WEFATHERM Pipe System PP-R

Technical Manual

WEFA PLASTIC
Kunststoffverarbeitungs GmbH

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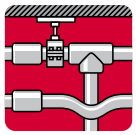

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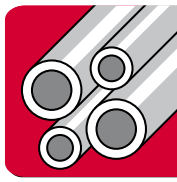

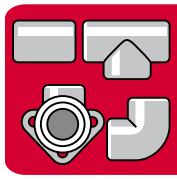

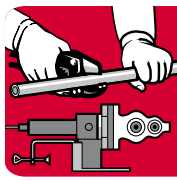

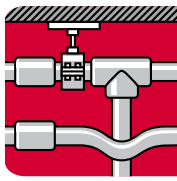

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Chapter I
The WEFATHERM pipe system

Properties of the polypropylene material PP-R 80

The basic material of the WEFATHERM pipe system is polypropylene random-copolymer PP-R 80. This material is characterized by excellent properties such as elasticity, rigidity, tightness, compression strength (table 1, P. 5) and a special resistance to high temperatures and extraction. In addition PP-R 80 possesses high resistance to a large number of materials which might pass through the pipe system in liquid or gaseous form. This material is particularly suitable for use in drinking water systems.

Excellent internal pressure resistance also at high temperatures

Our raw material is not only PP-R 80 classified, in addition it shows superior performance characteristics at elevated temperatures. The unique temperature resistance of allows for high safety margins in practical applications.
PP-R 80 ascertains high safety for longterm, trouble free operations of your sanitary installation. It is the first choice of PP-R raw material for a reliable sanitary piping system.
PP-R 80 has unique safety reserves as it can demonstrate compliance to the refence curves simultaneously at 20 °C, 70 °C, 95 °C and 110 °C based on third part testing and ISO/TR 9080 assessment.

Mechanical and thermal properties

In accordance with its areas of application, the WEFATHERM pipe system is designed for continuous temperatures of 0 °C to 70 °C, short-term peak temperatures of up to 100 °C and a service life of min. 50 years. More precise details are summarized in tables No. 2 and 3, P. 6 and 7.

Creep-depending-on-time test under internal compression

The creep-depending-on-time test under internal compression provides information on the high quality of the WEFATHERM pipe system. All the components in the system have been subjected to a multitude of tests at different pressures and temperatures (table 4, P. 8). These tests were carried out up to destruction or fracture. The diagrams on P. 6/7 show the findings obtained therefrom. Test structure and test sequences are in accordance with the standards.

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Mechanical and thermal properties

Table 1

Property	Typical Value	Unit	Test Method
Density	905	kg/m^3	ISO 1183
Melt Flow Rate			ISO 1183
230 °C/2.16 kg	≤ 0.5	g/10 min.	
190 °C/5 kg	≤ 0.8	g/10 min.	
Flexural Modulus			
(2 mm/min)	800	MPa	ISO 178
Tensile Modulus of Elasticity			
(1 mm/min)	900	MPa	ISO 527
Tensile Stress at Yield			
(50 mm/min)	25	MPa	ISO 527
Tensile Strain at Yield			
(50 mm/min)	13.5	%	ISO 527
Impact Strength (Charpy)			ISO 179/1eU
0 °C	no Break	kJ/m^2	
23 °C	no Break	kJ/m^2	
-20 °C	40	kJ/m^2	
Notched Impact Strength (Charpy)			ISO 179/1eA
23 °C	20	kJ/m^2	
0 °C	3.5	kJ/m^2	
-20 °C	2	kJ/m^2	
Coefficient of Linear Thermal			
Expansion	$1.5 * 10^{-4}$	1/K	DIN 53752
Coefficient of Thermal			
Conductivy	0.24	W/m K	DIN 52612
Specific Heat	2	J/g K	Calorimeter

*Data should not be used for specification work

Creep-depending-on-time test under internal compression

The tangential stress (a_v) is calculated in accordance with the formular below and can then represented in dimensionless manner

$$\alpha_v = p \cdot Sf \frac{(d_a - s)}{20\ s}\ .\ N/mm^2$$

If a safety factor does not need to be taken into account Sf = 1,0 applies.

Maximum operational pressures

Maximum operational pressures for pipes consisting of PP-R 80, for water Safety factor (SF) = 1,25 DIN 8077

Table 2

Temperature	Operating years	PN10	PN16	PN20	PN25
		Diameter wall thickness SDR			
		11	7,4	6	5
		Permissible operational pressure			
10	1	21,1	33,4	42,1	53,0
	5	19,8	31,5	39,7	49,9
	10	19,3	30,7	38,6	48,7
	25	18,7	29,7	37,4	47,0
	50	18,2	28,9	36,4	45,9
	100	17,8	28,2	35,5	44,7
20	1	18,0	28,5	35,9	45,2
	5	16,9	26,8	33,7	42,5
	10	16,4	26,1	32,8	41,4
	25	15,9	25,2	31,7	39,9
	50	15,4	24,5	30,9	38,9
	100	15,0	23,9	30,2	37,8
30	1	15,3	24,2	30,5	38,5
	5	14,3	22,7	28,6	36,0
	10	13,9	22,1	27,8	35,0
	25	13,4	21,3	26,8	33,8
	50	13,0	20,7	26,1	32,9
	100	12,7	20,1	25,4	31,9
40	1	13,0	20,6	25,9	32,6
	5	12,1	19,2	24,2	30,5
	10	11,8	18,7	23,5	29,6
	25	11,3	18,0	22,6	28,5
	50	11,0	17,4	22,0	27,7
	100	10,7	16,9	21,4	26,9
50	1	11,0	17,4	21,9	27,6
	5	10,2	16,2	20,4	25,7
	10	9,9	15,7	19,8	25,0
	25	9,5	15,1	19,0	24,0
	50	9,2	14,7	18,5	23,3
	100	9,0	14,2	17,9	22,6
60	1	9,2	14,7	18,5	23,3
	5	8,6	13,6	17,2	21,6
	10	8,3	13,2	16,6	21,0
	25	8,0	12,7	16,0	20,1
	50	7,7	12,3	15,5	19,5
70	1	7,8	12,3	15,5	19,6
	5	7,2	11,4	14,4	18,1
	10	7,0	11,1	13,9	17,5
	25	6,0	9,6	12,1	15,2
	50	5,1	8,1	10,2	12,8
80	1	6,5	10,3	13,0	16,4
	5	5,7	9,1	11,5	14,5
	10	4,8	7,7	9,7	12,2
	25	3,9	6,2	7,8	9,8
95	1	4,6	7,3	9,2	11,6
	5	3,1	4,9	6,2	7,8
	(10)	(2,6)	(4,1)	(5,2)	(6,6)

Data inside the brackets appliy by verification at longer testing periods than 1 year at the 110 °C-test.

Maximum operational pressures

Maximum operational pressures for hot water and central heating systems

Table 3

Heating period	Temperature	Years of operating	Permissible operational pressure SDR 6	SDR 7,4	SDR 5
Continuous working temperature 70 °C incl. 60 days per year with	75 °C	5	14,30	11,40	15,90
		10	13,70	10,90	14,50
		25	11,80	9,30	13,70
		45	10,40	8,10	12,80
	80 °C	5	12,90	10,07	15,80
		10	12,20	9,70	15,40
		25	10,70	8,60	13,20
		40	9,80	7,80	11,60
	85 °C	5	12,51	9,94	15,78
		10	11,90	9,50	15,30
		25	9,70	7,80	13,20
		35	8,90	7,10	11,20
	90 °C	5	11,80	9,37	14,90
		10	10,30	8,40	12,90
		25	8,40	6,60	10,48
		30	7,63	6,30	8,45
Continuous working temperature 70 °C incl. 90 days per year with	75 °C	5	13,95	11,50	14,73
		10	13,40	10,80	13,80
		25	11,50	9,20	12,40
		45	8,90	7,00	11,20
	80 °C	5	12,75	10,14	16,10
		10	12,33	9,81	15,50
		25	10,06	8,02	12,71
		37,5	9,15	7,27	11,52
	85 °C	5	12,00	9,54	15,15
		10	11,29	9,00	14,20
		25	9,62	7,63	12,16
		32,5	9,07	7,20	11,40
	90 °C	5	10,79	8,60	11,30
		10	9,30	7,41	10,45
		25	7,35	5,73	9,22

*SDR = Standard Dimension Ratio (Diameter-/Wall thickness)

Permissible operational pressures in accordance with DIN 8077 for drinking water or heating systems

Temperature and pressure play an important role in respect of the operational safety of WEFATHERM pipe systems. Table 2 on P. 6 gives the permissible operational overpressures for the different pipe series which are defined via the pressure stage PN whereby a safety factor of 1.25 has been taken into account in all cases. This table permits the pipe series appropriate for the particular area of application in question to be selected. Drinking water is one of our most important elements and is accordingly subject to very strict regulations not least in respect of the materials with which drinking water may come into contact. Since WEFATHERM pipe components are joined by heated-sleeve welding, no substances or materials that are detrimental to health or that are in any way questionable come into use. Regular checks are carried out as a matter of course by the DVGW (German Association of the Gas and Water Profession), the SKZ (South-German Plastics Centre) and the Technologiezentrum Wasser of the University of Karlsruhe.

Test method and duration

General quality demands / tests according to DIN 8078

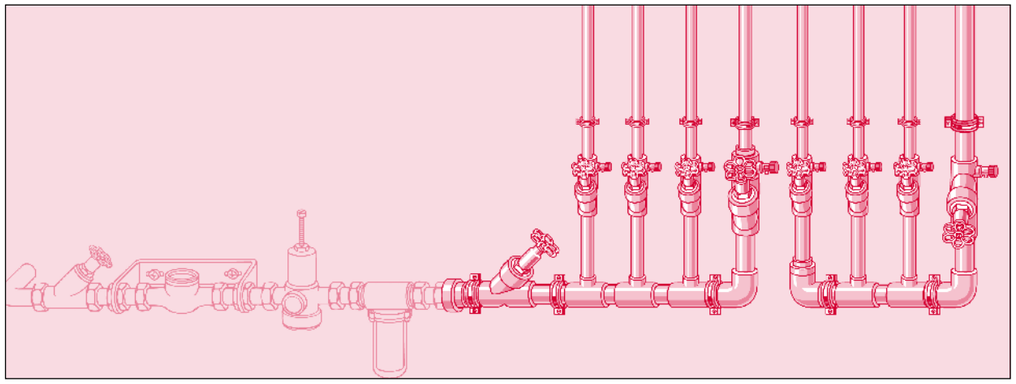
In our quality lab all types of pipes are tested continuously. In addition to our own inspection international test institutes secure that all our products are due to valid specifications and are according to continuous high quality standards.

Table 4

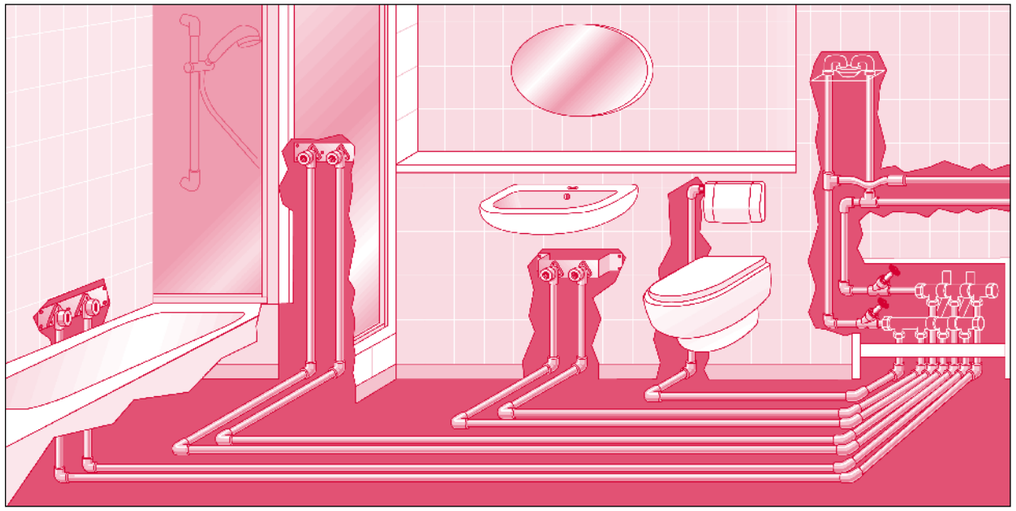
Test temperature °C	Pressure medium	Test pressure bar	Stress duration (minimum operating time) t h
20	Air on water	65	1
95	Air on water	16	1000
120	Air	8	8760

Drinking water systems

Due to its special material properties and chemical resistance (see list on P. 99-101), WEFATHERM pipe systems can be used for a wide range of areas of application including systems for drinking water and water for other purposes in houses and residential buildings, offices, schools, hotels, hospitals, ships etc. Agriculture and horticulture, compressed air systems, heat distribution systems, heat generation connections, distribution connections, floor distribution systems, rising mains, industrial pipe networks, the foodstuffs industry.



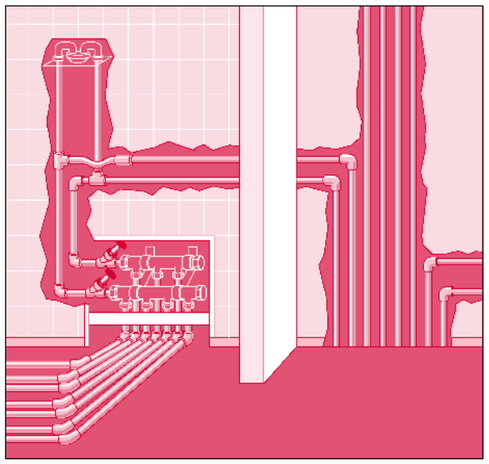
Systematic distribution from the housewater connection up to consumer points in the bathroom.



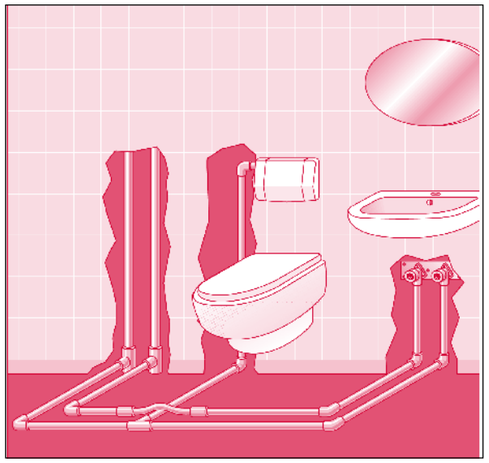
Drinking water systems

The WEFATHERM pipe system offers great advantages as connections are made by polyfusion welding, problemfree, flamefree even in the case of renovation work.

Thanks to the well designed system, many different types of system can be realized rapidly and reliably: rising mains, floor distribution systems, connection of rising mains to floor distribution systems, surface and buried installation, on-wall mounting, heat distribution systems.



The WEFATHERM pipe system with its components makes possible complete installations from the rising main via the connection point to floor distribution systems . . .



. . . to be realized up to the consumer points, whether these are buried or surface mounted, with one material in an environmentally friendly and reliable manner.

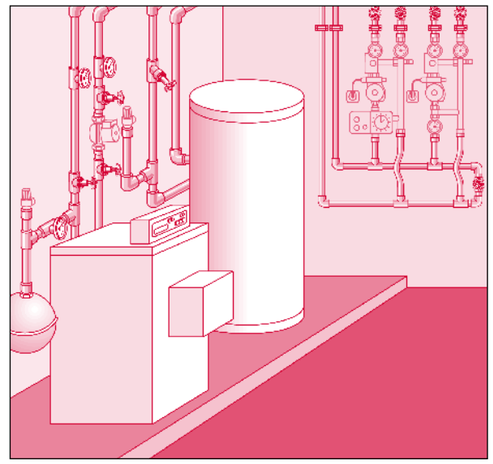
Heating and airconditioning systems

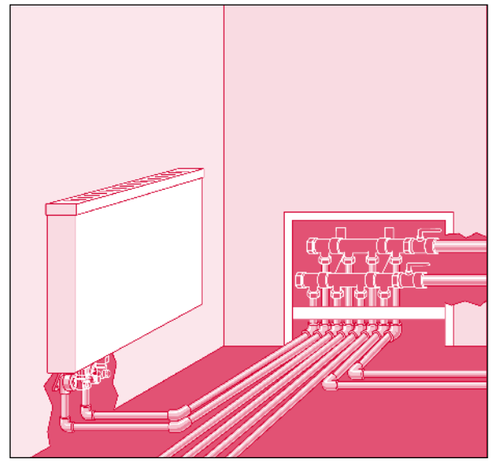
The WEFATHERM pipe system with its components enables transitions to existing systems of other materials to be achieved in a problemfree manner without any compromises. Polypropylene is corrosionfree and resistant to thermal aging. In addition it gives no opportunity for deposits to form. Flow noises are damped to a large extent.

As result of the low heat conducting capacity of PP-R 80 pipe systems isolation can be neglected, i.e. PP-R 80 pipes for cold water conduction do not need any isolation.
The low heat conducting capacity of polypropylene almost totally prevents the appearance of condensed water outside the pipe.

- **PP 0,24 W/mK**
- PE 0,35 W/mK
- Fe 50 W/mK
- Cu 400 W/mK

Please note:
The legal regulations of the specific countries have to be taken into consideration.



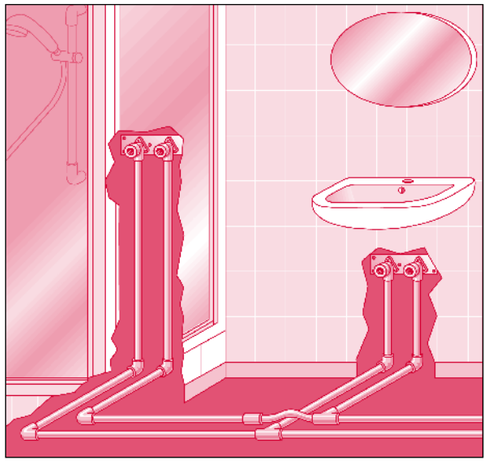


The WEFATHERM pipe system and its components

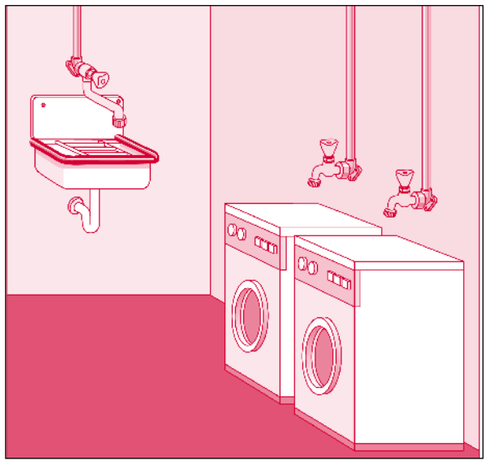
The WEFATHERM pipe and the WEFATHERM Stabi pipe are two components well adjusted to their practical application. With the help of the molded parts they can be connected easily, even in the transition to fittings or pipe systems of other materials.

The advantages in application of our new developed WEFATHERM Fiber pipe are low longitudinal expansion exposition (significantly less), higher circulation with maximum flow capacity, higher pipe stiffness as well as simple treatment without additional peeling process.

A pipe of the new generation for every application.



In drinking water installations from the house connection point or from the house connection distribution station up to the last consumer point, in heating installations from the boiler or water-heating unit up to the individual radiators or heat exchangers: in both areas each pipe system has precisely the right components. In all areas of application the material polypropylene and the WEFATHERM pipe system captivate with their corrosion resistance and high resistance to the forming of deposits, so that long service lives can be expected. Flow noises are damped so that systems are more user friendly than those based on metallic materials.



In cold water application the WEFATHERM pipe system is suitable. In hot water application the use of the WEFATHERM Stabi pipe is always advisable which is covered by an aluminium coat resulting in a reduced longitudinal expansion with heat load. Alternatively also the WEFATHERM Fiber pipe can be inserted now. Spans can be enlarged thus saving fastening cramps. Being impermeable to light it avoids the developement of algae. The socket heat welding process requires only shortest processing and cooling times so that the system after processing is in very fast working condition. Waiting times are minimized.

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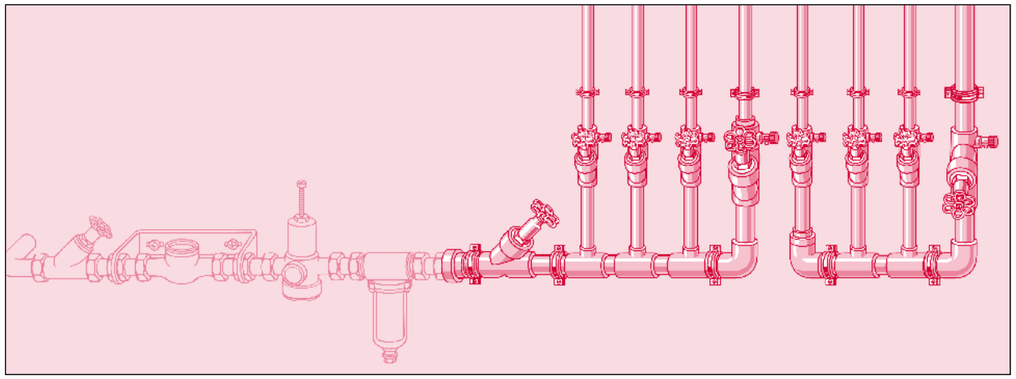

The system consists of 100% plastic and aluminium-plastic compound pipes, which are complemented and connected with fittings such as collar bush flange connections, shut-off valves, transition units from metal to PP-R and from PP-R to metal, fitting connections and accessories. The chapter „Product overview“ shows in a clear manner the products you need. The guarantee for our products is just as much a matter of course for us as our product liability. Quality checks are carried out regularly by external bodies such as the DVGW while in addition we carry out our own regular internal checks. Comprehensive planning and tender-preparation documents are available to facilitate your work.

Further information on the themes of quality, certificates and tests is provided on page 18/21.

Users often find flow noise disturbing. Such noise is however considerably reduced when the material is polypropylene. Metallic materials often transmit much more noise. Fire protection is regulated in accordance with national regulations. Building authorities and fire protection officers will provide information on this. WEFATHERM pipes and fittings fulfill the requirements of fire class B 2, i.e. they are classified as normally inflammable. Where a pipe system passes through structural parts of a building, steps must be taken that the required fire resistance capabilities are restored during the following installation.

Free or surface mounting

Quality

Protection against fire and noise

Protection against fire and noise

The extent and type of the protective measures required depends on the type of installation. In particular fire walls and ceilings must be restored to their original fire resistance class following installation of pipes through them.

Environmental protection and recycling

Polypropylene is an environmentally friendly material. It can be recycled up to 100%. When disposed of in landfills, polypropylene behaves in a neutral manner visa-vis groundwater. No poisonous residues arise when it is burnt in refuse incineration plants. Selection of polypropylene demonstrates consciousness of health and environmental problems.

Chemical resistance

Polypropylene is characterized by its high resistance to an immense range of chemical substances which might pass through a pipe system in gaseous or liquid form and at different temperatures and pressures. Pipe connectors are usually of brass that is nickel-plated and chromed. When it is intended that chemical materials should pass through a pipe system, please complete and send to us the questionnaire given on P. 15 so that we can work out suitable solutions with you. In this connection please see too the chemical resistance list on pages 99-101.

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Questionnaire on chemical resistance

Questionnaire on the chemical resistance of the WEFATHERM pipe system

Specialist firm carrying out the work:

Firm

Officer in charge

Road

Zip code/place

Telephone

Telefax

Area of application:

Medium to flow

through the system

°C operating temperature/s 1 / 4

mbar operating pressure/s 1 / 2 / 3

h/d operating time

Construction project Road Place

Road

Place

Ambient medium

°C ambient temperature

mbar ambient pressure

Data sheets

attached	not-attached	
o	o	Medium to flow through the system
o	o	Ambient medium

Place, date

Chapter II
WEFATHERM system quality

Standards

Various standards such as DIN, DVS and SKZ guidelines, ISO or DVGW worksheets form the framework for the production monitoring of the WEFATHERM system. Regular monitoring, checks and controls not only of the fabricated materials and production processes but also of the storage and delivery processes are a matter of course for us and assist us to maintain and guarantee our high standard of quality. In addition the results of our tests are confirmed regularly by external checks.

External checks

The WEFATHERM pipe system is subjected to a multitude of external and internal checks. National and international authorities and institutions, the neutrality of which is out of question, check our products regularly and certify their constant high level of quality. This guarantees the user a high level of safety and reliability.

Internal monitoring

The WEFATHERM system quality assurance starts at our works gate with the receipt of raw materials. Only raw material of approved quality is processed. Processing itself is checked regularly. The modern and computer-controlled production machines and systems are checked and set by qualified and experienced personnel to ensure that they always function optimally. This gives a continuous process monitoring system, the results of which are documented.

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Internal monitoring

The following monitoring sequence has been laid down: checking of incoming goods, process and manufacturing checks, intermediate checks, final checks, monitoring of test devices. Permanent records document this sequence in accordance with DIN ISO 9001.

Production monitoring

The settings of machines and the dimensional correctness of test pieces are checked carefully before production is commenced and adjustments are made if necessary. The dimensional correctness of the items produced, the setting data of the extrusion and injection moulding machines and the surfaces of the products produced are checked continuously and compared with the production specifications. These measures ensure optimum series production. Similar checks are also carried out regularly in the course of production runs.

Final checks

The final products are subjected to further tests. The results of these are laid down and documented in test memoranda. Only products which have been checked and released are transferred to the warehouse. When the checks laid down in the test memoranda have been carried out and documented, the final products are released for stockholding and dispatch. Precise instructions and regular checks ensure the proper storage of the products. Packing and dispatch are regulated internally in a precise manner

External monitoring Test certificates

The WEFATHERM pipe system is regularly checked by neutral, independent institutes. The monitoring is carried out by the South-German Plastics Centre (SKZ), Würzburg and TZW Karlsruhe. These are authorized as testing institutes by – amongst other institutions – the DVGW (German Association of the Gas and Water Profession). Analogous checks are carried out abroad. The results of these checks are passed on to Messrs. WEFA Plastic and documented in test certificates.

German Quality approved

Zertifikat über ein DVGW Prüfzeichen
certificate for a DVGW test mark

DW-8501AT2336

Anwendungsbereich *field of application*	Produkte der Wasserversorgung *products of water supply*
Zertifikatinhaber *owner of certificate*	WEFA PLASTIC Kunststoffverarbeitungs GmbH Benzstr. 24, D-57439 Attendorn
Vertreiber *distributor*	WEFA PLASTIC Kunststoffverarbeitungs GmbH Benzstr. 24, D-57439 Attendorn
Produktart *product category*	Verbinder und Installationssysteme: Trinkwasserinstallationssystem (8501)
Produktbezeichnung *product description*	System aus Rohren aus PP-R (PE 80) und Verbindern aus PP-R (PE 80)
Modell *model*	WEFATHERM
Prüfberichte *test reports*	Mechanik: 155202/2.3/50403 vom 10.01.2003 (SKZ) Mechanik: 225902/2.1/50398 vom 07.01.2003 (SKZ) Hygiene: KR 217//01 vom 18.12.2001 (TZW)
Prüfgrundlagen *basis of type examination*	DVGW W 534 (Entwurf 01.07.2002) BGA KTW (07.01.1977)
Ablaufdatum / AZ *date of expiry / file no.*	09.03.2008 / 02-0551-WNV

DAT-ZE-008/98-11

DVGW-Baumusterprüfzertifikat
DVGW type examination certificate

DW-8501AT2335

Anwendungsbereich *field of application*	Produkte der Wasserversorgung *products of water supply*
Zertifikatinhaber *owner of certificate*	WEFA PLASTIC Kunststoffverarbeitungs GmbH Askay 28, D-57439 Attendorn
Vertreiber *distributor*	WEFA PLASTIC Kunststoffverarbeitungs GmbH Askay 28, D-57439 Attendorn
Produktart *product category*	Installationssysteme und Systemverbinder: Trinkwasserinstallationssystem (8501)
Produktbezeichnung *product description*	Trinkwasserinstallationssystem bestehend aus Rohren aus PP-R und Verbindern aus PP-R
Modell *model*	WEFATHERM "grün" und "grau"
Prüfberichte *test reports*	Mechanikprüfung: 155202/2.350403 und Erg. vom 14.02.2005 (SKZ) Mechanikprüfung: 225902/2.1/50398 und Erg. vom 07.01.2003 (SKZ) Kontrollprüfung Labor: 225907/W1.1/82215 vom 01.08.2008 (SKZ) Kontrollprüfung Labor: 155208/1.3/82168 vom 21.07.2008 (SKZ) Kontrollprüfung Labor: 155208/1.2/82167 vom 21.07.2008 (SKZ) Mechanikprüfung: 359807/2.1/79497 vom 21.01.2008 (SKZ) Mechanikprüfung: 359907/1.4/78722 und Erg. vom 12.06.2007 (SKZ)
Prüfgrundlagen *basis of type examination*	DVGW W 534 (01.05.2004) DVGW W 544 (01.05.2007) BGA KTW (07.01.1977) DVGW W 270 (01.11.1999)
Ablaufdatum / AZ *date of expiry / file no.*	09.03.2013 / 07-0528-WNV

21.08.2008 Fk A-1/2

DAT-ZE-029/95-02

ZERTIFIKAT — SKZ

Verleihungs-Urkunde

Die SKZ - TeConA GmbH verleiht der Firma

WEFA PLASTIC
Kunststoffverarbeitungs GmbH
Benzstraße 24
D-57439 Attendorn

das Recht zum Führen des SKZ-Prüf- und Überwachungszeichens

A 356

für nachstehende Kunststofferzeugnisse

Faserverbundrohre aus PP-R 80 / PP-R 80-GF / PP-R 80
Fertigungsgruppe 1 und 2

Mit der Führung des SKZ-Zeichens ist die Verpflichtung verbunden, bei der Herstellung und Prüfung der Erzeugnisse die vorgeschriebenen Bestimmungen einzuhalten.

