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almona

POLYPROPYLENE
RANDOM COPOLYMER
PP-R SYSTEMS

Technical Manual

almona BUILDINGS

DVGW SKZ SASO NSF WRAS APPROVED PRODUCT

An ISO 9001:2015 certified company

Only products bearing the NSF, SASO, WRAS, DVGW and SKZ Mark are certified by those organizations.

almonaplast.com

"WE DESIGN, DEVELOP, MANUFACTURE AND PROVIDE INNOVATIVE PIPE SOLUTIONS THAT BEST MEET THE NEEDS OF OUR CUSTOMERS"

ABOUT US

Almona is a leading Saudi Arabian plastic pipe manufacturing company and since our establishment in 2008 we have constantly evolved to meet the requirements of our most demanding customers. Our aim is to provide sophisticated and diverse pipe solutions for hot and cold water applications, telecommunication networks, sewage and drainage systems together with water and gas infrastructure.

We are a certified to ISO 9001:2015 Quality Management Systems organization and all our products comply with the appropriate Saudi (SASO), German (DIN) and International (ISO) Standards. Our pipe systems for drinking water applications are NSF-61, WRAS and DVGW certified and all almona products are tested extensively in our state-of-the-art laboratory, to ensure that the quality and performance are continuously maintained.

Almona's success is the result of the company's persistent commitment to continuous innovation and investment in technology, in the relentless pursuit of providing quality products and services. Today, we are pleased to offer a wide range of plastic products, divided into four categories:


BUILDINGS

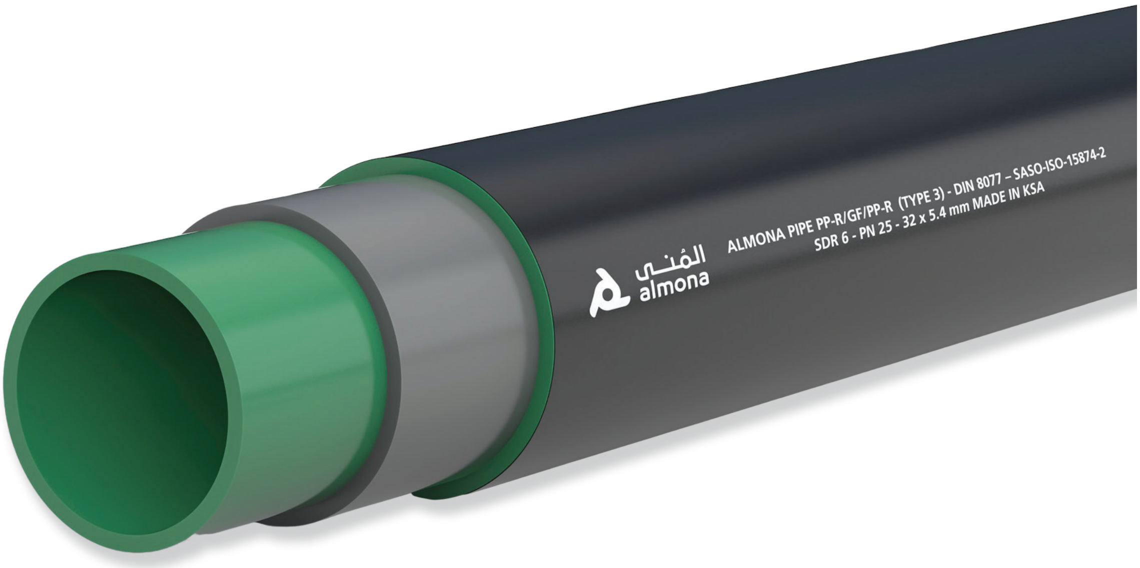

SEWAGE AND DRAINAGE


INFRASTRUCTURE


TELECOMMUNICATION DUCTING

almona PP-R Systems

"THE ALMONA THREE-LAYER TECHNOLOGY GUARANTEES MORE THAN 50 YEARS OPERATIONAL LIFE UP TO 70°C, LOW MAINTENANCE AND WATER TIGHTNESS OF THE PP-R PIPE AND FITTING NETWORKS"



CONTENTS

This manual is intended for plumbing engineers, plumbers, contractors and installers of hot and cold networks in both inside and outside buildings. It is divided into nine sections as follows:

Section I

1. General Information

1.1 Introduction

Almona offers a wide product range of polypropylene random copolymer (PP-R) pipes and fittings for use in hot and cold networks installed both inside and outside buildings. The pipes and fittings systems are specially designed to withstand long term pressure at high temperature (70°C). The extrapolated service life of almona piping systems is more than 50 years.

Almona manufactures a broad range of PP-R pipes in order to fulfill the market's demand for more advanced and long-lasting systems:

- PP-R single layer PP-R pipes
- UV resistant single layer PP-R pipes
- PP-R/GF/PP-R 3-layer pipes
- UV resistant PP-R/GF/PP-R 3-layer pipes

Almona PP-R system recommendations based on application is provided in the following table:

Application area	almona PP-R pipes type			
	monolayer PP-R pipe	UV monolayer PP-R pipe	PP-R/GF/ PP-R 3-layer pipes	UV PP-R/GF/ PP-R 3-layer pipes
Potable Hot and Cold water	●	●	●	●
Cooling/chilled water systems	●		●	
District cooling systems			●	
Heating systems	●		●	
Exterior water systems		●		●
Compressed air systems	●		●	
Agriculture	●	●	●	●
Rain water systems	●	●		●
Industrial applications			●	
Swimming pools		●	●	●
Outdoor applications		●		●

Almona PP-R systems, are manufactured in our ISO 9001:2015 accredited production facilities, using only the highest quality raw materials available from internationally renowned suppliers and follow highly controlled manufacturing processes employing the latest technology. Our products are approved to the most stringent internal, national and international standards, for delivering high quality, comprehensive service and products to be used with confidence for your plumbing networks.

1.2 Advantages of the System

Almona systems are designed to be used in highly demanding applications, such as hot and cold-water networks where the advantages of thermoplastics are desirable, and a high level of pressure and temperature resistance is also required. The main advantages of almona systems comprise:

- High temperature and pressure resistance - almona pipes and fittings are designed to withstand constant temperatures of up to 70°C. The service life expectancy depends on the operational pressure and temperatures. Even though the service life expectancy of the pipes is more than 50 years, a long-term temperature increase from 70°C to 90°C will accordingly reduce the operational life of the pipe. However, an increase in temperature up to even 100°C for short period of time is usually not a cause for concern. Resistant to flames and fire propagation.

- Corrosion and chemical resistance - almona pipe and fittings systems demonstrate a high corrosion resistance in addition to impressive resistance to the common chemicals used in virtually all household detergents and disinfectants.

- Non-toxic and environmentally friendly - almona pipe and fittings systems are produced from non-toxic, halogen free raw materials. Moreover, the PP-R pipes and fittings are recyclable and environmentally friendly green building materials.

- Low thermal conductivity - almona pipe and fittings systems demonstrate low thermal conductivity, which means minimal drop in temperature between the hot water production and delivery points, with consequent energy saving.

- Easy installation - almona pipe and fittings can be joined by fusion welding techniques. High and consistent quality raw materials used in the manufacture of our systems, ensure reliable and repeatable welding.

- Reduced thermal expansion coefficient - the thermal expansion coefficient of almona 3-layer PP-R/GF/PP-R systems is reduced by at least 75% compared to monolayer PP-R pipes allowing the installer to reduce the number of fixing clamps during the installation process and therefore reduce the overall project cost.

- **Easy handling** - almona pipes and fittings systems can be transported, installed and operated at lower temperatures (0°C) due to unique molecular structure of raw materials used in the manufacturing process.

- **Low noise** - the noise level of almona systems is considerably reduced lower than in systems comprising metallic pipes, particularly at high-water flow speeds and when water hammer occurs.

The significant advantages of polypropylene, over the traditional pipe systems, makes almona PP-R systems the first-choice materials for your plumbing networks. For more detailed information on the key characteristics and advantages of PP-R systems, refer to Section II and Section III of this document.

1.3 Characteristics of the System

Almona manufactures a broad range of PP-R pipes using single layer, three-layer extrusion and co-extrusion technologies.

1.3.1 Mono layer PP-R pipes

Almona PP-R monolayer pipes are made of polypropylene random copolymer (PP-R) materials engineered to meet the requirements of ISO 15874 and DIN 8077/8078. The unique molecular architecture, in combination with specialised stabilisation package makes almona PP-R pipe systems resistant to high temperature and pressure for more than 50 years.

1.3.2 Multilayer PP-R pipes

Almona multilayer glass reinforced PP-R pipes are manufactured using 3-layer technology, are described below:

- The outer layer is made of polypropylene random copolymer (PP-R) material which guarantee flawless and reliable welding of the pipes and fittings.

- Our middle layer is made of reinforced glass fiber polypropylene (PP-R/GF) which combines high strength and improved dimensional stability. The perfect connection of glass fiber and PP-R material reduces the thermal expansion caused by the temperature variation of fluids inside the pipes. Additionally, the resistance to impact loads at low temperature is also improved.

- The inner layer is made of PP-R which is specially designed to improve long-term behavior of the pipe throughout operational life, particularly, at increased temperatures. The smooth pipe inner surface prevents the sedimentation and allows for high flow rates.

The almona three-layer technology guarantees more than 50 years operational life up to 70°C, low maintenance and water tightness of the PP-R pipe and fitting networks.

1.3.3 UV resistant PP-R pipes

Almona UV resistant monolayer and multilayer pipes are manufactured using co-extrusion technology. The co-extruded UV resistant layer (black color) is made of UV stablised PP-R which guarantees pipe protection against UV rays and also secures a reliable welding of the pipes and fittings.

1.3.4 Fittings

Almona fittings are made of PP-R Type 3 and meets the requirements of ISO 15874 and DIN 8077/8078. The unique molecular architecture in combination with specialised stabilisation package makes almona PP-R fittings resistant to high temperature and pressure for more than 50 years.

Section II

2. Technical Specifications

2.1 Pipe and Fittings Specification

Almona offers a complete range of polypropylene random copolymers (PP-R) pipes and fittings with the following characteristics:

Pipes

Pipe diameter in mm	almona pipes product range overview										
	20	25	32	40	50	63	75	90	110	125	160
Monolayer pipe SDR 6	●	●	●	●	●	●	●	●	●	●	
UV resistant monolayer pipe SDR 6	●	●	●	●	●	●	●	●	●	●	
Monolayer pipe SDR 7.4	●	●	●	●	●	●	●	●	●	●	●
UV resistant multilayer pipe SDR 7.4	●	●	●	●	●	●	●	●	●	●	●

Pipes 20 - 125 mm = socket welding

Fittings and couplers

Fitting dimensions in mm	almona fittings and couplers product range overview									
	20	25	32	40	50	63	75	90	110	125
Couplings: PN25, SDR5	●	●	●	●	●	●	●	●		
Elbow 90°: PN25, SDR5	●	●	●	●	●	●	●	●		
Elbow 45°: PN25, SDR5	●	●	●	●	●	●	●	●		
Tee: PN25, SDR5	●	●	●	●	●	●	●	●		
End cap: PN25, SDR5	●	●	●	●	●	●	●	●		
End Piece (male)	●	●								
Crossover: PN20, SDR6	●	●	●							
Reducer: PN25, SDR5		● 25-20	● 32-20 32-25	● 40-25 40-32	● 50-32 50-40	● 63-25 63-32 63-40 63-50	● 75-50 75-63	● 90-63 90-75		
Tee reducer: PN25, SDR5	● 20-25-20 20-32-20	● 20-25-20 20-32-20	● 32-20-32 32-25-32	● 40-20-40 40-25-40 40-32-40	● 50-32-50 50-40-50	● 63-40-63 63-50-63				

Fitting dimensions in mm	almona fittings and couplers product range overview									
	20	25	32	40	50	63	75	90	110	125
Adaptor female: PN25, SDR5	● 20 (1/2") 20 (3/4")	● 25 (1/2") 25 (3/4")	● 32(3/4")	●	●	●				
Adaptor female (hexagon), PN25, SDR5			● 32(1")	● 40 (1,1/4")	● 50 (1,1/2")	● 63 (2")	● 75 (2,1/2")	● 90 (3")		
Adaptor male: PN25, SDR5	● 20 (1/2") 20 (3/4")	● 25 (1/2") 25 (3/4")	● 32(3/4")							
Adaptor male (hexagon), PN25, SDR5			● 32(1")	● 40 (1,1/4")	● 50 (1,1/2")	● 63 (2")	● 75 (2,1/2")	● 90 (3")		
Union female: PN25, SDR5	● 20 (1/2")	● 25 (3/4")	● 32 (1")	● 40 (1,1/4")	● 50 (1,1/4")					
Union male: PN25, SDR5	● 20 (1/2")	● 25 (3/4")	● 32 (1")	● 40 (1,1/4")	● 50 (1,1/4")					
Union two side socket: PN25, SDR5	●	●	●	●	●					
Elbow 90° female: PN25, SDR5	● 20 (1/2") 20 (3/4")	● 25 (1/2") 25 (3/4")	● 32 (3/4") 32 (1")							
Elbow 90° male: PN25, SDR5	● 20 (1/2") 20 (3/4")	● 25 (1/2") 25 (3/4")	● 32 (3/4") 32 (1")							
Tee adaptor female: PN25, SDR5	● 20 (1/2") 20 (3/4")	● 25 (1/2") 25 (3/4")	● 32 (3/4") 32 (1")							
Tee adaptor male: PN25, SDR5	● 20 (1/2") 20 (3/4")	● 25 (1/2") 25 (3/4")	● 32 (3/4") 32 (1")							
Butterfly valve: PN25, SDR5	●	●	●							
Chrome coated valve: PN25, SDR5	●	●	●							
Spherical valve: PN25, SDR5	●	●	●	●	●					

2.2 Raw Materials Specifications

Almona products are manufactured using only the highest quality raw materials available from internationally renowned suppliers. The raw material physical properties are checked and approved by independent international and national laboratories. In addition, almona is conducting tests in our state-of-the-art laboratory to ensure compliance to the following specified requirements.

