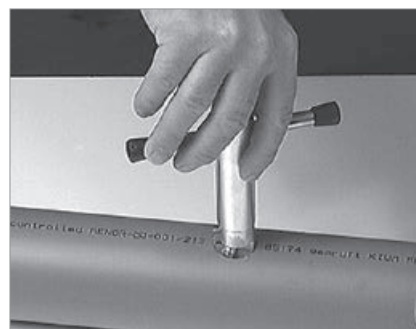
The welding elements must be clean and should be cleaned prior to every welding process.

Fig. 1

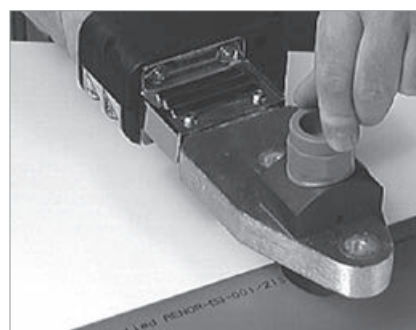
Bore the pipe wall with the boring machine (Part no. 8986b)

**Fig. 2**

For stabi composite pipes (Part no. 8215B) remove the residual aluminium with the chamfering tool (Part no. 8986a)

**Fig. 3**

Push into the heat nozzle of the welding saddle tool (Part no. 8984e) the bore hole as well as the connecting piece of the welding saddle into the heating socket. The heating time for all dimensions amounts to 30 seconds.

**Fig. 4**

Push the stub of the welding saddle quickly into the heated bore hole. Fix the fitting for about 15 seconds on the pipe.



After a cooling time of 10 minutes the fused joint can fully work under pressure.

The appropriate branch pipe will be assembled by means of socket fusion welding or by using female or male adaptors with the welding saddle.

Application area:

Repair of bored pipes.

Preparations:

Empty and uncover the damaged pipe. Select the heating unit, clean it before every welding process. Heat up the heating unit to 260° C ($\pm 10^\circ$ C). Check the temperature before the welding process.

Selection of welding elements:

Repair -Set: $d = 7$ mm
For welding of holes up to 6 mm

Repair-Set: $d = 11$ mm
For welding of holes up to 10 mm

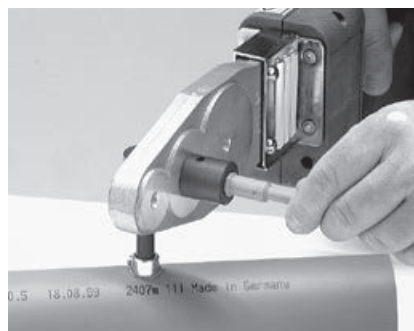
Fig. 1

Mark the degree of the push-in depth (wall thickness) on the repair plug.

Distance tool to be fixed according to the wall thickness of the pipe and tighten the screw.

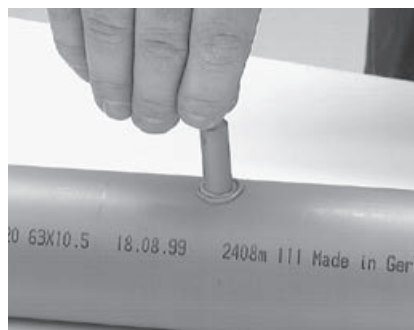
**Fig. 2**

Heat up the borehole and the welding plugs with the repair-set for 15 seconds.

**Fig. 3**

Remove the welding device and set in the repair plug precisely without twisting it.

After cooling time of 5 minutes remove the protruding end of the repair plug, and the repaired part can again work under pressure.



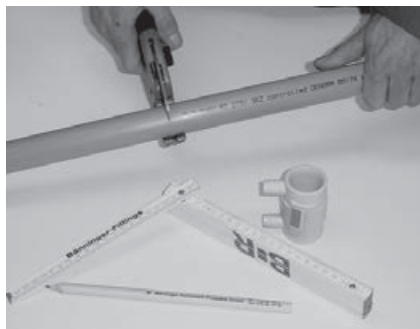


Fig. 1
Cut the pipe rectangularly with plastic scissors or with a pipe cutter.



Fig. 2
Remove the outside oxide layer using a scraper.



Fig. 3
On **Bänninger Stabi-Pipes**, the aluminum coating must be peeled off before jointing.



Fig. 4
Clean the joint surfaces with a purifying agent (e. g. spirit).



Fig. 5
Mark out the socket depth.