Würzburg, 24. März 2003

Leiter der Zertifizierungsstelle

DVGW-Baumusterprüfzertifikat
DVGW type examination certificate

DW-8201AU2132

Anwendungsbereich *field of application*	Produkte der Wasserversorgung *products of water supply*
Zertifikatinhaber *owner of certificate*	WEFA PLASTIC Kunststoffverarbeitungs GmbH Benzstr. 24, D-57439 Attendorn
Vertreiber *distributor*	WEFA PLASTIC Kunststoffverarbeitungs GmbH Benzstr. 24, D-57439 Attendorn
Produktart *product category*	Verbundrohre für die Trinkwasserinstallation: PP/Al/PP-Rohr, Fert.-Gr. 1 (8201)
Produktbezeichnung *product description*	Verbundrohr PP-R/Al/PP-R
Modell *model*	Verbundrohr "Wefa"
Prüfberichte *test reports*	Kontrollprüfung Labor: 259903/2.1/62377 vom 08.03.2004 (SKZ) Mechanikprüfung: 34798/98 vom 05.05.1999 (SKZ) KTW-Prüfung: KR 062A/03 vom 14.04.2003 (TZW)
Prüfgrundlagen *basis of type examination*	DVGW W 542 (01.04.1997) BGA KTW (07.01.1977)
Ablaufdatum / AZ *date of expiry / file no.*	05.05.2009 / 04-0427-WNV

International approvals of WEFA Plastic

DVGW Zertifizierungsstelle

Gas Wasser – Österreichische Vereinigung für das Gas- und Wasserfach ÖVGW

AENOR Producto Certificado

ÖQS

SKZ geprüft überwacht A 356

ON Österreichisches Normungsinstitut Austrian Standards Institute

IQNet

RANNSÓKNASTOFNUN BYGGINGARIÐNAÐARINS – THE ICELANDIC BUILDING RESEARCH INSTITUTE

WaterMark

TIN

Lietuvos Respublikos sveikatos apsaugos ministerija
Ministry of Health Republic of Lithuania

TGM Versuchsanstalt

РЕПУБЛИКА БЪЛГАРИЯ
МИНИСТЕРСТВО НА ЗДРАВЕОПАЗВАНЕТО
MINISTRY OF HEALTH

GW GEPRÜFT

ÉMI

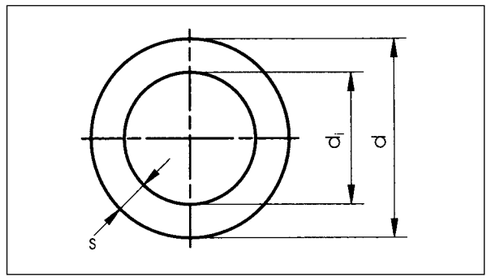
MINISTRY OF ELECTRICITY & WATER

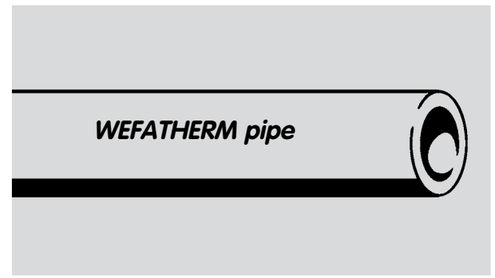
Chapter III
WEFATHERM product overview

WEFATHERM pipe SDR 11

Material:	PP-R
Pressure stage:	PN 10 – SDR 11
Pipe series:	5
To DIN:	8077/78; DIN EN ISO 15874
Delivery form:	in lengths of 4 m
Colour:	grey or green
Areas of application:	cold-water systems/ air conditioning rainwater lines

For the areas of application please see the table 2 „Maximum operational pressures“ under pipe series SDR 11 on P. 6.





20050 to 20059

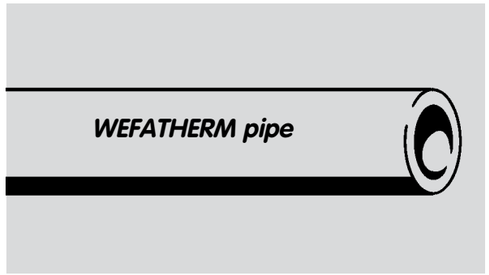
Pipe data			Diameter	Wall thickness	Internal diam.	Water content	Pipe weight	
Article number	Dimension	LE	d mm	s mm	d_i mm	l/m	kg/m	DN
20050	20 x 1,9 mm	100	20	1,9	16,2	0,205	0,110	15
20051	25 x 2,3 mm	100	25	2,3	20,4	0,328	0,167	20
20052	32 x 2,9 mm	40	32	2,9	26,2	0,531	0,267	25
20053	40 x 3,7 mm	40	40	3,7	32,6	0,834	0,412	32
20054	50 x 4,6 mm	20	50	4,6	40,8	1,307	0,638	40
20055	63 x 5,8 mm	20	63	5,8	51,4	2,075	1,010	50
20056	75 x 6,8 mm	12	75	6,8	61,4	2,941	1,420	–
20057	90 x 8,2 mm	12	90	8,2	73,6	4,254	2,030	65
20058	110 x 10,0mm	8	110	10,0	90,0	6,362	3,010	80
20059	125 x 11,4 mm	4	125	11,4	102,2	8,199	3,900	100

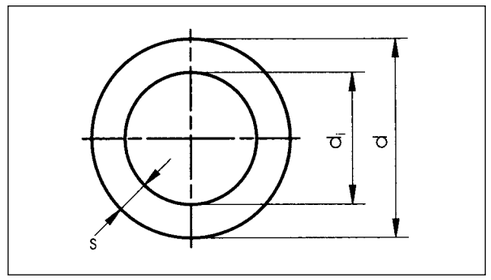
Article-No. with G = green

WEFATHERM pipe SDR 7,4

Material: PP-R
Pressure stage: PN 16 – SDR 7,4
Pipe series: 3,2
To DIN: 8077/78; DIN EN ISO 15874
Delivery form: in lengths of 4 m
Colour: grey or green

Areas of application: hot and cold water installation
central heating systems
air-conditioning





20100 to 20111

Pipe data			Diameter	Wall thickness	Internal diam.	Water content	Pipe weight	
Article number	Dimension	LE	d mm	s mm	d_i mm	l/m	kg/m	DN
20100	16 x 2,3 mm	100	16	2,2	11,6	0,102	0,096	12
20101	20 x 2,8 mm	100	20	2,8	14,4	0,163	0,148	15
20102	25 x 3,5 mm	100	25	3,5	18,0	0,254	0,232	20
20103	32 x 4,4 mm	40	32	4,4	23,2	0,415	0,376	25
20104	40 x 5,5 mm	40	40	5,5	29,0	0,615	0,583	32
20105	50 x 6,9 mm	20	50	6,9	36,2	1,029	0,896	40
20106	63 x 8,6 mm	20	63	8,6	45,8	1,633	1,420	50
20107	75 x 10,3 mm	12	75	10,3	54,4	2,307	2,020	–
20108	90 x 12,3 mm	12	90	12,3	65,4	3,318	2,910	65
20109	110 x 15,1 mm	8	110	15,1	79,8	5,001	4,320	80
20110	125 x 17,1mm	4	125	17,1	90,8	6,470	5,580	100
20111	160 x 21,9 mm	4	160	21,9	116,2	10,600	9,120	125

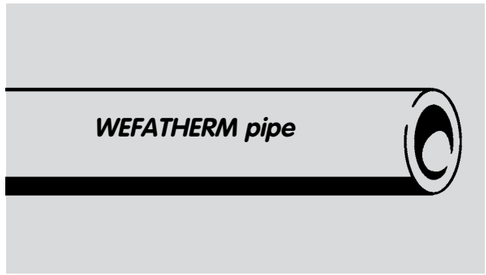
Article-No. with G = green

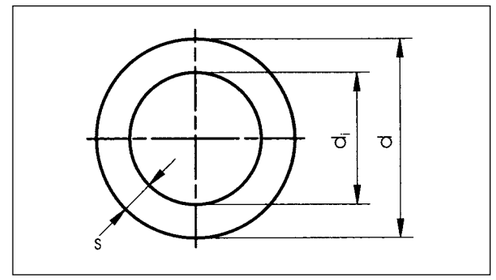
WEFATHERM pipe SDR 6

Material: PP-R
Pressure stage: PN 20 – SDR 6
Pipe series: 2,5
To DIN: 8077/78; DIN EN ISO 15874
Delivery form: in lengths of 4 m/coils
Colour: grey or green

Areas of application: hot and cold water installation
central heating systems
air-conditioning

For the areas of application please see the table 2 „Maximum operational pressures“ under pipe series SDR 6 on P. 6.





20001 to 20011

Pipe data			Diameter	Wall thickness	Internal diam.	Water content	Pipe weight	
Article number	Dimension	LE	d mm	s mm	d_i mm	l/m	kg/m	DN
20001	16 x 2,7 mm	100	16	2,7	10,6	0,088	0,105	10
20002	20 x 3,4 mm	100	20	3,4	13,2	0,137	0,161	12
20003	25 x 4,2 mm	100	25	4,2	16,6	0,216	0,250	15
20004	32 x 5,4 mm	40	32	5,4	21,2	0,353	0,410	20
20005	40 x 6,7 mm	40	40	6,7	26,6	0,556	0,635	25
20006	50 x 8,3 mm	20	50	8,3	33,2	0,866	0,995	32
20007	63 x 10,5 mm	20	63	10,5	42,0	1,385	1,570	40
20008	75 x 12,5 mm	12	75	12,5	50,0	1,963	2,230	50
20009	90 x 15,0 mm	12	90	15,0	60,0	2,827	3,360	–
20010	110 x 18,3 mm	8	110	18,3	73,2	4,208	5,040	65
20011	125 x 20,8 mm	4	125	20,8	83,4	5,460	6,470	80

available in coils:
20015 to 20017

20015	16 x 2,7 mm	100	16	2,7	10,6	0,088	0,105	10
20016	20 x 3,4 mm	100	20	3,4	13,2	0,137	0,161	12
20017	25 x 4,2 mm	100	25	4,2	16,6	0,216	0,250	15

Article-No. with G = green

New

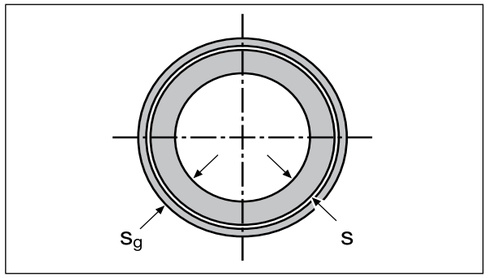
WEFATHERM Stabi pipe SDR 6

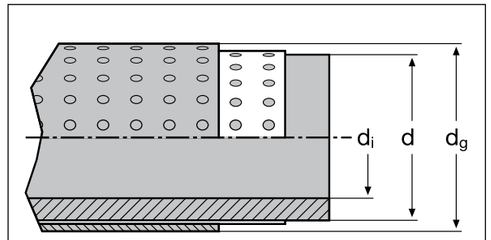
Material: PP-R in combination with aluminium
Pressure stage: PN 20 – SDR 6
Pipe series: 2,5
(d) and (s) to DIN: 8077/78; DIN EN ISO 15874
Delivery form: in lengths of 4 m / coils
Colour: grey or green

Mechanically stabilized by means of integrated combination with aluminium

Areas of application: hot and cold water installation
central heating systems

For the areas of application please see the tables
„Maximum operational pressures“ under pipe series
Table 2 (P. 6) SDR 6
Table 3 (P. 7) SDR 6





20300 to 20310

Pipe data			Diameter	Wall thickness	Internal. Diam.	(d) complete	(s) complete	Water content	Pipe weight	
Article no.	Dimension	LE	d mm	s mm	d_i mm	d_g	s_g	l/m	kg/m	DN
20300	16 x 2,2 mm	100	16	2,2	11,6	17,6	3,0	0,102	0,145	12
20301	20 x 2,8 mm	100	20	2,8	14,4	21,6	3,6	0,163	0,192	15
20302	25 x 3,5 mm	100	25	3,5	18,0	26,8	4,4	0,254	0,297	20
20303	32 x 4,4 mm	40	32	4,4	23,2	33,8	5,4	0,415	0,456	25
20304	40 x 5,5 mm	40	40	5,5	29,0	42,0	6,6	0,615	0,679	32
20305	50 x 6,9 mm	20	50	6,9	36,2	52,0	7,9	1,029	1,044	40
20306	63 x 8,6 mm	20	63	8,6	45,8	65,0	9,7	1,633	1,576	–
20307	75 x 10,3 mm	20	75	10,3	54,4	77,0	11,4	2,307	2,197	60
20308	90 x 12,3 mm	8	90	12.3	65,4	92,0	13,5	3,318	3,230	65
20309	110 x 15,1 mm	8	110	15,1	79,8	113,0	16,7	5,674	4,875	80
20310	125 x 17,1 mm	4	125	17,1	90,8	129,0	19,1	6.472	5.930	100

Article-No. with G = green

New

New

available in coils in three colours:

20314 grey	16 x 2,2 mm	100	16	2,2	11,6	17,6	3,0	0,102	0,145	12
G20314 green										
20317 white										

For pipes diameter 16 mm, internal pipe support Article-No. 20311 is recommended

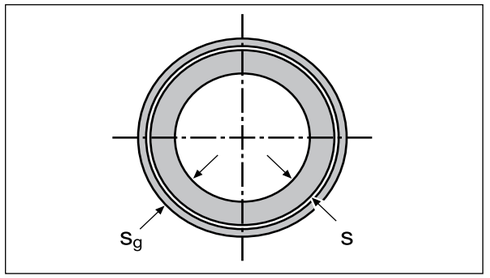
WEFATHERM Stabi pipe SDR 6/UV

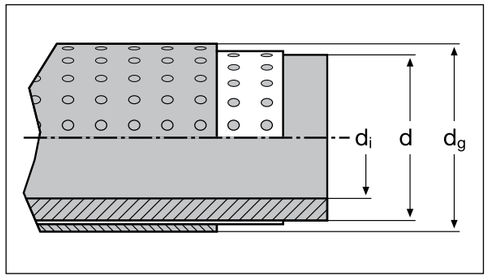
Material: PP-R in combination with aluminium
Pressure stage: PN 20 – SDR 6
Pipe series: 2,5
(d) and (s) to DIN: 8077/78; DIN EN ISO 15874
Delivery form: in lengths of 4 m
Colour: black

Mechanically stabilized by means of integrated combination with aluminium. External layer UV-stabilized

Areas of application: external
hot and cold water installations
central heating systems

For the areas of application please see the tables
„Maximum operational pressures“ under pipe
series Table 2 (P. 6) SDR 6
series Table 3 (P. 7) SDR 6





20370 to 20376

Pipe data			Diameter	Wall thickness	Internal. Diam.	(d) complete	(s) complete	Water content	Pipe weight	
Article no.	Dimension	LE	d mm	s mm	d_i mm	d_g	s_g	l/m	kg/m	DN
20370	20 x 2,8 mm	100	20	2,8	14,4	21,6	3,6	0,163	0,192	15
20371	25 x 3,5 mm	100	25	3,5	18,0	26,8	4,4	0,254	0,297	20
20372	30 x 4,4 mm	40	32	4,4	23,2	33,8	5,4	0,415	0,456	25
20373	40 x 5,5 mm	40	40	5,5	29,0	42,0	6,6	0,615	0,679	32
20374	50 x 6,9 mm	20	50	6,9	36,2	52,0	7,9	1,029	1,044	40
20375	63 x 8,6 mm	20	63	8,6	45,8	65,0	9,7	1,633	1,576	50
20376	75 x 10,3 mm	20	75	10,3	54,4	77,0	11,4	2,307	2,197	60

Article-No. with G = green

WEFATHERM Fiber pipe SDR 7,4

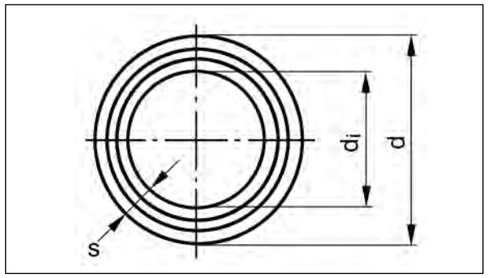
Material: PP-R in compound
Pressure stage: SDR 7,4 (PN 20 factory standard certified)
Pipe series: 3,2
(d) and (s) to DIN: 8077/78; DIN EN ISO 15874
Delivery form: in lengths of 4 m
Colour: grey or green

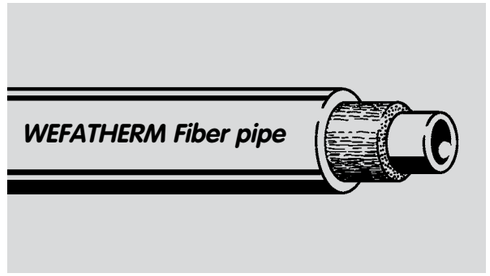
Mechanically stabilized by fiber compound mixture in the middle layer of material PP-R

Identification mark: **4 red stripes**

Areas of application: **hot and cold water installation, central heating systems**

The relationship between application temperature, pressure load an years of operation is shown in table 2, respectively table 3 (P. 6/7).





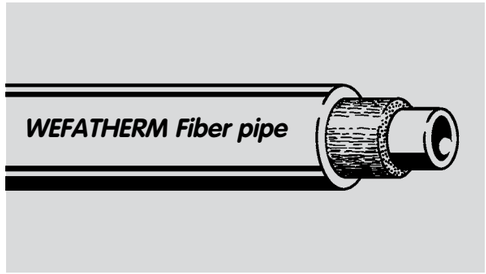
20150 to 20159

Pipe data			Diameter	Wall thickness	Internal diam.	Water content	Pipe weight	
Article number	Dimension	LE	d mm	s mm	d_i mm	l/m	kg/m	DN
20150	20 x 2,8 mm	100	20	2,8	14,4	0,163	0,156	15
20151	25 x 3,5 mm	100	25	3,5	18,0	0,254	0,237	20
20152	32 x 4,4 mm	40	32	4,4	23,2	0,415	0,380	25
20153	40 x 5,5 mm	40	40	5,5	29,0	0,615	0,607	32
20154	50 x 6,9 mm	20	50	6,9	36,2	1,029	0,901	40
20155	63 x 8,6 mm	20	63	8,6	45,8	1,633	1,440	50
20156	75 x 10,3 mm	20	75	10,3	54,4	2,307	2,090	–
20157	90 x 12,3 mm	12	90	12,3	65,4	3,318	2,983	65
20158	110 x 15,1 mm	8	110	15,1	79,8	5,674	4,387	80
20159	125 x 17,1 mm	4	125	17,1	90,8	6,472	5,580	100

Article-No. with G = green

Chapter I The WEFATHERM pipe system | Chapter II WEFATHERM system quality | Chapter III Product range | Chapter IV Welding and processing techniques | Chapter V Installation | Chapter VI Planning and design

WEFATHERM Fiber pipe of the newest generation



In cooperation with the plastic laboratoy of the group WEFA Plastic has developed a new compound representing a revolutionary improvement in the area of PP-R systems.

WEFATHERM PP-R Fiber pipe
3-layer Fiber compound technology at a glance
(SDR 7.4)

Low thermal expansion!
- No bending after installation
- Professional work guaranteed

High flow rate!
- 20 % higher flow rate with fiber pipe SDR 7.4

No UV transparency!
- No grow of algae
- No grow of bacterias
- Hygienic approval

High temperature resistance!
- Higher temperature resistance as plain pipe
- Higher pressure resistance as plain pipe
- More safety

Economical solution!
- Just cut and weld

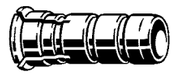
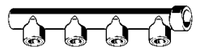
Comparison to copper pipes

Flow value V (l/s) in dependence of flow rate v (m/s)

Copper pipes according to DIN 1786		
Dimension	d_i (mm)	V_{max} (l/s) at v = 2,5 m/s
18,0 x 1,0 mm	16,0	0,50
22,0 x 1,0 mm	20,0	0,80
28,0 x 1,5 mm	25,0	1,25
35,0 x 1,5 mm	32,0	2,00
42,0 x 1,5 mm	39,0	3,00
54,0 x 2,0 mm	50,0	5,00
64,0 x 2,0 mm	60,0	7,20
76,1 x 2,0 mm	72,1	10,00
88,9 x 2,0 mm	84,9	14,00

Compound pipe SDR 7,4/PN 16		
Dimension	d_i (mm)	V_{max} (l/s) at v = 2,5 m/s
20 x 2,8 mm	14,4	0,40
25 x 3,5 mm	18,0	0,65
32 x 4,4 mm	23,0	1,00
40 x 5,5 mm	28,8	1,60
50 x 6,9 mm	36,2	2,55
63 x 8,6 mm	45,6	4,10
75 x 10,3 mm	54,2	5,75
90 x 12,3 mm	65,0	8,30
110 x 15,1 mm	79,6	12,00
125 x 17,1 mm	90,8	15,50

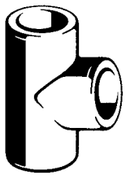
Fittings

Art-No.	Unit	Dimension	Description	Type
20311 20312	10 10	16 x 2,2 mm 16 x 2,0 mm	Pipe support case	
20500 20501 20502 20503	10 10 10 10	16 mm 20 mm 25 mm 32 mm	Bridge	
20600 20602	1 1	Ø 25-4 x 16 Ø 32-4 x 20	Distributor manifold	
20604 20606	1 1	Ø 32-4 x 1/2" Ø 40-4 x 1/2"	Distributor manifold with female thread	
20608 20610	1 1	Ø 32-4 x 1/2" Ø 40-4 x 1/2"	Distributor manifold with male thread	
21100 21101 21002 21003 21004	10 10 10 10 10	16 mm 20 mm 25 mm 32 mm 40 mm	Long bend 90° welding socket on both ends	
21001 21002 21003 21004 21005 21006 21007 21008 21009 21010 21011 21012	10 10 10 10 5 5 1 1 1 1 1 1	16 mm 20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm 125 mm 160 mm	Elbow 90°	
22000 22001 22002 22003	10 10 10 10	16 mm 20 mm 25 mm 32 mm	Elbow 90° female / male	

Article-No. with G = green

All WEFATHERM Fittings are PN 25 (except WEFATHERM Fitting PN 16: 160 mm)

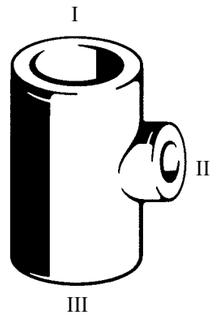
Fittings

Art-No.	Unit	Dimension	Description	Type
22100 22101 22102	10 10 5	20 mm 25 mm 32 mm	Elbow 45° female / male	
23001 23002 23003 23004 23005 23006 23007 23008 23009 23010 23011 23012	10 10 10 10 5 5 1 1 1 1 1 1	16 mm 20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm 125 mm 160 mm	Elbow 45°	
24001 24002 24003 24004 24005 24006 24007 24008 24009 24010 24011 24012	10 10 10 10 5 5 1 1 1 1 1 1	16 mm 20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm 125 mm 160 mm	T-piece 90°	

Article-No. with G = green

All WEFATHERM Fittings are PN 25 (except WEFATHERM Fitting PN 16: 160 mm)

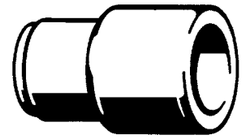
Fittings

Art-No.	Unit	Dimension	Description	Type
		I II III	T-piece 90°, red.	
25001	10	20 x 16 x 20		
25002	10	25 x 16 x 25		
25003	10	25 x 20 x 25		
25004	10	32 x 20 x 32		
25005	10	32 x 25 x 32		
25006	5	40 x 20 x 40		
25007	5	40 x 25 x 40		
25008	5	40 x 32 x 40		
25029	5	50 x 20 x 50		
25009	5	50 x 25 x 50		
25010	5	50 x 32 x 50		
25011	5	50 x 40 x 50		
25012	1	63 x 20 x 63		
25013	1	63 x 25 x 63		
25014	1	63 x 32 x 63		
25015	1	63 x 40 x 63		
25016	1	63 x 50 x 63		
25017	1	75 x 20 x 75		
25018	1	75 x 25 x 75		
25019	1	75 x 32 x 75		
25020	1	75 x 40 x 75		
25021	1	75 x 50 x 75		
25022	1	75 x 63 x 75		
25023	10	32 x 32 x 25		
25024	10	25 x 20 x 20		
25025	10	20 x 25 x 25		
25026	10	32 x 20 x 25		
25028	10	32 x 25 x 25		
25032	1	90 x 63 x 90		
25033	1	90 x 75 x 90		
25034	1	110 x 63 x 110		
25035	1	110 x 75 x 110		
25036	1	110 x 90 x 110		
25037	1	125 x 75 x 125		
25038	1	125 x 90 x 125		
25039	1	125 x 110 x 125		
25044	1	160 x 90 x 160		
25045	1	160 x 110 x 160		

Article-No. with G = green

All WEFATHERM Fittings are PN 25 (except WEFATHERM Fitting PN 16: 160 mm)

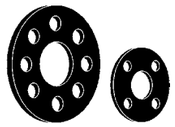
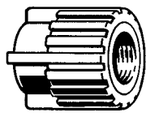
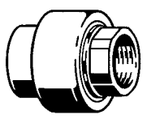
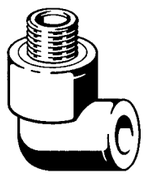
Fittings

Art-No.	Unit	Dimension	Description	Type
25101	10	32 mm	Cross / PN 16	
25102	5	40 mm		
25103	1	50 mm		
25104	1	63 mm		
26001	10	20 / 16	Red piece	
26002	10	25 / 16		
26003	10	25 / 20		
26004	10	32 / 20		
26005	10	32 / 25		
26006	5	40 / 20		
26007	5	40 / 25		
26008	5	40 / 32		
26009	5	50 / 20		
26010	5	50 / 25		
26011	5	50 / 32		
26012	5	50 / 40		
26013	1	63 / 40		
26014	1	63 / 25		
26015	1	63 / 32		
26016	1	63 / 50		
26017	1	75 / 50		
26018	1	75 / 63		
26019	1	90 / 63		
26020	1	90 / 75		
26025	1	110 / 90		
26026	1	125 / 110		
26032	1	160 / 110		
26033	1	160 / 125		
27001	10	16 mm	Socket	
27002	10	20 mm		
27003	10	25 mm		
27004	10	32 mm		
27005	5	40 mm		
27006	5	50 mm		
27007	1	63 mm		
27008	1	75 mm		
27009	1	90 mm		
27010	1	110 mm		
27011	1	125 mm		
28001	10	16 mm	End-cap	
28002	10	20 mm		
28003	10	25 mm		
28004	10	32 mm		
28005	5	40 mm		
28006	5	50 mm		
28007	5	63 mm		
28008	1	75 mm		
28009	1	90 mm		
28010	1	110 mm		
28011	1	125 mm		
28012	1	160 mm		

Article-No. with G = green

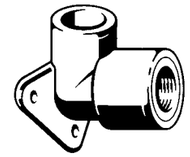
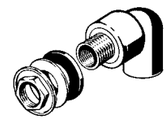
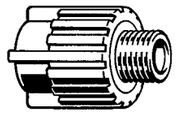
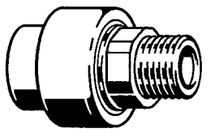
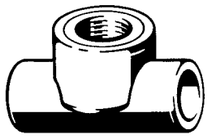
All WEFATHERM Fittings are PN 25 (except WEFATHERM Fitting PN 16: 160 mm)

Transition pieces

Art-No.	Unit	Dimension	Description	Type
28020 28021 28022 28023 28024 28025 28026 28027 28028	1 1 1 1 1 1 1 1 1	32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm 125 mm 160 mm	Flange sleeve with seal	
28030	10	7 / 11 mm	Pin for pipe repair	
28040 28041 28042 28043 28044 28045 28046 28047 28048	1 1 1 1 1 1 1 1 1	32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm 125 mm 160 mm	Plastic flange glass fiber reinforced for flange sleeve PN 10/16	
28100 28101 28102 28103 28104	10 10 10 10 10	16 x 1/2” 20 x 1/2” 20 x 3/4” 25 x 1/2” 25 x 3/4”	Transition-piece round / female	
28204 28205 28206 28207 28208 28213	5 5 1 1 1 1	32 x 1″ 40 x 1 1/4″ 50 x 1 1/2″ 63 x 2″ 75 x 2″ 125 x 5″	Transition-piece hexagon / male	
28300 28301 28302 28303 28304 28305 28306	10 10 10 10 10 10 5	16 x 1/2″ 20 x 1/2″ 20 x 3/4″ 25 x 1/2″ 25 x 3/4″ 32 x 3/4″ 32 x 1″	Transition-angle / female	
28400 28401 28402 28403 28404 28405 28406	10 10 10 10 10 10 5	16 x 1/2″ 20 x 1/2″ 20 x 3/4″ 25 x 1/2″ 25 x 3/4″ 32 x 3/4″ 32 x 1″	Transition-angle / male	