Almona pipes and fittings are manufactured of polypropylene random copolymers (PP-R) with the following properties:

Property	Test Method	Unit	Value
Melt flow rate at 230°C/2.16 kg	ISO 1133	g/10 min	0.3
Density at 23°C	ISO 1183	g/cm^3	0.900
Melting zone	DIN 53736	°C	150-154
Tensile modulus of elasticity (1mm/min)	ISO 527	MPa	900
Charpy impact strength 0°C	DIN 8078		no break
Charpy impact strength 23°C	ISO 179	kJ/m^2	25
Coefficient of thermal expansion	DIN 53752	mm/mk	0.15
Thermal conductivity at 20°C	DIN 52612	W/m K	0.24
Dielectric loss factor	DIN 53483		< 5 x 10-4
Dielectric constant	DIN 53483		2.3
Volume resistivity	DIN 53482	Ω cm	> 1 x 1016
Dielectric strength	DIN 53481	kV/mm	≥ 20
Specific heat capacity at 20°C	ISO 11357-4	kJ/kg K	2.0
Tensile stress at yield (50mm/min)	ISO 527	MPa	25

2.3 Lifetime - long term temperature and pressure resistance

Almona PP-R systems have a lifetime of more than 50 years.

The creep rupture chart shown on the following page is derived from ISO15874 and shows the relationship between temperature and hoop stress in the pipe wall in determining the operational life of all PP-R pipe systems. It should be noted that the scales on both the horizontal and vertical axes are logarithmic rather than linear. Each of the individual curves, known as strength isotherms, sets out the minimum required performance of the pipe system in resisting hoop stress in the pipe wall (caused by the pressure inside the pipe) at a set constant temperature. The relationship between the hoop stress, also referred to as the hydrostatic stress, in the pipe wall and the pressure inside the pipe is determined by the pipe formula shown below:

$\sigma v = p \times (D-s)/2 \times s$

v – hydrostatic hoop stress [MPa]

D – outer diameter of the pipe [mm]

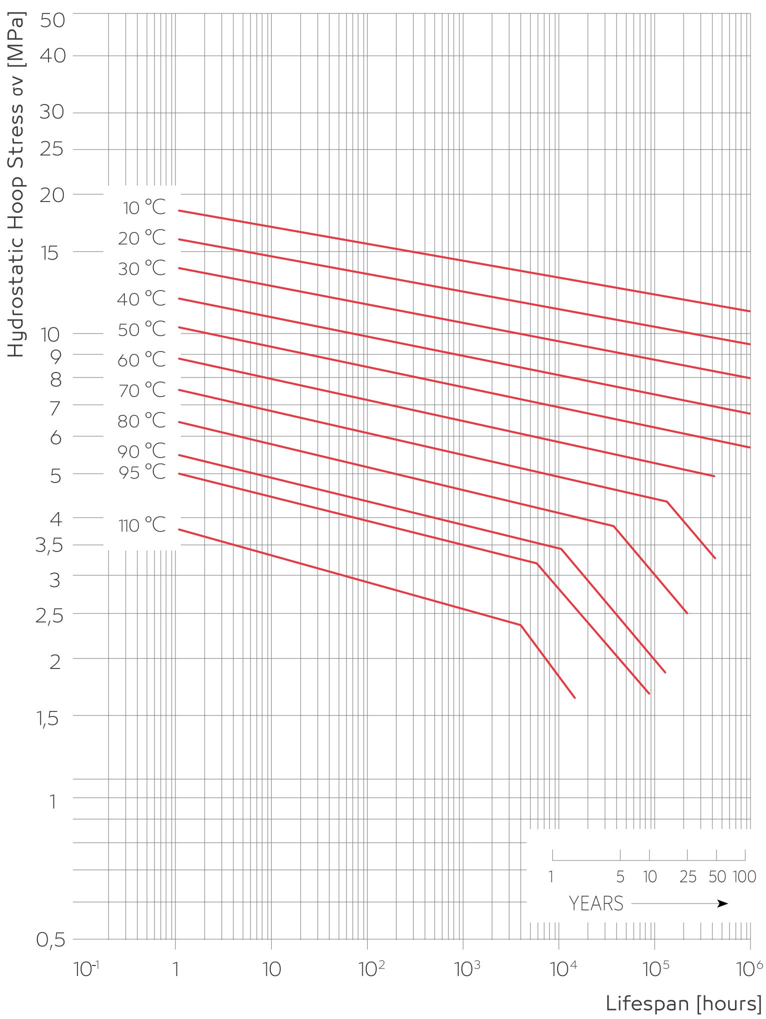
s – pipe wall thickness [mm]

p – maximal pressure [MPa]

The minimum expected pipe lifetime at a particular operating pressure and temperature can be predicted from the chart by undertaking the following steps:

1. Calculating the pipe wall hoop stress for the estimated pressure by using the above formula and identifying that point on the vertical axis;
2. Extending a horizontal line across the chart from the above point until it intersects with the isotherm corresponding to the operational temperature.
3. Extending a vertical line down from the intersection point to the horizontal axis where the predicted lifespan under those operational conditions can be read off.

In the real world, designers also include for a safety coefficient "k". For the almona PP-R systems, a coefficient of 1.25 is used for water supply calculations and a coefficient of 1.5 for heating systems.



After a PP-R material has undergone hydrostatic testing, in accordance with ISO9080, at a range of temperatures and for a period of at least 10,000 hours then the pipe failure points are plotted on a chart similar to the one shown above. Analysis of the data points allows the prediction of a PP-R's Long-Term Hydrostatic Strength (LTHS), which is measured in Mega Pascals (MPa). This in turn allows prediction of the σ_{LPL}, (Lower Predicted Limit) which represents the 97.5% lower confidence limit of the predicted hydrostatic strength of the material at any given temperature and point in time.

The Minimum Required Strength (MRS) defines minimum σ_{LPL} value that a PP-R material must be able to meet after a period of 50 years at a temperature of 20°C and the Categorized Required Strength (CRS) defines the minimum σ_{LPL} value required after a period of 50 years at 70°C. The following table lists the required MRS and CRS values together with the σ_{LPL} values of the materials used by almona. Based on the MRS figure, almona PP-R pipe systems can be classified as PP100 in accordance with ISO12162.

Parameter	MRS/CRS (MPa)	Almona (MPa)
$\sigma_{LPL(50°C,\ 50y)}$	10.0	10.02
$\sigma_{LPL(70°C,\ 50y)}$	3.2	3.63

2.4 Fire Resistance

Almona PP-R pipe systems components comply with the requirements of DIN 4102 and EN 13501-1 (fire classification B22.4) for building and construction materials.

Almona PP-R systems, do not exhibit an increased conflagration gas toxicity. In construction applications with a greater need for fire protection measures, pipe ducts through walls and ceilings must be protected against fire in such a way that, as a general principle, all pipe ducts have the same classification as the structural components through which the ducts pass.

In the case of a wall, which features a fire resistance period of 90 minutes (F90), the pipe ducting must also have a fire resistance period of 90 minutes (R90). One possible solution is the fire protection measure using fire protection collars or special mineral insulation with a melting temperature of > 1,000°C.

The self-ignition temperature of almona PP-R systems is 350°C. Suitable fire-fighting agents are water, foam, carbon dioxide or powder. In case of fire with PP-R Pipes, any fire extinguisher may be used. Powder extinguishers are very effective in quenching flames. Water sprays are especially effective in rapid cooling and damping down a fire but are not recommended in the early stages of a fire since they may help to spread the flames. Other factors will also influence the selection of fire extinguishers eg. proximity of live electrical equipment. Please refer to specific classifications of firefighting extinguishers.

2.5 Chemical Resistance

The outstanding chemical resistance of almona PP-R systems to a variety of chemicals and solvents, allows their use in a wide range of applications. Almona PP-R systems offer better resistance to corrosive acids, alkaline solutions, solvents, fuels, alcohol and salts than traditional piping systems.

In broad terms, almona PP-R systems do not rust, pit, corrode or lose wall thickness through chemical or electrical reaction with the surrounding environmental factors. Additionally, almona PP-R systems do not support the growth of, nor are affected by, algae, bacteria or fungi.

Nevertheless, special care is required in some applications where effluents contain harmful chemicals such as oxidisers, cracking agents and certain solvents. The degree of resistance to a specific chemical will depend on the concentration, temperature, length and type of exposure (i.e. intermittent or continuous) and working pressure, each of which may affect the long-term life of any system. The chemical resistance list provided in Section VIII: Appendix shall be used as a guide for evaluating the suitability of our products with the chemical agent is intended to be carried inside the pipe.

2.6 Drinking water

The basic requirements for PP-R systems which are used for potable water installations are defined in the "Drinking Water Ordinance of Water intended for human consumption (Trinkwasserverordnung - TrinkwV 2001)".

The dimensional design of the pipe system and the types of materials used shall minimize water stagnation in the pipes. Improper design and assembly of an installation may result in formation and growth of biofilm, which establishes optimum conditions for the growth of undesirable microorganisms such as legionellae and pseudomonads. Furthermore, the distance of flow up to the tap should be as short as possible and dead-water sections in which the water flows only rarely or does not flow at all, shall be avoided.

If the influence of the above factors can be minimized at the planning stage, this will ensure that the interior installations will maintain an optimum water quality. Planning and assembly of drinking water installations shall ensure that the drinking water is conveyed under perfect hygienic conditions.

For optimum drinking water quality, almona recommends that during planning and assembly the following shall be considered:

- Avoidance of stagnation
- Operation as intended
- Short connecting lines

- Separation of sections that are not in use
- Correct dimensioning
- Avoidance of cold water heating up (max. 25°C)
- Avoidance of hot water cooling down (min. 55°C)
- Expert initial operation (pressure test, flushing)

Almona PP-R systems are tested and certified by DVGW and NSF and therefore can be safely used in the design and construction of drinking water systems.

2.7 Sustainability

During the production of PP-R systems, almona focus on sustainable, environmentally friendly operation that minimizes the resources consumed in the production process. The raw material polypropylene PP-R can be completely recycled, and production residues can also be reused.

Compared to other materials, the energy expenditure required for the production of almona PP-R systems is significantly lower. Furthermore, the process does not produce any environmentally hazardous substances, leading to an excellent environmental performance.

2.8 Quality Assurance

Almona PP-R systems provide the highest levels of quality and our target is to exceed the requirements of national and international standards. This is achieved through highly controlled manufacturing processes and the implementation of a state-of-the-art quality control system which covers raw material, pipe and fittings, packing, storage, supply chain and post-sales support.

Our pipe and fittings are produced using the latest generation of machinery operated by trained skilled professionals that are supported by a continuous research and development programme. Deviations on product quality are avoided through stringent quality control checks undertaken by our inhouse quality control laboratory.

This commitment to high quality assurance is further evidenced by accreditation of ISO 9001:2015 Quality Management Systems organization and compliance of all almona products with the appropriate Saudi (SASO), German (DIN), UK(WRAS) and International (ISO, EN) Standards.

Section III

3. System requirements, planning and design

3.1 Applicable Standards

Various standards such as EN, ISO, DIN, SKZ guidelines, DVGW and SASO are followed during the production monitoring of the almona PP-R system. Regular monitoring checks and controls of the fabricated materials and production processes support almona to maintain and guarantee high quality of our products.

Applicable standards for almona PP-R systems are presented on the below table

EN ISO SASO 15874	Plastic Piping Systems for Hot and Cold Water Installations – Polypropylene (PP)
DIN 8077	Polypropylene (PP) pipes – PP-H, PP-B, PP-R, PP-RCT - Dimensions
DIN 8078	Polypropylene (PP) pipes – PP-H, PP-B, PP-R, PP-RCT - General quality requirements and testing
EN ISO 21003	Multilayer Composite Pipe Systems for Hot and Cold Water, Installations inside Buildings
DVGW W 270	Propagation of microorganisms on materials for the drinking water sector - testing and rating
KTW	Guideline of the Federal Environmental Agency on the Assessment of Organic Materials in Contact with Drinking Water
DVS 2207	Welding of Thermoplastics
DVS 2208	Welding of Thermoplastics – Tools and devices for heated tool welding of pipes and piping partsWater
WRAS	Water regulation advisory scheme
ÖNORM B5019	Hygienic relevant planning, execution, operation, monitoring and rehabilitation of central drinking water heating systems
ISO 12162:2009	Thermoplastics materials for pipes and fittings for pressure applications. Classification, designation and design coefficient
EN 806-5:2012	Specifications for installations inside buildings conveying water for human consumption. Operation and maintenance

3.2 Terms used

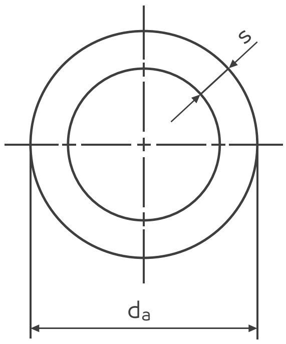
3.2.1 Standard dimension ratio

SDR is ratio used for the classification of plastic pipes, which describes the ratio between a pipe's outer diameter and its wall thickness.

$SDR = 2 \times s + 1$	S = pipe series number
$SDR \sim d_a/S$	s = wall thickness d_a = outer diameter

The SDR ratio together with the hydrostatic strength of the pipe material determine the pressure resistance. The following correlation applies:

- The thicker the wall, in relation to the pipe diameter, the lower the SDR ratio;
- The lower the SDR ratio, the higher the resistance of a pipe to pressure.



3.2.2 Pipe series number S

The nominal pipe series number is a dimensionless index, which is used for the calculation of the wall thickness of pipes. The following equation is used for the calculation of the pipe series number S:

$$S=(SDR-1)/2$$

Example: almona SDR6 PP-R pipe has a S number of 2.5

3.2.3 Nominal Pressure (PN)

The nominal pressure indicates a reference value that is representative for a pipe system and can be found in plastic pipe standards (for example, DIN 8077-1974/1989). The maximum working pressure of 20 bar, 16 bar, 10 bar refers only to a service life of 50 years at a working temperature of 20°C. However, at elevated temperatures the maximum operating pressure is lower (see section 3.3.2).