Fig. 6
Push in the socket up to the marked position on the pipe.



Fig. 7
Plug the cable plugs into the contact bushings. Enter the voltage and the welding time in the welding device. The welding data can be seen on the barcode label of the socket. Start the welding device with the switch.

Preparing the welding surfaces.
Cut the PP-R/PP-RCT pipe ends rectangularly to the pipe axis with a pair of plastic pipe scissors. Remove the outer surface oxide layer in chips with a scraper and clean it with non-fuzzing, absorbent paper and purifying agent (e. g. spirit).

On **Bänninger Stabi-Tubes** the aluminum coating has to be peeled off before connecting them. For this purpose the **Bänninger** peeling tools (no. 8977) for electrofusion welding sockets must be used. They achieve a greater peeling length than that required for normal socket welding. The pipe ends are pushed into the peeling tool to remove the aluminum coating up to the stop of the peeling tool.

Mounting of the electrofusion welding sockets.

Mark the socket depth on the pipe. After having finished all preparations take the electrofusion welding socket out of packing and **be careful not to touch the inner surfaces of the socket**. Now shift the socket slowly on the tube up to the marked point.

Fixation of pipes/fittings.

To protect the welding point against tensile and bending stress during the welding process the pipes and fittings to be welded have to be fixed in a clamping device after they have been adjusted in the electrofusion socket. Attention has to be paid to the fact that the position of pipe and fitting is exactly axially parallel.

Connecting the socket cord.

Position the electrofusion welding sockets in a way offering easiest connection of the cord plugs to the contact bushes. Having checked the required generator voltage to be available switch on the device and put the cord plugs on to the contact bushes. Set the diameter of the pipe to be connected and start the welding process with the switch. The electrofusion machine automatically calculates and controls the required welding time and shows the welding indicators after successful welding. The welding indicator does not evidence the welding quality. Its value may differ depending on the slot width between the electrofusion welding socket and the pipe.

Cooling Time

Never disregard the required cooling times. The full loading capacity of the welded section for example for test pressure or working pressure requires a minimum cooling time of 2 hours.

Pressure test with water according to DIN 1988.

For completely installed but not yet concealed pipes DIN 1988 (Technische Regeln für Trinkwasser-Installation/Technical Regulations for Drinking Water Installations) requires a hydraulic pressure test. Under pressure testing the properties of the PP-R/PP-RCT pipe material cause an expansion of the pipe affecting the test result. The difference between pipe and test medium temperatures can additionally influence the test result. Due to the thermal expansion coefficient a change in temperature of 10 K results in a change in pressure of 0,5 to 1 bar. The pressure testing of parts of plastic pipe systems should therefore be done at an as much as possible constant test medium temperature.

Filling of the Pipe System

Fill the pipes with filtered water until they are free of air. Use pressure gauges allowing to clearly read pressure changes of 0.1 bar. Install the pressure gauge at the lowest point of the pipe system.

The pressure test must be done as a preliminary test and a principal test, whereas a preliminary test only may be considered sufficient for smaller installations such as supply and distributing pipes in moist rooms.

Preliminary Test

For the preliminary test a test pressure corresponding to the allowed working pressure plus 5 bar is applied which has to be renewed 2 times at 10-minute intervals within 30 minutes. After another 30 minutes the test pressure shall not have dropped by more than 0.6 bar (0.1 bar per 5 minutes) and no leakage must have occurred.

Principal Test

Directly after the preliminary test the principal test has to be carried out. The test period is 2 hours. The test pressure determined after the preliminary test shall not have dropped by more than 0.2 bar after 2 hours.

No leakage shall be found at any section of the tested installation.

To avoid stagnation of residual water and damages caused by frost a pressure test as dry leak test with compressed air (or inert gas) can be carried out (pages 78 + 79).

TEST SHEET (draft)

(According to the standards given in DIN 1988)

Object description: _____

Executing company: _____

Client: _____

Object: _____

Raw material: **PP-R / PP-RCT** ☐ _____ ☐

Pipe length:	Ø 16	m	Ø 20	m	Ø 25	m	Ø 32	m
	Ø 40	m	Ø 50	m	Ø 63	m	Ø 75	m
	Ø 90	m	Ø 110	m	Ø 125	m	Ø 140	m
	Ø 160	m	Ø 225	m	Ø 250	m	Ø 280	m
	Ø 315	m						

Joining: Welding _____ pcs. Gluing _____ pcs.