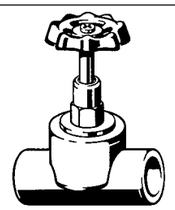
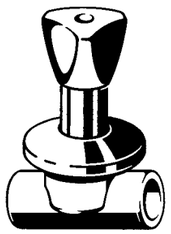
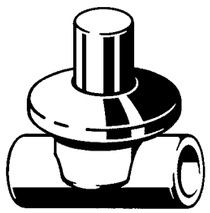
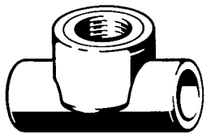
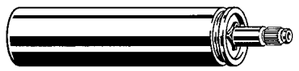
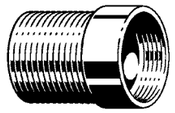
Article-No. with G = green

Transition pieces

Art-No.	Unit	Dimension	Description	Type
29001 29002 29003 29004 29005	10 10 10 10 10	16 x 1/2″ 20 x 1/2″ 20 x 3/4″ 25 x 1/2″ 25 x 3/4″	Flush-wall-disk / female	
29020 29021	10 10	20 x 1/2″ female x 3/4″ male 25 x 1/2″ female x 3/4″ male	Connection angle incl. counternut, seal and chuck	
29030	10	20 x 1/2″ female x 3/4″ male	Connection angle for cavity wall screw thread 30 mm incl. counternut, seal and chuck	
29100 29101 29102 29103 29104	10 10 10 10 10	16 x 1/2″ 20 x 1/2″ 20 x 3/4″ 25 x 1/2″ 25 x 3/4″	Transition-piece round / male	
29204 29205 29206 29207 29208 29209 29210 29211 29213	5 5 1 1 1 1 1 1 1	32 x 1″ 40 x 1 1/4″ 50 x 1 1/2″ 63 x 2″ 75 x 2 1/2″ 90 x 3″ 110 x 3″ 110 x 4″ 125 x 5″	Transition-piece hexagon / male	
29300 29301 29302 29303 29304 29305 29306	10 10 10 10 10 10 5	16 x 1/2″ x 16 20 x 1/2″ x 20 20 x 3/4″ x 20 25 x 1/2″ x 25 25 x 3/4″ x 25 32 x 3/4″ x 32 32 x 1″ x 32	Transition T-piece / female	

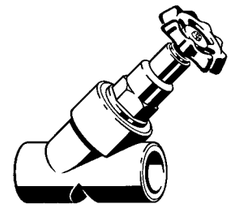
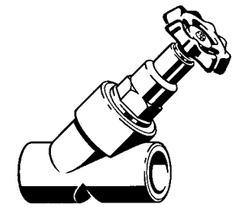
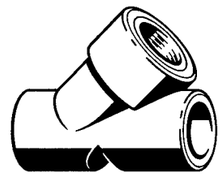
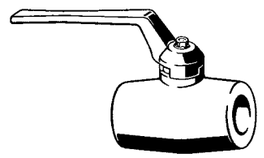
Article-No. with G = green

Stop valve straigth type

Art-No.	Unit	Dimension	Description	Type
29500 29501 29502	1 1 1	20 mm 25 mm 32 mm	Stop valve for surface assembly	
29510 29511 29512	1 1 1	20 mm 25 mm 32 mm	Stop valve for mounted assembly	
29515 29516	1 1	20 mm 25 mm	Stop valve for flush mounted installation chromium-plated public authority execution	
29530 29531 29532	1 1 1	20 mm 25 mm 32 mm	Stop valve lower part	
29520	1	95 mm suitable for Article-No. 29510/29511/29512	Extension for WEFATHERM burled valve, chromium plated	
29521	1	30 mm suitable for Article-No. 29515/29516	Extension	

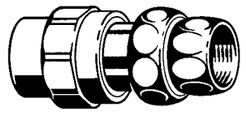
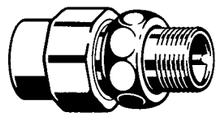
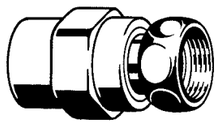
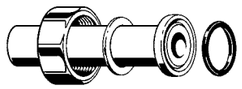
Article-No. with G = green

Stop valve Y-Type

Art-No.	Unit	Dimension	Description	Type
29540 29541 29542	1 1 1	25 mm 32 mm 40 mm	Y-valve without drainage	
29550 29551 29552	1 1 1	25 mm 32 mm 40 mm	KFR valve without drainage	
29560 29561 29562 29563	1 1 1 1	20 mm 25 mm 32 mm 40 mm	Outflow connection piece to be welded into Y-valves	
29570 29571 29572	1 1 1	25 mm 32 mm 40 mm	Y-valve lower part	
25580 25581 25582 25583 25584 25585 25586	1 1 1 1 1 1 1	20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm	Ball valve	

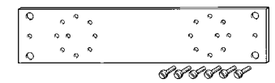
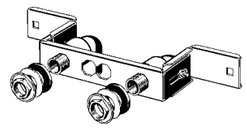
Article-No. with G = green

Transition unions

Art-No.	Unit	Dimension	Description	Type
29600 29601 29602 29603 29604 29605 29606 29607 29608 29609 29610	10 10 10 10 10 5 5 1 1 1 1	16 – 1/2” 20 – 1/2” 20 – 3/4” 25 – 1/2” 25 – 3/4” 32 – 1” 32 – 3/4” 40 – 1 1/4” 50 – 1 1/2” 63 – 2” 75 – 2 1/2”	Pipe-screwing	
29700 29701 29702 29703 29704 29705 29706 29707 29708 29709 29710	10 10 10 10 10 5 5 1 1 1 1	16– 1/2” 20 – 1/2” 20 – 3/4” 25 – 1/2” 25 – 3/4” 32 – 1” 32 – 3/4” 40 – 1 1/4” 50 – 1 1/2” 63 – 2” 75 – 2 1/2”	Pipe-screwing	
29800 29801 29802 29803 29804 29805 29806 29807 29808 29809 29810	10 10 10 10 10 5 5 1 1 1 1	16 – 3/4” 20 – 3/4” 20 – 1” 25 – 3/4” 25 – 1” 32 – 1” 32 – 1 1/4” 40 – 1 1/2” 50 – 1 3/4” 63 – 2 3/8” 75 – 2 3/8”	Pipe-screwing	
29850 29852 29854	1 1 1	16 – 3/4” 20 – 1” 25 – 1 1/4”	Connector with joint ring only in grey	

Article-No. with G = green

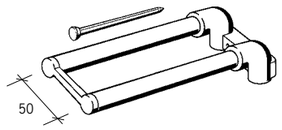
Assembly sets

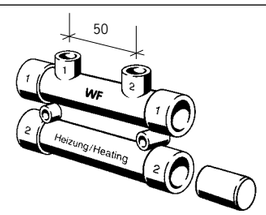
Art-No.	Unit	Dimension	Description	Type
34000	1		Mounting plate for the attachment of flush wall disks as double connection	
34120	1		Mounting unit double incl. 2 connection angles (Article-No. 29020)	

Article-No. with G = green

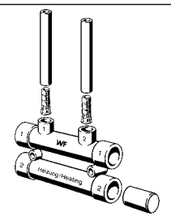
Radiator connection system

New

Art-No.	Unit	Dimension	Description	Type
29900		16 x 2,0 mm	WEFATHERM Connection bend incl. 1 fastening plug Colour: white	

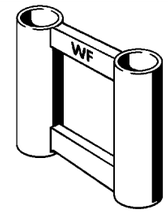
Art-No.	Unit	Dimension	Description	Type
29910	1	20/16 mm	WEFATHERM Distributor block for base board or floor connection incl. 1 piece drain plug 20 mm Colour: white	

Passage: 2 x 20 mm socket, exit: 2 x 16 mm socket

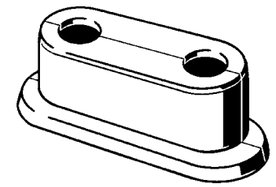
Art-No.	Unit	Dimension	Description	Type
29911	1	20/16 mm	WEFATHERM Distributor block - set for base board or floor connection incl. 1 piece drain plug 20 mm and 2 pieces pipe parts Ø 16 mm, L: 100 mm and 2 pieces support shell made of brass Ø 11,7 mm Colour: white	

Passage: 2 x 20 mm socket, exit: 2 x 16 mm socket

Radiator connection system

Art-No.	Unit	Dimension	Description	Type
29920	10	for pipes up to Ø 17 mm, pipe distance 50 mm	WEFATHERM Protection steeve Colour: white	

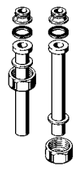
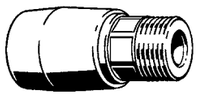
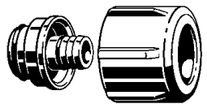
To protect the vertical connecting pipes between floor and radiator

Art-No.	Unit	Dimension	Description	Type
29922	Dimension	for pipes up to Ø 17 mm, pipe distance 50 mm	WEFATHERM Double - cap rosette Colour: white	

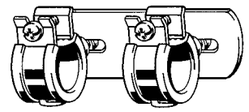
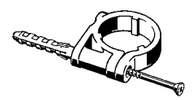
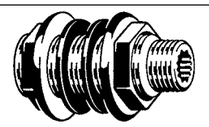
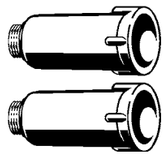
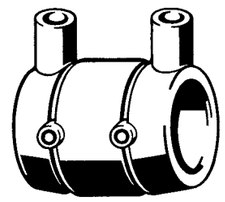
To cover connection pipes coming out of the floor

Art-No.	Unit	Dimension	Description	Type
29924	10	16 mm	WEFATHERM Elbow 90° Colour: white	

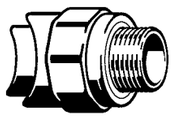
Radiator connection system

Art-No.	Unit	Dimension	Description	Type
29926	10	16 mm i./o.	Elbow male / female 90° Colour: white	
29945	10	16 mm	End-cap Colour: white	
29950	10	16 mm	Socket Colour: white	
29930	1	16 mm with nut R 3/4“ + Euro Konus	Radiator connection set Colour: white Brass: Chromium-plated	
29940	10	16 mm x 1/2“ male	Radiator connection unit Colour: white Brass: Chromium-plated	
29955	1	16 x 2,2 mm 3/4“ Euro-Konus for Stabi-Pipe 16 x 2,2 mm	Compression joint	

Pipe Clamps

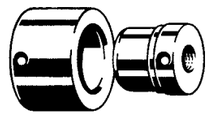
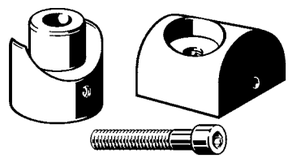
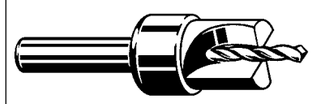
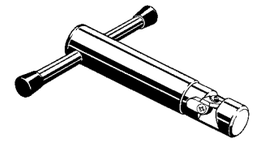
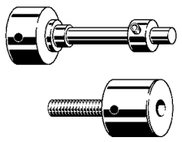
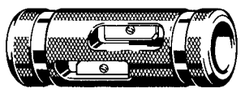
Art-No.	Unit	Dimension	Description	Type
34200 34201 34202 34203 34204 34205 34206 34207 34208 34209 34210	1 1 1 1 1 1 1 1 1 1 1	16 mm 20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm 125 mm	Pipe clamp (single) suited for both sliding and fixed-position mounting	
34300 34301 34302 34303 34304 34305 34306 34307	1 1 1 1 1 1 1 1	16 mm 20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm	Pipe clamp for fixed point	
34401 34402 34403	1 1 1	20 mm 25 mm 32 mm	Pipe clamp for fixed point	
35000	1	1/2“	Cavity-wall-disk	
36100 36101	1 1	1/2“ male red 1/2“ male blue	Plugs for pressure test	
50001 50002 50003 50004 50005 50006 50007 50008 50009	1 1 1 1 1 1 1 1 1	20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm	Electric welding sleeve 220 V suitable with Article-No. 31010 PN 16/PN 10 available only in grey	
50012 50013	1 1	125 mm 160 mm	Electric welding sleeve 40 V PN 16	

Weld in saddle

Art-No.	Unit	Dimension	Description	Type
28052 28053 28054 28055 28056 28057 28058 28059 28060 28061 28062 28063 28064 28065	1 1 1 1 1 1 1 1 1 1 1 1 1 1	40 – 20 mm 40 – 25 mm 50 – 20 mm 50 – 25 mm 63 – 20 mm 63 – 25 mm 75 – 20 mm 75 – 25 mm 90 – 20 mm 90 – 25 mm 110 – 20 mm 110 – 25 mm 125 – 20 mm 125 – 25 mm	WEFATHERM weld in saddle with welding sleeve	
28071 28072 28073 28074 28075 28076 28077 28171 28172 28173 28174 28175 28176 28177	1 1 1 1 1 1 1 1 1 1 1 1 1 1	40 – 1/2” 50 – 1/2” 63 – 1/2” 75 – 1/2” 90 – 1/2” 110 – 1/2” 125 – 1/2” 40 – 3/4” 50 – 3/4” 63 – 3/4” 75 – 3/4” 90 – 3/4” 110 – 3/4” 125 – 3/4”	WEFATHERM weld in saddle / female	
28081 28082 28083 28084 28085 28086 28087 28181 28182 28183 28184 28185 28186 28187	1 1 1 1 1 1 1 1 1 1 1 1 1 1	40 – 1/2” 50 – 1/2” 63 – 1/2” 75 – 1/2” 90 – 1/2” 110 – 1/2” 125 – 1/2” 40 – 3/4” 50 – 3/4” 63 – 3/4” 75 – 3/4” 90 – 3/4” 110 – 3/4” 125 – 3/4”	WEFATHERM weld in saddle / male	

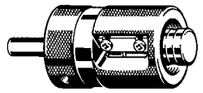
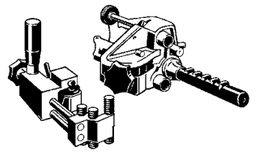
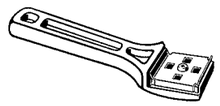
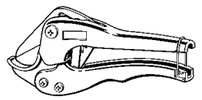
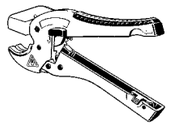
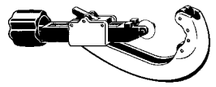
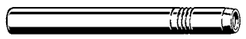
Article-No. with G = green

Tools

Art-No.	Unit	Dimension	Description	Type
30001 30002 30003 30004 30005 30006 30007 30008 30009 30010 30011	1 1 1 1 1 1 1 1 1 1 1	16 mm 20 mm 25 mm 32 mm 40 mm 50 mm 63 mm 75 mm 90 mm 110 mm 125 mm	Welding tool	
30051 30052 30053 30054 30055 30056 30057	1 1 1 1 1 1 1	40 – 25 mm 50 – 25 mm 63 – 25 mm 75 – 25 mm 90 – 25 mm 110 – 25 mm 125 – 25 mm	Welding tool for weld in saddles of Article-No. 28052–28086	
30070	1	25 mm	Drill for weld in saddles	
30075	1	25 mm	Chamfering device for weld in saddles	
30080 30081	1 1	7 mm 11 mm	Repair set to close holes for Article-No. 28030	
34100 34101 34102 34103 34104 34105 34106 34107	1 1 1 1 1 1 1 1	16 + 20 mm 20 + 25 mm 32 + 40 mm 50 + 63 mm 75 mm 90 mm 110 mm 125 mm	Peeling-tool for Stabi pipe May be modified to accommo- date increased peeling depths in order to connect the Stabi pipe with electric welding sleeves.	
38001	1		Replacement knife for peeling tool	

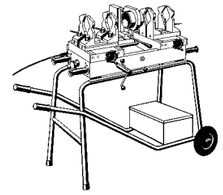
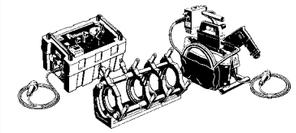
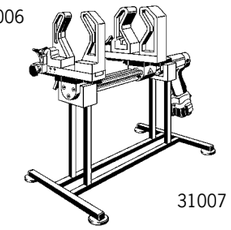
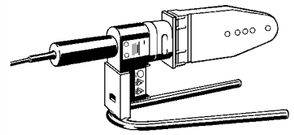
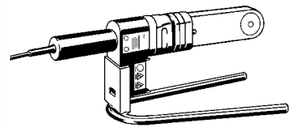
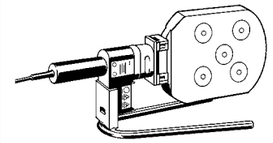
Article-No. with G = green

Tools

Art-No.	Unit	Dimension	Description	Type
35100 35101 35102 35103	1 1 1 1	16 mm 20 mm 25 mm 32 mm	Peeling-tool for Stabi pipe incl. mandrel to load into drilling machine. May be modified to accommodate increased peeling depths in order to connect the Stabi pipe with electric welding sleeves.	
35110	1		Replacement knife for peeling tool	
31020	1	20 – 225 mm	Peeling devices for safe removal of oxide skin on PP-R pipes. Peeling knife made of hard metal. Including spare peeling knife and oil maintenance spray.	
31030	1		Manual scraper for removal of oxide skin on PP-R pipes. Spare blades: 5 per pack (Article-No. 31031)	
31031	1		Replacement knife for manual scraper (Article-No. 31030)	
32001	1	16 – 40 mm	Pipe shears	
32002	1	0 – 42 mm	Profi-Cut pipe cutter	
32010	1	50 – 125 mm	Pipe cutter	
31100	1		Heat chalk (colour changing) for checking correct welding temperature	

Article-No. with G = green

Welding devices

Art-No.	Unit	Dimension	Description	Type
31003	1	25 – 125 mm	WEFATHERM Welding machine (1400 W) for pipe diameter Ø 25 – 125 mm without welding tools	
31004	1	160 – 250 mm	WEFATHERM Butt welding machine (1880 W) electrohydraulic gearcase / machine body 160 mm / milling cutter / heating plate support	
31006	1	63 – 125 mm	WEFATHERM Storage battery-welding tool for PP-R pipes and fittings Ø 63 – 125 mm	31006  31007
31007	1		Rack for Article-No. 31006	
31000	1	16 – 63 mm	WEFATHERM Manual welding device (800 W) for taking up two tools with stand and case	
31002	1	16 – 25 mm	WEFATHERM Manual welding device (500 W) with stand and case for taking up one tool	
31005	1	16 – 125 mm	WEFATHERM Manual welding device (1400 W) with stand and case for taking up five tools	

Article-No. with G = green

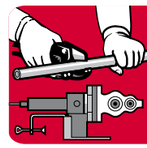
Welding devices

Art-No.	Unit	Dimension	Description	Type
31010	1	20 – 110 mm	WEFATHERM Electric welding device for electric welding sleeves 220 V	
31011	1		Electric welding device for electric welding sleeves 40 V	
36110	1		WEFATHERM Repair set for the exchange of 1/2“ threaded insert	

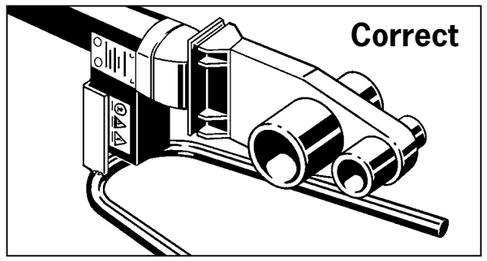
Article-No. with G = green

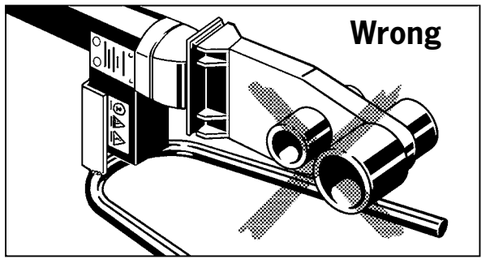
Chapter IV
Welding and processing techniques

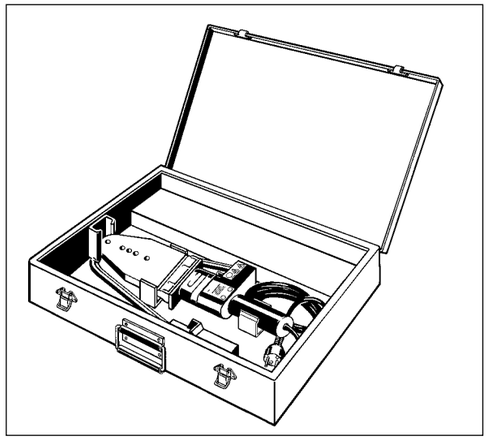
Page



Welding device and tool







1. Only WEFATHERM welding devices and tools may be used for welding WEFATHERM pipes and WEFATHERM Stabi pipes.
2. Tighten up the threaded inserts for holding the tools in cold condition firmly with the Allen wrench and clean with a fibre-free cloth or paper if necessary. Screw on the tools hand tight. They may not extend beyond the edge of the tongue!
3. Switch on the device. The thermostat lamp and control lamp must now light up. Set the thermostat to 260°C. The heating-up process has been completed when the thermostat lamp goes out.
4. Tighten up the tools once again with the Allen key. Never tighten up a tool with pliers or other tools since this would damage the coating and could make the tool unusable.
5. The welding tools have to be mounted according to the diameters thus the edges do not loom over the heating device. Tools from diameter 40 on are always to be installed at the back hole.
6. Plug in welding device and control whether green operating lamp is switched on. The warm-up phase takes between 5 and 20 minutes depending on the outside temperature. The welding device is operational as soon as the orange lamp is switched on.
7. After the device has been switched off, wait until it has cooled down. Never cool down the device with water! Danger of injury! In addition electronic parts such as the thermostat could be damaged. Remove contamination with a fibre-free cloth or paper as well as alcohol if necessary.
8. The device may only be used when it is in a dry state. It must be stored in dry and dust-free conditions.
9. Proper functioning of the device can only be guaranteed when the tongue and tools are in perfect condition. Defective or contaminated parts must always be replaced.

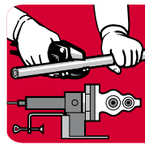
Preparations and operation

Before starting assembly, the welding tools have to be checked for impurities. If necessary, the welding tool needs to be cleaned by a non-fibrous cotton cloth or rough paper cloth and possibly also with spirit. While doing so, the Teflon coating of the tools must not be mechanically damaged.

General guidelines for heated-sleeve welding to DVS 2207 Part 11 Table 5

Decisive data for heated-sleeve welding				
Pipe outside diameter	**Welding depth**	**Heating-up time**	**Processing time**	**Cooling-down time**
mm	mm	sec.	sec.	min.
16	13	5	4	2
20	14	5	4	2
25	15	7	4	2
32	17	8	6	4
40	18	12	6	4
50	20	18	6	4
63	26	24	8	6
75	29	30	8	8
90	32	40	8	8
110	35	50	8	8
125	41	60	10	8

If welding is to be carried out outdoors when the temperature is below + 5 °C, the heating-up time in accordance with DVS 2207 Part 11 should be increased by 50 %.

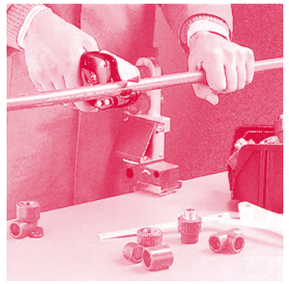


Safety instructions and guidelines

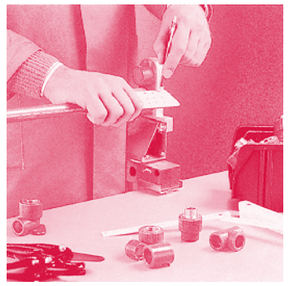
The general industrial hygiene and accident prevention regulations of the particular country or state in which the device is to be used are to be observed. In addition: General Guidelines DVS 2208 Part 1 of the German Association for Welding Techniques.

Welding instructions for butt-welding with WEFATHERM pipe 160 mm. General guidelines for butt-welding to DVS 2207 Part 11 or the operating instructions from machine manufacture. The butt-welding temperature should be 210 °C.

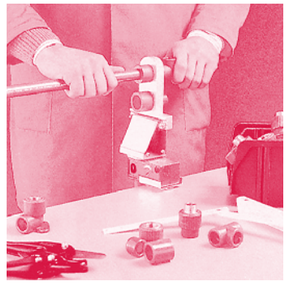
Processing times, welding depths



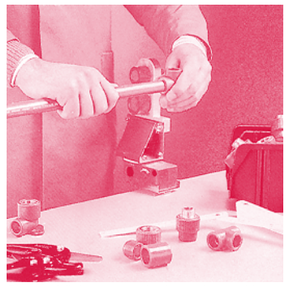
The pipe is cut.



The welding depth is marked with a gauge and suitable marker



Pipe and fitting are heated up (device 260°C ± 10°C).



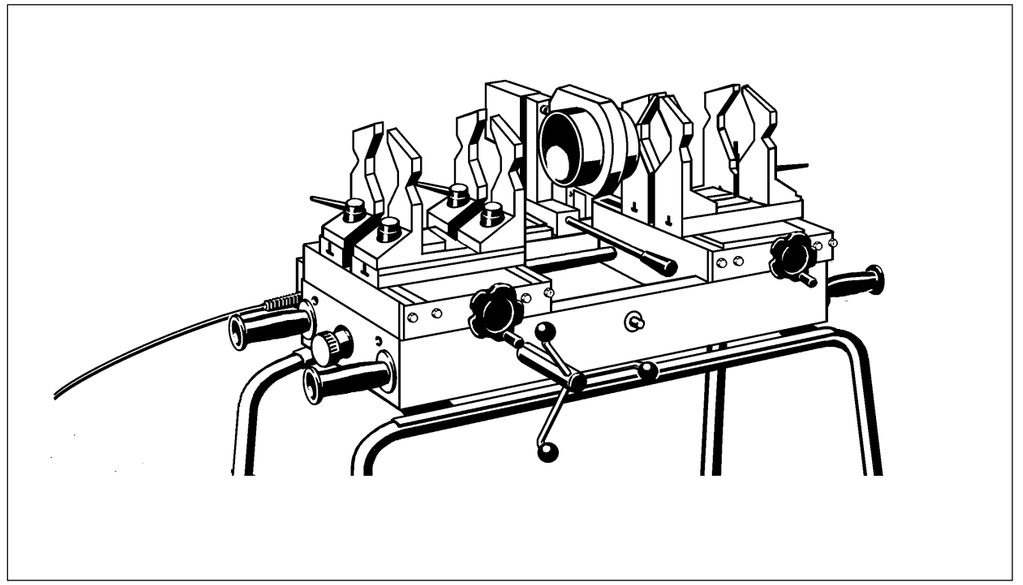
Pipe and fitting are pushed together and become joined in an inseparable manner (do not rotate relative to one another and wait until the cooling time has expired).

1. Prepare the welding device and make it ready for operation as described in part I.
2. Cut the pipe at right angles to the axis of the pipe (Use only WEFATHERM pipe cutters or other suitable pipe-cutting wrenches!)
3. Remove any cutting chips and deburr the pipe.
4. Mark the welding depth with a gauge and suitable marker
5. Align the position of the fitting with the aid of the auxiliary marking on the fitting and the continuous line on the pipe
6. In the case of Stabi pipes, remove the aluminium cover with the aid of the peeling tool up to the depth of welding. (Use only original WEFATHERM peeling devices with blades in perfect condition! Replace blunt peeling blades!)
7. Insert the end of the pipe into the heating sleeve up to the marked welding depth without turning it and at the same time slide the fitting without turning it on to the heating mandrel up to the stop. Observe the heating-up time given in table 5 on P. 51 without fail!

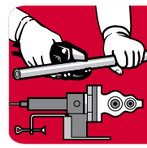
   IMPORTANT: Timing for the heating-up time should not be commenced until the welding depth on the heating sleeve or the stop on the heating mandrel have been reached!
8. At the end of the heating-up time, draw the pipe rapidly from the sleeve and the fitting rapidly from the mandrel and push them together immediately up to the point at which the mark indicates the welding depth, being covered by the bead that will have formed. During this process do not rotate pipe and fitting relative to one another.

   IMPORTANT: In order to prevent the internal diameter of the pipe being reduced or in an extreme case to prevent the pipe being closed, do not insert the pipe too far into the fitting!
9. During the processing time keep the pipe and fitting in constant position relative to one another. (The parts which have been welded can still be aligned relative to one another during this phase but may not be twisted relative to one another!) The welded item can be fully loaded immediately with completion of the cooling time. This welding technique produces an inseparable union. The material of the fitting and of the pipe will have melded together with one another.

WEFATHERM welding machine



The WEFATHERM welding machine for heated-sleeve welding of PP-R pipes and fittings with diameters in the range 25 - 125 mm. The axial movements are brought about by a transport wheel and a toothed rod. V-shaped fixtures of hardened steel are provided as clamping tools for holding the workpieces. These permit the workpieces to be clamped in a manner independently of their external diameter. Two V-shaped clamps are provided on the pipe side and a single one with insert stop on the fitting side. The two tool carriages can be aligned axially. The insertion depth for welding is limited by a stop. The electronically controlled welding reflector, which can be swung into the machine, holds the heating tools which are provided with an anti-stick coating. A steel case is provided for keeping the machine and accessories in.