3.3 Requirements of PP-R pipe systems

Standards on the various products (for PP-R: EN ISO 15874), as well as the most recent standard on multilayer pipes (DIN EN ISO 21003) have introduced the term "classification of operating conditions". The requirements made on PP-R pipe systems over their operating life, according to ISO 15874 have been defined for four classes of application as in the table given in section 3.3.1.

3.3.1 Application classes

Almona PP-R systems application classes according to EN ISO 15874 are summarized below.

- Class 1 delivery of hot water 60°C, lifespan 50 years.
- Class 2 delivery of hot water 70°C, lifespan 50 years.
- Class 4 floor heating, low-temperature radiators, lifespan 50 years, with the stipulation that 20 years are expected (overall, during the entire lifespan) for operation temperature of 40°C, 25 years for 60°C and 2.5 years for 70°C.
- Class 5 high-temperature radiators, lifespan 50 years, with the stipulation that 14 years are expected (overall, during the entire lifespan) for operation temperature of 20°C, 25 years for 60°C, 10 years for 80°C, and 1 year for 90°C.

Class of application	Design temperature T_D (°C)	Duration of operation at T_D (years)	T_{max}	Duration of operation at T_{max} (°C)	T_{max} (°C)	Duration of operation at T_{times} (hours)	Typical field of application
1[a]	60	49	80	1	95	100	Hot water supply (60°C)
2[a]	70	49	80	1	95	100	Hot water supply (70°C)
4[b]	20	2,5	70	2,5	100	100	Underfloor heating and low-temperature radiator connection
	40	20					
	60	25					
5[b]	20	14	90	1	100	100	High-temperature radiator connection
	60	25					
	80	10					

Note: This international standard is usable only for enclosed systems, in which the T_D ,T_{max} and T_{times} do not exceed the values specified for class 5.

[a] Pursuant to national regulations either class 1 or class 2 may be selected.

[b] The temperature range for any class should consist of individual time sections (for example, the range of operation temperatures for the period of 50 years for class 5 is: 20°C for 14 years, 60°C for 25 years, 80°C for 10 years, 90°C for 1 year and 100 °C for 100 hours).

Pipe dimensions for each application class pursuant to EN 15874 are given in the following table:

Class of application	Operation pressure 8 bar	Operation pressure 10 bar
Application Class 1 Hot water supply (60°C)	S3,2 SDR7,4	S2,5 SDR6
Application Class 2 Hot water supply (70°C)	S2,5 SDR6	S2 SDR5
Application Class 4 Underfloor heating and low-temperature radiator connection	S3,2 SDR7,4	S3,2 SDR7,4
Application Class 5 High-temperature radiators	S2 SDR5	-

3.3.2 Table of working pressure values

Almona PP-R pipe and fittings are designed according to the values presented in the following table for maximum pressure, temperature and continuous operating time. These values have been calculated based on two different safety coefficients i.e. 1.25 and 1.5 for all conditions.

The table below is indicative, as the actual working conditions to which an installation is exposed can vary in pressure and temperature over time. This approach, which is close to reality, complies with the standard EN ISO 15874, which refers to "Plastic piping systems for hot and cold-water installations – Polypropylene (PP)" in its various parts.

Temperature	Operating time (years)	Maximum working pressure (bar)			
		almona monolayer PP-R pipe incl. UV SDR 6		almona multilayer PP-R pipe incl. UV SDR 7.4	
		Safety factor 1.25	Safety factor 1.5	Safety factor 1.25	Safety factor 1.5
20°C	1	36.0	-	28.5	-
	5	33.8	-	26.8	-
	10	32.8	-	26.1	-
	25	31.8	-	25.2	-
	50	30.9	-	24.5	-
30°C	1	30.6	25.4	24.2	20.2
	5	28.7	23.8	22.7	18.9
	10	27.7	23.2	22.1	18.4
	25	26.8	22.3	21.3	17.7
	50	26.1	21.7	20.7	17.2

Temperature	Operating time (years)	Maximum working pressure (bar)			
		almona monolayer PP-R pipe incl. UV SDR 6		almona multilayer PP-R pipe incl. UV SDR 7.4	
		Safety factor 1.25	Safety factor 1.5	Safety factor 1.25	Safety factor 1.5
40°C	1	25.8	21.6	20.6	17.1
	5	24.2	20.2	19.2	16.0
	10	23.6	19.6	18.7	15.5
	25	22.6	18.8	18.0	15.0
	50	22.0	18.3	17.4	14.5
50°C	1	22.0	18.2	17.4	13.5
	5	20.4	17.0	16.2	13.1
	10	19.7	16.5	15.7	12.6
	25	19.1	15.9	15.1	12.2
	50	18.5	15.4	14.7	12.2
60°C	1	18.5	15.4	14.7	12.2
	5	17.2	14.3	13.6	11.3
	10	16.6	13.9	13.2	11.5
	25	15.9	13.3	12.7	11.0
	50	15.3	12.9	12.3	10.5
70°C	1	15.6	12.9	12.3	10.3
	5	14.3	12.0	11.4	9.5
	10	14.0	11.6	11.1	9.2
	25	12.1	10.0	9.6	8.0
	50	10.2	8.5	8.1	6.7
80°C	1	13.1	10.8	10.3	8.6
	5	11.5	9.6	9.1	7.6
	10	9.6	8.1	7.7	6.4
	25	7.6	6.5	6.2	5.1
95°C	1	9.2	7.6	7.3	6.1
	5	6.2	5.2	4.9	4.1
	10	5.2	-	4.2	-

3.4 Disinfection

3.4.1 Thermal disinfection

In proven cases of contamination, the disinfection of almona drinking water PP-R systems should only be carried out for a limited period of time. The limit values for disinfectant concentration specified in the Drinking Water Ordinance represent maximum values, which were set in accordance to hygienic and toxicological standards. Only trained specialists shall carry out the disinfection of drinking water installations. The disinfection measures must be recorded in writing.

Disinfection measures carried out incorrectly can damage the drinking water installation. A combined thermal-chemical disinfection procedure is not permitted.

The thermal disinfection of almona pipe systems shall be carried out as follows:

- The water heater and the entire circulation system shall be heated to at least 70°C.
- Open all draw-off points in succession or line by line.
- Hot water at a temperature of 70°C shall be allowed to run from all draw-off points for at least five minutes.
- Do not allow the temperature to drop during the disinfection process.
- Do not exceed the maximum temperature of 95°C.
- Take suitable measures to eliminate the risk of scalding.

The total thermal disinfection time for almona PP-R systems shall not exceed 150 hours per year. Longer disinfection times or excessive temperatures can reduce the service life of the drinking water installation and can damage the system. To provide appropriate disinfection the temperature of 70°C shall be achieved within the entire system for a period of at least 5 minutes.

3.4.2 Chemical disinfection

During the process of chemical disinfection ("shock disinfection") in accordance with ÖNORM Standard B 5019, the disinfecting agent can be fed into the cold or hot water circulation. When the disinfecting agent is fed into the hot water circulation, the temperature shall first be reduced to minimum 25°C. Carrying out "shock disinfections" at higher temperatures is not permissible, as premature material damage cannot be ruled out. In relation to the service life of the installed system, the number of disinfecting procedures shall not exceed 5 cycles.

The below table lists the concentration and contact times of chemicals based on ÖNORM-Standard B 5019.

Active component	Chemical formula	Max. concentration applied	Contact time	Max. water temp. in the system
Chlorine Dioxide	ClO_2	6mg/l as ClO_2	8 to 12 hrs	< 25°C
Hypochlorite	ClO^-	50mg/l as ClO_2	8 to 12 hrs	< 25°C
Permanganate	MnO_4^-	15 mg/l	24 hrs	< 25°C
Hydrogen Peroxide	H_2O_2	150 mg/l	24 hrs	< 25°C

The concentrations and temperature stated in the above table shall not be exceeded at any point within the almona PP-R system.

3.5 Dimensioning of almona PP-R systems

3.5.1 Detailed calculation procedure

Design and sizing of almona PP-R drinking water installations is based on the detailed procedure given in DIN-1988-300:2012. This defines the procedure used to determine the pipe diameters, which is achieved by calculating the loss of pressure in the pipe system. The pressure loss depends on the pipe size, length and material, the type and number of valves and fittings and the flow rate.

The following data is required to determine pressure losses and dimensions for almona PP-R systems:

- The pressure at the inlet to the system.
- Difference in level between the inlet and different parts of the system.
- Loss of pressure due to the hydraulic resistance of the pipe materials used.
- Resistant coefficients for the valves and fittings within the system.
- Pressure loses related to other system elements such as heaters and meters.
- The minimum flow pressure required by different equipment installed at system outlets.

Whilst almona recommend that designers follow the detailed design method given in DIN 1988-300:2012, a simplified method given in BS EN 806-3:2006 can also be used. The choice of methods allows the selection of the most suitable method for the relevant application.

The simplified method is suitable for small-scale projects and simple drinking water installations. However, in the interest of hygiene, the detailed calculation procedure is preferable, in order to ensure the precise calculation and dimensioning of the installation.

The procedure for the detailed calculation is described below:

a. **Determine the flow rate at each outlet tapping.** This shall be determined based on information supplied by the manufacturer, Table 2 of DIN 1998-300 or the information provided in section 3.5.2 of this manual.

b. **Calculate the total flow rates of each section of the system**. Starting from the farthest tapping point and working back towards the inlet, add together the flow rates of each outlet to calculate the total flow rate of each branch of the system.

c. **Determine the system peak flow rate based on the total flow rate.** Whilst in step b) the designer calculated the total flow in the system or at least each section, it is generally assumed that not all tappings will be drawing water at the same time. The larger the system the smaller will be the proportion of tappings that will simultaneously take water. Whilst the pattern of taking water will also vary based on the type of system eg. residential, industrial, communal or commercial. The peak flow rate is generally determined based on the type of installation and the calculated total flow rate using the formula given in section 5.3 of DIN 1988-300. With regards to residential buildings, designers can make use of the table given in section 3.5.3 of this manual.

d. **Determine pressure loss due to hydraulic resistance**. Designers can make use of hydraulic equations such as Darcy-Weisbach and Hazen-Williams to calculate the pressure loss due to hydraulic resistance as water flows along the pipes. In the case of almona SDR 6 and SDR 7.4 pipe systems designers can instead refer to the tables given in section 3.5.5 of this manual.

e. **Determine the pressure loss due to individual valves, fittings and other equipment.** Each individual valve, fitting and other piece of equipment through which water flows is likely to induce a small local pressure loss due to the turbulence generated by the water flow. The degree of the pressure loss can be calculated using the following equation and depends on the flow velocity and a resistant coefficient, which varies depending on the equipment. Resistant coefficients can be provided by equipment manufacturers, whilst annex A of DIN 1998-300 contains extensive information on the resistant coefficients of fittings and valves. Section 3.5.4 of this manual provides the resistant coefficients for almona fittings and ball valves.

$$Pe = \zeta \frac{\rho v^2}{2}$$

Pe = pressure loss

ζ = resistant coefficient

ρ = fluid density

v = flow velocity

g. **Calculate total pressure loss along each section of the system back to the inlet point** based on d) and e) and by taking in to account any differences in level and the minimum flow pressures required at each outlet, determine if sufficient pressure is available. If not, increase the size of selected sections of pipework or redesign the system and repeat the pressure loss calculations until a satisfactory design is achieved

DIN 1988-300 Simplified Calculation Procedure. Section 5.4.2 of DIN1988-300 allows designers to only calculate the hydraulic resistance due to the system pipework and then to increase this pressure loss by between 40 and 60% to make an allowance for pressure losses at valves and fittings. Whilst this approach is suitable for preliminary sizing of a system, almona recommends that the final design follows the detailed procedure.

For sound insulation reasons and in order to limit pressure surges, the calculated flow rate shall not exceed the values provided on the table below:

Line section		**Maximum calculated flow rate for a duration of**	
		≤ 15 min	> 15 min
Connecting lines		2 m/s	2 m/s
Supply pipes	pipe sections with pipe valve fittings featuring low pressure loss ($z < 2.5$)*	5 m/s	2 m/s
	pipe sections with pipe valve fittings with higher loss coefficient values**	2.5 m/s	2 m/s

*e.g. piston slide valves acc. to DIN 3500, ball valves, slanted seat valves acc. to DIN 3502 (starting from DN 20)
*e.g. shut off valves acc. to DIN 351

3.5.2 Parameters to be used in the detailed calculation procedure

Minimum flow pressure values and calculated flow rates for selected drinking water equipment to be installed at tapping (system outlet) points are listed in the following table and in Table 2 of DIN 1988-300. Details should also be available from equipment manufacturers.

Minimum flow pressure p_{min} bar	Type of drinking water tapping point		Calculated flow for outlet of		
			mixed water*		either cold or hot drinking water
			volume flow cold l/s	volume flow hot l/s	volume flow l/s
0.5	outlet valves without aerator**	DN 15	–	–	0.30
0.5		DN 20	–	–	0.50
0.5		DN 25	–	–	1.00
1.0	outlet valves with aerator	DN 10	–	–	0.15
1.0		DN 15	–	–	0.15
1.0	shower heads for cleaning showers		0.10	0.10	0.20
1.2	pressure flusher according to DIN 3265. part 1	DN 15	–	–	0.70
1.2	pressure flusher according to DIN 3265. part 1	DN 20	–	–	1.00
0.4	pressure flusher according to DIN 3265. part 1	DN 25	–	–	1.00
1.0	pressure flusher for urinals	DN 15	–	–	0.30
1.0	household dishwasher	DN 15	–	–	0.15
1.0	household washing machine	DN 15	–	–	0.25
1.0	mixers for showers	DN 15	0.15	0.15	0.50
1.0	mixers for bathtubs	DN 15	0.15	0.15	0.50
1.0	mixers for kitchen sinks	DN 15	0.07	0.07	0.50
1.0	mixers for wash basins	DN 15	0.07	0.07	0.50
1.0	mixers for bidets	DN 15	0.07	0.07	0.50
1.0	mixer	DN 20	0.30	0.30	0.50
0.5	cistern according to DIN 19542	DN 15	–	–	0.13
1.0	electric water boiler	DN 15	–	–	0.10***

* The calculated flow rates for the supply of mixed water are based on a temperature of 15 °C for cold water and 60 °C for heated drinking water.