Number of tapping points:	pcs.	Highest tapping point above pressure gauge:	pcs.	Total pipe length:	m
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Preliminary test:

Test pressure _____ bar

1st regulation after 10 minutes _____ bar2nd regulation after 10 minutes _____ bar

Pressure after 30 minutes _____ bar

Pressure decrease _____ bar

Result of preliminary:

Principal test:

Test pressure _____ bar

Pressure decrease after 2 hours _____ bar
(0,2 bar max.)

Result of the principal test:

Pressure test acknowledged:

Beginning of the test _____ h End of test _____ h Test period _____ h

Place _____ Date _____ Time _____

Signatures:

Customer

Contractor

Leak test with compressed air or inert gas

General

Because of compressibility of gases during proceeding pressure tests with air the provisions for prevention of accidents "Working on gas facilities" as well as the regulation "Technical rules for gas installations DVGW-TRGI (German Technical and Scientific Association for Gas and Water – Technical rules for gas installations)" should be taken into account because of physical and technical security reasons. In coordination with the responsible professional organization and following this regulation the testing pressure was set at max. 3 bar as during load and leak tests for gas pipelines.

General provisions

New pipeline facilities may only be put into operation if the compulsory pressure test is successfully passed. No leakages are allowed. The pressure test should be carried out before the lines are buried. The tests on the new line facility can be implemented either on the whole facility or in line sections. The division into smaller test sections (small pressure / liter product) provides higher level of reliability and is more precise while testing. On the pressure gauge leaks can be identified faster compared to bigger and widely branched voluminous sections. Hence leak locations can be determined faster. Apparatuses, drinking water warmers, armatures or pressure tanks must be disconnected from the pipelines prior to the air pressure test in case they have larger capacity and can affect reliability and test accuracy. All pipeline openings must be directly closed with metallic plugs, metallic blanking plates or blank flanges that withstand the testing pressure. Closed shut-off valves do not count as leak-proof closures. Exhaust valves for deflation of the testing pressure should be installed in sufficient quantity and on appropriate locations where the air can be deflated in a safe manner.

If leaks are observed during the visual or noise inspections or if a pressure drop is identified above the allowed values all connections should be checked with regard to leak tightness with test equipment that creates bubbles. After removal of possible leaks the pressure test should be repeated. During the testing period no single leak may be detected on any location of the inspected facility.

In exceptional cases a minor pressure drop may be identified on the pressure gauge although during the visual inspection or during the inspection with testing equipment that creates bubbles no leaks could be observed.

Nevertheless the facility can be water proof.

In case of any doubts a water proof test can bring a certainty regarding the leak tightness.

The safety of people and goods during the test should be taken into account as a basic principle.

Because of technical security reasons e. g. slipping away of a defective pipe connection, higher pressures than 3 bar are not permitted.

A gradual pressure increase and a regular visual inspection of the pipe connections are appropriate as additional safety measures.

Leak tightness test

The leak tightness test is implemented with a pressure test of **110 mbar** prior to the load test. The applied pressure gauge must have an appropriate precision of 1 mbar (10 mmWS) display range for the pressure that will be measured. For this purpose the U-pipe pressure gauges known from the TRGI test or the standpipes can be used. The components on the pipeline facility must be suitable for the test pressures or have to be dismantled before the test.

After application of the test pressure the testing period for **up to 100 liter line volume must be at least 30 minutes**. For every additional 100 liters the testing period must be increased by 10 minutes. The leak tightness test starts once the test pressure is achieved and taking into consideration the respective waiting period for adjusting the medium to the ambient temperature.

Load test

The load test is implemented with a maximum test pressure of **3 bar** and a pressure gauge with a display range of 0,1 bar. The load test is combined with a visual inspection of all pipe connections during which it is checked whether welding, solder pressure and clamp connections as well as adhesive and screwed joints are performed in a proper manner in order to be leak-proof.

The load test with diameter increased pressure should be:

- **at nominal up to DN 50 maximum 3 bar and**
- **at nominal diameter over DN 50 - DN 100 maximum 1 bar.**

After application of the test pressure the testing period is 10 minutes.

Selection of the test medium

For leak tightness and load test the following media can be used:

- oil-free compressed air,
- inert gas
 - e. g. Nitrate and carbon dioxide
- inert gas with 5% hydrogen in the nitrogen (applied at the procedure for locating the leakage)

By means of technical security equipment like pressure reducing regulator on compressors it has to be ensured that the specified test pressure for the pipe facility is not exceeded.