Operating instructions for the WEFATHERM welding machine

Part A: Setting up the welding machine

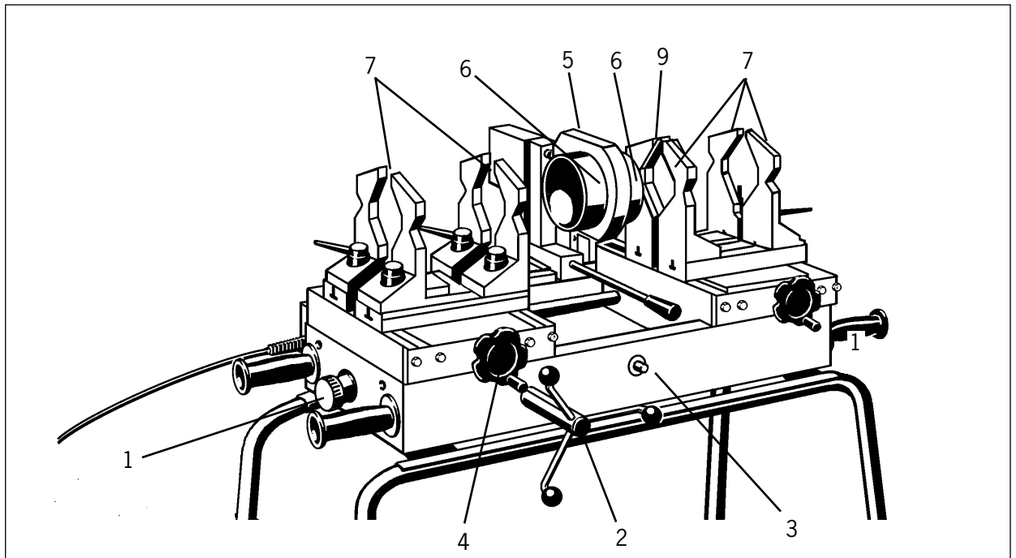
1. Remove the machine and accessories from the metal case and place the machine on a suitable non-slip base; clamp it if necessary.
2. Slide welding reflector (No. 5) into guide.
3. Fold welding reflector (No. 5) between the clamping tools (No. 7) and adjust if necessary.

Part B: Aligning the welding machine

1. Select a heating mandrel (No. 6) and a heating sleeve (No. 6) in accordance with the dimensions of the pipe and fitting and fit them on the tongue (heating mandrel on the right, heating sleeve on the left).
2. Unscrew the clamping tools (No. 7) in accordance with the diameter of the pipe and fitting.
3. Clean tools, pipe and fitting with fibre-free, undyed paper and alcohol on the inside and outside.
4. Heat up the welding reflector and set the welding temperature (260°C), observing manufacturer's instructions. The processing temperature has been reached and the device is ready for use when the control lamp goes out.

Part C: Welding

1. Press fitting into clamping tool (No. 7) up to the stop (No. 9) and clamp firmly.
2. Push the button (No. 3).
3. Move the carriage with handwheel (No. 2) up to stop (No. 3) and secure with locking screw (No. 4). Insert WEFATHERM pipe, WEFATHERM Stabi pipe or WEFATHERM Fiber pipe, the end of which has been cut at right angles, into the fitting in such a way that its face is in contact with the fitting. Clamp firmly with clamping tools (No. 7).
4. Set diameter stop (No. 1) to the diameter to be processed.
5. Check welding reflector temperature and adjust if necessary.
6. Swing in welding reflector (No. 5).
7. Slide in both parts to be welded at the same time up into the heating tools (No.6) up to the stops and hold in this position for the heating-up time (for heating-up times see table 5, P. 51).
8. After the heating-up time has expired, move the carriages rapidly back and swing out mirror (No.5). Then move up pipe and press it into the fitting up to the stop and lock it in this position.
9. Remove the welded parts from the machine and align if necessary but do not rotate them relative to one another! After the cooling-down time has expired, the welded parts can be immediately subjected to the full permissible pressure. IMPORTANT: For the heating-up, processing and cooling-down times see table 9, P. 51.
10. The next welding operation can now be commenced as previously described.



Part D: Care and maintenance

1. The heating element is operated with 220 V/50 Hz.
2. The guide shafts, toothed rods and trapezoidal spindles must be kept free of dirt.
3. Clean the heating sleeves/tools before commencing welding with fibre-free paper and alcohol.
4. Use only original spare parts when carrying out repairs.
5. Cover the machine when not using it.

Health and safety regulations

There is always a certain risk of injury when operating with plastic pipe welding machines. Observation of the following accident prevention regulations reduces this danger to a minimum. Non-observation of them can lead to accidents!

1. Dirty and untidy workplaces increase the chances for accidents.
2. Ambient surroundings:
   Protect electrical tools from rain and drips. Do not use them in wet or moist rooms. Keep onlookers and visitors away from the places where welding is carried out (safety distance).
3. Storage:
   Store machines and devices under dry conditions and secured against unauthorized access.
4. Working clothing:
   Wear tightly fitting clothing and no rings or jewellery when working; loose clothing and rings or jewellery could be caught by moving parts.
5. Electrical parts:
   Before connecting a device to the mains, check that it is switched off. Always pull out the plug before carrying repairs. Replace damaged or brittle connection cables and pull reliefs immediately. Protect cables from heat and sharp edges. Never pull plugs out of the socket by pulling on the cable. Never carry a device by the cable.
6. Workpieces:
   Ensure that pipe and fitting are always located firmly in the clamping devices.
7. Danger of injury:
   Beware of squashing when closing the clamps.
8. Danger of burning:
   The metal parts on the heating element will have temperatures up to 300 °C. Take precautions so that it is not possible to touch them. Keep inflammable materials at a safe distance away.
9. Spare parts:
   Replace damaged parts immediately; protect electrical parts carefully – dirt and moisture are very good electrical conductors.

Use only original WEFATHERM spare parts. Always state the machine number and version number when ordering spare parts.

Welding with electric welding sleeves

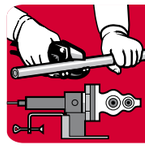
The WEFATHERM electric welding sleeve device has been developed for use on building sites. It is protected against dust, dirt, rain and drips of water when it is in its case. Suitable for use at ambient temperatures from approx. –10 °C to 60 °C. Electrical connection: 220 V/ 50 Hz

1. The ends of pipes must be free of dust and dirt; clean them if necessary with a fibre-free paper or cloth and with alcohol.
2. Strip the cover from WEFATHERM Stabi pipes back to the welding depth.
   Use only original WEFATHERM peeling tools.
   With utilization of Standard-pipes or Fiber pipes clean the surface of the pipe ends by the help of sand paper.
3. Do not remove the WEFATHERM electric welding sleeves from their protective packing until immediately before commencing welding. They too must be kept free of dirt, dust and grease.
4. Place on the electric welding sleeve and slide in the two pipe ends (up to the stop) and hold the pipes in this position during the welding process.
5. Connect the welding device to the electric welding sleeve and start the welding process by pressing the green button.
6. The springing out of the two indicator pins indicates that the heating time has ended.
7. Disconnect the cable from the electric welding sleeve.
8. Maintain the cooling-down times without fail! (See table 6).

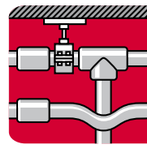
Further information is enclosed with the device and should be observed.

Table 6

Type of loading	Pressure load	Minimum waiting period
Tensile stress, bending or twisting of lines that are not under pressure		20 minutes
Subjection of lines to test our operational pressure	up to 0,1 bar 0,1 up to 1 bar over 1 bar	20 minutes 60 minutes 120 minutes
Repeat of a welding process		60 minutes



Chapter V
Installation



Types of laying

All components of the WEFATHERM pipe system are fundamentally suitable for use in sanitary and heating applications and are thus also suitable for the different methods of installation employed in these areas. As a result of this the planner or the craftsmen's firm carrying out the work can decide how to carry out an installation, i.e. in shafts, with pipes buried in plaster or on the surface of plaster or also laying direct in concrete or floor topping. In the following sections the different ways of carrying out installations in an optimum manner, of observing the insulation regulations and of solving problems resulting from thermal longitudinal expansion are dealt with. You can obtain information on how to deal with this problem from the tables and examples given in the chapter on longitudinal expansion. The section on mounting techniques indicate the ways of carrying out installation in such a way that the particular design requirements can be met. In addition we treat insulation, pressure testing and testing of systems.

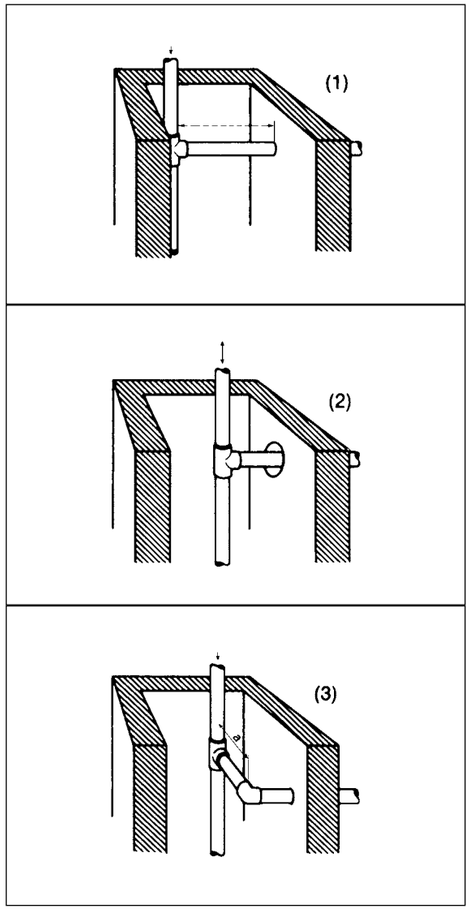
Buried laying

Longitudinal expansion does not necessarily have to be taken into account even with buried laying. If a system has to be insulated in accordance with the relevant regulations, the insulation will absorb the longitudinal expansion arising without any problem. In other words the laying space only needs to be executed in accordance with the thickness of insulation. Problems resulting from longitudinal expansion generally do not arise. Pipes, which do not have to be insulated, can be laid in floor topping or concrete or buried beneath plaster when clamped appropriately without measures having to be taken to compensate for longitudinal expansion. In this way longitudinal expansion arising from heat will be uncritical since it will be absorbed by the material.

Chapter I The WEFATHERM pipe system | Chapter II WEFATHERM system quality | Chapter III Product range | Chapter IV Welding and processing techniques | Chapter V Installation | Chapter VI Planning and design

As a rule installation can be carried out in shafts in a variety of different ways. In addition to lines for the supplying of individual floors, there can be lines to a tank at the top of a building. As a result of these tasks, there will be a number of outlet points in a shaft. Longitudinal expansion need not be taken into account when appropriate use is made of these when installing and clamping WEFATHERM pipes. Lengths of pipe, which are free and uninterrupted and lengths between clamps should not exceed 3 m. As a rule this will be the case. Care should be taken that holes in walls are sufficiently large to give the pipe adequate freedom of movement and in order to provide space for insulation material if necessary.

Installation in shafts



Exposed / surface laying

Fundamentally it will always be possible to lay a WEFATHERM pipe network in an open and visible manner. Since with exposed or surface laying the pipe system will always be visible, high requirements will be placed here on the optical aspects in general. As a result of its high dimensional stability and reduced longitudinal expansion, WEFATHERM Stabi pipework is specially suitable for systems laid in an exposed manner. Since the coefficient of longitudinal expansion of the Stabi pipes is α = 0,030 mm/mK and Fiber pipe α = 0,057 mm/mK, longitudinal expansion compensation measures are not necessary except with very long, free lengths of pipe. WEFATHERM standard pipe has an expansion coefficient of α = 0,15 mm/mK and – for exposed laying – its use should be restricted to cold-water applications since here no longitudinal expansion problems will arise. Optically acceptable pipework can be achieved subject to observation of the permissible effective spans (see tables 10a-10d, P. 70/71).

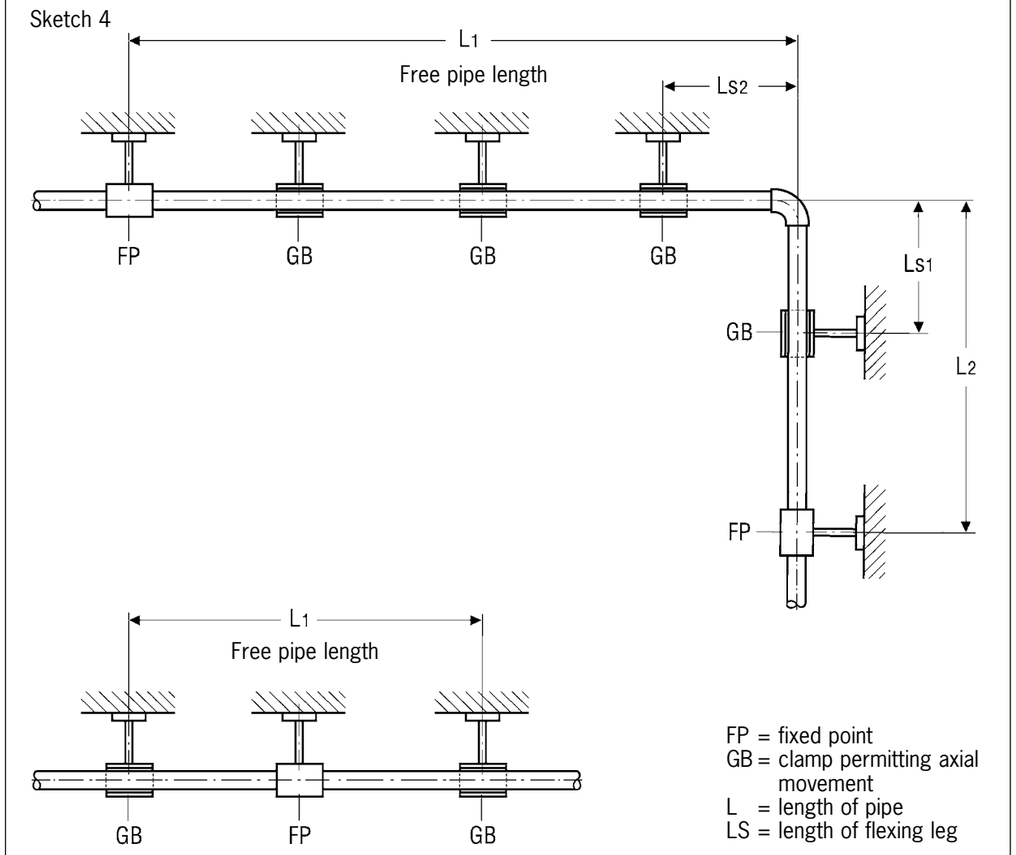
Longitudinal expansion

WEFATHERM pipe systems extend when subjected to heat in accordance with their different material characteristics. The longitudinal expansions of the WEFATHERM Stabi pipe or WEFATHERM Fiber pipes are considerably much less than that of the 100% plastic pipe. The method of calculating the longitudinal expansion theoretically is given in an example. For practical use we have shown the longitudinal expansion to be expected with the three different materials in tables. From these the longitudinal expansion to be expected for a particular free length of pipe can be read off. Of decisive importance for the determination of the longitudinal expansion is the difference between the temperature at which the pipework is installed and the maximum operating temperature to be expected (see tables 7-9, P. 64 and 65). After the longitudinal expansion to be expected has been determined, a decision can be taken on which if any of the possible different measures should be taken to compensate for it.

Free pipe length – definition

The free pipe length is the length of pipe between two points at which the pipe is secured or clamped in a fixed manner.

Sketch 4



Longitudinal expansion

Type of laying	Longitudinal expansion compensation yes/no	Comments
Laying in shafts Rising mains	no	Free length less than 3 m
Buried laying in plaster Laying in floor topping Laying in concrete	no	Expansion is absorbed by the insulation or by the pipe material
Exposed laying	yes	Take expansion compensation measure alternative use WEFATHERM Stabi pipe/Fiber pipe.

Calculation example for longitudinal expansion

The longitudinal expansion is calculated as follows:

$\Delta_l = \alpha \times L \times \Delta_t$

The meaning is:

Δ_l = longitudinal expansion in mm

α = linear expansion factor

for WEFATHERM standard pipe 0,150 mm/m · K

for WEFATHERM Stabi pipe 0,030 mm/m · K

for WEFATHERM Fiber pipe 0,057 mm/m · K

L = Length of pipe in m

Δ_t = temperature difference between assembly temperature and operation temperature

Calculation example for longitudinal expansion:

Longitudinal expansion of WEFATHERM pipe; = 0,15 mm/m · K

Table 7

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

Longitudinal expansion Δ_l in mm

Longitudinal expansion in mm

Longitudinal expansion of WEFATHERM Stabi pipe; α = 0,03 mm/m · K

Table 8

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

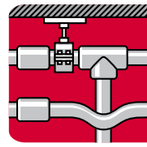
Longitudinal expansion Δ_l in mm

Longitudinal expansion of WEFATHERM Fiber pipe; α = 0,057 mm/m · K

Table 9

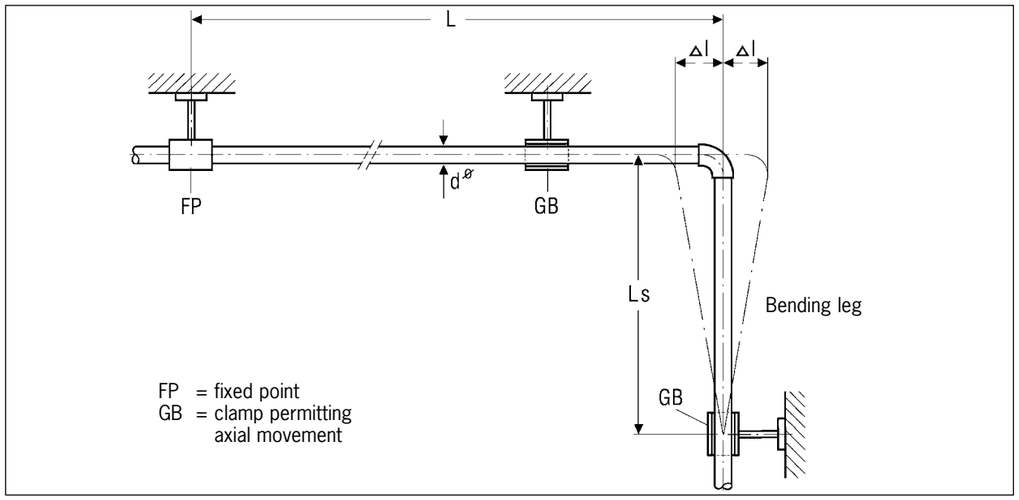
Pipe length in metres (m)	Temperature difference Δ_t (K) 10	20	30	40	50	60	70	80
0,1	0,06	0,11	0,17	0,23	0,29	0,34	0,40	0,46
0,2	0,11	0,23	0,34	0,46	0,57	0,68	0,80	0,91
0,3	0,17	0,34	0,51	0,68	0,86	1,03	1,20	1,37
0,4	0,23	0,46	0,68	0,91	1,14	1,37	1,60	1,82
0,5	0,29	0,57	0,86	1,14	1,43	1,71	2,00	2,28
0,6	0,34	0,68	1,03	1,37	1,71	2,05	2,39	2,74
0,7	0,40	0,80	1,20	1,60	2,00	2,39	2,79	3,19
0,8	0,46	0,91	1,37	1,82	2,28	2,74	3,19	3,65
0.9	0,51	1,03	1,54	2,05	2,57	3,08	3,59	4,10
1.0	0,57	1,14	1,71	2,28	2,85	3,42	3,99	4,56
2,0	1,14	2,28	3,42	4,56	5,70	6,84	7,98	9,12
3,0	1,71	3,42	5,13	6,84	8,55	10,26	11,97	13,68
4,0	2,28	4,56	6,84	9,12	11,40	13,68	15,96	18,24
5.0	2,85	5,70	8,55	11,40	14,25	17,10	19,95	22,80
6,0	3,42	6,84	10,26	13,68	17,10	20,52	23,94	27,36
7,0	3,99	7,98	11,97	15,96	19,95	23,94	27,93	31,92
8.0	4,56	9,12	13,68	18,24	22,80	27,36	31,92	36,48
9,0	5,13	10,26	15,39	20,52	25,65	30,78	35,91	41,04
10,0	5,70	11,40	17,10	22,80	28,50	34,20	39,90	45,60

Longitudinal expansion Δ_l in mm



Bending legs

Frequently changes in direction of a pipe, which are in any case necessary, will enable bending legs to be planned which can compensate for the previously determined longitudinal expansion.



FP = fixed point
GB = clamp permitting axial movement

Calculation example for the length of a bending leg

The minimum length L_S of the bending leg can be calculated with the following formula:

$$L_S = K \times \sqrt{d \times \Delta l}$$

Where:
L_S = length of the bending leg in mm
d = external diameter WEFATHERM pipe in mm
Δl = longitudinal expansion in mm
K = constant for the material, for WEFATHERM pipes = 15

1. Calculation ot the longitudinal expansion Δl

For a temperature difference of Δt 40 K between the hot-water temperature and the ambient temperature

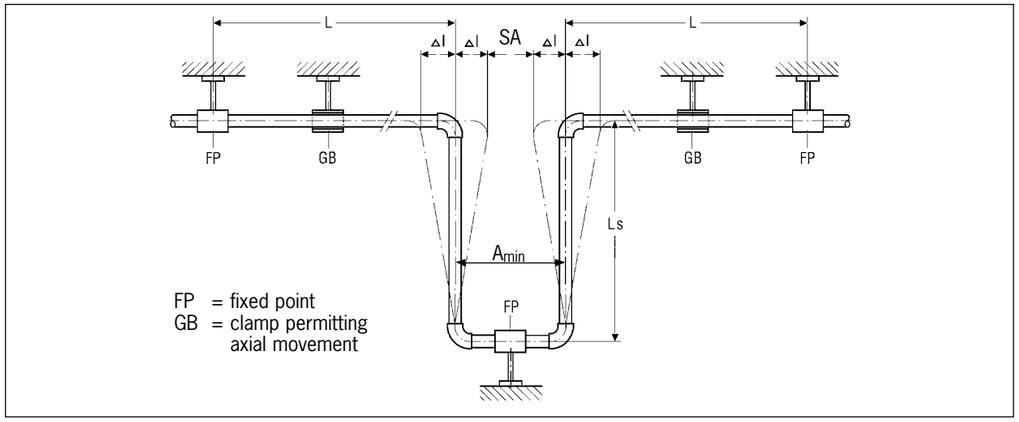
given: α = 0,15mm/m · K; L = 10,0 m; Δt = 40 K (°C)
to be calculated: Δl
$\alpha \times L \times \Delta t = \Delta l$
0,15 x 10,0 x 40 = 60 mm

2. Calculation ot the minimum length L_S of the bending leg

given: d = 40 mm; Δl = 60 mm; K = 15
to be calculated: L_S
$K \times \sqrt{d \times \Delta l} = L_S$
$15 \times \sqrt{40 \times 60} = 735$ mm

Expansion bow

If the installation requires a „U“, this can be used to provide compensation for longitudinal expansion. Here the width of the pipe bow A_{min} and the lengths of the two bending legs must be calculated.



FP = fixed point
GB = clamp permitting axial movement

Calculation example: expansion bow width A_{min}
Given values and values to be calculated

Designation	Significance	Value	Unit
A_{min}	Width of expansion bow	?	mm
Δl	Longitudinal expansion	60,0	mm
SA	Safety distance	150,0	mm

The width of the expansion bow A_{min} is calculated with the following formula:

$A_{min} = 2 \times \Delta l + SA$
$A_{min} = 2 \times 60,0 \text{ mm} + 150 \text{ mm}$
$A_{min} = 270 \text{ mm}$

The width of the expansion A_{min} should be at least 270 mm.

Calculation example: Length of bending legs with prestressing!

Given values and values to be calculated

Desig-nation	Significance	Value	Unit
L_{SV}	Length of the bending leg with prestressing	?	mm
K	Material-specific constant for WEFATHERM pipes	15	
d	External diameter WEFATHERM pipes	40,0	mm
Δ l	Longitudinal expansion	60,0	mm

The length of the bending leg with prestressing is calculated in accordance with the following formula (U-shape):

$$L_S = K \times \sqrt{d \bullet \frac{\Delta l}{2}}$$

$$L_{SV} = 15 \times \sqrt{40\ mm \bullet \frac{60\ mm}{2}}$$

$$L_{SV} = 520\ mm$$

In accordance with the above stated starting values, the length of the bending leg is 520 mm.

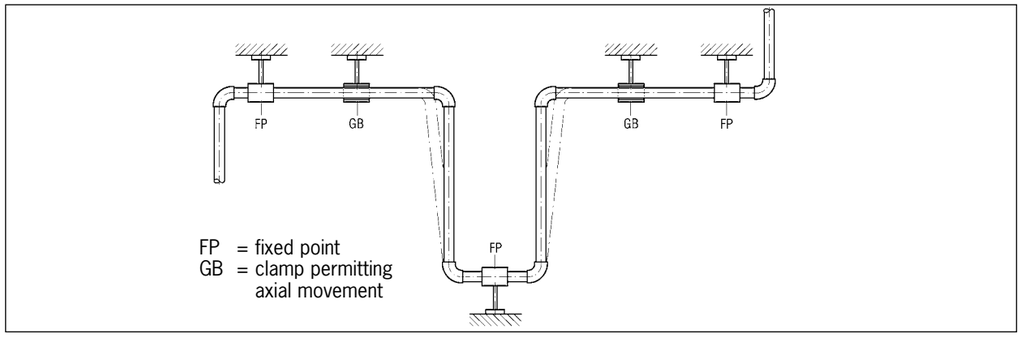
Prestressing!

By prestressing of a bending leg the length of the leg might be shortened with narrow space.

When exactly planned and carried out preload assemblies offer an optically perfect image as expansion movement is not visible.

The calculated Δ l is negatively prestressed when being installed.

After initial operation of pipe system a correct 90° angle will arise.



Techniques for mounting pipework

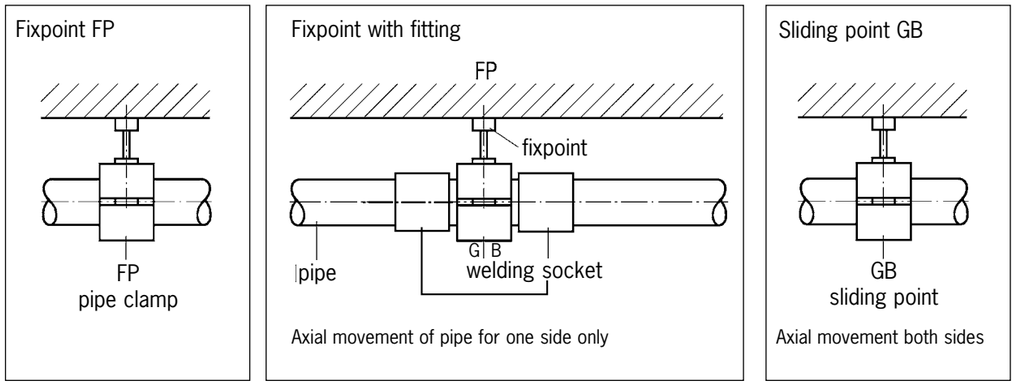
When considering the techniques for mounting pipework, one must differentiate fundamentally between fixed point mountings (hereafter fixed points) and loose or sliding point mountings (hereafter sliding points). By definition the fixed point or fixed clamp holds the pipe in a fixed manner whereby in contrast a sliding point will permit the pipe to move in the axial direction of the pipe. An optimally satisfactory installation can be ensured by appropriate selection of these two different methods of mounting. Rubber clamp inserts for plastic pipe prevent the pipe surface from being damaged at the clamp and ensure the desired guiding and holding of the pipe.

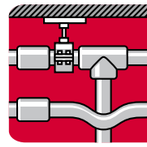
Fixed points

Fixed points (fixed point mountings) divide a pipe network into sections. The free lengths from a fixed point must be measured and the possible longitudinal expansion that can take place in this free length calculated. Fixed point mountings with a long distance between the part of the clamp holding the pipe and the ceiling or wall to which the clamp is mounted should be avoided, since in these cases the clamps can act in a self-aligning manner and will not provide a fixed point. Sliding point clamps positioned on either side of fittings will act as fixed points! Vertical distribution lines (shaft mounting) and pipework laid beneath plaster or in concrete or floor topping can also be laid in a rigid manner. Branch points, where the pipe branching off passes through a wall, must be mounted in a fixed manner since otherwise the pipe branching off could be cut off.

Loose or sliding mounting points

Axial movement of a pipe produced by longitudinal expansion should not be influenced by loose or sliding point mountings. The clamps should have suitable inserts (e.g. rubber) to prevent the pipe surface from being damaged and allow movement. Fittings must be at a sufficient distance from sliding point clamps since otherwise these will then act as fixed points.





WEFATHERM pipes PN 20

Recommended spans L_A at pipe wall temperature T_R

Table 10a

Pipe wall temperature T_R [°C]	Pipe diameter d [mm]										
	16	20	25	32	40	50	63	75	90	110	125
	Recommended spans L_A [cm] (Montage distance)										
0	70	85	105	125	140	165	190	205	220	250	250
20	50	60	75	90	100	120	140	150	160	180	190
30	50	60	75	90	100	120	140	150	160	180	190
40	50	60	70	80	90	110	130	140	150	170	180
50	50	60	70	80	90	110	130	140	150	170	180
60	50	55	65	75	85	100	115	125	140	160	170
70	50	50	60	70	80	95	105	105	125	140	150

WEFATHERM Stabi pipes

Recommended spans L_A at pipe wall temperature T_R

Table 10b

Pipe wall temperature T_R [°C]	Pipe diameter d [mm]										
	16	20	25	32	40	50	63	75	90	110	125
	Recommended spans L_A [cm] (Montage distance)										
0	130	155	170	195	220	245	270	285	300	325	340
20	100	120	130	150	170	190	210	220	230	250	265
30	100	120	130	150	170	190	210	220	230	240	255
40	100	110	120	140	160	180	200	210	220	230	245
50	100	110	120	140	160	180	200	210	220	210	225
60	80	100	110	130	150	170	190	200	210	200	210
70	70	90	100	120	140	160	180	190	200	200	210

WEFATHERM Fiber pipes

Recommenced spans L_A at pipe wall temperature

Table to determine support intervals for WEFATHERM Fiber pipes in conjunction with temperature and outside diameter

Table 10c

Pipe wall temperature T_R [°C]	Pipe diameter d [mm]									
	20	25	32	40	50	63	75	90	110	125
	Recommended spans L_A [cm] (Montage distance)									
0	120	140	160	180	205	230	245	260	290	320
20	90	105	120	135	155	175	185	195	215	240
30	90	105	120	135	155	175	185	195	210	230
40	85	95	110	125	145	165	175	185	200	220
50	85	95	110	125	145	165	175	185	190	205
60	80	90	105	120	135	155	165	175	180	190
70	70	80	95	110	130	145	155	165	170	180

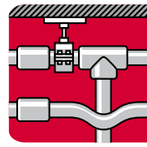
WEFATHERM pipes PN 10

WEFATHERM Effective spans pipes PN 10

Table 10d

Pipe distance in cm between pipe clamps for horizontal lines at a temperature 20 °C

Ø d mm	Horizontal 20 °C	Ø d mm	Horizontal 20 °C
20	60	63	140
25	75	75	150
32	90	90	160
40	100	110	180
50	120	125	190



Insulation cold water lines

Energy-saving is environmental protection.
The legal regulation of the specific countries have to be taken into consideration.