** For outlet valves without aerator and with threaded hose connection, the pressure loss in the hose assembly (up to a length of 10 m) and in the connected appliance (e.g. lawn sprinkler) is taken into account as a flat rate minimum flow pressure. In this case, the minimum flow pressure increases by 1.0 bar to 1.5 bar.

*** With fully opened throttle valve.

When determining the pipe diameter, draw-off points which are not included in the table as well as valves and fittings of a similar kind with flow rates of fittings or minimum flow pressures that are greater than indicated shall be taken into account as per the recommendations of the manufacturer.

3.5.3 Determination of peak flow rate

As explained in section 3.5.1 of this manual, peak flow rates are estimated based on the total system flow rate, size of the system (volume of the flow) and the type of building in which the system is installed. The peak flow can be calculated using the formula given in section 5.3 of DIN 1988-300 or in the case of residential and commercial buildings designers can make use of the following table.

The peak flow rate (VS) is calculated based on the total system flow rate (VR). Values given in the following table are in l/s.

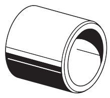
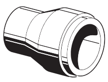
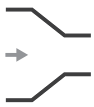
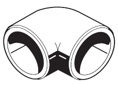
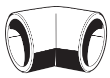
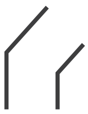
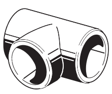
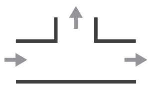
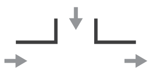
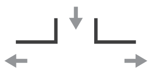
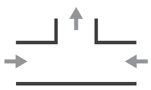
$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s
0.02	0.02	1.02	0.55	2.02	0.80	3.02	0.98	4.02	1.14	5.10	1.28	10.10	1.79	15.10	2.17
0.04	0.04	1.04	0.55	2.04	0.80	3.04	0.98	4.04	1.14	5.20	1.29	10.20	1.80	15.20	2.18
0.06	0.06	1.06	0.56	2.06	0.80	3.06	0.99	4.06	1.14	5.30	1.30	10.30	1.81	15.30	2.19
0.08	0.08	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
0.10	0.10	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
0.12	0.12	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
0.14	0.14	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
0.16	0.16	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
0.18	0.18	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

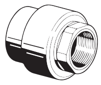
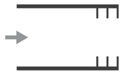
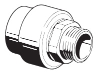
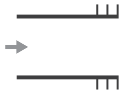
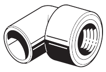
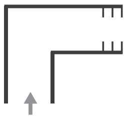
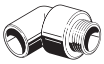
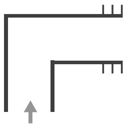
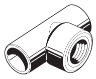
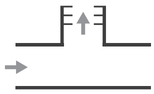
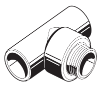
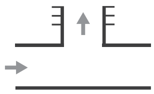
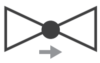
$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s	$\sum V_R$	V_s
0.58	0.39	1.58	0.70	2.58	0.90	3.58	1.07	4.58	1.21	7.90	1.59	12.90	2.02	17.90	2.36
0.58	0.39	1.58	0.70	2.58	0.90	3.58	1.07	4.58	1.21	7.90	1.59	12.90	2.02	17.90	2.36
0.60	0.40	1.60	0.70	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
0.72	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
0.76	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

"THE SMOOTH INNER SURFACE OF ALMONA PIPE AND FITTING SYSTEMS PREVENTS THE SEDIMENTATION AND ALLOWS FOR HIGH FLOW RATES"

3.5.4 Pressure loss resistant coefficients for almona pipe systems

As explained in section 3.5.1 of this manual, each individual valve and fitting through which water flows is likely to induce a small local pressure loss due to the turbulence generated by the water flow. The degree of the pressure loss can be calculated based on the flow velocity and a resistant coefficient, which varies depending on the type and size of the valve or fitting. The following table provides the resistant coefficients for almona fittings and ball valves. Other coefficients can be found in Annex A of DIN 1988-300.

Fittings		Symbol	Remarks	Resistant coefficient
Socket				0.25
Reducer			by 1 dimension	0.40
			by 2 dimension	0.50
			by 3 dimension	0.60
Elbow 90°				1.50
Elbow 45°				0.60
Tee				0.25
			Separation of flow	1.20
			Conjunction of flow	0.80
			Counter current in case of separation of flow	1.80
			Counter current in case of conjunction of flow	3.00

Fittings		Symbol	Remarks	Resistant coefficient
Socket female thread				0.50
Socket male thread				0.60
Elbow female thread				1.40
Elbow male thread				1.60
Tee female thread			Separation flow	1.40
Tee male thread			Separation flow	1.80
Ball valve				0.50

3.5.5 Hydraulic resistance pressure loss tables

A continuous loss of pressure is generated by the resistance which a fluid encounters as it flows along a pipe. Such resistance consists of the internal friction of the fluid itself, due to viscosity and resistance generated by contact between the flow and inside surface of the pipe. This is commonly referred to as hydraulic resistance and typically stated as a loss of pressure per set length of pipe. Typical units are bars per kilometre or as in the following table, millibars per metre of pipe.

The pressure loss (R), at 20°C, due to hydraulic resistance and the flow velocity (v) can be determined for SDR 6 and SDR 7.4 pipes based on the rate of flow (V) and the pipe dimensions.

Pipe SDR 6, Temperature 20°C, pipe roughness: 0.007 mm

l/s	m³/h	Dimension	20 mm	25 mm	32 mm	40 mm	50 mm	63 mm	75 mm	90 mm	110 mm	125 mm
		Wall thickness	3.4 mm	4.2 mm	5.4 mm	6.7 mm	8.3 mm	10.5 mm	12.5 mm	15.0 mm	18.3 mm	20.8 mm
0.01	0.04	R in mbar/m	0.15	0.05	0.02	0.01						
		v in m/s	0.07	0.05	0.03	0.02						
0.02	0.07	R	0.45	0.16	0.05	0.02	0.01					
		v	0.15	0.09	0.06	0.04	0.02					
0.03	0.11	R	0.87	0.30	0.10	0.03	0.01					
		v	0.22	0.14	0.08	0.05	0.02					
0.04	0.14	R	1.39	0.48	0.15	0.05	0.02	0.01				
		v	0.29	0.18	0.11	0.07	0.05	0.03				
0.05	0.18	R	2.02	0.69	0.22	0.08	0.03	0.01				
		v	0.37	0.23	0.14	0.09	0.06	0.04				
0.06	0.22	R	2.74	0.94	0.30	0.10	0.04	0.01	0.01			
		v	0.44	0.28	0.17	0.11	0.07	0.04	0.03			
0.07	0.25	R	3.55	1.21	0.39	0.13	0.05	0.02	0.01			
		v	0.51	0.32	0.20	0.13	0.08	0.05	0.04			
0.08	0.29	R	4.46	1.51	0.48	0.17	0.06	0.02	0.01			
		v	0.58	0.37	0.23	0.14	0.09	0.06	0.04			
0.09	0.32	R	5.45	1.85	0.59	0.20	0.07	0.02	0.01			
		v	0.66	0.42	0.25	0.16	0.10	0.06	0.05			
0.10	0.36	R	6.52	2.21	0.70	0.24	0.08	0.03	0.01	0.01		
		v	0.73	0.46	0.28	0.18	0.11	0.07	0.05	0.04		
0.12	0.43	R	8.92	3.01	0.95	0.33	0.11	0.04	0.02	0.01		
		v	0.88	0.55	0.34	0.22	0.14	0.09	0.06	0.04		
0.14	0.50	R	11.66	3.92	1.23	0.42	0.15	0.05	0.02	0.01		
		v	1.02	0.65	0.40	0.25	0.16	0.10	0.07	0.05		
0.16	0.58	R	14.71	4.93	1.55	0.53	0.18	0.06	0.03	0.01		
		v	1.17	0.74	0.45	0.29	0.18	0.12	0.08	0.06		
0.18	0.65	R	18.07	6.05	1.89	0.65	0.22	0.08	0.03	0.01	0.01	
		v	1.32	0.83	0.51	0.32	0.21	0.13	0.09	0.06	0.04	
0.20	0.72	R	21.75	7.26	2.57	0.78	0.27	0.09	0.04	0.02	0.01	
		v	1.46	0.92	0.57	0.36	0.23	0.14	0.10	0.07	0.05	
0.30	1.08	R	44.65	14.77	4.58	1.56	0.53	0.18	0.08	0.03	0.01	0.01
		v	2.19	1.39	0.85	0.54	0.34	0.22	0.15	0.11	0.07	0.05
0.40	1.44	R	74.89	24.60	7.58	2.56	0.87	0.29	0.13	0.05	0.02	0.01
		v	2.92	1.85	1.13	0.72	0.46	0.29	0.20	0.14	0.09	0.07
0.50	1.80	R	112.32	36.68	11.24	3.78	1.28	0.43	0.19	0.08	0.03	0.02
		v	3.65	2.31	1.42	0.90	0.57	0.36	0.25	0.18	0.12	0.09
0.60	2.16	R	156.82	50.97	15.55	5.21	1.76	0.59	0.26	0.11	0.04	0.02
		v	4.38	2.77	1.70	1.08	0.68	0.43	0.31	0.21	0.14	0.11
0.70	2.52	R	208.34	67.43	20.49	6.85	2.30	0.77	0.34	0.14	0.05	0.03
		v	5.12	3.23	1.98	1.26	0.80	0.51	0.36	0.25	0.17	0.13
0.80	2.88	R	266.84	86.05	26.05	8.68	2.91	0.97	0.42	0.18	0.07	0.04
		v	5.85	3.70	2.27	1.44	0.91	0.58	0.41	0.28	0.19	0.15
0.90	3.24	R	332.29	106.80	32.22	10.72	3.58	1.20	0.52	0.22	0.08	0.05
		v	6.58	4.16	2.55	1.62	1.03	0.65	0.46	0.32	0.21	0.16
1.00	3.60	R	404.65	129.67	30.01	12.94	4.32	1.44	0.63	0.26	0.10	0.06
		v	7.31	4.62	2.83	1.80	1.14	0.72	0.51	0.35	0.24	0.18

l/s	m^3/h	Dimension	20 mm	25 mm	32 mm	40 mm	50 mm	63 mm	75 mm	90 mm	110 mm	125 mm
		Wall thickness	3.4 mm	4.2 mm	5.4 mm	6.7 mm	8.3 mm	10.5 mm	12.5 mm	15.0 mm	18.3 mm	20.8 mm
1.10	3.96	R	483.92	154.66	46.40	15.36	5.11	1.70	0.74	0.31	0.12	0.07
		v	8.04	5.08	3.12	1.98	1.26	0.79	0.56	0.39	0.26	0.20
1.20	4.32	R	570.09	181.75	54.40	17.97	5.97	1.98	0.86	0.36	0.14	0.08
		v	8.77	5.54	3.40	2.16	1.37	0.87	0.61	0.42	0.28	0.22
1.30	4.68	R	663.13	210.95	62.99	20.77	6.89	2.29	0.99	0.42	0.16	0.09
		v	9.50	6.01	3.68	2.34	1.48	0.94	0.66	0.46	0.31	0.24
1.40	5.04	R	763.06	242.24	72.18	23.75	7.86	2.61	1.13	0.47	0.18	0.10
		v	10.23	6.47	3.97	2.52	1.60	0.71	0.71	0.50	0.33	0.26
1.60	5.76	R		311.09	92.33	30.28	10.00	3.31	1.43	0.60	0.23	0.12
		v		7.39	4.53	2.88	1.83	1.15	0.81	0.57	0.38	0.29
1.80	6.48	R		388.29	114.85	37.56	12.37	4.08	1.76	0.74	0.28	0.15
		v		8.32	5.10	3.24	2.05	1.30	0.92	0.64	0.43	0.33
2.00	7.20	R		473.81	139.72	45.56	14.97	4.93	2.13	0.89	0.34	0.18
		v		9.24	5.67	3.60	2.28	1.44	1.02	0.71	0.47	0.37
2.20	7.92	R		567.64	166.93	54.30	17.80	5.85	2.52	1.05	0.40	0.22
		v		10.17	6.23	3.96	2.51	1.59	1.12	0.78	0.52	0.40
2.40	8.64	R			196.48	63.77	20.85	6.84	2.94	1.22	0.47	0.25
		v			6.80	4.32	2.74	1.73	1.22	0.85	0.57	0.44
2.60	9.36	R			228.36	73.96	24.14	7.90	3.40	1.41	0.54	0.29
		v			7.37	4.68	2.97	1.88	1.32	0.92	0.61	0.48
2.80	10.08	R			262.57	84.87	27.65	9.04	3.88	1.61	0.61	0.33
		v			7.93	5.04	3.20	2.02	1.43	0.99	0.66	0.51
3.00	10.80	R			299.11	96.51	31.38	10.24	4.39	1.82	0.69	0.38
		v			8.50	5.40	3.42	2.17	1.53	1.06	0.71	0.55
3.50	12.60	R			400.59	128.74	41.70	13.56	5.80	2.40	0.91	0.49
		v			9.92	6.30	3.99	2.53	1.78	1.24	0.83	0.64
4.00	14.40	R			516.57	165.44	53.41	17.31	7.39	3.05	1.15	0.62
		v			11.33	7.20	4.57	2.89	2.04	1.41	0.95	0.73
4.50	16.20	R				206.60	66.50	21.49	9.16	3.78	1.42	0.77
		v				8.10	5.14	3.25	2.29	1.59	1.06	0.82
5.00	18.00	R				252.22	80.96	26.09	11.10	4.57	1.72	0.93
		v				9.00	5.71	3.61	2.55	1.77	1.18	0.92
5.50	19.80	R				302.28	96.79	31.12	13.12	5.43	2.04	1.10
		v				9.90	6.28	3.97	2.80	1.95	1.30	1.01
6.00	21.60	R				356.78	113.99	36.57	15.51	6.36	2.39	1.29
		v				10.80	6.85	4.33	3.06	2.12	1.42	1.10
6.50	23.40	R					132.56	42.44	17.97	7.36	2.76	1.49
		v					7.42	4.69	3.31	2.30	1.54	1.19
7.00	25.20	R					152.49	48.73	20.61	8.43	3.16	1.70
		v					7.99	5.05	3.57	2.48	1.65	1.28
7.50	27.00	R					173.78	55.44	23.42	9.57	3.58	1.93
		v					8.56	5.41	3.82	2.65	1.77	1.37
8.00	28.80	R					196.43	62.57	26.39	10.77	4.03	2.17
		v					9.13	5.77	4.07	2.83	1.89	1.46
8.50	30.60	R					220.43	70.11	29.54	12.04	4.50	2.42
		v					9.70	6.14	4.33	3.01	2.01	1.56