Pressure test protocol for drinking water installation with compressed air or inert gas as a control medium (model)

Construction project: _____

Client represented by: _____

Contractor / responsible
expert represented by: _____

Material of the pipeline system: _____

Connection type: _____

Pressure on the facility: _____ bar Ambient temperature::: _____ °C Temperature of the control medium: _____ °C

Control medium ☐ Oil-Free compressed air ☐ Nitroge ☐ Carbon dioxide ☐ _____

The water supply facility was controlled as ☐ a complete facility ☐ sectionwise

All lines are closed with metallic plugs, caps, blanking plates or blank flange.
 Aparatuses, pressure tanks or drinking water warmers are disconnected from the lines.
 A visual inspection of all pipe connections was done with regard to the professional construction.

☐ **Leak tightness test** Test pressure 110 mbar
 Testing period up to 100 l line volume for at least 30 minutes.
 For each additional 100 liters the testing period should be increased by 10 minutes.

Line volume

Liter

Testing period

Minutes

Temperature balance and steady-state condition are awaited, after this the testing period starts.

☐ During the testing period no pressure decrease was observed.

☐ **Loading test with higher pressure**

Testing pressure ≤ 50 DN max. 3 bar > 50 DN max 1 bar

Testing time 10 Minutes

First a temperature balance and a steady-state condition is awaited, after this the testing period starts.

☐ During the testing period no pressure decrease was observed.

☐ The pipelines are leak-proof.

Location _____

Date _____

Client / Representative _____

Contractor / Representative _____

Authoritative for the insulation of pipework the German Heating Installation Regulation of the Energy Saving Act/Heizungsanlagen-Verordnung zum Energieeinsparungsgesetz (HeizAnLV)

Heat insulation according to DIN 1988

Drinking water systems for cold water must be protected against heating and, if necessary, condensation water. For the minimum insulation layer standard values see table (fig. 16).

Installation mode	Insulation layer thickness $\lambda = 0,040 \text{ W/(m} \cdot \text{K)}$
Pipes freely installed, in non-heated room (e. g. cellar)	4 mm
Pipes freely installed, in heated room	9 mm
Pipes in channel, no hot-water pipes	4 mm
Pipes in channel, beside hot-water pipes	13 mm
Pipes in wall conduit, risers	4 mm
Pipes in wall recesses, beside hot water pipes	13 mm
Pipes on concrete surface	4 mm
For other heat conductivity values, convert insulation layer thickness accordingly by using a diameter of $d = 20 \text{ mm}$.	

Fig. 16

Heat insulation according to the Heating installation regulation.

Heat distribution installations must be insulated against heat loss. See figures 17 + 18

Line	Nominal width (NW) of the pipes/Fittings in mm	Minimum insulation layer Thickness, related to a thermal conductivity of $0,035 \text{ W m}^{-1} \text{K}^{-1}$
1	up to NW 20	20 mm
2	from NW 22 to NW 35	30 mm
3	from NW 40 to NW 100	as NW
4	over NW 100	100 mm
5	Pipes and fittings under lines 1 to 4 in ceiling and wall cut-throughs, pipe-crossing sections, with central distributing pipes, radiator connection pipes of max. 8 m length	1/2 of the requirements given in lines 1 to 4

Fig. 17

	d x s	DN	Insulation layer thickness $\lambda = 0,035 \text{ W/(m} \cdot \text{K)}$
Pipes PN 20	16 x 2,7	10,6	20 mm
	20 x 3,4	13,2	
	25 x 4,2	16,6	
	32 x 5,4	21,2	30 mm
	40 x 6,7	26,6	
	50 x 8,4	33,2	
	63 x 10,5	42,0	42 mm
	75 x 12,5	50,0	50 mm
	90 x 15,0	60,0	60 mm

Fig. 18

Polypropylene pipes according to DIN 8077 are highly selfinsulating in respect to their heat transfer. Thus PN 20 PP-R/PP-RCT pipes in continuous operation at a passing medium temperature of 80°C show an about 27°C lower temperature at their outside diameter. This proves their heat insulation to be much more effective than that of metal pipes.

Fire Protection

PP-R/PP-RCT is classified under building material class 2 - normal flammability. The respective national building laws (building regulations on all administrative levels and their implementing regulations) must be adhered to. The application of approved fire protection measures prevent the passing of smoke and fire for the pipes through walls and ceilings.