Guideline values for minimum thicknesses of insulation for insulating drinking water systems (cold)

Mounting situation	Insulating layer thickness at λ = 0,040 W (m K)
Pipework laid exposed in unheated, room (e.g. basement)	4 mm
Pipework laid exposed in heated room	9 mm
Pipework laid in channel with additional heated pipe lines	4 mm
Pipework laid in channel next to heated pipe lines	13 mm
Pipework laid in masony slit Rising main	4 mm
Pipework laid in wall recess next to heated pipe lines	13 mm
Pipework laid on cement floor	4 mm

Insulation warm water lines

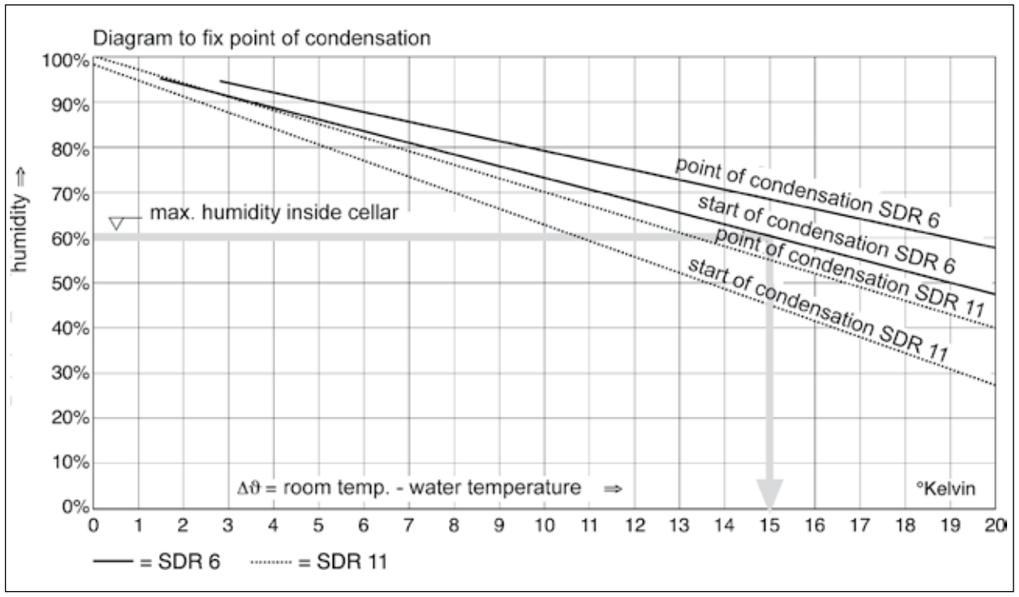
In spite of the high level of insulation it provides itself, pipework of WEFATHERM must be insulated to prevent noise and heat lost. This can be derived from the Drinking Water System Order in accordance with DIN 1988 Part 2. For more Information pls. contact our technical support.

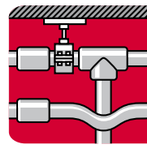
Chapter I The WEFATHERM pipe system | Chapter II WEFATHERM system quality | Chapter III Product range | Chapter IV Welding and processing techniques | Chapter V Installation | Chapter VI Planning and design

Condensation point

- The normal case is a cellar submerged to two thirds of the wall height in the earth, that has no continuously opened doors and windows.
- Such a "normal case" stays even in summer after strong rain below a room temperature of 25 °C and 60 % moisture.
- With 25 °C and 60 % moisture and 10 °C water temperature the pipe begins to sweat.
- For southern regions is important that these temperatures are sometimes exceeded, but the water temperature is often higher than 10 °C.
- With all rooms not according to standard cellar, it has to be determined from case to case, whether maximum room temperature may be 15 °C higher than the water temperature.
- For PN 10 pipes the permissible temperature difference is at 11 °C.

Result: Cold water systems consisting of PN 20 pipe normally do not have to be isolated against condensation water.





Pressure test

After a drinking water system has been installed but before it is commissioned, it must be tested for tightness whereby this should be done while the system is still visible. The test pressure must be 1.5 times the operating pressure. Polypropylene expands under the influence of heat and pressure. For this reason it is necessary that the test medium (as a rule water) and the pipework material are at the same temperature. Attention should therefore be paid to the fact that the test medium has a temperature that is as constant as possible. The pressure test is divided into three parts, namely the initial, the main and the final test.

Initial test

The highest possible operating pressure is increased by a factor of 1.5. This test pressure must be restored twice at intervals of in each case 10 minutes within a period of 30 minutes. After the pressure has been restored again a second time, the test pressure may not fall by more than 0.6 bar within the next 30 minutes. In addition no leakage may occur.

Main test

The main test commences immediately after the completion of the initial test and lasts two hours. During this period the pressure may not fall by more than 0.2 bar relative to the pressure at the end of the initial test.

Final test

Test pressures of 10 bar and 1 bar are applied alternately at intervals of at least 5 minutes. After each application of pressure, the pipe network is to be depressurized. Leakage may not occur at any point in the network being tested.

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Measuring devices

The pressure measuring device used must permit accurate readings to the nearest 0.1 bar. Where possible the pressure is to be determined at the lowest point of the network.

Test memorandum

The test as carried out is to be documented in a memorandum which must be signed by the client and contractor with statement of the place and date of signing (see p. 77 for a test memorandum form).

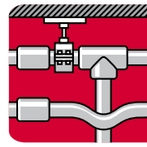
Flushing out of pipework systems

The sense and purpose of flushing out pipework systems: Ensuring the quality of drinking water, avoidance of corrosion damage, avoidance of damage to fittings and equipment, cleaning of the inner surface of the pipes.

Regardless of the material of the pipes, all pipework systems carrying drinking water are to be flushed out.

Suitable process are:
1. Flushing out with water
2. Flushing out with a mixture of air and water

Flushing out process 1, namely flushing out with water, is sufficient in the case of drinking water systems which are composed exclusively of WEFATHERM pipes and fittings. The appropriate flushing out process should be selected on the basis of the experience of the installing firm and of the client.



Transport and storage

Thanks to the excellent properties of the material from which WEFATHERM pipe systems are manufactured, the pipes and fittings can fundamentally be stored at all temperatures without any problems. The storage place should, however, be selected in accordance with the following conditions:

1. The pipes should be supported along their full length.
2. Bending of the pipes is to be avoided.
3. The material becomes sensitive to impact at low temperatures and in particular at temperatures below zero °C. For this reason knocks and similar impacts are to be avoided under these conditions.
4. High-polymer materials are sensitive to UV radiation. For this reason WEFATHERM material should also be protected against the effects of UV radiation.

Test memorandum

WEFATHERM pipework installation test memorandum

Firm carrying out the installation: _____

Place: _____ Building: _____

Pipe lengths Ø 16 mm: _____ m
Pipe lengths Ø 20 mm: _____ m
Pipe lengths Ø 25 mm: _____ m
Pipe lengths Ø 32 mm: _____ m
Pipe lengths Ø 40 mm: _____ m

Pipe lengths Ø 50 mm: _____
Pipe lengths Ø 63 mm: _____
Pipe lengths Ø 75 mm: _____
Pipe lengths Ø 90 mm: _____
Pipe lengths Ø 110 mm: _____
Pipe lengths Ø 125 mm: _____

Highest removal point: _____ m above pressure gauge

Initial test:

Test pressure _____ bar
Pressure following 1st restoration of test _____ bar
Pressure following 2nd restoration of test _____ bar
Pressure drop after 30 minutes _____ bar
Result of the initial test: _____

Main test:

Operating pressure (result of the initial test): _____ bar
Pressure after 1 hour _____ bar(start of test)
Pressure after 2 hours _____ bar
Pressure drop _____ bar (max. 0.2 bar)
Result of the main test: _____

Start of test: _____ End: _____ Duration of test: _____h

Client: _____

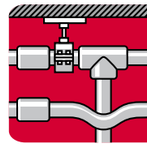
Contractor: _____

Place: _____

Date: _____

Stamp / signature of client:

Stamp / signature of contractor:



Chapter VI
Planning and design

Selection of pipe diameters

In order to select the pipe diameters correctly, the following must be determined:

1. Number and size of the removal points connected
2. Peak flow at each removal point
3. Flow speeds
4. Pressure losses

Flow speeds

Flow speeds must be selected in such a way that flow noise and water hammer are avoided as far as possible. When the pipe diameters are selected correctly, the flow speeds given in table 11 will not be exceeded.

Table 11

Pipework section	max. computed flow speed at flow duration of	
	≤ 15 min. m/s	> 15 min. m/s
Connection lines	2	2
Consumer lines, part sections for low pressur loss fitting pressure (< 2,5) *)	5	2
Part sections with through fittings with higher pressure loss coefficient **)	2,5	2

*) e.g. ball valve, angle valve DIN 3500/3502

**) e.g. straight seat valve DIN 3512

Calculation fundamentals

A considerable amount of data is required in order to calculate the correct diameters for a pipe network.

The following data is needed:

- Geodetic height difference
- Minimum supply overpressure and/or pressure on the output side of a pressure reducing or pressre increasing device
- Pressure losses at items of equipment such as water gauges, filters, water treatment units etc.
- Minimum flow pressures of the removal point fittings employed
- Pipe friction pressure gradient of the pipe material employed
- Coefficients of resistance of the fittings and connection units employed

Planning aids

WEFA Plastic has available tables providing the relevant information (pipe friction resistances, loss coefficients for fittings and connection units etc.) for its products.

Software

For the calculation of drinking water pipe nets acc. to DIN 1988 WEFA Plastic offers calculation programmes and data sheets. In case of questions please contact our technical department.

Program	Particulars	Softwarehouse
SAN-CAD-2000	HT 2000	WILLMS
SAN-CAD-2000-WIN		WILLMS
FROSAN	Datanorm 3.0 Datanorm 4.0	CONSOFT

Minimum flow pressures

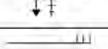
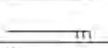
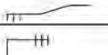
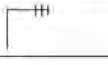
Minimum flow pressures and calculation flow rates for commonly available fittings and items of apparatus (Guideline values)

Minimum flow pressure P min Fl bar	Extract DIN 1988 E: Type of drinking water removal point	Calculation flow rate with the removal of: Mixed water Q_R cold l/s	Mixed water Q_R hot l/s	Only cold or only hot water Q_R l/s
	Outlet valves			
0,5	without aeration ..... DN 15	±	±	0,30
0,5	..... DN 20	±	±	0,50
0,5	..... DN 25	±	±	1,00
1,0	with aeration ..... DN 10	±	±	0,15
1,0	..... DN 15	±	±	0,15
1,0	Shower heads for cleaning showers ..... DN 15	0,10	0,10	0,20
1,2	Flushing valves to DIN 3265 Part 1 ..... DN 15	±	±	0,70
1,2	Flushing valves to DIN 3265 Part 1 ..... DN 20	±	±	1,00
0,4	Flushing valves to DIN 3265 Part 1 ..... DN 25	±	±	1,00
1,0	Flushing valves to urinal basins ..... DN 15	±	±	0,30
0,5	Corner valves for urinal basins ..... DN 15	±	±	0,30
1,0	Domestic dishwashing machine ..... DN 15	±	±	0,15
1,0	Domestic washing machine ..... DN 15	±	±	0,25
	Mixing battery for			
1,0	shower tubs ..... DN 15	0,15	0,15	±
1,0	bath tubs ..... DN 15	0,15	0,15	±
1,0	kitchen sinks ..... DN 15	0,07	0,07	±
1,0	wash stands ..... DN 15	0,07	0,07	±
1,0	bidets ..... DN 15	0,07	0,07	±
1,0	Mixing battery ..... DN 20	0,30	0,30	±
0,5	Flushing boxes to DIN 19 542 ..... DN 15	±	±	0,13
	Drinking water heaters for supplying a tap (incl. mixed removal fitting)			
1,0	Electric water boiling device ..... DN 15	±	±	0,10 *)
1,1 **)	Electric hot-water tank and boiler with nominal volume 5 bis 15 l ..... DN 15	±	±	0,10
1,2 **)	with nominal volume 30 bis 150 l ..... DN 15	±	±	0,20
	Electric continuous-flow water heater, hydraulically controlled, without flow limiter			
1,5	Rated power ..... 12 kW	±	±	0,06
1,9	..... 18 kW	±	±	0,08
2,1	..... 21 kW	±	±	0,09
2,4	..... 24 kW	±	±	0,10
1,0	Gas continuous-flow water heater ..... 12 kW	±	±	0,10

*) With throttle screw fully openede
**) Values with unfavourable conditions (shower))

Note: Water removal points not listed in the table as well as items of apparatus as listed in the table but with greater flow rates are to be taken into account in accordance with the manufacturer's statements when calculating pipe diameters.

Resistance coefficients for WEFATHERM PP-R fittings

No.	Individual resistance	Graphical symbol	Resistance coefficient
1	Socket		0,25
2	Reduction of to 2 Dimension		0,55
2a	Reduction from 3 Dimension		0,85
3	Angle 90°		2,0
3a	Angle 90° i. / a.		1,2
4	Angle 45°		0,6
4a	Angle 45° i. / a.		0,5
5	T-piece (separation)		1,8
5a	T-piece (reduced)		3,6
6	T-piece (combination)		1,3
6a	T-piece (reduced)		2,6
7	T-piece (counterflow)		4,2
7a	T-piece (reduced)		9,0
8	T-piece (counter flow)		2,2
8a	T-piece (reduced)		5,0
9	T-piece with transition		0,8
10	Transition with outside thread, without counterpart		0,4
11	Transition with outside thread, reduced, without counterpart		0,85
12	Transition angle piece with outside thread, without counterpart		2,2
13	Transition angle piece with outside thread, reduced, without counterpart		3,5
14	Straight seat valve 20 mm 25 mm 32 mm 40 mm		9,5 8,5 7,6 5,7
15	Inclined seat valve 20 mm 25 mm 32 mm 40 mm		5,0 4,4 3,8 3,2
16	KFR valve 20 mm 25 mm 32 mm 40 mm		5,0 4,4 3,8 3,2
17	Drain nozzle		0,25

Pressure losses from individual resistance

Pressure losses from individual resistances Z for resistance coefficient $\zeta = 1$ (at $\vartheta = 10°C$ and $\varrho = 999.7\ kg/m^3$) as a function of the flow speed v ($Z = 5v^2 \cdot \Sigma\zeta$)

Computed flow speed v m/s	Pressure loss Z for ζ = 1 mbar	Computed flow speed v m/s	Pressure loss Z for ζ = 1 mbar
0.1	0.1	2.6	33.8
0.2	0.2	2.7	36.5
0.3	0.5	2.8	39.2
0.4	0.8	2.9	42.1
0.5	1.3	3.0	45
0.6	1.8	3.1	48
0.7	2.5	3.2	51
0.8	3.2	3.3	55
0.9	4.1	3.4	58
1.0	5.0	3.5	61
1.1	6.1	3.6	65
1.2	7.2	3.7	68
1.3	8.5	3.8	72
1.4	9.8	3.9	76
1.5	11.3	4.0	80
1.6	12.8	4.1	84
1.7	14.5	4.2	88
1.8	16.2	4.3	92
1.9	18.1	4.4	97
2.0	20.0	4.5	101
2.1	22.1	4.6	106
2.2	24.2	4.7	110
2.3	26.5	4.8	115
2.4	28.8	4.9	120
2.5	31.3	5.0	125

The total pressure loss of the line is the sum of the pressure losses from the pipe friction and from the individual resistances. $\Delta p = \Sigma (l \cdot R + Z)$

Please see the table above for the guideline values for the individual resistances.

Maximum Flow Rate

Determination of the maximum flow rate Vs from the flow ΣV_R for buildings acc. to DIN 1988 part 3 - $V_S = 0{,}682 \cdot (\Sigma V_R)^{0{,}45} - 0{,}14$ [l/s]

This table is valid, if the calculated flow VR of the respective water points in < 0,5 l/s.

ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS
0,03	0,00	1,02	0,55	2,02	0,80	3,02	0,98	4,02	1,14	5,10	1,28	10,10	1,79	15,10	2,17
0,04	0,02	1,04	0,55	2,04	0,80	3,04	0,98	4,04	1,14	5,20	1,29	10,20	1,80	15,20	2,18
0,06	0,05	1,06	0,56	2,06	0,80	3,06	0,99	4,06	1,14	5,30	1,30	10,30	1,81	15,30	2,19
0,07	0,07	1,08	0,57	2,08	0,81	3,08	0,99	4,08	1,14	5,40	1,32	10,40	1,82	15,40	2,19
0,08	0,08	1,10	0,57	2,10	0,81	3,10	0,99	4,10	1,15	5,50	1,33	10,50	1,82	15,50	2,20
0,09	0,09	1,12	0,58	2,12	0,82	3,12	1,00	4,12	1,15	5,60	1,34	10,60	1,83	15,60	2,21
0,10	0,10	1,14	0,58	2,14	0,82	3,14	1,00	4,14	1,15	5,70	1,35	10,70	1,84	15,70	2,21
0,13	0,13	1,16	0,59	2,16	0,82	3,16	1,00	4,16	1,16	5,80	1,36	10,80	1,85	15,80	2,22
0,15	0,15	1,18	0,59	2,18	0,83	3,18	1,01	4,18	1,16	5,90	1,38	10,90	1,86	15,90	2,23
0,20	0,19	1,20	0,60	2,20	0,83	3,20	1,01	4,20	1,16	6,00	1,39	11,00	1,87	16,00	2,23
0,22	0,21	1,22	0,61	2,22	0,84	3,22	1,01	4,22	1,16	6,10	1,40	11,10	1,87	16,10	2,24
0,24	0,22	1,24	0,61	2,24	0,84	3,24	1,02	4,24	1,17	6,20	1,41	11,20	1,88	16,20	2,25
0,26	0,23	1,26	0,62	2,26	0,84	3,26	1,02	4,26	1,17	6,30	1,42	11,30	1,89	16,30	2,25
0,28	0,24	1,28	0,62	2,28	0,85	3,28	1,02	4,28	1,17	6,40	1,43	11,40	1,90	16,40	2,26
0,30	0,26	1,30	0,63	2,30	0,85	3,30	1,03	4,30	1,17	6,50	1,44	11,50	1,91	16,50	2,27
0,32	0,27	1,32	0,63	2,32	0,86	3,32	1,03	4,32	1,18	6,60	1,45	11,60	1,91	16,60	2,27
0,34	0,28	1,34	0,64	2,34	0,86	3,34	1,03	4,34	1,18	6,70	1,47	11,70	1,92	16,70	2,28
0,36	0,29	1,36	0,64	2,36	0,86	3,36	1,04	4,36	1,18	6,80	1,48	11,80	1,93	16,80	2,29
0,38	0,30	1,38	0,65	2,38	0,87	3,38	1,04	4,38	1,19	6,90	1,49	11,90	1,94	16,90	2,29
0,40	0,31	1,40	0,65	2,40	0,87	3,40	1,04	4,40	1,19	7,00	1,50	12,00	1,95	17,00	2,30
0,42	0,32	1,42	0,66	2,42	0,88	3,42	1,05	4,42	1,19	7,10	1,51	12,10	1,95	17,10	2,31
0,44	0,33	1,44	0,66	2,44	0,88	3,44	1,05	4,44	1,19	7,20	1,52	12,20	1,96	17,20	2,31
0,46	0,34	1,46	0,67	2,46	0,88	3,46	1,05	4,46	1,20	7,30	1,53	12,30	1,97	17,30	2,32
0,48	0,35	1,48	0,67	2,48	0,89	3,48	1,06	4,48	1,20	7,40	1,54	12,40	1,98	17,40	2,33
0,50	0,36	1,50	0,68	2,50	0,89	3,50	1,06	4,50	1,20	7,50	1,55	12,50	1,99	17,50	2,33
0,52	0,37	1,52	0,68	2,52	0,89	3,52	1,06	4,52	1,20	7,60	1,56	12,60	1,99	17,60	2,34
0,54	0,38	1,54	0,69	2,54	0,90	3,54	1,06	4,54	1,21	7,70	1,57	12,70	2,00	17,70	2,35
0,56	0,39	1,56	0,69	2,56	0,90	3,56	1,07	4,56	1,21	7,80	1,58	12,80	2,01	17,80	2,35
0,58	0,39	1,58	0,70	2,58	0,90	3,58	1,07	4,58	1,21	7,90	1,59	12,90	2,02	17,90	2,36
0,60	0,40	1,60	0,70	2,60	0,91	3,60	1,07	4,60	1,22	8,00	1,60	13,00	2,02	18,00	2,36
0,62	0,41	1,62	0,71	2,62	0,91	3,62	1,08	4,62	1,22	8,10	1,61	13,10	2,03	18,10	2,37
0,64	0,42	1,64	0,71	2,64	0,92	3,64	1,08	4,64	1,22	8,20	1,62	13,20	2,04	18,20	2,38
0,66	0,43	1,66	0,72	2,66	0,92	3,66	1,08	4,66	1,22	8,30	1,63	13,30	2,05	18,30	2,38
0,68	0,43	1,68	0,72	2,68	0,92	3,68	1,09	4,68	1,23	8,40	1,64	13,40	2,05	18,40	2,39
0,70	0,44	1,70	0,73	2,70	0,93	3,70	1,09	4,70	1,23	8,50	1,65	13,50	2,06	18,50	2,40
0,72	0,45	1,72	0,73	2,72	0,93	3,72	1,09	4,72	1,23	8,60	1,66	13,60	2,07	18,60	2,40
0,74	0,46	1,74	0,74	2,74	0,93	3,74	1,09	4,74	1,23	8,70	1,67	13,70	2,07	18,70	2,41
0,76	0,46	1,76	0,74	2,76	0,94	3,76	1,10	4,76	1,24	8,80	1,67	13,80	2,08	18,80	2,41
0,78	0,47	1,78	0,74	2,78	0,94	3,78	1,10	4,78	1,24	8,90	1,68	13,90	2,09	18,90	2,42
0,80	0,48	1,80	0,75	2,80	0,94	3,80	1,10	4,80	1,24	9,00	1,69	14,00	2,10	19,00	2,43
0,82	0,48	1,82	0,75	2,82	0,95	3,82	1,11	4,82	1,24	9,10	1,70	14,10	2,10	19,10	2,43
0,84	0,49	1,84	0,76	2,84	0,95	3,84	1,11	4,84	1,25	9,20	1,71	14,20	2,11	19,20	2,44
0,86	0,50	1,86	0,76	2,86	0,95	3,86	1,11	4,86	1,25	9,30	1,72	14,30	2,12	19,30	2,44
0,88	0,50	1,88	0,77	2,88	0,96	3,88	1,12	4,88	1,25	9,40	1,73	14,40	2,12	19,40	2,45
0,90	0,51	1,90	0,77	2,90	0,96	3,90	1,12	4,90	1,25	9,50	1,74	14,50	2,13	19,50	2,46
0,92	0,52	1,92	0,77	2,92	0,96	3,92	1,12	4,92	1,26	9,60	1,75	14,60	2,14	19,60	2,46
0,94	0,52	1,94	0,78	2,94	0,97	3,94	1,12	4,94	1,26	9,70	1,76	14,70	2,15	19,70	2,47
0,96	0,53	1,96	0,78	2,96	0,97	3,96	1,13	4,96	1,26	9,80	1,76	14,80	2,15	19,80	2,47
0,98	0,54	1,98	0,79	2,98	0,97	3,98	1,13	4,98	1,26	9,90	1,77	14,90	2,16	19,90	2,48
1,00	0,54	2,00	0,79	3,00	0,98	4,00	1,13	5,00	1,27	10,00	1,78	15,00	2,17	20,00	2,49

Maximum Flow Rate

Determination of the maximum flow rate Vs from the total flow ΣV_R for buildings acc. to DIN 1988 part 3 · $V_S = 1{,}7 \cdot (\Sigma V_R)^{0{,}21} - 0{,}7$ [l/s]

This table is valid, if the calculated flow VR of the respective water points is > 0,5 l/s.

ΣV_R	V_S	ΣV_R	V_S	ΣV_R	V_S	ΣV_R	V_S	ΣV_R	V_S	ΣV_R	V_S	ΣV_R	V_S	ΣV_R	V_S
1,00	1,00	5,10	1,69	10,10	2,06	15,10	2,31	22,40	2,57	142,40	4,12	262,40	4,78	382,40	5,23
1,05	1,02	5,20	1,70	10,20	2,07	15,20	2,31	24,80	2,64	144,80	4,13	264,80	4,79	384,80	5,23
1,10	1,03	5,30	1,71	10,30	2,07	15,30	2,31	27,20	2,70	147,20	4,15	267,20	4,80	387,20	5,24
1,15	1,05	5,40	1,72	10,40	2,08	15,40	2,32	29,60	2,76	149,60	4,17	269,60	4,81	389,60	5,25
1,20	1,07	5,50	1,73	10,50	2,09	15,50	2,32	32,00	2,82	152,00	4,18	272,00	4,82	392,00	5,26
1,25	1,08	5,60	1,74	10,60	2,09	15,60	2,33	34,40	2,87	154,40	4,20	274,40	4,83	394,40	5,26
1,30	1,10	5,70	1,75	10,70	2,10	15,70	2,33	36,80	2,92	156,80	4,21	276,80	4,84	396,80	5,27
1,35	1,11	5,80	1,76	10,80	2,10	15,80	2,34	39,20	2,97	159,20	4,23	279,20	4,85	399,20	5,28
1,40	1,12	5,90	1,77	10,90	2,11	15,90	2,34	41,60	3,02	161,60	4,25	281,60	4,86	401,60	5,29
1,45	1,14	6,00	1,78	11,00	2,11	16,00	2,34	44,00	3,06	164,00	4,26	284,00	4,87	404,00	5,29
1,50	1,15	6,10	1,79	11,10	2,12	16,10	2,35	46,40	3,11	166,40	4,28	286,40	4,88	406,40	5,30
1,55	1,16	6,20	1,79	11,20	2,12	16,20	2,35	48,80	3,15	168,80	4,29	288,80	4,89	408,80	5,31
1,60	1,18	6,30	1,80	11,30	2,13	16,30	2,35	51,20	3,19	171,20	4,31	291,20	4,90	411,20	5,32
1,65	1,19	6,40	1,81	11,40	2,13	16,40	2,36	53,60	3,22	173,60	4,32	293,60	4,91	413,60	5,32
1,70	1,20	6,50	1,82	11,50	2,14	16,50	2,36	56,00	3,26	176,00	4,34	296,00	4,92	416,00	5,33
1,75	1,21	6,60	1,83	11,60	2,14	16,60	2,37	58,40	3,29	178,40	4,35	298,40	4,93	418,40	5,34
1,80	1,22	6,70	1,83	11,70	2,15	16,70	2,37	60,80	3,33	180,80	4,36	300,80	4,93	420,80	5,35
1,85	1,23	6,80	1,84	11,80	2,15	16,80	2,37	63,20	3,36	183,20	4,38	303,20	4,94	423,20	5,35
1,90	1,25	6,90	1,85	11,90	2,16	16,90	2,38	65,60	3,39	185,60	4,39	305,60	4,95	425,60	5,36
2,00	1,27	7,00	1,86	12,00	2,16	17,00	2,38	68,00	3,42	188,00	4,41	308,00	4,96	428,00	5,37
2,10	1,29	7,10	1,87	12,10	2,17	17,10	2,39	70,40	3,45	190,40	4,42	310,40	4,97	430,40	5,38
2,20	1,31	7,20	1,87	12,20	2,17	17,20	2,39	72,80	3,48	192,80	4,43	312,80	4,98	432,80	5,38
2,30	1,32	7,30	1,88	12,30	2,18	17,30	2,39	75,20	3,51	195,20	4,45	315,20	4,99	435,20	5,39
2,40	1,34	7,40	1,89	12,40	2,18	17,40	2,40	77,60	3,54	197,60	4,46	317,60	5,00	437,60	5,40
2,50	1,36	7,50	1,90	12,50	2,19	17,50	2,40	80,00	3,57	200,00	4,47	320,00	5,01	440,00	5,40
2,60	1,38	7,60	1,90	12,60	2,19	17,60	2,40	82,40	3,59	202,40	4,49	322,40	5,02	442,40	5,41
2,70	1,39	7,70	1,91	12,70	2,20	17,70	2,41	84,80	3,62	204,80	4,50	324,80	5,03	444,80	5,42
2,80	1,41	7,80	1,92	12,80	2,20	17,80	2,41	87,20	3,64	207,20	4,51	327,20	5,04	447,20	5,42
2,90	1,43	7,90	1,92	12,90	2,21	17,90	2,42	89,60	3,67	209,60	4,52	329,60	5,04	452,00	5,43
3,00	1,44	8,00	1,93	13,00	2,21	18,00	2,42	92,00	3,69	212,00	4,54	332,00	5,05	454,40	5,44
3,10	1,46	8,10	1,94	13,10	2,22	18,10	2,42	94,40	3,72	214,40	4,55	334,40	5,06	456,80	5,44
3,20	1,47	8,20	1,94	13,20	2,22	18,20	2,43	96,80	3,74	216,80	4,56	336,80	5,07	459,20	5,45
3,30	1,48	8,30	1,95	13,30	2,23	18,30	2,43	99,20	3,76	219,20	4,57	339,20	5,08	461,60	5,46
3,40	1,50	8,40	1,96	13,40	2,23	18,40	2,43	101,60	3,79	221,60	4,58	341,60	5,09	464,00	5,47
3,50	1,51	8,50	1,96	13,50	2,24	18,50	2,44	104,00	3,81	224,00	4,60	344,00	5,10	466,40	5,47
3,60	1,52	8,60	1,97	13,60	2,24	18,60	2,44	106,40	3,83	226,40	4,61	346,40	5,10	468,80	5,48
3,70	1,54	8,70	1,98	13,70	2,25	18,70	2,44	108,80	3,85	228,80	4,62	348,80	5,11	471,20	5,49
3,80	1,55	8,80	1,98	13,80	2,25	18,80	2,45	111,20	3,87	231,20	4,63	351,20	5,12	473,60	5,49
3,90	1,56	8,90	1,99	13,90	2,25	18,90	2,45	113,60	3,89	233,60	4,64	353,60	5,13	476,00	5,50
4,00	1,57	9,00	2,00	14,00	2,26	19,00	2,45	116,00	3,91	236,00	4,66	356,00	5,14	478,40	5,51
4,10	1,59	9,10	2,00	14,10	2,26	19,10	2,46	118,40	3,93	238,40	4,67	358,40	5,15	480,80	5,51
4,20	1,60	9,20	2,01	14,20	2,27	19,20	2,46	120,80	3,95	240,80	4,68	360,80	5,15	483,20	5,52
4,30	1,61	9,30	2,02	14,30	2,27	19,30	2,47	123,20	3,97	243,20	4,69	363,20	5,16	485,60	5,52
4,40	1,62	9,40	2,02	14,40	2,28	19,40	2,47	125,60	3,99	245,60	4,70	365,00	5,17	488,00	5,53
4,50	1,63	9,50	2,03	14,50	2,28	19,50	2,47	128,00	4,01	248,00	4,71	368,00	5,18	490,40	5,54
4,60	1,64	9,60	2,03	14,60	2,29	19,60	2,48	130,40	4,03	250,40	4,72	370,40	5,19	492,40	5,54
4,70	1,65	9,70	2,04	14,70	2,29	19,70	2,48	132,80	4,05	252,80	4,763	372,80	5,19	492,80	5,55
4,80	1,66	9,80	2,05	14,80	2,29	19,80	2,48	135,20	4,06	255,20	4,74	375,20	5,20	495,20	5,56
4,90	1,67	9,90	2,05	14,90	2,30	19,90	2,49	137,60	4,08	257,60	4,75	377,60	5,21	497,60	5,56
5,00	1,68	10,00	2,06	15,00	2,30	20,00	2,49	140,00	4,10	260,00	4,77	380,00	5,22	500,00	5,57