l/s	m³/h	Dimension	20 mm	25 mm	32 mm	40 mm	50 mm	63 mm	75 mm	90 mm	110 mm	125 mm
		Wall thickness	3.4 mm	4.2 mm	5.4 mm	6.7 mm	8.3 mm	10.5 mm	12.5 mm	15.0 mm	18.3 mm	20.8 mm
9.00	32.40	R					245.80	78.06	32.86	13.38	4.99	2.68
		v					10.27	6.50	4.58	3.18	2.13	1.65
9.50	34.20	R						86.43	36.34	14.79	5.51	2.96
		v						6.86	4.84	3.36	2.25	1.74
10.00	36.00	R						95.22	40.00	16.26	6.05	3.25
		v						7.22	5.09	3.54	2.36	1.83
10.50	37.80	R						104.42	43.82	17.80	6.62	3.55
		v						7.58	5.35	3.71	2.48	1.92
11.00	39.60	R						114.03	47.82	19.40	7.21	3.87
		v						7.94	5.60	3.89	2.60	2.01
11.50	41.40	R						124.06	51.98	21.07	7.83	4.19
		v						8.30	5.86	4.07	2.72	2.11
12.00	43.20	R						134.49	56.31	22.81	8.46	4.53
		v						8.66	6.11	4.24	2.84	2.20
12.50	45.00	R						145.34	60.80	24.61	9.12	4.88
		v						9.02	6.37	4.42	2.95	2.29
13.00	46.80	R						156.61	65.47	26.48	9.81	5.25
		v						9.38	6.62	4.60	3.07	2.38
13.50	48.60	R						162.28	70.30	28.41	10.52	5.62
		v						9.74	6.88	4.77	3.19	2.47
14.00	50.40	R						180.37	75.30	30.41	11.25	6.01
		v						10.11	7.13	4.95	3.31	2.56
14.50	52.20	R							80.47	32.48	12.00	6.41
		v							7.38	5.13	3.43	2.65
15.00	54.00	R							85.80	34.61	12.78	6.83
		v							7.64	5.31	3.54	2.75
16.00	57.60	R							96.97	39.06	14.41	7.69
		v							8.15	5.66	3.78	2.93
17.00	61.20	R							108.80	43.78	16.13	8.60
		v							8.66	6.01	4.02	3.11
18.00	64.80	R							121.31	48.76	17.94	9.56
		v							9.17	6.37	4.25	3.29
19.00	68.40	R							134.47	54.00	19.85	10.57
		v							9.68	6.72	4.49	3.48
20.00	72.00	R							148.31	59.49	21.84	11.63
		v							10.19	7.07	4.73	3.66
21.00	75.60	R								65.25	23.93	12.73
		v								7.43	4.96	3.84
22.00	79.20	R								71.27	26.12	13.88
		v								7.78	5.20	4.03
23.00	82.80	R								77.54	28.39	15.08
		v								8.13	5.44	4.21
24.00	86.40	R								84.08	30.75	16.33
		v								8.49	5.67	4.39
2500	90.00	R								90.87	33.21	17.63
		v								8.84	5.91	4.58

Pipe SDR 7.4, Temperature 20°C, pipe roughness: 0.007 mm

l/s	m³/h	Dimension	20 mm	25 mm	32 mm	40 mm	50 mm	63 mm	75 mm	90 mm	110 mm	125 mm
		Wall thickness	2.8 mm	3.5 mm	4.4 mm	5.5 mm	6.9 mm	8.6 mm	10.3 mm	12.3 mm	15.1 mm	17.1 mm
0.01	0.04	R in mbar/m	0.10	0.04	0.01							
		v in m/s	0.06	0.04	0.02							
0.02	0.07	R	0.30	0.11	0.03	0.01						
		v	0.12	0.08	0.05	0.03						
0.03	0.11	R	0.58	0.21	0.06	0.02						
		v	0.18	0.12	0.07	0.05						
0.04	0.14	R	0.93	0.33	0.10	0.04	0.01					
		v	0.25	0.16	0.09	0.06	0.04					
0.05	0.18	R	1.34	0.47	0.15	0.05	0.02					
		v	0.31	0.20	0.12	0.08	0.05					
0.06	0.22	R	1.82	0.64	0.20	0.07	0.03	0.01				
		v	0.44	0.24	0.14	0.09	0.06	0.04				
0.07	0.25	R	2.36	0.83	0.25	0.09	0.03	0.03				
		v	0.43	0.28	0.17	0.11	0.07	0.04				
0.08	0.29	R	2.96	1.04	0.32	0.11	0.04	0.01				
		v	0.49	0.31	0.19	0.12	0.08	0.05				
0.09	0.32	R	3.61	1.26	0.38	0.14	0.05	0.02				
		v	0.55	0.35	0.21	0.14	0.09	0.05				
0.10	0.36	R	4.32	1.51	0.46	0.16	0.06	0.02	0.01			
		v	0.61	0.39	0.24	0.15	0.10	0.06	0.04			
0.12	0.43	R	5.90	2.05	0.62	0.22	0.08	0.03	0.01			
		v	0.74	0.47	0.28	0.18	0.12	0.07	0.05			
0.14	0.50	R	7.70	2.67	0.81	0.28	0.10	0.03	0.02			
		v	0.86	0.55	0.33	0.21	0.14	0.08	0.06			
0.16	0.58	R	9.70	3.36	1.01	0.35	0.13	0.04	0.02			
		v	0.98	0.63	0.38	0.24	0.16	0.10	0.07			
0.18	0.65	R	11.91	4.11	1.24	0.43	0.15	0.05	0.02	0.01		
		v	1.11	0.71	0.43	0.27	0.17	0.11	0.08	0.05		
0.20	0.72	R	14.32	4.94	1.48	0.52	0.18	0.06	0.03	0.01		
		v	1.23	0.79	0.47	0.30	0.19	0.12	0.09	0.06		
0.30	1.08	R	29.30	10.01	2.98	1.03	0.36	0.12	0.02	0.01		
		v	1.84	1.18	0.71	0.45	0.29	0.13	0.09	0.06		
0.40	1.44	R	49.02	16.64	4.92	1.70	0.59	0.20	0.09	0.04	0.01	0.01
		v	2.46	1.57	0.95	0.61	0.39	0.24	0.17	0.12	0.08	0.06
0.50	1.80	R	73.35	24.77	7.29	2.50	0.87	0.29	0.13	0.05	0.02	0.01
		v	3.07	1.96	1.18	0.76	0.49	0.30	0.22	0.15	0.10	0.08
0.60	2.16	R	102.21	34.36	10.06	3.45	1.20	0.39	0.17	0.07	0.03	0.02
		v	3.68	2.36	1.42	0.91	0.58	0.36	0.26	0.18	0.12	0.09
0.70	2.52	R	135.57	45.40	13.24	4.52	1.57	0.51	0.23	0.09	0.04	0.04
		v	4.30	2.75	1.66	1.06	0.68	0.42	0.30	0.21	0.14	0.11
0.80	2.88	R	173.38	57.86	16.82	5.73	1.98	0.64	0.28	0.12	0.05	0.03
		v	4.91	3.14	1.89	1.21	0.78	0.49	0.34	0.24	0.16	0.12
0.90	3.24	R	215.63	71.73	20.78	7.06	2.43	0.79	0.35	0.15	0.06	0.03
		v	5.53	3.54	2.13	1.36	0.87	0.55	0.39	0.27	0.18	0.14
1.00	3.60	R	262.30	87.00	25.14	8.52	2.93	0.95	0.42	0.17	0.07	0.04
		v	6.14	3.93	2.37	1.51	0.97	0.61	0.43	0.30	0.20	0.15

l/s	m^3/h	Dimension	20 mm	25 mm	32 mm	40 mm	50 mm	63 mm	75 mm	90 mm	110 mm	125 mm
		Wall thickness	3.4 mm	4.2 mm	5.4 mm	6.7 mm	8.3 mm	10.5 mm	12.5 mm	15.0 mm	18.3 mm	20.8 mm
1.10	3.96	R v	313.36 6.75	103.67 4.32	29.87 2.60	10.11 1.67	3.47 1.07	1.12 0.67	0.49 0.47	0.21 0.33	0.08 0.22	0.04 0.17
1.20	4.32	R v	368.81 7.37	121.73 4.72	34.99 2.84	11.82 1.82	4.05 1.17	1.31 0.73	0.58 0.52	0.24 0.36	0.09 0.24	0.05 0.19
1.30	4.68	R v	428.65 7.98	141.17 5.11	40.48 3.08	13.65 1.97	4.67 1.26	1.51 0.79	0.66 0.56	0.28 0.39	0.11 0.26	0.06 0.20
1.40	5.04	R v	492.86 8.60	162.00 5.50	46.35 3.31	15.60 2.12	5.33 1.36	1.72 0.85	0.76 0.60	0.31 0.42	0.12 0.28	0.07 0.22
1.60	5.76	R v	634.39 9.82	207.77 6.29	59.21 3.78	19.86 2.42	6.77 1.55	2.18 0.97	0.96 0.69	0.40 0.48	0.15 0.32	0.08 0.25
1.80	6.48	R v	793.36 11.05	259.03 7.07	73.57 4.26	24.61 2.73	8.37 1.7	2.69 1.09	1.18 0.77	0.49 0.54	0.19 0.36	0.10 0.28
2.00	7.20	R v		315.77 7.86	89.40 4.73	29.83 3.03	10.12 1.94	3.24 1.21	1.42 0.86	0.59 0.60	0.23 0.40	0.12 0.31
2.20	7.92	R v		377.96 8.65	106.70 5.20	35.52 3.33	12.02 2.14	3.85 1.34	1.68 0.95	0.69 0.65	0.27 0.44	0.14 0.34
2.40	8.64	R v		445.60 9.43	125.47 5.68	41.67 3.63	14.08 2.33	4.50 1.46	1.96 1.03	0.81 0.71	0.31 0.48	0.17 0.37
2.60	9.36	R v		518.69 10.22	145.71 6.15	48.30 3.94	16.29 2.53	5.19 1.58	2.26 1.12	0.93 0.77	0.36 0.52	0.19 0.40
2.80	10.08	R v			167.40 6.62	55.38 4.24	18.64 2.72	5.93 1.70	2.58 1.20	1.06 0.83	0.41 0.56	0.22 0.43
3.00	10.80	R v			190.56 7.10	62.93 4.54	21.15 2.91	6.72 1.82	2.92 1.29	1.20 0.89	0.46 0.60	0.25 0.46
3.50	12.60	R v			254.82 8.28	83.82 5.30	28.07 3.40	8.89 2.12	3.86 1.51	1.58 1.04	0.61 0.70	0.33 0.54
4.00	14.40	R v			328.14 9.46	107.58 6.06	35.90 3.89	11.3 2.43	4.91 1.72	2.01 1.19	0.77 0.80	0.42 0.62
4.50	16.20	R v			410.53 10.65	134.1 6.81	44.65 4.37	14.0 2.73	6.07 1.94	2.49 1.34	0.95 0.90	0.51 0.69
5.00	18.00	R v				163.6 7.57	54.32 4.86	17.0 3.03	7.36 2.15	3.01 1.49	1.15 1.00	0.62 0.77
5.50	19.80	R v				195.9 8.33	64.88 5.34	20.3 3.34	8.75 2.37	3.57 1.64	1.36 1.10	0.73 0.85
6.00	21.60	R v				231.1 9.08	76.36 5.83	23.8 3.64	10.2 2.58	4.18 1.79	1.60 1.20	0.86 0.93
6.50	23.40	R v				269.0 9.84	88.73 6.32	27.6 3.95	11.8 2.80	4.84 1.93	1.84 1.30	0.99 1.00
7.00	25.20	R v				309.8 10.60	102.0 6.80	31.7 4.25	13.6 3.01	5.54 2.08	2.11 1.40	1.13 1.08
7.50	27.00	R v					116.1 7.29	36.1 4.55	15.4 3.23	6.28 2.23	2.39 1.50	1.28 1.16
8.00	28.80	R v					131.24 7.77	40.7 4.86	17.4 3.44	7.07 2.38	2.68 1.60	1.44 1.24
8.50	30.60	R v					147.2 8.26	45.6 5.16	19.4 3.66	7.90 2.53	3.00 1.70	1.60 1.31

l/s	m^3/h	Dimension	20 mm	25 mm	32 mm	40 mm	50 mm	63 mm	75 mm	90 mm	110 mm	125 mm
		Wall thickness	3.4 mm	4.2 mm	5.4 mm	6.7 mm	8.3 mm	10.5 mm	12.5 mm	15.0 mm	18.3 mm	20.8 mm
9.00	32.40	R					164.0	50.7	21.6	8.77	3.32	1.78
		v					8.74	5.46	3.87	2.68	1.80	1.39
9.50	34.20	R					181.8	56.1	23.9	9.69	3.67	1.96
		v					9.23	5.77	4.09	2.83	1.90	1.47
10.00	36.00	R					200.4	61.8	26.3	10.6	4.03	2.15
		v					9.72	6.07	4.30	2.98	2.00	1.54
10.50	37.80	R					219.9	67.7	28.8	11.6	4.40	2.35
		v					10.20	6.37	4.52	3.13	2.10	1.62
11.00	39.60	R						73.9	31.4	12.7	4.79	2.56
		v						6.68	4.73	3.27	2.20	1.70
11.50	41.40	R						80.4	34.2	13.7	5.20	2.77
		v						6.98	4.95	3.42	2.30	1.78
12.00	43.20	R						87.2	37.0	14.9	5.62	3.00
		v						7.28	5.16	3.57	2.40	1.85
12.50	45.00	R						94.2	39.9	16.0	6.06	3.23
		v						7.59	5.38	3.72	2.50	1.93
13.00	46.80	R						101	43.0	17.3	6.51	3.47
		v						7.89	5.59	3.87	2.60	2.01
13.50	48.60	R						109	46.1	18.5	6.98	3.71
		v						8.19	5.81	4.02	2.70	2.08
14.00	50.40	R						117	49.4	19.8	7.46	3.97
		v						8.50	6.02	4.17	2.80	2.16
14.50	52.20	R						124	52.8	21.2	7.96	4.23
		v						8.80	6.24	4.32	2.90	2.24
15.00	54.00	R						133	56.3	22.5	8.48	4.50
		v						9.10	6.45	4.47	3.00	2.32
16.00	57.60	R						150	63.6	25.4	9.55	5.07
		v						9.71	6.88	4.76	3.20	2.47
17.00	61.20	R						169	71.3	28.5	10.6	5.67
		v						10.3	7.31	5.06	3.40	2.63
18.00	64.80	R							79.5	31.7	11.8	6.30
		v							7.74	5.36	3.60	2.78
19.00	68.40	R							88.0	35.1	13.1	6.96
		v							8.17	5.66	3.80	2.93
20.00	72.00	R							97.1	38.7	14.4	7.65
		v							8.60	5.95	4.00	3.09
21.00	75.60	R							106	42.4	15.8	8.38
		v							9.04	6.25	4.20	3.24
22.00	79.20	R							116	46.3	17.2	9.13
		v							9.47	6.55	4.40	3.40
23.00	82.80	R							126	50.4	18.7	9.92
		v							9.90	6.85	4.60	3.55
24.00	86.40	R							137	54.6	20.3	10.7
		v							10.3	7.14	4.80	3.71
2500	90.00	R								59.0	21.9	11.5
		v								7.44	5.00	3.86

l/s	m³/h	Dimension Wall thickness	20 mm 3.4 mm	25 mm 4.2 mm	32 mm 5.4 mm	40 mm 6.7 mm	50 mm 8.3 mm	63 mm 10.5 mm	75 mm 12.5 mm	90 mm 15.0 mm	110 mm 18.3 mm	125 mm 20.8 mm
26.00	93.60	R v								63.5 7.74	23.6 5.20	12.4 4.02
27.00	97.20	R v								68.3 8.04	25.3 5.40	13.3 4.17
28.00	100.80	R v								73.2 8.34	27.1 5.60	14.3 4.32
29.00	104.40	R v								78.2 8.63	28.9 5.80	15.2 4.48
30.00	108.00	R v								83.4 8.93	30.9 6.00	16.2 4.63
32.00	115.20	R v								94.4 9.53	34.9 6.40	18.3 4.94
34.00	122.40	R v								106 10.1	39.1 6.80	20.5 5.25
36.00	129.60	R v									43.6 7.20	22.9 5.56
38.00	136.80	R v									48.3 7.60	25.3 5.87
40.00	144.00	R v									53.2 8.00	27.9 6.18
42.00	151.20	R v									58.4 8.40	30.6 6.49
44.00	158.40	R v									63.8 8.80	33.4 6.80
46.00	165.60	R v									69.5 9.20	36.4 7.10
48.00	172.80	R v									75.4 9.60	39.5 7.41
50.00	180.00	R v									81.5 10.0	42.6 7.72

Section IV

4. Product Range

4.1 Pipes

Almona manufactures PP-R pipes range in size from 20mm to 160 mm. Additional pipe dimensions for single layer (up to 630mm) can be produced on request.

almona pipe PP-R - PN20, SDR6

Structure of pipe: Single layer PP-R

Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11

Part No.	Pipe Dimension (mm)			Length (m)	Packing/ Bag	Weight (kg/m)
	O.D.	I.D.	T			
10302	20	13,2	3,4	5,8	35	0,172
10304	25	16,6	4,2	5,8	25	0,266
10306	32	21,2	5,4	5,8	15	0,434
10308	40	26,6	6,7	5,8	10	0,671
10310	50	33,2	8,4	5,8	7	1,04
10355	63	42	10,5	4	4	1,65
10356	75	50	12,5	4	1	2,36
10357	90	60	15	4	1	3,36
10358	110	73,2	18,4	4	1	5,01
10359	125	83,2	20,9	4	1	6,25

almona pipe PP-R (UV) - PN20, SDR6

Structure of pipe: Single layer PP-R
Special feature: UV resistant
Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11

Part No.	Pipe Dimension (mm)			Length (m)	Packing/ Bag	Weight (kg/m)
	O.D.	I.D.	T			
10302/UV	20	13,2	3,4	5,8	35	0,172
10304/UV	25	16,6	4,2	5,8	25	0,266
10306/UV	32	21,2	5,4	5,8	15	0,434
10308/UV	40	26,6	6,7	5,8	10	0,671
10310/UV	50	33,2	8,4	5,8	7	1,04
10355/UV	63	42	10,5	4	4	1,65
10356/UV	75	50	12,5	4	1	2,36
10357/UV	90	60	15	4	1	3,36
10358/UV	110	73,2	18,4	4	1	5,01
10359/UV	125	83,2	20,9	4	1	6,25

almona pipe PP-R/GF/PP-R - PN25, SDR6

Structure of pipe: Multilayer, with fiberglass reinforced middle layer
Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11, ISO 21003

Part No.	Pipe Dimension (mm)			Length (m)	Packing/ Bag	Weight (kg/m)
	O.D.	I.D.	T			
10332	20	13,2	3,4	5,8	35	0,166
10334	25	16,6	4,2	5,8	25	0,257
10336	32	21,2	5,4	5,8	15	0,423
10338	40	26,6	6,7	5,8	10	0,657
10340	50	33,2	8,4	5,8	7	1,029
10342	63	42	10,5	4	4	1,624
10344	75	50	12,5	4	1	2,301
10346	90	60	15	4	1	3,488
10348	110	73,2	18,4	4	1	4,943
10350	125	83,2	20,9	4	1	6,385

almona pipe PP-R/GF/PP-R (UV) - PN25, SDR6

Structure of pipe: Multilayer, with fiberglass reinforced middle layer
Special feature: UV resistant
Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11, ISO 21003

Part No.	Pipe				Packing/ Bag	Weight (kg/m)
	Dimension (mm)			Length (m)		
	O.D.	I.D.	T			
10332/UV	20	13,2	3,4	5,8	35	0,166
10334/UV	25	16,6	4,2	5,8	25	0,257
10336/UV	32	21,2	5,4	5,8	15	0,423
10338/UV	40	26,6	6,7	5,8	10	0,657
10340/UV	50	33,2	8,4	5,8	7	1,029
10342/UV	63	42	10,5	4	4	1,624
10344/UV	75	50	12,5	4	1	2,301
10346/UV	90	60	15	4	1	3,488
10348/UV	110	73,2	18,4	4	1	4,943
10350/UV	125	83,2	20,9	4	1	6,385

almona pipe PP-R - PN16, SDR7.4

Structure of pipe: Single layer PP-R
Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11

Part No.	Pipe				Packing/ Bag	Weight (kg/m)
	Dimension (mm)			Length (m)		
	O.D.	I.D.	T			
10101	20	14,4	2,8	5,8	35	0,138
10103	25	18	3,5	5,8	25	0,215
10105	32	23,2	4,4	5,8	15	0,347
10107	40	29	5,5	5,8	10	0,542
10109	50	36,2	6,9	5,8	7	1,849
10111	63	45,8	8,6	4	4	1,336
10113	75	54,8	10,3	4	1	1,903
10115	90	65,8	12,3	4	1	2,729
10117	110	79,8	15,1	4	1	4,092
10119	125	90,8	17,1	4	1	5,269
10121	160	116,2	21,9	4	1	8,637

almona pipe PP-R (UV) - PN16, SDR7.4

Structure of pipe: Single layer PP-R
Special feature: UV resistant
Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11

Part No.	Pipe Dimension (mm)			Pipe Length (m)	Packing/ Bag	Weight (kg/m)
	O.D.	I.D.	T			
10101/UV	20	14,4	2,8	5,8	35	0,138
10103/UV	25	18	3,5	5,8	25	0,215
10105/UV	32	23,2	4,4	5,8	15	0,347
10107/UV	40	29	5,5	5,8	10	0,542
10109/UV	50	36,2	6,9	5,8	7	0,849
10111/UV	63	45,8	8,6	4	4	1,336
10113/UV	75	54,4	10,3	4	1	2,903
10115/UV	90	65,4	12,3	4	1	2,729
10117/UV	110	79,8	15,1	4	1	4,092
10119/UV	125	90,8	17,1	4	1	5,269
10121/UV	160	116,2	21,9	4	1	8,637

almona pipe PP-R/GF/PP-R - PN20, SDR7.4

Structure of pipe: Multilayer, with fiberglass reinforced middle layer
Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11, ISO 21003

Part No.	Pipe Dimension (mm)			Pipe Length (m)	Packing/ Bag	Weight (kg/m)
	O.D.	I.D.	T			
10102	20	14,4	2,8	5,8	35	0,142
10104	25	18	3,5	5,8	25	0,222
10106	32	23,2	4,4	5,8	15	0,358
10108	40	29	5,5	5,8	10	0,559
10110	50	36,2	6,9	5,8	7	0,876
10112	63	45,8	8,6	4	4	1,378
10114	75	54,4	10,3	4	1	1,963
10116	90	65,4	12,3	4	1	2,815
10118	110	79,8	15,1	4	1	4,221
10120	125	90,8	17,1	4	1	5,435
10122	160	116,2	21,9	4	1	8,909

almona pipe PP-R/GF/PP-R (UV) - PN20, SDR7.4

Structure of pipe: Multilayer, with fiberglass reinforced middle layer
Special feature: UV resistant
Standard: DIN 8077/78, EN ISO SASO 15874, ASTM F 2389, CSA B 137.11, ISO 21003

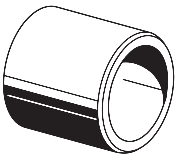
PP-R/GF/PP-R (UV)

Part No.	Pipe				Packing/ Bag	Weight (kg/m)
	Dimension (mm)			Length (m)		
	O.D.	I.D.	T			
10102/UV	20	14,4	2,8	5,8	35	0,142
10104/UV	25	18	3,5	5,8	25	0,222
10106/UV	32	23,2	4,4	5,8	15	0,358
10108/UV	40	29	5,5	5,8	10	0,559
10110/UV	50	36,2	6,9	5,8	7	0,876
10112/UV	63	45,8	8,6	4	4	1,378
10114/UV	75	54,4	10,3	4	1	1,963
10116/UV	90	65,4	12,3	4	1	2,815
10118/UV	110	79,8	15,1	4	1	4,221
10120/UV	125	90,8	17,1	4	1	5,435
10122/UV	160	116,2	21,9	4	1	8,909

Fittings

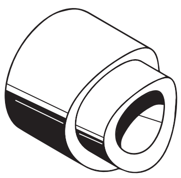
Almona manufactures a variety of PP-R fittings, reducers and accessories, presented below:

almona coupling, PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
10402	20	50	9
10404	25	30	15
10406	32	25	27
10408	40	10	49
10410	50	6	84
10412	63	6	154
10414	75	3	254
10416	90	2	418
10418	110	1	581

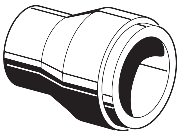
almona Saddle, PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
10420	40-25	10	17
10422	50-25	6	19
10424	63-25	6	19
10426	63-32	6	28
10428	75-25	3	19
10430	75-32	3	28
10432	90-25	2	20
10434	90-32	2	28
10436	110-25	1	20
10438	110-32	1	30

almona reducer PN25, SDR 5

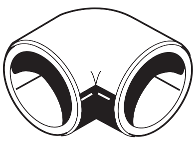
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
10504	25-20	50	11
10506	32-20	40	15
10508	32-25	30	17
10511	40-25	20	32
10512	40-32	15	35
10514	50-32	10	52
10520	50-40	10	62
10522	63-25	5	109
10524	63-32	8	102
10526	63-40	8	89
10528	63-50	5	93
10530	75-50	6	147
10532	75-63	4	163
10534	90-63	2	256
10535	90-75	2	252
10536	110-75	1	516
10537	110-90	1	520

almona elbow 90° PN25, SDR 5

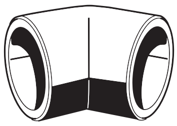
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
10602	20	50	14
10604	25	30	25
10606	32	15	47
10608	40	8	86
10610	50	6	158
10612	63	2	295
10614	75	2	501
10616	90	1	811
10618	110	1	1292

almona elbow 45° PN25, SDR 5

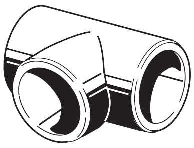
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
10624	20	50	12
10626	25	25	19
10628	32	15	32
10630	40	10	72
10632	50	6	133
10634	63	4	245
10636	75	2	387
10638	90	1	659
10640	110	1	1025

almona tee PN25, SDR 5

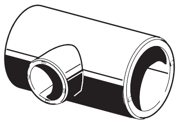
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
10702	20	25	18
10704	25	20	20
10706	32	10	58
10708	40	6	104
10710	50	4	198
10712	63	2	357
10714	75	1	582
10716	90	1	981
10718	110	1	1598

almona Tee reducer PN25, SDR 5

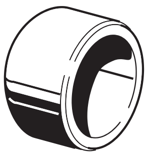
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
10730	20-25-20	20	39
10732	25-20-25	20	36
10734	20-32-20	10	72
10736	25-32-25	10	63
10738	32-20-32	10	57
10740	32-25-32	10	55
10742	40-20-40	6	125
10744	40-25-40	6	125
10746	40-32-40	6	115
10750	50-32-50	4	231
10752	50-40-50	4	222
10753	63-40-63	2	419
10754	63-50-63	2	418