Pipe friction gradient / flow speed WEFATHERM pipes SDR 11 (PN 10)

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}^\circ$

Roughness: K=0,007 mm · sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C · kin. tenacity: ν=1,02 x 10^{-6} m²/s

$\dot{V}^\circ$ = circulation (l/s) · R = pressure gradient [mbar/m] · v = speed [m/s]

$\dot{V}^\circ$	d x s / di		20 x 1,9 16,2 mm	25 x 2,3 20,4 mm	32 x 2,9 26,0 mm	40 x 3,7 32,6 mm	50 x 4,6 40,8 mm	63 x 5,8 51,4 mm	75 x 6,8 61,2 mm	90 x 8,2 73,6 mm	110 x10,0 90,0 mm	125 x 11,4 102,2 mm
0,01		R	0,06	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
		v	0,05	0,03	0,02	0,01	0,01	0,00	0,00	0,00	0,00	0,00
0,02		R	0,12	0,05	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,00
		v	0,10	0,06	0,04	0,02	0,02	0,01	0,01	0,00	0,00	0,00
0,03		R	0,18	0,07	0,03	0,01	0,00	0,00	0,00	0,00	0,00	0,00
		v	0,15	0,09	0,06	0,04	0,02	0,01	0,01	0,01	0,00	0,00
0,04		R	0,50	0,17	0,04	0,01	0,01	0,00	0,00	0,00	0,00	0,00
		v	0,19	0,12	0,08	0,05	0,03	0,02	0,01	0,01	0,00	0,00
0,05		R	0,74	0,25	0,08	0,02	0,01	0,00	0,00	0,00	0,00	0,00
		v	0,24	0,15	0,09	0,06	0,04	0,02	0,02	0,01	0,00	0,00
0,06		R	1,01	0,34	0,11	0,02	0,01	0,00	0,00	0,00	0,00	0,00
		v	0,29	0,18	0,11	0,07	0,05	0,03	0,02	0,01	0,00	0,00
0,07		R	1,32	0,44	0,14	0,05	0,01	0,00	0,00	0,00	0,00	0,00
		v	0,34	0,21	0,13	0,08	0,05	0,03	0,02	0,02	0,00	0,00
0,08		R	1,66	0,56	0,18	0,06	0,02	0,00	0.00	0,00	0,00	0,00
		v	0,39	0,24	0,15	0,10	0,06	0,04	0,03	0,02	0,00	0,00
0,09		R	2,03	0,68	0,22	0,07	0,03	0,01	0,00	0,00	0,00	0,00
		v	0,44	0,28	0,17	0,11	0,07	0,04	0,03	0,02	0,00	0,00
0,10		R	2,44	0,82	0,26	0,09	0,03	0,01	0,00	0,00	0,00	0,00
		v	0,49	0,31	0,19	0,12	0,08	0,05	0,03	0,02	0,00	0,00
0,12		R	3,35	1,12	0,35	0,12	0,04	0,01	0,01	0,00	0,00	0,00
		v	0,58	0,37	0,23	0,14	0,09	0,06	0,04	0,03	0,00	0,00
0,14		R	4,39	1,46	0,46	0,16	0,06	0,02	0,01	0,00	0,00	0,00
		v	0,68	0,43	0,26	0,17	0,11	0,07	0,05	0,03	0,00	0,00
0,16		R	5,55	1,85	0,58	0,20	0,07	0,02	0,01	0,00	0,00	0,00
		v	0,78	0,49	0,30	0,19	0,12	0,08	0,05	0,04	0,00	0,00
0,18		R	6,64	2,27	0,72	0,24	0,08	0,03	0,01	0,01	0,00	0,00
		v	0,87	0,55	0,34	0,22	0,14	0.09	0,06	0,04	0,00	0,00
0,20		R	8,23	2,73	0,86	0,29	0,10	0,03	0,01	0,01	0,00	0,00
		v	0,97	0,61	0,38	0,24	0,15	0,10	0,07	0,05	0,00	0,00
0,30		R	16,93	5,59	1,75	0,59	0,20	0,07	0,03	0,01	0,00	0,00
		v	1,46	0,92	0,57	0,36	0,23	0,14	0,10	0,07	0,00	0,04
0,40		R	28,37	9,32	2,91	0,99	0,34	0,11	0,05	0,02	0,01	0,00
		v	1,94	1,22	0,75	0,48	0,31	0,19	0,14	0,09	0,06	0,05
0,50		R	42,45	13,89	4,32	1,46	0,50	0,17	0,07	0,03	0,01	0,01
		v	2,43	1,53	0,94	0,60	0,38	0,24	0,17	0,12	0,08	0,06
0,60		R	59,11	19,28	5,98	2,02	0,69	0,23	0,10	0,04	0,02	0,01
		v	2,91	1,84	1,13	0,72	0,46	0,29	0,20	0,14	0,09	0,07
0,70		R	78,31	25,46	7,87	2,65	0,90	0,30	0,13	0,05	0,02	0,01
		v	3,40	2,14	1,32	0,84	0,54	0,34	0,24	0,16	0,11	0,09

Pipe friction gradient/flow speed WEFATHERM pipes SDR 11 (PN 10)

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10^{-6} m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		20 x 1,9	25 x 2,3	32 x 2,9	40 x 3,7	50 x 4,6	63 x 5,8	75 x 6,8	90 x 8,2	110 x10,0	125 x 11,4
$\dot{V}$	di ▶	16,2 mm	20,4 mm	26,0 mm	32,6 mm	40,8 mm	51,4 mm	61,2 mm	73,6 mm	90,0 mm	102,2 mm
0,80	R	100,01	32,43	10,01	3,36	1,15	0,38	0,17	0,07	0,03	0,01
	v	3,88	2,45	1,51	0,96	0,61	0,39	0,27	0,19	0,13	0,10
0,90	R	124,19	40,18	12,37	4,15	1,41	0,47	0,20	0,08	0,03	0,02
	v	4,37	2,75	1,70	1,08	0,69	0,43	0,31	0,21	0,14	0,11
1,00	R	150,84	48,69	14,96	5,01	1,70	0,56	0,24	0,10	0,04	0,02
	v	4,85	3,06	1,88	1,20	0,76	0,48	0,34	0,24	0,16	0,12
1,20	R	211,46	67,99	20,81	6,95	2,36	0,78	0,34	0,14	0,05	0,03
	v	5,82	3,67	2,26	1,44	0,92	0,58	0,41	0,28	0,19	0,15
1,40	R	281,77	90,28	27,55	9,18	3,11	1,02	0,44	0,18	0,07	0,04
	v	6,79	4,28	2,64	1,68	1,07	0,67	0,48	0,33	0,22	0,17
1,60	R	361,70	115,54	35,16	11,69	3,95	1,30	0,56	0,23	0,09	0,05
	v	7,76	4,90	3,01	1,92	1,22	0,77	0,54	0,38	0,25	0,20
1,80	R	451,22	143,73	43,63	14,48	4,88	1,60	0,69	0,29	0,11	0,06
	v	8,73	5,51	3,39	2,16	1,38	0,87	0,61	0,42	0,28	0,22
2,00	R	552,07	174,84	52,94	17,54	5,90	1,94	0,84	0,35	0,13	0,07
	v	9,70	6,12	3,77	2,40	1,53	0,96	0,68	0,47	0,31	0,24
2,20	R	660,78	208,86	63,11	20,87	7,02	2,30	0,99	0,41	0,16	0,09
	v	10,67	6,73	4,14	2,64	1,68	1,06	0,75	0,52	0,35	0,27
2,40	R	778,98	245,77	74,11	24,47	8,21	2,69	1,16	0,48	0,18	0,10
	v	11,64	7,34	4,52	2,88	1,84	1,16	0,82	0,56	0,38	0,29
2,60	R	906,64	285,56	85,94	28,33	9,50	3,10	1,34	0,55	0,21	0,11
	v	12,61	7,95	4,90	3,11	1,99	1,25	0,88	0,61	0,41	0,32
2,80	R	1043,75	328,23	98,61	32,46	10,87	3,55	1,53	0,63	0,24	0,13
	v	13,58	8,57	5,27	3,35	2,14	1,35	0,95	0,66	0,44	0,34
3,00	R	1190,30	373,77	112,10	36,85	12,32	4,02	1,73	0,71	0.27	0,15
	v	14,55	9,18	5,65	3,59	2,29	1,45	1,02	0,71	0,47	0,37
3,20	R	1346,28	423,56	126,42	41,50	13,86	4,52	1,94	0,80	0,30	0,17
	v	15,52	9,79	6,03	3,83	2,45	1,54	1,09	0,75	0,50	0,39
3,40	R	1511,68	474,89	141,56	46,41	15,49	5,04	2,17	0,89	0,34	0,18
	v	16,50	10,40	6,40	4,07	2,60	1,64	1,16	0,80	0,53	0,41
3,60	R	1686,50	529,07	157,51	51,58	17,19	5,59	2,40	0,99	0,38	0,20
	v	17,47	11,01	6,78	4,31	2,75	1,73	1,22	0,85	0,57	0,44
3,80	R	1870,73	586,10	174,29	57,00	18,98	6,17	2,65	1,09	0,41	0,22
	v	18,44	11,63	7,16	4,55	2,91	1,83	1,29	0,89	0,60	0,46
4,00	R	2064,37	645,97	191,88	62,69	20,86	6,77	2,91	1,19	0,45	0,25
	v	19,41	12,24	7,53	4,79	3,06	1,93	1,36	0,94	0,63	0,49
4,20	R	2267,41	708,68	210,28	68,63	22,81	7,40	3,18	1,30	0,49	0,27
	v	20,38	12,85	7,91	5,03	3,21	2,02	1,43	0,99	0,66	0,51
4,40	R	2479,85	774,22	229,50	74,82	24,85	8,06	3,46	1,42	0,54	0,29
	v	21,35	13,46	8,29	5,27	3,37	2,12	1,50	1,03	0,69	0,54

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Pipe friction gradient/flow speed WEFATHERM pipes SDR 11 (PN 10)

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10^{-6} m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		20 x 1,9	25 x 2,3	32 x 2,9	40 x 3,7	50 x 4,6	63 x 5,8	75 x 6,8	90 x 8,2	110 x10,0	125 x 11,4
$\dot{V}$	di ▶	16,2 mm	20,4 mm	26,0 mm	32,6 mm	40,8 mm	51,4 mm	61,2 mm	73,6 mm	90,0 mm	102,2 mm
4,60	R	2701,69	842,61	249,53	81,27	26,97	8,74	3,75	1,54	0,58	0,32
	v	22,32	14,07	8,66	5,51	3,52	2,22	1,56	1,08	0,72	0,56
4,80	R	2932,92	913,82	271,35	87,98	29,17	9,44	4,05	1,66	0,63	0,34
	v	23,29	14,69	9,04	5,75	3,67	2,31	1,63	1,13	0,75	0,59
5,00	R	3173,54	987,87	293,03	94,93	31,45	10,17	4,36	1,78	0,68	0,37
	v	24,26	15,30	9,42	5,99	3,82	2,41	1,70	1,18	0,79	0,61
5,20	R	3423,56	1064,75	315,52	102,14	33,81	10,93	4,68	1,92	0,73	0,39
	v	25,23	15,91	9,79	6,23	3,98	2,51	1,77	1,22	0,82	0,63
5,40	R	3682,96	1144,46	338,82	109,61	36,26	11,71	5,01	2,05	0,78	0,42
	v	26,20	16,52	10,17	6,47	4,13	2,60	1,84	1,27	0,85	0,66
5,60	R	3951,74	1227,00	362,92	117,32	38,78	12,52	5,36	2,19	0,83	0,45
	v	27,17	17,13	10,55	6,71	4,28	2,70	1,90	1,32	0,88	0,68
5,80	R	4229,92	1312,37	387,82	125,29	41,39	13,35	5,71	2,33	0,88	0,48
	v	28,14	17,75	10,92	6,95	4,44	2,80	1,97	1,36	0,91	0,71
6,00	R	4517,48	1400,00	413,53	133,51	44,07	14,21	6,07	2,48	0,94	0,51
	v	29,11	18,36	11,30	7,19	4,59	2,89	2,04	1,41	0,94	0,73
6,20	R	4814,42	1491,58	440,05	141,98	46,83	15,09	6,45	2,63	1,00	0,54
	v	30,08	18,97	11,68	7,43	4,74	2,99	2,11	1,46	0,97	0,76
6,40	R	5120,74	1585,42	467,37	150,70	49,68	16,00	6,83	2,79	1,06	0,57
	v	31,05	19,58	12,05	7,67	4,90	3,08	2,18	1,50	1,01	0,78
6,60	R	5436,44	1682,09	495,48	159,67	52,60	16,93	7,23	2,95	1,12	0,60
	v	32,02	20,19	12,43	7,91	5,05	3,18	2,24	1,55	1,04	0,80
6,80	R	5761,53	1781,58	524,41	168,89	55,60	17,89	7,63	3,12	1,18	0,64
	v	32,99	20,80	12,81	8,15	5,20	3,28	2,31	1,60	1,07	0,83
7,00	R	6095,99	1883,89	554,13	178,37	58,69	18,87	8,05	3,28	1,24	0,67
	v	33,96	21,42	13,18	8,39	5,35	3,37	2,38	1,65	1,10	0,85
7,50	R	6973,19	2152,02	631,95	203,89	66,74	21,43	9,13	3,72	1,41	0,76
	v	36,39	22,95	14,13	8,99	5,74	3,61	2,55	1,76	1,18	0,91
8,00	R	7908,99	2437,78	714,76	230,26	75,28	24,14	10,28	4,19	1,58	0,85
	v	38,81	24,48	15,07	9,58	6,12	3,86	2,72	1,88	1,26	0,98
9,00	R	9956,40	3062,18	895,39	287,67	93,85	30,02	12,77	5,19	1,96	1,06
	v	43,66	27,54	16,95	10,78	6,88	4,34	3,06	2,12	1,41	1,10
10,00	R		3757,04	1095,99	351,27	114,38	36,51	15,50	6,30	2,37	1,28
	v		30,59	18,83	11,98	7,65	4,82	3,40	2,35	1,57	1,22

Pipe friction gradient / flow speed WEFATHERM pipes SDR 6 (PN 20)

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10^{-6} m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		16 x 2,7	20 x 3,4	25 x 4,2	32 x 5,4	40 x 6,7	50 x 8,3	63 x 10,5	75 x 12,5	90 x 15,0	110 x 18,3
$\dot{V}$	di ▶	16,2 mm	20,4 mm	26,0 mm	32,6 mm	40,8 mm	51,4 mm	61,2 mm	73,6 mm	90,0 mm	102,2 mm
0,01	R	0,33	0,14	0,05	0,02	0,01	0,00	0,00	0,00	0,00	0,00
	v	0,11	0,07	0,05	0,03	0,02	0,01	0,01	0,01	0,00	0,00
0,02	R	1,15	0,27	0,11	0,04	0,02	0,01	0,00	0,00	0,00	0,00
	v	0,23	0,15	0,09	0,06	0,04	0,02	0,01	0,01	0,01	0,00
0,03	R	2,29	0,81	0,16	0,06	0,02	0,01	0,00	0,00	0,00	0,00
	v	0,34	0,22	0,14	0,08	0,05	0,03	0,02	0,02	0,01	0,00
0,04	R	3,74	1,33	0,45	0,14	0,03	0,01	0,01	0,00	0,00	0,00
	v	0,45	0,29	0,18	0,11	0,07	0,05	0,03	0,02	0,01	0,00
0,05	R	5,51	1,94	0,66	0,21	0,07	0,02	0,01	0,00	0,00	0,00
	v	0,57	0,37	0,23	0,14	0,09	0,06	0,04	0,03	0,02	0,00
0,06	R	7,56	2,66	0,90	0,28	0,10	0,02	0,01	0,00	0,00	0,00
	v	0,68	0,44	0,28	0,17	0,11	0,07	0,04	0,03	0,02	0,00
0,07	R	9,89	3,48	1,17	0,37	0,13	0,04	0,01	0,00	0,00	0,00
	v	0,79	0,51	0,32	0,20	0,13	0,08	0,05	0,04	0,02	0,00
0,08	R	12,50	4,39	1,48	0,46	0,16	0,06	0,02	0,01	0,00	0,00
	v	0,91	0,58	0,37	0,23	0,14	0,09	0,06	0,04	0,03	0,00
0,09	R	15,38	5,39	1,81	0,57	0,19	0,07	0,02	0,01	0,00	0,00
	v	1,02	0,66	0,42	0,25	0,16	0,10	0,06	0,05	0,03	0,00
0,10	R	18,52	6,48	2,17	0,68	0,23	0,08	0,03	0,01	0,00	0,00
	v	1,13	0,73	0,46	0,28	0,18	0,12	0,07	0,05	0,04	0,00
0,12	R	25,57	8,92	2,99	0,93	0,32	0,11	0,04	0,02	0,01	0,00
	v	1,36	0,88	0,55	0,34	0,22	0,14	0,09	0,06	0,04	0,00
0,14	R	33,63	11,71	3,91	1,22	0,42	0,15	0,05	0,02	0,01	0,00
	v	1,59	1,02	0,65	0,40	0,25	0,16	0,10	0,07	0,05	0,00
0,16	R	42,69	14,83	4,94	1,54	0,52	0,18	0,06	0,03	0,01	0,00
	v	1,81	1,17	0,74	0,45	0,29	0,18	0,12	0,08	0,06	0,00
0,18	R	52,73	18,28	6,08	1,89	0,64	0,22	0,07	0,03	0,01	0,01
	v	2,04	1,32	0,83	0,51	0,32	0,21	0,13	0,09	0,06	0,04
0,20	R	63,72	22,05	7,32	2,27	0,77	0,27	0,09	0,04	0,02	0,01
	v	2,27	1,46	0,92	0,57	0,36	0,23	0,14	0,10	0,07	0,05
0,30	R	132,83	45,61	15,05	4,64	1,57	0,55	0,18	0,08	0,03	0,01
	v	3,40	2,19	1,39	0,85	0,54	0,35	0,22	0,15	0,11	0,07
0,40	R	224,93	76,78	25,21	7,74	2,61	0,90	0,29	0,13	0,05	0,02
	v	4,53	2,92	1,85	1,13	0,72	0,46	0,29	0,20	0,14	0,10
0,50	R	339,55	115,34	37,70	11,53	3,87	1,34	0,44	0,19	0,08	0,03
	v	5,67	3,65	2,31	1,42	0,90	0,58	0,36	0,25	0,18	0,12
0,60	R	476,42	161,16	52,48	16,00	5,35	1,85	0,60	0,26	0,11	0,04
	v	6,80	4,38	2,77	1,70	1,08	0,69	0,43	0,31	0,21	0,14
0,70	R	635,34	214,16	69,50	21,13	7,05	2,43	0,79	0,34	0,14	0,06
	v	7,93	5,12	3,23	1,98	1,26	0,81	0,51	0,36	0,25	0,17

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In pipe friction gradient / flow speed WEFATHERM pipes SDR 6 (PN 20)

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=998,00 kg/m²
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10^{-6} m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		16 x 2,7	20 x 3,4	25 x 4,2	32 x 5,4	40 x 6,7	50 x 8,3	63 x 10,5	75 x 12,5	90 x 15,0	110 x 18,3
$\dot{V}$	di ▶	10,6 mm	13,2 mm	16,6 mm	21,2 mm	26,6 mm	33,2 mm	42,0 mm	50,0 mm	60,0 mm	73,4 mm
0,80	R	816,21	274,25	88,74	26,90	8,96	3,08	1,00	0,43	0,18	0,07
	v	9,07	5,85	3,70	2,27	1,44	0,92	0,58	0,41	0,28	0,19
0,90	R	1021,95	341,40	110,17	33,31	11,08	3,80	1,23	0,53	0,22	0,09
	v	10,20	6,58	4,16	2,55	1,62	1,04	0,65	0,46	0,32	0,21
1,00	R	1246,72	415,58	133,77	40,36	13,39	4,59	1,48	0,64	0,27	0,10
	v	11,33	7,31	4,62	2,83	1,80	1,16	0,72	0,51	0,35	0,24
1,20	R	1761,36	584,86	187,44	56,32	18,63	6,37	2,05	0,89	0,37	0,14
	v	13,60	8,77	5,54	3,40	2,16	1,39	0,87	0,61	0,42	0,29
1,40	R	2362,60	784,32	249,67	74,74	24,65	8,41	2,70	1,17	0,49	0,19
	v	15,86	10,23	6,47	3,97	2,52	1,62	1,01	0,71	0,50	0,33
1,60	R	3050,27	1009,36	320,39	95,60	31,45	10,70	3,43	1,48	0,62	0,24
	v	18,13	11,69	7,39	4,53	2,88	1,85	1,15	0,81	0,57	0,38
1,80	R	3824,26	1261,97	399,56	118,88	39,02	13,25	4,24	1,83	0,76	0,29
	v	20,40	13,15	8,32	5,10	3,24	2,08	1,30	0,92	0,64	0,43
2,00	R	4684,50	1542,10	487,13	144,56	47,34	16,05	5,13	2,21	0,92	0,35
	v	22,66	14,61	9,24	5,67	3,60	2,31	1,44	1,02	0,71	0,48
2,20	R	5630,92	1849,71	584,92	172,62	56,42	19,09	6,10	2,63	1,09	0,42
	v	24,93	16,08	10,17	6,23	3,96	2,54	1,59	1,12	0,78	0,52
2,40	R	6663,50	2184,77	689,39	203,06	66,24	22,38	7,14	3,07	1,28	0,49
	v	27,20	17,54	11,06	6,80	4,32	2,77	1,73	1,22	0,85	0,57
2,60	R	7782,20	2547,26	802,20	235,86	76,81	25,91	8,25	3,55	1,47	0,57
	v	29,46	19,00	12,01	7,37	4,68	3,00	1,88	1,32	0,92	0,62
2,80	R	8986,99	2937,15	923,33	271,02	88,12	29,69	9,44	4,06	1,68	0,65
	v	31,73	20,46	12,94	7,93	5,04	3,23	2,02	1,43	0,99	0,67
3,00	R		3354,43	1052,78	308,54	100,16	33,70	10,70	4,59	1,90	0,73
	v		21,92	13,86	8,50	5,40	3,47	2,17	1,53	1,06	0,71
3,20	R		3799,10	1190,54	348,40	112,93	37,95	12,04	5,16	2,14	0,87
	v		23,38	14,79	9,07	15,76	3,70	2,31	1,63	1,13	0,76
3,40	R		4271,13	1336,61	391,92	126,44	42,43	13,45	5,76	2,39	0,91
	v		24,85	15,71	9,63	6,12	3,93	2,45	1,73	1,20	0,81
3,60	R		4770,53	1490,96	436,53	140,68	47,16	14,93	6,39	2,65	1,01
	v		26,31	16,63	10,20	6,48	4,16	2,60	1,83	1,27	0,86
3,80	R		5297,29	1653,61	483,48	155,64	52,11	16,48	7,06	2,92	1,17
	v		27,77	17,56	10,77	6,84	4,39	2,74	1,94	1,34	0,90
4,00	R		5851,39	1824,55	532,75	171,33	57,30	18,10	7,75	3,20	1,23
	v		29,23	18,48	11,33	7,20	4,62	2,89	2,04	1,41	0,95
4,20	R		6432,84	2003,76	584,35	187,74	62,73	19,80	8,47	3,50	1,34
	v		30,69	19,41	11,90	7,56	4,85	3,03	2,14	1,49	1,00
4,40	R		7041,63	2191,26	638,28	204,87	68,39	21,57	9,22	3,80	1,45
	v		32,15	20,33	12,46	7,92	5,08	3,18	2,24	1,56	1,05

Pipe friction gradient/flow speed
WEFATHERM pipes SDR 6 (PN20)

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10⁻⁶ m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		16 x 2,7	20 x 3,4	25 x 4,2	32 x 5,4	40 x 6,7	50 x 8,3	63 x 10,5	75 x 12,5	90 x 15,0	110 x 18,3
$\dot{V}$	di ▶	10,6 mm	13,2 mm	16,6 mm	21,2 mm	26,6 mm	33,2 mm	42,0 mm	50,0 mm	60,0 mm	73,4 mm
4,60	R		7677,76	2387,03	694,53	222,73	74,28	23,40	9,99	4,12	1,58
	v		33,61	21,25	13,03	8,28	5,31	3,32	2,34	1,63	1,03
4,80	R		8341,23	2591,07	753,10	241,30	80,40	25,31	10,80	4,45	1,70
	v		35,08	22,18	13,60	8,64	5,54	3,46	2,44	1,70	1,09
5,00	R		9032,03	2803,39	813,99	261,55	86,75	27,29	11,64	4,80	1,83
	v		36,54	23,10	14,16	9,00	5,78	3,61	2,55	1,77	1,19
5,20	R		9750,16	3023,97	877,20	281,60	93,33	29,33	12,51	5,15	1,97
	v		38,00	24,03	14,73	9,36	6,01	3,75	2,65	1,84	1,24
5,40	R			3252,82	942,73	302,37	100,15	31,45	13,40	5,52	2,11
	v			24,95	15,30	9,72	6,24	3,90	2,75	1,91	1,28
5,60	R			3489,94	1010,58	323,85	107,19	33,64	14,33	5,90	2,25
	v			25,88	15,86	10,08	6,47	4,04	2,85	1,98	1,33
5,80	R			3735,32	1080,74	346,04	114,46	35,89	15,28	6,29	2,40
	v			26,80	16,43	10,44	6,70	4,19	2,95	2,05	1,38
6,00	R			3988,97	1153,21	368,95	121,96	38,22	16,26	6,69	2,55
	v			27,72	17,00	10,80	6,93	4,33	3,06	2,12	1,43
6,20	R			4250,88	1228,00	392,58	129,69	40,61	17,27	7,10	2,70
	v			28,65	17,56	11,16	7,16	4,48	3,16	2,19	1,47
6,40	R			4521,05	1305,10	416,92	137,65	43,07	18,31	7,52	2,87
	v			29,57	18,13	11,52	7,39	4,62	3,26	2,26	1,52
6,60	R			4799,49	1384,52	441,97	145,84	45,60	19,38	7,96	3,03
	v			30,50	18,70	11,88	7,62	4,76	3,36	2,33	1,57
6,80	R			5086,18	1466,24	467,74	154,25	48,20	20,48	8,41	3,20
	v			31,42	19,26	12,24	7,85	4,91	3,46	2,41	1,62
7,00	R			5381,13	1550,28	494,21	162,90	50,87	21,60	8,86	3,27
	v			32,34	19,83	12,60	8,09	5,05	3,57	2,48	1,66
7,50	R			6154,64	1770,48	563,52	186,21	57,84	24,53	10,06	3,8
	v			34,65	21,25	13,50	8,66	5,41	3,82	2,65	1,78
8,00	R			6979,76	2005,11	637,28	210,27	65,24	27,64	11,32	4,30
	v			36,96	22,66	14,40	9,24	5,77	4,07	2,83	1,90
9,00	R			8784,80	2517,66	798,11	262,63	81,30	34,39	14,06	5,33
	v			41,58	25,50	16,20	10,40	6,50	4,58	3,18	2,14
10,00	R				3087,89	976,68	320,63	99,05	41,83	17,08	6,47
	v				28,33	17,99	11,55	7,22	5,09	3,54	2,38