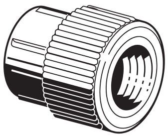
almona end cap PN25, SDR 5

Standards: DIN 16962, EN ISO SASO 15874



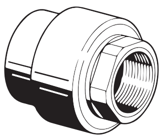
Part No.	Dimension (mm)	Packing	Weight (g)
10802	20	100	5
10804	25	50	10
10806	32	30	16
10808	40	20	25
10810	50	15	46
10812	63	10	101
10814	75	4	168
10816	90	2	296
10818	110	1	440

almona adaptor female PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



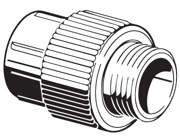
Part No.	Dimension (mm)	Packing	Weight (g)
11202	20 (1/2")	25	57
11204	20 (3/4")	25	79
11206	25 (3/4")	20	81
11208	25 (1/2")	20	59
11209	32 (3/4")	10	93
11210	32 (1")	10	190

almona adaptor female (hexagon) PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



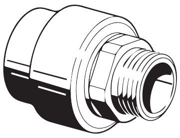
Part No.	Dimension (mm)	Packing	Weight (g)
11211	32 (1")	10	227
11212	40 (1,1/4")	5	227
11214	50 (1,1/2")	4	413
11216	63 (2")	3	567
11218	75 (2,1/2")	2	890
11220	90 (3")	1	1185
11222	110 (4")	1	1510

almona adaptor male PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



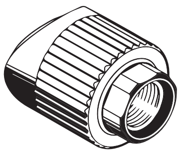
Part No.	Dimension (mm)	Packing	Weight (g)
11402	20 (1/2")	25	64
11404	20 (3/4")	20	94
11406	25 (3/4")	15	99
11408	25 (1/2")	15	65
11409	32 (3/4")	10	108
11410	32 (1")	10	200

almona adaptor male (hexagon) PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11411	32 (1")	10	245
11412	40 (1,1/4")	4	300
11414	50 (1,1/4")	4	455
11416	63 (2")	2	654
11418	75 (2,1/2")	1	1013
11420	90 (3")	1	1508
11422	110 (4")	1	2730

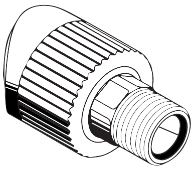
almona saddle adaptor female PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11230	40 (1/2")	4	88
11232	50 (1/2")	4	90
11234	63 (1/2")	2	95
11236	63 (3/4")	2	109
11238	75 (1/2")	1	100
11240	75 (3/4")	1	109
11242	90 (1/2")	1	90
11244	90 (3/4")	1	110
11246	110 (1/2")	1	95
11248	110 (3/4")	1	110

almona saddle adaptor male PN25, SDR 5

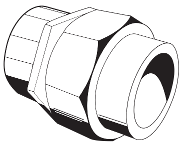
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11430	40 (1/2")	4	88
11432	50 (1/2")	4	90
11434	63 (1/2")	2	95
11436	63 (3/4")	2	109
11438	75 (1/2")	1	100
11440	75 (3/4")	1	109
11442	90 (1/2")	1	90
11444	90 (3/4")	1	110
11446	110 (1/2")	1	95
11448	110 (3/4")	1	110

almona union female PN25, SDR 5

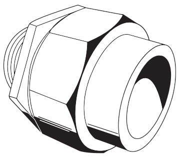
Standards: DIN 16962,EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11302	20 (1/2")	20	123
11304	25 (1/2")	15	157
11305	25 (3/4")	15	157
11306	32 (1")	8	225
11307	32 (3/4")	8	225
11314	40 (1,1/4")	6	303
11316	50 (1,1/4")	4	404
11318	63 (2")	2	924

almona union male PN25, SDR 5

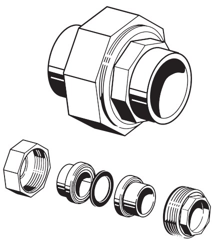
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11502	20 (1/2")	20	121
11503	25 (1/2")	15	166
11504	25 (3/4")	15	166
11508	32 (1")	8	227
11509	32 (3/4")	8	227
11516	40 (1,1/4")	6	365
11518	50 (1,1/4")	4	461
11520	63 (2")	2	1045

almona union two side socket PN25, SDR 5

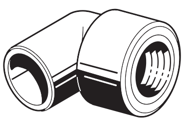
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11522	20	20	205
11524	25	15	345
11526	32	8	481
11528	40	6	617
11530	50	4	559

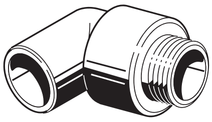
almona elbow 90° female PN25, SDR 5

Standards: DIN 16962, EN ISO SASO 15874



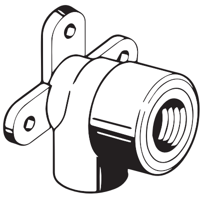
Part No.	Dimension (mm)	Packing	Weight (g)
11602	20 (1/2")	20	67
11604	20 (3/4")	12	81
11606	25 (1/2")	15	77
11608	25 (3/4")	15	95
11610	32 (3/4")	5	110
11612	32 (1")	8	251

almona elbow 90° male PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



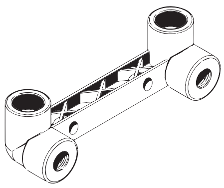
Part No.	Dimension (mm)	Packing	Weight (g)
11616	20 (1/2")	15	74
11618	20 (3/4")	12	89
11620	25 (1/2")	10	99
11622	25 (3/4")	10	82
11624	32 (3/4")	6	133
11626	32 (1")	8	266

almona elbow 90° female with clamp PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



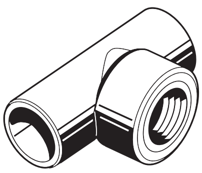
Part No.	Dimension (mm)	Packing	Weight (g)
11614	20 (1/2")	15	80
11615	25 (1/2")	12	90

almona wall elbows with holder PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



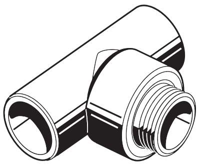
Part No.	Dimension (mm)	Packing	Weight (g)
11630	20 (1/2")	15	80
11632	25 (1/2")	12	90

almona tee adaptor female PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



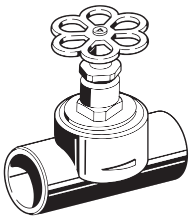
Part No.	Dimension (mm)	Packing	Weight (g)
11702	20 (1/2")	15	74
11704	20 (3/4")	12	89
11706	25 (1/2")	10	116
11708	25 (3/4")	10	85
11710	32 (3/4")	6	118
11712	32 (1")	6	272

almona tee adaptor male PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



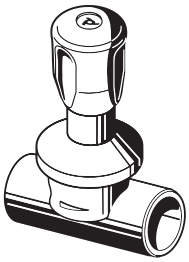
Part No.	Dimension (mm)	Packing	Weight (g)
11716	20 (1/2")	15	80
11714	20 (3/4")	12	98
11718	25 (1/2")	10	111
11720	25 (3/4")	10	92
11721	32 (3/4")	5	122
11722	32 (1")	5	288

almona butterfly valve PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



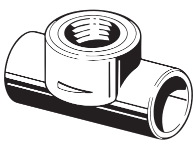
Part No.	Dimension (mm)	Packing	Weight (g)
11804	20	5	205
11806	25	5	211
11808	32	5	351

almona chrome coated valve PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



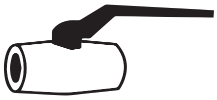
Part No.	Dimension (mm)	Packing	Weight (g)
11810	20	1	323
11811	25	1	438
11812	32	1	351

almona valve body PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



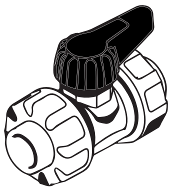
Part No.	Dimension (mm)	Packing	Weight (g)
11720	20	1	53
11722	25	1	85
11724	32	1	135

almona spherical valve PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11826	20	10	105
11828	25	10	113
11830	32	6	179
11832	40	3	260
11834	50	2	517
11836	63	2	-
11838	75	2	-

almona spherical valve with union PN25, SDR 5
Standards: DIN 16962, EN ISO SASO 15874



Part No.	Dimension (mm)	Packing	Weight (g)
11827	20	10	105
11829	25	10	113
11831	32	6	179

almona crossover PN20, SDR 6
Standards: DIN 16962, EN ISO SASO 15874

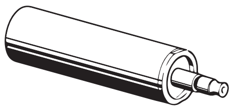
Part No.	Dimension (mm)	Packing	Weight (g)
10902	20	1	52
10904	25	1	75
10906	32	1	153

almona end piece (male)

Standards: : DIN 16962, EN ISO SASO 15874

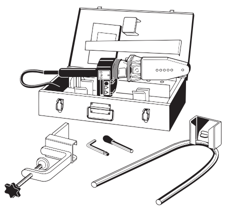
Part No.	Dimension (mm)	Packing	Weight (g)
11890	20 (1/2")	100	7
11892	25 (3/4")	100	10

almona chrome coated valve extension



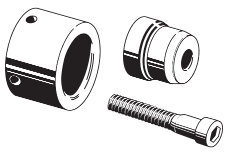
Part No.	Dimension (mm)	Packing
11805	30	1

almona welding machine



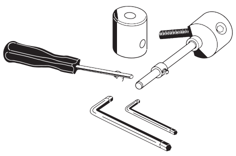
Part No.	Dimension (mm)	Packing
12410	16-63	1
12411	50-125	1
12412	125-160	1

almona welding sockets



Part No.	Dimension (mm)	Packing
12704	20	1
12706	25	1
12708	32	1
12710	40	1
12712	50	1
12714	63	1
12716	75	1
12718	90	1
12720	110	1
12722	125	1
12724	160	1

almona repair sockets tools

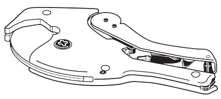


Part No.	Dimension (mm)	Packing
12726	9	1

almona repair sockets

Part No.	Dimension (mm)	Packing
12728	9	1

almona repair sockets



Part No.	Dimension (mm)	Packing
12800	16-40	1
12802	40-63	1

Section V

5. Jointing

5.1 Socket welding using a heated tool

Before starting the work, make sure that the welding tools lie flat against the heated rod. It is not recommended to use pliers or other unsuitable tools for the assembly, to avoid damage to the coating of the welding tools. The required welding temperature for almona PP-R systems installation system is between 250°C to 270°C.

Caution:

- Danger of burns from hot welding equipment
- The first welding should not be carried out until five minutes after the welding temperature has been reached!

almona welding equipment and welding tools shall be protected against impurities. Burned particles can lead to faulty welding connections. Tools may be cleaned with non-fibrous, coarse paper towels. The welding tools must be kept dry at all times. Damaged and soiled welding tools must be replaced.

Almona PP-R system components should not be twisted during the welding process. Minor corrections can only be made immediately after the parts are connected.

5.2 Guidelines

General work protection and accident prevention guidelines are to be observed when using welding equipment.

For the handling of almona welding equipment, machines and tools, the General Guidelines DVS 2208, Section 1 shall apply. In order to establish a connection between the almona pipe and the fitted part, the welding tools used must correspond to the measurements as stipulated by procedure A.

In accordance with DVS Guidelines, control of the necessary application temperature using quick-display surface temperature thermometers is permissible.

5.3 Processing information for welding

The following welding parameters shall be followed during the socket welding of almona PP-R systems with a heated tool.

Outer pipe diameter (mm)	Insertion depth (mm)	Heating period for SDR 6, SDR 7.4 (s)	Processing period (maximum period (s)	Cooling period	
				fixed (s)	total (min)
20	14	5	4	6	2
25	15	7	4	10	2
32	16.5	8	6	10	4
40	18	12	6	20	4
50	20	18	6	20	4
63	24	24	8	30	6
75	26	30	8	30	6
90	29	40	8	40	6
40	18	12	6	20	4
50	20	18	6	20	4
63	24	24	8	30	6
75	26	30	8	30	6
90	29	40	8	40	6
110	32.5	50	10	50	8
125	35	60	10	60	8

The required welding temperature for almona PP-R systems installation system is between 250°C to 270°C.

Instructions for socket welding can be found in DVS standard no. 2207, Section 11, "Socket welding with a heated tool – welding of thermoplastic plastics and pipelines made of polypropylene (PP)". Socket welding for almona systems shall be performed according to DVS guidelines.

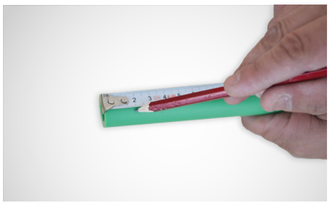
5.3.1 Socket welding with a hand-held welding device, from 20mm

The following steps shall be followed during socket welding process of almona PP-R systems using a hand-held welding machine.

- Step 1- Cutting pipes to proper length. Cut pipes perpendicularly to their axis with a pipe cutter or a rotary pipe cutter.
- Step 2 - Cleaning and marking. Before socket welding clean and de-grease the end of the pipe and inside of the fitting. Then, mark the depth of the insertion of the pipe into the fitting in accordance with the table in section 5.3.
- Step 3 - Welding of elements. When the heating tool has reached the required temperature, push the fitting and the end of the pipe to the the welding tool by means of a sliding non-rotary motion to the depth previously marked and heat them according to the time specified in the table (see section 5.3).
- Step 4 - Joining. Take the pipe and fitting off the welding tool and join them by pushing together without turning, up to the previously marked welding depth. During pushing determine the mutual position of a pipe and a fitting. Hold the pipe and fitting together for the fixing period given in the table (see section 5.3). After fixing do not disturb the joint during the cooling period.