Pipe friction gradient/flow speed
WEFATHERM Fiber pipes SDR 7,4 (PN20)
WEFATHERM Stabi pipes PN20
WEFATHERM pipes PN16

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K= 0,007 mm sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10⁻⁶ m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		16 x 2,2	20 x 2,8	25 x 3,5	32 x 4,5	40 x 5,6	50 x 6,9	63 x 8,7	75 x 10,4	90 x 12,5	110 x 15,1	125 x 17,1
$\dot{V}$	di ▶	11,6 mm	14,4 mm	18,0 mm	23,0 mm	28,8 mm	36,2 mm	45,6 mm	54,2 mm	65,0 mm	79,8 mm	90,8 mm
0,01	R	0,23	0,10	0,04	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00
	v	0,09	0,06	0,04	0,02	0,02	0,01	0,01	0,00	0,00	0,00	0,00
0,02	R	0,46	0,19	0,08	0,03	0,01	0,00	0,00	0,00	0,00	0,00	0,00
	v	0,19	0,12	0,08	0,05	0,03	0,02	0,01	0,01	0,01	0,00	0,00
0,03	R	1,49	0,54	0,12	0,04	0,02	0,01	0,00	0,00	0,00	0,00	0,00
	v	0,28	0,18	0,12	0,07	0,05	0,03	0,02	0,01	0,01	0,00	0,00
0,04	R	2,44	0,88	0,31	0,06	0,02	0,01	0,00	0,00	0,00	0,00	0,00
	v	0,38	0,25	0,16	0,10	0,06	0,04	0,02	0,02	0,01	0,00	0,00
0,05	R	3,59	1,29	0,45	0,14	0,03	0,01	0,00	0,00	0,00	0,00	0,00
	v	0,47	0,31	0,20	0,12	0,08	0,05	0,03	0,02	0,02	0,00	0,00
0,06	R	4,92	1,76	0,61	0,19	0,07	0,01	0,01	0,00	0,00	0,00	0,00
	v	0,57	0,37	0,24	0,14	0,09	0,06	0,04	0,03	0,02	0,00	0,00
0,07	R	6,43	2,30	0,80	0,25	0,09	0,03	0,01	0,00	0,00	0,00	0,00
	v	0,66	0,43	0,28	0,17	0,11	0,07	0,04	0,03	0,02	0,00	0,00
0,08	R	8,12	2,90	1,01	0,32	0,11	0,04	0,01	0,00	0,00	0,00	0,00
	v	0,76	0,49	0,31	0,19	0,12	0,08	0,05	0,03	0,02	0,00	0,00
0,09	R	9,99	3,56	1,23	0,39	0,13	0,05	0,02	0,00	0,00	0,00	0,00
	v	0,85	0,55	0,35	0,22	0,14	0,09	0,06	0,04	0,03	0,00	0,00
0,10	R	12,02	4,28	1,48	0,46	0,16	0,05	0,02	0,00	0,00	0,00	0,00
	v	0,95	0,61	0,39	0,24	0,15	0,10	0,06	0,04	0,03	0,00	0,00
0,12	R	16,58	5,88	2,03	0,63	0,22	0,07	0,03	0,01	0,00	0,00	0,00
	v	1,14	0,74	0,47	0,29	0,18	0,12	0,07	0,05	0,04	0,00	0,00
0,14	R	21,78	7,72	2,66	0,83	0,29	0,10	0,03	0,01	0,01	0,00	0,00
	v	1,32	0,86	0,55	0,34	0,21	0,14	0,09	0,06	0,04	0,00	0,00
0,16	R	27,62	9,76	3,36	1,04	0,36	0,12	0,04	0,02	0,01	0,00	0,00
	v	1,51	0,98	0,63	0,39	0,25	0,16	0,10	0,07	0,05	0,00	0,00
0,18	R	34,08	12,03	4,13	1,28	0,44	0,15	0,05	0,02	0,01	0,00	0,00
	v	1,70	1,11	0,71	0,43	0,28	0,17	0,11	0,08	0,05	0,00	0,00
0,20	R	41,16	14,50	4,97	1,54	0,53	0,18	0,06	0,03	0,01	0,00	0,00
	v	1,89	1,23	0,79	0,48	0,31	0,19	0,12	0,09	0,06	0,00	0,00
0,30	R	85,52	29,92	10,19	3,14	1,07	0,36	0,12	0,05	0,02	0,01	0,00
	v	2,84	1,84	1,18	0,72	0,46	0,29	0,18	0,13	0,09	0,06	0,05
0,40	R	144,45	50,25	17,04	5,23	1,78	0,60	0,20	0,09	0,04	0,01	0,01
	v	3,78	2,46	1,57	0,96	0,61	0,39	0,24	0,17	0,12	0,08	0,06
0,50	R	217,60	75,36	25,45	7,79	2,64	0,88	0,29	0,13	0,05	0,02	0,01
	v	4,73	3,07	1,96	1,20	0,77	0,49	0,31	0,22	0,15	0,10	0,08
0,60	R	304,78	105,14	35,38	10,79	3,65	1,22	0,41	0,18	0,08	0,03	0,02
	v	5,68	3,68	2,36	1,44	0,92	0,58	0,37	0,26	0,18	0,12	0,09
0,70	R	405,84	139,52	46,81	14,24	4,81	1,60	0,53	0,23	0,10	0,04	0,02
	v	6,62	4,30	2,75	1,68	1,07	0,68	0,43	0,30	0,21	0,14	0,11

Pipe friction gradient flow/speed
WEFATHERM Fiber pipes SDR 7,4 (PN20)
WEFATHERM Stabi pipes PN20
WEFATHERM pipes PN16

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10⁻⁶ m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s / $\dot{V}$		16 x 2,2	20 x 2,8	25 x 3,5	32 x 4,5	40 x 5,6	50 x 6,9	63 x 8,7	75 x 10,4	90 x 12,5	110 x 15,1	125 x 17,1
di		11,6 mm	14,4 mm	18,0 mm	23,0 mm	28,8 mm	36,2 mm	45,6 mm	54,2 mm	65,0 mm	79,8 mm	90,8 mm
0,80	R	520,68	178,47	59,71	18,11	6,11	2,03	0,67	0,29	0,12	0,05	0,03
	v	7,57	4,91	3,14	1,93	1,23	0,78	0,49	0,35	0,24	0,16	0,12
0,90	R	649,23	221,93	74,06	22,41	7,54	2,51	0,83	0,36	0,15	0,06	0,03
	v	8,52	5,53	3,54	2,17	1,38	0,87	0,55	0,39	0,27	0,18	0,14
1,00	R	791,45	269,88	89,86	27,13	9,12	3,03	1,00	0,44	0,18	0,07	0,04
	v	9,46	6,14	3,93	2,41	1,54	0,97	0,61	0,43	0,30	0,20	0,15
1,20	R	1119,70	379,18	125,78	37,82	12,67	4,19	1,38	0,60	0,25	0,10	0,05
	v	11,35	7,37	4,72	2,89	1,84	1,17	0,73	0,52	0,36	0,24	0,19
1,40	R	1499,59	506,22	167,26	50,13	16,75	5,53	1,82	0,79	0,33	0,13	0,07
	v	13,25	8,60	5,50	3,37	2,15	1,36	0,86	0,61	0,42	0,28	0,22
1,60	R	1933,55	650,91	214,40	64,07	21,35	7,04	2,31	1,01	0,42	0,16	0,09
	v	15,14	9,82	6,29	3,85	2,46	1,55	0,98	0,69	0,48	0,32	0,25
1,80	R	2421,48	815,49	267,11	79,59	26,47	8,71	2,85	1,24	0,52	0,20	0,11
	v	17,03	11,05	7,07	4,33	2,76	1,75	1,10	0,78	0,54	0,36	0,28
2,00	R	2963,31	995,51	325,37	96,70	32,09	10,54	3,45	1,50	0,63	0,24	0,13
	v	18,92	12,28	7,86	4,81	3,07	1,94	1,22	0,87	0,60	0,40	0,31
2,20	R	3558,98	1193,02	389,15	115,39	38,22	12,53	4,10	1,78	0,74	0,28	0,15
	v	20,82	13,51	8,65	5,30	3,38	2,14	1,35	0,95	0,66	0,44	0,34
2,40	R	4208,48	1407,98	458,44	135,64	44,85	14,68	4,79	2,08	0,87	0,33	0,17
	v	22,71	14,74	9,43	5,78	3,68	2,33	1,47	1,04	0,72	0,48	0,37
2,60	R	4911,76	1640,39	534,89	157,45	51,98	16,99	5,54	2,40	1,00	0,38	0,20
	v	24,60	15,96	10,22	6,26	3,99	2,53	1,59	1,13	0,78	0,52	0,40
2,80	R	5668,81	1890,23	615,26	180,82	59,60	19,46	6,33	2,75	1,14	0,43	0,23
	v	26,49	17,19	11,00	6,74	4,30	2,72	1,71	1,21	0,84	0,56	0,43
3,00	R	6479,61	2157,47	701,10	205,73	67,71	22,08	7,18	3,11	1,29	0,49	0,26
	v	28,39	18,42	11,79	7,22	4,61	2,91	1,84	1,30	0,90	0,60	0,46
3,20	R	7344,14	2442,11	792,39	232,18	76,31	24,85	8,07	3,50	1,45	0,55	0,29
	v	30,28	19,65	12,58	7,70	4,91	3,11	1,96	1,39	0,96	0,64	0,49
3,40	R	8262,40	2744,15	889,14	260,18	85,39	27,77	9,01	3,90	1,62	0,61	0,32
	v	32,17	20,88	13,36	8,18	5,22	3,30	2,08	1,47	1,02	0,68	0,53
3,60	R	9234,38	3063,57	991,34	289,71	94,97	30,85	10,00	4,33	1,80	0,68	0,36
	v	34,06	22,10	14,15	8,66	5,53	3,50	2,20	1,56	1,08	0,72	0,56
3,80	R		3400,36	1098,99	320,78	105,02	34,08	11,04	4,77	1,98	0,75	0,40
	v		23,33	14,93	9,15	5,83	3,69	2,33	1,65	1,15	0,76	0,59
4,00	R		3754,53	1212,07	354,57	115,56	37,46	12,12	5,24	2,17	0,82	0,43
	v		24,56	15,72	9,63	6,14	3,89	2,45	1,73	1,21	0,80	0,62
4,20	R		4126,07	1330,59	388,75	126,58	41,00	13,25	5,72	2,37	0,89	0,47
	v		25,79	16,50	10,11	6,45	4,08	2,57	1,82	1,27	0,84	0,65
4,40	R		4514,97	1454,54	424,46	138,09	44,68	14,43	6,23	2,58	0,97	0,52
	v		27,02	17,29	10,59	6,75	4,28	2,69	1,91	1,33	0,88	0,68

Pipe friction gradient/flow speed
WEFATHERM Fiber pipes SDR 7,4 (PN20)
WEFATHERM Stabi pipes PN20
WEFATHERM pipes PN16

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=998,00 kg/m³
Temperature: t=20 °C kin. tenacity: ν=1,02 x 10⁻⁶ m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s / $\dot{V}$			16 x 2,2	20 x 2,8	25 x 3,5	32 x 4,5	40 x 5,6	50 x 6,9	63 x 8,7	75 x 10,4	90 x 12,5	110 x 15,1	125 x 17,1
di			11,6 mm	14,4 mm	18,0 mm	23,0 mm	28,8 mm	36,2 mm	45,6 mm	54,2 mm	65,0 mm	79,8 mm	90,8 mm
4,60	R		4921,23	1583,93	461,69	150,07	48,51	15,66	6,75	2,80	1,05	0,56	
	v		28,25	18,08	11,07	7,06	4,47	2,82	1,99	1,39	0,92	0,71	
4,80	R		5344,85	1718,74	500,44	162,53	52,49	16,93	7,30	3,02	1,14	0,60	
	v		29,47	18,86	11,55	7,37	4,66	2,94	2,08	1,45	0,96	0,74	
5,00	R		5785,83	1858,98	540,71	175,47	56,62	18,25	7,86	3,25	1,22	0,65	
	v		30,70	19,65	12,03	7,68	4,86	3,06	2,17	1,51	1,00	0,77	
5,20	R		6244,16	2004,64	582,51	188,89	60,89	19,61	8,44	3,49	1,31	0,70	
	v		31,93	20,43	12,52	7,98	5,05	3,18	2,25	1,57	1,04	0,80	
5,40	R		6719,85	2155,73	625,82	202,78	65,32	21,02	9,05	3,74	1,40	0,74	
	v		33,16	21,22	13,00	8,29	5,25	3,31	2,34	1,63	1,09	0,83	
5,60	R		7212,88	2312,24	670,65	217,15	69,89	22,48	9,67	4,00	1,50	0,79	
	v		34,39	22,01	13,48	8,60	5,44	3,43	2,43	1,69	1,13	0,86	
5,80	R		7723,26	2474,18	717,00	232,86	74,61	23,98	10,31	4,26	1,60	0,85	
	v		35,61	22,79	13,96	8,90	5,64	3,55	2,51	1,75	1,17	0,90	
6,00	R		8250,99	2641,53	764,86	248,21	79,48	25,52	10,97	4,53	1,70	0,90	
	v		36,84	23,58	14,44	9,21	5,83	3,67	2,60	1,81	1,21	0,93	
6,20	R		8796,07	2814,30	814,25	264,03	84,50	27,12	11,65	4,81	1,80	0,95	
	v		38,07	24,36	14,92	9,52	6,02	3,80	2,69	1,87	1,25	0,96	
6,40	R		9358,49	2992,49	865,14	280,33	89,66	28,76	12,35	5,10	1,91	1,01	
	v		39,30	25,15	15,40	9,82	6,22	3,92	2,77	1,93	1,29	0,99	
6,60	R		9938,26	3176,09	917,55	297,09	94,97	30,44	13,07	5,39	2,02	1,07	
	v		40,53	25,94	15,89	10,13	6,41	4,04	2,86	1,99	1,33	1,02	
6,80	R			3365,11	971,48	314,34	100,42	32,17	13,80	5,69	2,13	1,13	
	v			26,72	16,37	10,44	6,61	4,16	2,95	2,05	1,37	1,05	
7,00	R			3559,55	1026,92	332,05	106,02	33,94	14,56	6,00	2,25	1,19	
	v			27,51	16,85	10,75	6,80	4,29	3,03	2,11	1,41	1,08	
7,50	R			4069,34	1172,13	378,40	120,66	38,57	16,53	6,81	2,55		
	v			29,47	18,05	11,51	7,29	4,59	3,25	2,26	1,51		
8,00	R			4612,96	1326,80	427,70	136,21	43,48	18,62	7,66	2,86	1,51	
	v			31,44	19,26	12,28	7,77	4,90	3,47	2,41	1,61	1,24	
9,00	R			5801,69	1664,46	535,13	170,68	54,14	23,14	9,51	3,55	1,87	
	v			35,37	21,66	13,82	8,74	5,51	3,90	2,71	1,81	1,39	
10,00	R			7125,70	2039,87	654,31	208,18	65,91	28,13	11,55	4,30	2,27	
	v			39,30	24,07	15,35	9,72	6,12	4,33	3,01	2,01	1,54	

Pipe friction gradient/flow speed

WEFATHERM Fiber pipes SDR 7,4 (PN20)
WEFATHERM Stabi pipes PN20
WEFATHERM pipes PN16

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=983,2 kg/m³
Temperature: t=60 °C kin. tenacity: ν=0,47 x 10^{-6} m²/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		16 x 2,2	20 x 2,8	25 x 3,5	32 x 4,5	40 x 5,6	50 x 6,9	63 x 8,7	75 x 10,4	90 x 12,5	110 x 15,1	125 x 17,1
$\dot{V}$	di	11,6 mm	14,4 mm	18,0 mm	23,0 mm	28,8 mm	36,2 mm	45,6 mm	54,2 mm	65,0 mm	79,8 mm	90,8 mm
0,01	R	0,18	0,04	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	v	0,09	0,06	0,04	0,02	0,02	0,01	0,01	0,00	0,00	0,00	0,00
0,02	R	0,59	0,21	0,07	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,00
	v	0,19	0,12	0,08	0,05	0,03	0,02	0,01	0,01	0,01	0,00	0,00
0,03	R	1,19	0,42	0,15	0,05	0,02	0,00	0,00	0,00	0,00	0,00	0,00
	v	0,28	0,18	0,12	0,07	0,05	0,03	0,02	0,01	0,01	0,00	0,00
0,04	R	1,96	0,70	0,24	0,08	0,03	0,01	0,00	0,00	0,00	0,00	0,00
	v	0,38	0,25	0,16	0,10	0,06	0,04	0,02	0,02	0,01	0,00	0,00
0,05	R	2,90	1,03	0,36	0,11	0,04	0,01	0,00	0,00	0,00	0,00	0,00
	v	0,47	0,31	0,20	0,12	0,08	0,05	0,03	0,02	0,02	0,00	0,00
0,06	R	4,01	1,42	0,49	0,15	0,05	0,02	0,01	0,00	0,00	0,00	0,00
	v	0,57	0,37	0,24	0,14	0,09	0,06	0,04	0,03	0,02	0,00	0,00
0,07	R	5,27	1,86	0,64	0,20	0,07	0,02	0,01	0,00	0,00	0,00	0,00
	v	0,66	0,43	0,28	0,17	0,11	0,07	0,04	0,03	0,02	0,00	0,00
0,08	R	6,68	2,36	0,81	0,25	0,09	0,03	0,01	0,00	0,00	0,00	0,00
	v	0,76	0,49	0,31	0,19	0,12	0,08	0,05	0,03	0,02	0,00	0,00
0,09	R	8,25	2,91	1,00	0,31	0,11	0,04	0,01	0,01	0,00	0,00	0,00
	v	0,85	0,55	0,35	0,22	0,14	0,09	0,06	0,04	0,03	0,00	0,00
0,10	R	9,97	3,51	1,20	0,37	0,13	0,04	0,01	0,01	0,00	0,00	0,00
	v	0,95	0,61	0,39	0,24	0,15	0,10	0,06	0,04	0,03	0,00	0,00
0,12	R	13,85	4,86	1,66	0,51	0,18	0,06	0,02	0,01	0,00	0,00	0,00
	v	1,14	0,74	0,47	0,29	0,18	0,12	0,07	0,05	0,04	0,00	0,00
0,14	R	18,31	6,40	2,18	0,67	0,23	0,08	0,03	0,01	0,00	0,00	0,00
	v	1,32	0,86	0,55	0,34	0,21	0,14	0,09	0,06	0,04	0,00	0,00
0,16	R	23,34	8,14	2,77	0,85	0,29	0,10	0,03	0,01	0,01	0,00	0,00
	v	1,51	0,98	0,63	0,39	0,25	0,16	0,10	0,07	0,05	0,00	0,00
0,18	R	28,93	10,07	3,42	1,05	0,36	0,12	0,04	0,02	0,01	0,00	0,00
	v	1,70	1,11	0,71	0,43	0,28	0,17	0,11	0,08	0,05	0,00	0,00
0,20	R	35,09	12,19	4,13	1,27	0,43	0,14	0,05	0,02	0,01	0,00	0,00
	v	1,89	1,23	0,79	0,48	0,31	0,19	0,12	0,09	0,06	0,00	0,00
0,30	R	74,18	25,55	8,58	2,61	0,88	0,30	0,10	0,04	0,02	0,01	0,00
	v	2,84	1,84	1,18	0,72	0,46	0,29	0,18	0,13	0,09	0,06	0,05
0,40	R	126,91	43,42	14,50	4,39	1,48	0,49	0,16	0,07	0,03	0,01	0,01
	v	3,78	2,46	1,57	0,96	0,61	0,39	0,24	0,17	0,12	0,08	0,06
0,50	R	193,69	65,73	21,84	6,58	2,21	0,73	0,24	0,11	0,04	0,02	0,01
	v	4,73	3,07	1,96	1,20	0,77	0,49	0,31	0,22	0,15	0,10	0,08
0,60	R	273,37	92,42	30,59	9,18	3,07	1,02	0,33	0,15	0,06	0,02	0,01
	v	5,68	3,68	2,36	1,44	0,92	0,58	0,37	0,26	0,18	0,12	0,09
0,70	R	366,39	123,47	40,72	12,18	4,06	1,34	0,44	0,19	0,08	0,03	0,02
	v	6,62	4,30	2,75	1,68	1,07	0,68	0,43	0,30	0,21	0,14	0,11
0,80	R	472,71	159,33	52,23	15,58	5,18	1,71	0,56	0,24	0,10	0,04	0,02
	v	7,57	4,91	3,14	1,93	1,23	0,78	0,49	0,35	0,24	0,16	0,12
0,90	R	592,31	199,09	65,10	19,36	6,43	2,11	0,69	0,30	0,13	0,05	0,03
	v	8,52	5,53	3,54	2,17	1,38	0,87	0,55	0,39	0,27	0,18	0,14
1,00	R	725,17	243,16	79,34	23,53	7,80	2,56	0,84	0,36	0,15	0,06	0,03
	v	9,46	6,14	3,93	2,41	1,54	0,97	0,61	0,43	0,30	0,20	0,15
1,20	R	1030,66	344,20	112,23	33,04	10,91	3,57	1,16	0,50	0,21	0,08	0,04
	v	11,35	7,37	4,72	2,89	1,84	1,17	0,73	0,52	0,36	0,24	0,19
1,40	R	1389,12	462,41	150,22	44,07	14,50	4,73	1,54	0,67	0,28	0,10	0,06
	v	13,25	8,60	5,50	3,37	2,15	1,36	0,86	0,61	0,42	0,28	0,22
1,60	R	1800,52	597,75	193,59	56,62	18,57	6,04	1,96	0,85	0,35	0,13	0,07
	v	15,14	9,82	6,29	3,85	2,46	1,55	0,98	0,69	0,48	0,32	0,25
1,80	R	2264,83	750,22	242,32	70,93	23,13	7,50	2,43	1,05	0,44	0,16	0,09
	v	17,03	11,05	7,07	4,33	2,76	1,75	1,10	0,78	0,54	0,36	0,28
2,00	R	2782,05	919,80	296,41	86,53	28,16	9,11	2,94	1,27	0,53	0,20	0,11
	v	18,92	12,28	7,86	4,81	3,07	1,94	1,22	0,87	0,60	0,40	0,31
2,20	R	3352,17	1106,49	355,85	103,66	33,66	10,87	3,51	1,51	0,63	0,24	0,12
	v	20,82	13,51	8,65	5,30	3,38	2,14	1,35	0,95	0,66	0,44	0,34
2,40	R	3975,17	1310,27	420,64	122,22	39,63	12,78	4,11	1,77	0,73	0,28	0,15
	v	22,71	14,74	9,43	5,78	3,68	2,33	1,47	1,04	0,72	0,48	0,37
2,60	R	4651,06	1531,15	490,77	142,32	46,07	14,83	4,77	2,05	0,85	0,32	0,17
	v	24,60	15,96	10,22	6,26	3,99	2,53	1,59	1,13	0,78	0,52	0,40
2,80	R	5379,84	1769,13	566,24	163,91	53,17	17,02	5,47	2,35	0,97	0,36	0,19
	v	26,49	17,19	11,00	6,74	4,30	2,72	1,71	1,21	0,84	0,56	0,43
3,00	R	6161,49	2024,19	647,05	186,99	60,56	19,36	6,21	2,67	1,10	0,41	0,22
	v	28,39	18,42	11,79	7,22	4,61	2,91	1,84	1,30	0,90	0,60	0,46
3,20	R	6996,02	2296,33	733,20	211,56	68,42	21,85	7,00	3,00	1,24	0,46	0,25
	v	30,28	19,65	12,58	7,70	4,91	3,11	1,96	1,39	0,96	0,64	0,49
3,40	R	7883,42	2585,57	824,68	237,63	76,74	24,48	7,83	3,35	1,38	0,52	0,27
	v	32,17	20,88	13,36	8,18	5,22	3,30	2,08	1,47	1,02	0,68	0,53
3,60	R	8823,70	2891,88	921,50	265,18	85,53	27,25	8,70	3,73	1,54	0,57	0,30
	v	34,06	22,10	14,15	8,66	5,53	3,50	2,20	1,56	1,08	0,72	0,56
3,80	R	9816,85	3215,28	1023,65	294,23	94,78	30,17	9,62	4,12	1,69	0,63	0,33
	v	35,96	23,33	14,93	9,15	5,83	3,69	2,33	1,65	1,15	0,76	0,59
4,00	R		3555,76	1131,13	324,76	104,50	33,23	10,59	4,53	1,86	0,69	0,37
	v		24,56	15,72	9,63	6,14	3,89	2,45	1,73	1,21	0,80	0,62
4,20	R		3913,33	1243,94	356,78	114,67	36,57	11,60	4,96	2,04	0,76	0,40
	v		25,79	16,50	10,11	6,45	4,08	2,57	1,82	1,27	0,84	0,65
4,40	R		4287,97	1362,08	390,29	125,32	39,91	12,65	5,40	2,22	0,83	0,44
	v		27,02	17,29	10,59	6,75	4,28	2,69	1,91	1,33	0,88	0,68

Pipe friction gradient/flow speed

WEFATHERM Fiber pipes SDR 7,4 (PN20)
WEFATHERM Stabi pipes PN20
WEFATHERM pipes PN16

Pipe friction gradient R and calculated flow speed in dependence of circulation $\dot{V}$

Roughness: K=0,007 mm sp. density: ρ=983,2 kg/m^3
Temperature: t=60 °C kin. tenacity: ν=0,47 x 10^{-6} m^2/s

$\dot{V}$ = circulation (l/s) R = pressure gradient [mbar/m] v = speed [m/s]

d x s		16 x 2,2	20 x 2,8	25 x 3,5	32 x 4,5	40 x 5,6	50 x 6,9	63 x 8,7	75 x 10,4	90 x 12,5	110 x 15,1	125 x
$\dot{V}$	di	11,6 mm	14,4 mm	18,0 mm	23,0 mm	28,8 mm	36,2 mm	45,6 mm	54,2 mm	65,0 mm	79,8 mm	90,8 mm
4,60	R		4679,70	1485,56	425,28	136,42	43,41	13,74	5,86	2,41	0,90	0,47
	v		28,25	18,08	11,07	7,06	4,47	2,82	1,99	1,39	0,92	0,71
4,80	R		5088,50	1614,36	461,77	147,99	47,04	14,88	6,35	2,60	0,97	0,51
	v		29,47	18,86	11,55	7,37	4,66	2,94	2,08	1,45	0,96	0,74
5,00	R		5514,38	1748,49	499,73	160,01	50,82	16,06	6,85	2,81	1,04	0,55
	v		30,70	19,65	12,03	7,68	4,86	3,06	2,17	1,51	1,00	0,77
5,20	R		5957,35	1887,95	539,19	172,50	54,73	17,29	7,36	3,02	1,12	0,59
	v		31,93	20,43	12,52	7,98	5,05	3,18	2,25	1,57	1,04	0,80
5,40	R		6417,39	2032,75	580,13	185,46	58,79	18,56	7,90	3,24	1,20	0,63
	v		33,16	21,22	13,00	8,29	5,25	3,31	2,34	1,63	1,09	0,83
5,60	R		6894,51	2182,87	622,55	198,87	62,99	19,87	8,45	3,46	1,29	0,68
	v		34,39	22,01	13,48	8,60	5,44	3,43	2,43	1,69	1,13	0,86
5,80	R		7388,70	2338,31	666,46	212,75	67,33	21,23	9,03	3,69	1,37	0,72
	v		35,61	22,79	13,96	8,90	5,64	3,55	2,51	1,75	1,17	0,90
6,00	R		7899,98	2499,09	711,86	227,08	71,81	22,62	9,61	3,93	1,46	0,77
	v		36,84	23,58	14,44	9,21	5,83	3,67	2,60	1,81	1,21	0,93
6,20	R		8428,34	2665,19	758,74	241,88	76,44	24,16	10,22	4,18	1,55	0,82
	v		38,07	24,36	14,92	9,52	6,02	3,80	2,69	1,87	1,25	0,96
6,40	R		8973,77	2836,63	807,11	257,14	81,20	25,65	10,85	4,43	1,64	0,86
	v		39,30	25,15	15,40	9,82	6,22	3,92	2,77	1,93	1,29	0,99
6,60	R		9536,28	3013,39	856,96	272,86	86,11	27,18	11,49	4,69	1,74	0,92
	v		40,53	25,94	15,89	10,13	6,41	4,04	2,86	1,99	1,33	1,02
6,80	R			3195,48	908,29	289,04	91,15	28,75	12,15	4,96	1,84	0,97
	v			26,72	16,37	10,44	6,61	4,16	2,95	2,05	1,37	1,05
7,00	R			3382,89	961,11	305,68	96,34	30,37	12,38	5,23	1,94	1,02
	v			27,51	16,85	10,75	6,80	4,29	3,03	2,11	1,41	1,08
7,50	R			3874,74	1099,66	349,30	109,92	34,60	14,60	5,95	2,20	1,16
	v			29,47	18,05	11,51	7,29	4,59	3,25	2,26	1,51	1,16
8,00	R			4399,89	1247,48	395,80	124,38	39,09	16,48	6,71	2,48	1,30
	v			31,44	19,26	12,28	7,77	4,90	3,47	2,41	1,61	1,24
9,00	R			5550,06	1570,95	497,44	155,94	48,88	20,66	8,36	3,08	1,62
	v			35,37	21,66	13,82	8,74	5,51	3,90	2,71	1,81	1,39
10,00	R			6833,41	1931,52	610,57	191,01	59,73	25,20	10,19	3,75	1,97
	v			39,30	24,07	15,35	9,72	6,12	4,33	3,01	2,01	1,54

Chemical resistance table polypropylene

Introduction

The table in this document summarises the data given in a number of polypropylene chemical resistance tables at present in use in various countries, derived from both practical experience and test results.

Source: ISO/TR 10358.

The table contains an evaluation of the chemical resistance to a number of fluids judged to be either aggressive or not towards polypropylene. This evaluation is based on values obtained by immersion of polypropylene test specimens in the fluid concerned at 20, 60 and 100 °C and atmospheric pressure, followed in certain cases by the determination of tensile characteristics.

A subsequent classification will be established with respect to a restricted number of fluids deemed to be technically or commercially more important, using equipment which permits testing under pressure and the determination of the „coefficient of chemical resistance“ for each fluid. These tests will thus furnish more complete indications on the use of polypropylene pipes for the transport of stated fluids, including their use under pressure.

Scope and filed application

This document establishes a provisional classification of the chemical resistance of polypropylene with respect to about 180 fluids. It is intended to provide general guidelines on the possible utilization of polypropylene piping for the conveyance of fluids:

- at temperatures up to 20, 60 and 100 °C
- in the absence of internal pressure and external mechanical stress (for example flexural stresses, stresses due to thrust, rolling loads etc.)

Definitions, symbols and abbreviations

The criteria of classification, definitions, symbols and abbrevisions adopted in this document are as follows:

S = Satisfactory

The chemical resistance of polypropylene exposed to the action of a fluid is classified as „satisfactory“ when the results of test are acknowledged to be „satisfactory“ by the majority of the countries participating in the evaluation.

L = Limited

The chemical resistance of polypropylene exposed to the action of a fluid is classified as „limited“ when the results of tests are acknowledged to be „limited“ by the majority of the countries participating in the evaluation.

Also classified as „limited“ are the resistance to the action of chemical fluids for which judgements „S“ and „NS“ or „L“ are pronounced to an equal extent.

NS = Not satisfactory

The chemical resistance of polypropylene exposed to the action of a fluid is classified as „not satisfactory“ when the results of tests are acknowledged to be „not satisfactory“ by the majority of the countries participating in the evaluation.

Also classified as „not satisfactory“ are materials for which judgements „L“ and „NS“ are pronounced to an equal extent.

Sat.sol Satured aqueous solution, prepared at 20 °C
Sol Aqueous solution at a concentration higher than 10%, but not saturated
Dil.sol Dilute aqueous solution at a concentration equal to or lower than 10%
Work.sol Aqueous solution having the usual concentration for industrial use

Solution concentrations reported in the text are expressed as a percentage by mass. The aqueous solutions of sparingly soluble chemicals are considered, as far as chemical action towards polypropylene is concerned, as saturated solutions.

In general, common chemical names are used in this document.

The table is made as a first guideline for user of polypropylene. If a chemical compound is not to be found or if there is an uncertainty on the chemical resistance in an application, please contact WEFA Plastic for advise and proposal on testing.

Chemical resistance of polypropylene, not subjected to mechanical stress, to various fluids at 20, 60 and 100 °C

Chemical or product	Concentration	Temperature °C 20	60	100
Acetic acid	Up to 40 %	S	S	–
Acetec acid	50 %	S	S	–
Acetic acid, glacial	Greater than 96 %	S	L	NS
Acetic anhydride	100 %	S	–	–
Acetone	100 %	S	S	–
Aceptophenone	100 %	S	L	–
Acrylonitrite	100 %	S	–	–
Air		S	S	S
Almond oil		S	–	–
Alum	Sol	S	–	–
Ammonia, aqueous	Up to 30 %	S	–	–
Ammonia, dry gas	100 %	S	–	–
Ammonia, liquid	100 %	S	–	–
Ammonium acetate	Sat.sol	S	S	–
Ammonium chloride	Sat.sol	S	–	–
Ammonium fluoride	Sol	S	S	–
Ammonium hydrogen carbonate	Sat.sol	S	S	–
Ammonium hydroxide	Sat.sol	S	–	–
Ammonium metaphosphate	Sat.sol	S	S	–
Ammonium nitrate	Sat.sol	S	S	S
Ammonium phosphate	Sat.sol	S	–	–
Ammonium sulphate	Sat.sol	S	S	S
Amyl acetate	100 %	L	–	–
Amyl alcohol	100 %	S	S	S
Aniline	100 %	S	S	–
Apple juice		S	–	–
Aqua regia	HCl/HNO_3=3/1	NS	NS	NS
Barium carbonate	Sat.sol	S	S	S
Barium chloride	Sat.sol	S	S	S
Barium hydroxide	Sat.sol	S	S	S
Barium sulphate	Sat.sol	S	S	S
Benzene	100 %	L	NS	NS
Benzoic acid	Sat.sol	S	–	–
Bernzyl alcohol	100 %	S	L	–
Borax	Sol	S	S	–
Boric acid	Sat.sol	S	–	–
Bromine, gas		L	NS	NS
Bromine, liquid	100 %	NS	NS	NS

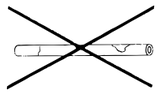
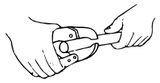
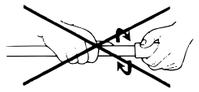
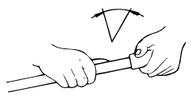
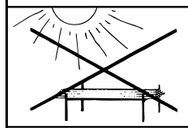
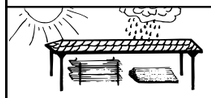
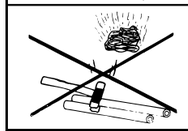
Chemical or product	Concentration	Temperature °C 20	60	100
Butane	100 %	S	–	–
Butanol	100 %	S	L	L
Butyl acetate	100 %	S	L	L
Butyl glycol	100 %	S	–	–
Butyl phenol	Cold sat.sol	S	–	–
Butyl phthalate	100 %	S	L	L
Calcium carbonate	Sat.sol	S	S	S
Calcium chloride	Sat.sol	S	S	S
Calcium hydroxide	Sat.sol	S	S	–
Calcium hypochlorite	Sol	S	–	–
Calcium nitrate	Sat.sol	S	S	–
Camphor oil		NS	NS	NS
Carbon dioxide, dry gas	100 %	S	S	–
Carbon dioxide, wet		S	S	–
Carbon disulphide	100 %	S	NS	NS
Carbon tetrachloride	100 %	NS	NS	NS
Castor oil	100 %	S	S	–
Caustic soda	Up to 50 %	S	L	L
Chlorine, aqueous	Sat.sol	S	L	–
Chlorine, dry gas	100 %	NS	NS	NS
Chlorine, liquid	100 %	NS	NS	NS
Cloroacetic acid	Sol	S	–	–
Chloroethanol	100 %	S	–	–
Chloroform	100 %	L	NS	NS
Chlorosulphonic acid	100 %	NS	NS	NS
Chrome alum	Sol	S	S	–
Chromic acid	Up to 40 %	S	L	N
Citric acid	10 %	S	S	S
Coconut oil		S	–	–
Corn oil		S	L	–
Cottonseed oil		S	S	–
Cresol	Greater than 90 %	S	–	–
Copper (II) Chloride	Sat.sol	S	S	–
Copper (II) nitrate	30 %	S	S	S
Copper (II) sulphate	Sat.sol	S	S	–
Cyclohexane	100 %	S	–	–
Cyclohexanol	100 %	S	L	–
Cyclohexanone	100 %	L	NS	NS

Chemical resistance of polypropylene, not subjected to mechanical stress, to various fluids at 20, 60 and 100 °C

Chemical or product	Concentration	Temperature °C 20	60	100
Dekalin (decahydro-naphthalene)	100 %	NS	NS	NS
Dextrin	Sol	S	S	–
Dextrose	Sol	S	S	–
Dibutyl phthalate	100 %	S	L	NS
Dichloroacetic acid	100 %	L	–	–
Dichloroethylene (A und B)	100 %	L	–	–
Diethanolamine	100 %	S	–	–
Diethyl ether	100 %	S	–	–
Diethylene glycol	100 %	S	S	–
Diglycolic acid	Sat.sol	S	–	–
Disooctyl phthalate	100 %	S	L	–
Dimethyl amine	100 %	S	–	–
Dimethyl formamide	100 %	S	S	–
Dioctyl phthalate	100 %	L	L	–
Dioxane	100 %	L	L	–
Distilled water	100 %	S	S	S
Ethanolamine	100 %	S	–	–
Ethyl acetate	100 %	L	NS	NS
Ethyl alcohol	Up to 95 %	S	S	S
Ethyl chloride	100 %	NS	NS	NS
Ethylene chloride (mono and di)		L	L	–
Ethylene glycol	100 %	S	S	S
Formaldehyde	40 %	S	–	–
Formic acid	10 %	S	S	–
Formic acid	85 %	S	NS	NS
Formic acid, anhydrous	100 %	S	L	L
Fructose	Sol	S	S	S
Fruit juice		S	S	S
Gasoline, petrol (aliphatic hydrocarbons)		NS	NS	NS
Gelatine		S	S	–
Glucose	20 %	S	S	S
Glycerine	100 %	S	S	S
Glycolic acid	30 %	S	–	–
Heptane	100 %	L	NS	NS
Hexane	100 %	S	L	–
Hydrobromic acid	Up to 48 %	S	–	NS
Hydrochloric acid	From 2 to 7 %	S	S	S
Hydrochloric acid	From 10 to 20 %	S	S	–
Hydrochloric acid	30 %	S	L	L
Hydrochloric acid	From 35 to 36 %	S	–	–
Hydrofluoric acid	Dil.sol	S	–	–
Hydrofluoric acid	40 %	S	–	–
Hydrogen	100 %	S	–	–
Hydrogen chloride, dry gas	100 %	S	S	–
Hydrogen peroxide	Up to 10 %	S	–	–
Hydrogen peroxide	Up to 30 %	S	L	–
Hydrogen sulphide, dry gas	100 %	S	S	–
Iodine in alcohol		S	–	–
Isopropyl alcohol	100 %	S	S	S
Isopropyl ether	100 %	L	–	–
Isooctane	100 %	L	NS	NS
Lactic acid	Up to 90 %	S	S	–
Lanoline		S	L	–
Linseed oil		S	S	S
Magnecium carbonate	Sat.sol	S	S	S
Magnecium chloride	Sat.sol	S	S	–
Magnesium sulphate	Sat.sol	S	S	–
Mailc acid	Sol	S	S	–
Mercury (II) chloride	Sat.sol	S	S	–
Mercury (II) cyanide	Sat.sol	S	S	–
Mercury (I) nitrate	Sol	S	S	–
Mercury	100 %	S	S	–
Methyl acetate	100 %	S	S	–
Methyl alcohol	5 %	S	L	L
Methyl amine	Up to 32 %	S	–	–
Methyl bromide	100 %	NS	NS	NS
Methyl ether ketone	100 %	S	–	–
Methylene chloride	100 %	L	NS	NS
Milk		S	S	S
Monochloroacetic acid	Greater than 85 %	S	S	–
Naphtha		S	NS	NS
Nickel chloride	Sat.sol	S	S	–
Nickel nitrate	Sat.sol	S	S	–
Nickel sulphate	Sat.sol	S	S	–
Nitric acid	10 %	S	NS	NS
Nitric acid	30 %	S	–	–
Nitric acid	From 40 to 50 %	L	NS	NS
Nitric acid, fuming (with nitrogen dioxide)		NS	NS	NS
Nitrobenzene	100 %	S	L	–
Oleic acid	100 %	S	L	–
Oleum sulphuric acid with 60 % of SO_3)		NS	NS	NS
Olive oil		S	S	L
Oxalic acid	Sat.sol	S	L	NS
Oxygen	100 %	S	S	–

Chemical or product	Concentration	Temperature °C 20	60	100
Paraffin oil (FL 65)		S	L	NS
Peanut oil		S	S	–
Peppermint oil		S	–	–
Perchloric acid	2 N	S	–	–
Petroleum ether (ligroine)		L	L	–
Phenol	5 %	S	S	–
Phenol	90 %	S	–	–
Phosphoric acid	25 %	S	S	S
Phosphoric acid	From 25 to 85 %	S	S	S
Phosphoric oxychloride	100 %	L	–	–
Picric acid	Sat.sol	S	S	–
Potassium bicarbonate	Sat.sol	S	S	–
Potassium borate	Sat.sol	S	S	–
Potassium bromate	Up to 10 %	S	S	–
Potassium bromide	Sat.sol	S	S	–
Potassium carbonate	Sat.sol	S	–	–
Potassium chlorate	Sat.sol	S	S	–
Potassium chloride	Sat.sol	S	–	–
Potassium chromate	Sat.sol	S	S	–
Potassium syanide	Sol	S	–	–
Potassium fluoride	Sat.sol	S	S	–
Potassium hydroxide	Up to 50 %	S	S	S
Potassium iodide	Sat.sol	S	–	–
Potassium nitrate	Sat.sol	S	S	–
Potassium perchlorate	10 %	S	S	–
Potassium permanganate	2 N	S	–	–
Potassium persulphate	Sat.sol	S	–	–
Potassium sulphate	Sat.sol	S	–	–
Propane	100 %	S	–	–
Propionic acid	Greater than 50 %	S	–	–
Pyridine	100 %	L	–	–
Sea water		S	S	S
Silicone oil		S	S	S
Silver nitrate	Sat.sol	S	S	L
Sodium acetate	Sat.sol	S	S	S
Sodium benzoate	35 %	S	–	–
Sodium carbonate	Up to 50 %	S	S	L
Sodium chlorate	Sat.sol	S	–	–
Sodium chloride	Sat.sol	S	S	S
Sodium chlorite	2 %	S	L	NS
Sodium chlorite	20 %	S	L	NS
Sodium dichromate	Sat.sol	S	S	S
Sodium hydrogen carbonate	Sat.sol	S	S	S
Sodium hydrogen sulphate	Sat.sol	S	S	–
Sodium hydrogen sulphite	Sol	S	–	–
Sodium hydroxide	1 %	S	S	S
Sodium hydroxide	From 10 to 60 %	S	S	S
Sodium hypochlorite	5 %	S	–	–
Sodium hypochlorite	10 %	S	–	–
Sodium hypochlorite	20 %	S	–	–
Sodium metaphosphate	Sol	S	–	–
Sodium nitrate	Sat.sol	S	S	–
Sodium perborate	Sat.sol	S	–	–
Sodium phosphate (neutral)	Sat.sol	S	S	S
Sodium silicate	Sol	S	S	–
Sodium sulphate	Sat.sol	S	S	–
Sodium sulphide	Sat.sol	S	–	–
Sodium sulphite	40 %	S	S	S
Sodium thiosulphate (hypo)	Sat.sol	S	–	–
Soybean oil		S	L	–
Succinic acid	Sat.sol	S	S	–
Sulphur acid	Up to 10 %	S	S	S
Sulphur dioxide, dry or wet	100 %	S	S	–
Sulphur acid	From 10 to 30 %	S	S	–
Sulphuric acid	50 %	S	L	L
Sulphuric acid	96 %	S	L	NS
Sulphuric acid	98 %	L	NS	NS
Sulphurous acid	Sol	S	–	–
Tartaric acid	10 %	S	S	–
Tetrahydrofuran	100 %	L	NS	NS
Tetralin	100 %	NS	NS	NS
Thiophene	100 %	S	L	–
Tin (IV) chloride	Sat.sol	S	S	–
Tin (II) chloride	Sat.sol	S	S	–
Toluene	100 %	L	NS	NS
Trichloroacetic acid	Up to 50 %	L	S	–
Trichloroethylene	100 %	NS	NS	NS
Triethanolamine	Sol	S	–	–
Turpentine		NS	NS	NS
Urea	Sat.sol	S	–	–
Vinegar		S	S	–
Water brackish, mineral, potable		S	S	S
Whiskey		S	–	–
Wines		S	–	–
Xylene	100 %	NS	NS	NS
Yeast	Sol	S	S	S
Zinc chloride	Sat.sol	S	S	–
Zinc sulphate	Sat.sol	S	S	–

WEFA PLASTIC suggestions for the correct treatment of pipe systems:

No	Yes
 Avoid hard knocks or impacts at the end of a pipe	 Put pipes down carefully
 Do not use pipes which are damaged or cracked at the interface	 Cut pipes only with sharp tools
 Do not twist either pipe or fitting after joining together	 Alignment corrections of up to 5 relative to the axis of the pipe can be carried out immediately after joining
 Do not expose to UV-radiation for any extended period of time	 Store protected from sun and rain
 Provide protection against hard impacts and falling stones on the site	 Cover pipes at risk to prevent damage

Subject to technical modifications

Due to the constant improvements being made in the field of raw materials, both PP-R 100 and PP-RCT materials are now available on the market, in additional to the long-established PP-R 80. We categorically reserve the right to supply products made of the higher quality PP-R 100 or PP-RCT materials in all deliveries.

The latest edition of this catalogue and the current general terms and conditions of business are available for download from www.wefaplastic.com. Only these current wordings are valid.

Terms of Sale and Delivery of WEFA Plastic Kunststoffverarbeitungs GmbH

I. Applicable Terms and Conditions, Conclusion of Contract

1. All orders shall be exclusively subject to the following terms and conditions. Terms of purchase to the contrary shall have no legal validity even if we do not expressly raise objection to them. The ordering party accepts our terms and conditions when he places the order and/or when he accepts delivery of the consignment.

2. The order shall become binding for us when we acknowledge the order in writing or send the goods. Our sales employees are not authorised to make verbal collateral agreements which go beyond the content of the written acknowledgement of order or of the written contract. Moreover, amendments, supplements and any other additional agreements shall only be binding if they have been confirmed by us in writing.

3. Drawings, illustrations, dimensions, weights and other performance data are only binding if they have been explicitly agreed upon in writing.

4. Our terms of sale only apply to companies in accordance with § 310 (1) BGB – German Civil Code.

II. Offer, estimate, brochures, prices, reservation of right to change prices

1. In the case of delivery periods exceeding 4 months, our offers as well as the prices quoted in our catalogues, lists etc. are without obligation; with all confirmed orders – including orders for goods to be delivered on demand and multiple delivery contracts in the case of which delivery exceeds 4 months after the order has been placed according to the agreement or at the request of the ordering party, we are entitled to pass on increases in prices for materials and labour to the ordering party within the scope of these increases and to make up for such increases between the time when the contract was concluded and the delivery of the goods.

Estimates are without obligation; no liability is assumed for the correctness of the estimate.

2. Our prices are quoted in EUR, ex works, excluding VAT at the currently valid rate. For orders below a net value of 100.00 EUR, for which we reserve the right to accept, a processing fee of 10.00 EUR will be charged.

3. Subsequent reduction in the ordered quantity or subsequent reduction in the number of units in the case of an agreed part shipment as well as the reduction in agreed deliveries on demand will bring about an increase in the unit prices and, where applicable, in the stipulated portion of costs for tools.

III. Packaging, costs, dispatch, passing of risk, additional delivery and short delivery

1. Packaging

The goods will be packaged in the conventional manner and packaging will be charged at cost price. If recyclable packaging material is returned carriage paid and in perfect and reusable condition within 4 weeks, $^{2}/_{3}$ of the amount charged will be refunded. A higher amount will only be refunded if recyclable packaging material has been used on a permanent basis.

2. Dispatch

Except as otherwise expressly stipulated or agreed upon, we reserve the right to decide on the mode of dispatch without assuming responsibility for selecting the most common means of transport. Dispatch is effected for the account and risk of the ordering party. All dispatch-related expenses and risks shall pass to the ordering party when the goods leave the factory – even if the goods are delivered carriage paid.

3. Passing of risk

a) If the goods are dispatched – regardless of at whose expense – the risk will pass to the ordering party when the goods are delivered to the party commissioned with the dispatch, at the latest, however, when they leave the factory.

b) If the goods are ready for dispatch and there is a delay in the shipment or acceptance of the goods for reasons beyond our control, the risk will pass to the ordering party upon receipt of the notification that the goods are ready for dispatch.

4. In the case of multiple delivery contracts, we are to be notified of quantities and delivery dates when the order is placed. We are, however, entitled to choose to manufacture the entire amount of the order insofar as agreements to the contrary have not been explicitly reached. Subsequent changes regarding the ordered goods can only be considered if we have not already manufactured them. Should the ordering party fail to schedule and request delivery, we are entitled – after expiration of a final deadline – to schedule the goods ourselves and effect delivery thereof or to withdraw from the as yet unfulfilled part of the contract and/or to demand compensation for the damage caused to us as a result of this.

IV. Terms of payment and consequences of non-compliance, set-off

1. Our invoices are payable postage-free and free of expenses and without deductions within 30 days after date of invoice or after the date of the notification concerning the goods being ready for dispatch. The ordering party is entitled to 2% discount for payment effected within 10 days on condition that all previous invoices have been settled. After the due date of the invoice we are entitled to charge interest on arrears at the statutory amount, whereby we explicitly reserve the right to assert claims for additional damages.

2. In the event of failure to observe credit periods, we are also authorised to carry out orders only against advance payment or the provision of security or to rescind the contract after a reasonable period of respite and/or to demand compensation. In the case of a fundamental deterioration in the assets on the part of the ordering party which occurs after conclusion of the contract or which we do not become aware of until after conclusion of the contract, we are entitled to refuse performance and to demand that the ordering party eliminates the risk to the purpose of the contract by providing adequate security. Should the ordering party fail to provide security as demanded within a reasonable period of time, we shall be entitled to rescind the contract and/or to demand compensation.

3. The ordering party may only set off our receivables with counterclaims that are uncontested or which have been declared final and absolute.

4. We expressly reserve the right to accept bills of exchange or cheques; they will fundamentally only be accepted on account of payment and shall not be deemed as payment with the effect of a full discharge until they have been honoured. Discount charges shall be charged to the ordering party.

V. Delivery and delay in delivery

1. Delivery dates and delivery periods are only binding if they have been explicitly agreed upon or if they have been confirmed by us in writing.

Delivery periods shall commence either with the written acknowledgement of order or otherwise as soon as all fundamental details regarding the execution of the order have been clarified and both parties have agreed upon all the fundamental terms and conditions of the business transaction. The delivery period shall be deemed observed if the object to be delivered has left our factory at a time at which the punctual arrival of the goods may be expected in accordance with customary conditions of dispatch or upon notification of the goods being ready for dispatch before expiration of the stipulated delivery period. The indication of specific delivery periods is always subject to our suppliers effecting delivery in a timely manner and of the right goods.

2. In case of force majeure or disruptions of operations at our company or at the companies of our suppliers (e.g. through insurrection, strike, lock-out) which, through no fault of our own, temporarily prevent us from delivering the object at the stipulated date or within the period agreed upon, the delivery dates and/or delivery periods will alter for the term of these disruptions to performance caused by these circumstances. Should such disruptions lead to a delay in performance of more than 4 months, both the ordering party and ourselves are entitled to rescind the contract. This period of deferment shall not apply in the case of fixed-date contracts and in the case of the ordering party being able to prove that the consignment is no longer of interest to him if delivery dates are not observed.

3. If the ordering party grants us a reasonable additional period of time after we have already got into arrears with delivery, he shall be entitled to rescind the contract and to demand compensation after the unsuccessful expiration of this extension.

4. Should we only be in arrears with part of the performance, the rescission of the ordering party from the entire contract or compensation claims due to non-performance of the entire contract are excluded insofar as the partial performance is of no interest to the ordering party; the burden of proof shall lie with the ordering party.

5. The ordering party is only entitled to assert claims for damages if the delay is due to intent or gross negligence. (Item VIII.). Insofar as the delay is due to negligence, the claim for damages due to non-performance shall only be to the value of typical and predictable damage.

VI. Acceptance

1. The ordering party is obliged to accept the object of purchase within 14 days of the notification of the provision of the goods. In the event of non-acceptance, we are entitled to make use of our statutory rights.

2. Should we demand compensation, this will be in the amount of 15 % of the stipulated purchase price. Compensation will be fixed at a higher or lower rate if we prove that the damage is higher or the ordering party proves that the damage is lower.

3. We are entitled to render partial services. In the event of part shipments and services we are entitled to proportionate payment of the purchase price.

4. We shall not take back goods, particularly goods made to specification, unless the ordering party can effectively rescind the contract or we have agreed to the return of the goods. In the case of unjustified returns we shall charge a processing fee of 15 % of the purchase price as compensation. Compensation will be fixed at a higher or lower amount if we prove that the damage is higher or the ordering party proves that the damage is lower.

VII. Duties, rights and claims of the ordering party in the case of defects of quality

1. Notwithstanding the duties to examine and give notice of defects existing in the case of reciprocal commercial transactions pursuant to §§ 377, 378 HGB (Commercial Code), we are to be notified of such a defect of quality in writing immediately after the passing of risk. Notification of latent defects is also to effected in writing immediately after detection, however, at the latest within 12 months after the passing of risk or, in the absence of facilities or opportunities for inspection, within the aforementioned period of time after gaining possession of the goods or delivery.

2.Should rejected consignments have undergone further processing without written agreement or without an important reason to be proven on the part of the customer or the ordering party, or if the ordering party has attempted to remedy the defects himself, all rights of the ordering party due to defects of quality will be forfeited.

3. In the event of goods being rejected, we are entitled to inspection and subsequent performance, whereby we may opt to remedy the defect or effect delivery of an object that is free of defects. Should we choose to remedy the defect as subsequent performance, the ordering party may only assert further statutory rights if he has granted us the opportunity to remedy the defect(s) twice. Should we have assumed a guarantee of quality, the ordering party is entitled to statutory rights in the case of defects of quality without limitation.

4. In the event of the failure of subsequent performance in accordance with the above clause, the ordering party may reduce the purchase price or rescind the contract. Claims for compensation for a defect of quality can only be asserted in accordance with Roman numeral VIII. below.

5. Furthermore, statutory rights in the case of defects of quality do not exist if the defect of quality is caused by a violation of the regulations concerning use, maintenance, care or installation, improper use, incorrect handling or natural wear and tear, improper assembly or if the entire distribution network does not comply with the approved regulations or in the case of misuse.

6. The rights of the ordering party within the scope of dealer's recourse according to §§ 478, 479 BGB shall remain unaffected.

VIII. Damages and limitation of liability

1. We shall only be liable for damages resulting from negligent injury to life, body or health, for negligent and fundamental breach of contract insofar as the purpose of the agreement is endangered as a result, and, furthermore, in the case of intentional or grossly negligent breach of duty. The same limitation of liability applies to our legal representatives and our vicarious agents.

2. The amount of liability is limited to compensation for typical and predictable damage. However, this limitation of liability does not apply to liability for damages arising from culpable injury to life, body or health or to liability due to any other wilful or grossly negligent breach of duty; a breach of duty by us is equal to a breach of duty of our legal representative or of our vicarious agents.

3. Should we be responsible for the breach of duty, the ordering party is entitled to rescind the contract under the statutory requirements insofar as the defect concerned is not a defect of the item delivered itself.

IX. Statute of limitation

The period of limitation for claims and rights of the ordering party/buyer due to defects of quality in accordance with the aforementioned items VII. and VIII. is restricted to one year. This does not apply to the delivery of an item which has been used in the construction of a building according to its customary purpose and has caused the defectiveness of this building; in this case the statutory warranty periods shall apply.

X. Proprietary rights, tools, models and drawings

1. Proprietary rights, models and drawings

Should goods be delivered on the basis of drawings, models or any other specifications of the ordering party, the latter shall be responsible for their correctness and for ensuring that the rights of third parties are not violated; he shall indemnify us from all claims of a proprietor of industrial rights.

2. Tools

a) The tools and fixtures made for the production of the ordered goods shall remain our property regardless of the calculation of the proportionate costs. Proportionate costs for tools will be billed for separately from the value of the goods. Payment for the tools is to be effected upon receipt of the type sample or, if no sample has been requested, when the first goods are delivered.

b) The costs for renewal, maintenance and proper storage of the tools as well as the risk of breakage shall be borne by us; therefore, there is no depreciation.

c) In the case of client-specific tools, we undertake to use them exclusively for deliveries to the ordering party.

d) We undertake to store the tools for the ordering party for a period of three years after the last delivery. Should the ordering party inform us before expiration of this period that orders will be placed within a further year, we are obliged to store the tools for this period of time. Otherwise, the tools will be at our free disposal.

XI. Reservation of ownership

1. We reserve the right to ownership of the item delivered (conditional commodity) until all of our accounts receivable vis-à-vis the ordering party from the business relationship have been settled, including future accounts receivable and also from contracts concluded at the same time or at a later date. In the case of the current account, the reserved ownership and all rights shall serve as collateral for our overall receivables together with interest and expenses. The ordering party shall notify us without delay with regard to levies of execution or other intervention by third parties.

As at: 06/2006

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