Step 1

Step 2



Step 3

Step 4

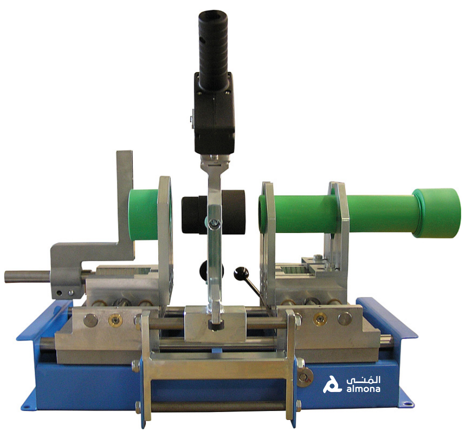
In case of UV resistant pipe, prior to the fusion, remove the outside layer of polypropylene with a cutter.

5.3.2 Socket welding with a stationary welding machine, from 40mm

Almona recommends the use of a stationary welding machine for the welding of larger pipe diameters and for the preassembly of installation elements. The general guidelines provided by DVS brochure no. 2207, Section 11, "Socket welding with a heated tool. Detailed information on welding times." apply.

The following steps shall be followed during socket welding process of almona PP-R systems using a stationary welding machine.

- Step 1 - Check the machine and establish welding insertion depth by setting the dimension; make sure the welding temperature is reached.
- Step 2 - Clean and degrease the inside of the fitting and outside of the pipe that will be inserted in the fitting.
- Step 3 - Fix the moulded fitting with the clamp, taking care not to wind it too tightly, as this can lead to ovality, with a negative impact on the resulting weld. Make sure the moulded part is correctly positioned; use counter-tension to prevent the possibility of slipping.
- Step 4 - Place the pipe loosely into the jaw chuck.
- Step 5 - Adjust the dimension using the rotary button, which sets the precise welding insertion depth.
- Step 6 - Push both tools together until they reach the stop.
- Step 7 - Push the pipe as far as the fitting, then tighten. Make sure that the welding partners are accurately aligned. Open the welding tool.
- Step 8 - Insert the welding device. Using the crank, gradually push the fitting and the pipe into the tool until the stop is reached. Pay attention to the welding time.
- Step 9 - The welding period begins when the pipe and the fitting have been fitted together closely. Allow them to heat up without exerting any further pressure. Once the heating time has elapsed, move the tools apart, remove the welding device, and fit together the fitting and the pipe.
- Step 10 - Observe the required cooling time.



5.3.3 Welding saddle for 40-125mm pipes

The saddles can be used for subsequent extension of existing pipe systems, as an alternative to regular tees and for direct branching of a service line to a supply line.

The following steps shall be followed during saddle welding process:

- Step 1 - Before you start the work, prepare material and tools. Ensure that the welding saddle, the drill and the welding tool have the same diameters.
- Step 2 - Uncover the pipe at the exact location where the welding saddle is supposed to be welded and mark the welding area. Drain existing pipes and vent the pressure.
- Step 3 - Prepare the welding device and the saddle welding tools for the socket fusion welding and heat to operating temperature (250°C–270°C).
- Step 4 - Drill through the marked pipe wall with a plastic drilling machine and clear any cuttings from the drill hole.
- Step 5 - The parts and areas to be welded must be clean, dry and degreased.
- Step 6 - Push the welding plate into the hole in the wall of the pipe using a suitable and aligned saddle tool, until the tool reaches its stop position. At the same time the weld-in saddle must be pushed in, until the saddle surface reaches the camber of the tool.
- Step 7 - The heating time for the pipe and fittings for the drilled hole 25mm up to 63mm is 25 seconds for all dimensions.
- Step 8 - Once the heating time has elapsed, remove the welding tool, push the heated weld-in saddle straight into the heated hole as far as it will go without turning it and hold the pipe in position for at least 20 seconds applying the necessary pressure.
- Step 9 - After a cooling period of at least 10 minutes, the connection can withstand a full load.

5.3.4 Repair plugs

Repair plugs are used to repair of damaged pipes up to hole size of 8mm.

The following steps shall be followed during the damage pipe reparation process:

- Step 1 - Drain and uncover the damaged pipe.
- Step2 - Mark the correct insertion depth on the repair plug.

- Step 3 - Drill damaged area of pipe out to a diameter of 8 mm at a right angle to the pipe. Then clean the hole and repair plug, removing any grease or other material and ensuring both are dry.
- Step 4 - Heat up drill hole and repair plug with hole welding tool for 15 seconds.
- Step 5 - Insert repair plug immediately.
- Step 6 - Cut off protruding end of repair plug.
- Step 7 - The repaired area of pipe should reach full strength after approximately 5 minutes.

5.3.5 Use of electric welding sockets

Electric welding sockets are used in areas with restricted space, as a repair welding and alternative welding option for large diameter PP-R pipes and fittings.

Besides the correct operation, cleanliness is the most important requirement for achieving good welding results. For the electrical sockets to stay thoroughly clean, they need to be left in the original packaging until they are used. Furthermore, the surface of the pipe must be clean and undamaged. Incorrectly collapsed pipe ends must be cut off. We recommend PP cleaner or cloths with ethyl alcohol for cleaning and degreasing.

The pipe elements to be welded as well as the electric socket and the welding equipment must show precisely the same temperature level within the permitted temperature range (i.e. +5°C to 40°C according to DVS 2207). UV radiation or improper storage can cause significant differences in temperature, which will result in faulty welding.

The following steps shall be followed when electric welding sockets are used:

Preparatory work

- Step 1 - Cut pipe ends at a right angle and burr them (control carved ends).
- Step 2 - Remove any dirt from the pipe ends at the required length and dry them.
- Step 3 - Mark the insertion depth of the electro-welded sockets at the pipe end.
- Step 4 - Remove the oxide film with a pipe scraper on the pipe surface along the length of the insertion depth. Use the peeler intended for the respective diameter of the pipe.
- Step 5 - Clean thoroughly using ethyl alcohol. A homogeneous and impermeable welded connection can only be established, if the surface in the welding range is peeled and cleaned comprehensively.

Do not touch peeled pipe ends again and protect them from any contamination. Weld within 30 minutes after the peeling process.

Assembly of electric welding socket

- Step 6 - Carefully clean the inner surface of the socket using lint-free cloth. Mount the socket within 30 minutes after opening the packaging.
- Step 7 - Slide the electric welding socket onto the clean and dry pipe end until you reach the marked insertion depth.
- Step 8 - Completely remove the protective packaging and slide the peeled and clean second pipe end into the electric welding socket.

Welding process

- Step 9 - Position the socket so that the air gap is evenly distributed around the circumference.
- Step 10 - Set the welding equipment to the diameter of the welding socket.
- Step 11 - Compare the data on the welding equipment's display screen with the details on the label and enter the requested code by scanner or manual (see barcode label on the electric welding socket).
- Step 12 - Start the welding process and monitor it closely.

Contamination is to be avoided diligently and all parts must be securely fastened. Pipes must be free of flexural strain or self-weight when they are inserted into the electric welding socket. The socket should still be able move on the pipe ends after the mounting process. The air gap must be evenly distributed around the circumference. A joint that is not free of tension or that has shifted can result in undesired molten mass or in an inadequate connection. The pipe ends and welded sockets must be dry when mounted.

Cooling-off time and pressure test

The welded pipe joint may only be put under pressure or moved, and the fastening may only be loosened once the cooling-off period has elapsed. The minimum required cooling-off time is marked on the electric welding sockets. In case of ambient temperatures above 25 °C or when there is strong solar radiation, the cooling-off time must be extended accordingly!

In order to achieve an ideal and stable welding result, both pipe ends must be plane and parallel within the electric welding socket. It is imperative to mark the socket insertion depth on the pipe and to adhere to it.

Section VI

6. Installation

Almona PP-R systems are suitable for being installed inside and outside buildings. For installation outside building UV stabilized PP-R pipe shall be used.

6.1 Pipe and fittings fixing techniques

For installation inside and outside buildings almona PP-R pipe systems shall be fixed using fixing systems subject to the following requirements:

- The fixing systems shall be able to absorb any forces that may occur.
- The external impact upon pipes and fittings, caused e.g. by sagging, changes in length, mechanical load, must be prevented by applying appropriate fixing techniques.
- The pipework must be held firmly in the intended position.

The fixing mechanisms shall be selected in accordance with the outside diameter of the pipe and to completely circumvent the pipe. Appropriate measures shall be taken to ensure that the pipe surface is not damaged by any of the pipe fastening elements.

Almona recommends that the pipe clamps with rubber inserts shall be used as the fixing mechanism for almona installation systems. If no inner lining is used inside the clamp, then the inside edge of the clamp must be rounded off and the inside surface must be smooth.

Two type of fixing mechanisms are commonly used for PP-R systems, fixed and sliding bearings.

Fixed bearings:

- Fixed points are determined to divide the pipeline into individual sections, which helps to avoid uncontrolled pipe movement.
- These fixed points shall be designed to compensate for the expansion forces arising from the pipe and possibly existing additional loads.
- Short distances in the ceiling should be chosen as the clamp and the fastening element need to be fastened tightly because of the forces that arise there.

Sliding bearings:

- Shall compensate for the axial pipe movement without causing any damage.
- When positioning the sliding bearings, care must be taken that no fittings or fixtures obstruct the pipe movement.

6.2 Mounting distances

The distance between the clamps depends on the outside diameter of the pipes and temperatures. The mounting distances shown on the below table, provide guidance for horizontal and vertical installations of almona PP-R systems.

Mounting distances for almona monolayer pipes SDR 6, SDR 7.4

Pipe Diameter (mm)	Temperature (°C)						
	20	30	40	50	60	70	80
	Mounting Distances (cm)						
20	90	80	80	80	70	65	60
25	95	95	95	90	85	80	75
32	110	105	105	100	95	90	80
40	120	120	115	105	100	95	95
50	135	130	125	120	115	110	100
63	155	150	145	135	130	120	115
75	170	165	160	150	145	130	125
90	180	180	170	165	160	150	135
110	200	195	190	180	175	165	155
125	220	215	200	195	190	170	165

Mounting distances for almona multilayer pipes SDR 6, SDR 7.4

Pipe Diameter (mm)	Temperature (°C)						
	20	30	40	50	60	70	80
	Mounting Distances (cm)						
20	95	90	85	85	80	70	65
25	100	100	100	95	90	90	85
32	120	115	115	110	100	95	90
40	130	130	125	120	115	110	100
50	150	150	140	130	125	120	110
63	170	160	155	150	145	130	125
75	185	180	175	160	155	150	140
90	200	200	185	180	175	160	160
110	220	215	210	195	190	180	180
125	240	230	225	210	200	200	190

A smaller number of clamps are needed during installation of almona multilayer glass fiber reinforced PP-R pipes compared to standard PP-R pipes without fibre reinforcement.

6.3 Laying almona pipe systems

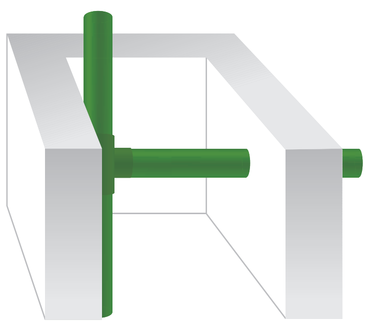
During installation of almona PP-R pipes in walls and ceilings, the friction forces that occur prevent the expansion of the pipes and therefore no compensation is necessary. The resulting tension is absorbed by the pipe materials. Due to the low expansion forces, the masonry or the plaster are not damaged.

For installation of almona PP-R pipe systems in a shaft the following guidelines shall be considered:

- Changes in length can be disregarded if pipes are laid in a vertical shaft.
- It will be sufficient to mount a fixed-point clamp ahead of every branch in a rising pipe, all clamps are fixed points.
- Rising pipes can be laid without expansion elbows.
- The distance between two fixed points shall not be greater than 3m.

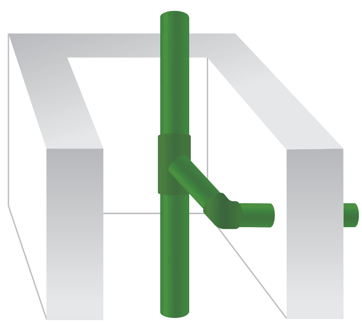
When open laying of almona PP-R pipes the followings need to be considered:

- The pipes need to be laid using fixed and slide bearings. This will ensure sufficient space for the pipe to expand.
- If the line length equals or exceeds 40m, expansion must be compensated for using bending legs and angles.



keep sufficient distance from the wall pass-through point.

create possibility of branch pipe movement in the wall pass through point.



create a compensating length to allow expansion at the riser normal line.

6.4 Length variation

Temperature variations influence strongly the length of almona PP-R pipes. The temperature change can be caused by different installation and operating temperatures, as well as varying fluid temperatures. The potential variation in length shall be taken into account when installing almona PP-R systems. If the operating temperature is higher than the installation temperature, the pipe will elongate. If the fluid temperature (e.g. cold water) is lower than the installation temperature, the calculation will result in a reduction in length.

The following factors shall be considered when calculating the length variation of almona PP-R pipes.

- Installation temperature
- Operating temperatures (media temperatures)
- Temperature difference between installation and operating temperatures
- Coefficient of linear expansion
- Pipe length

The coefficient of linear expansion α for almona PP-R pipes:

- Monolayer PP-R pipe α = 0.15 mm/mK
- Multilayer PP-R pipes α = 0.05 mm/mK

The formula for the calculation of the variation in length is:

$\Delta L = \alpha \times l_0 \times \Delta T$		
ΔL	variation in length	mm
l_0	pipe length prior to temperature change	m
α	length variation coefficient	mm /mxK
ΔT	difference between installation and operating temperature	K or °C

Example of ΔL calculation for almona multilayer PP-R pipe with the following characteristics:

- length = 10m
- assembly temperature 20°C
- Working temperature: 40°C

$\Delta L = 0.05mm/mK \times 10m \times 20K = 10mm$

Length extension for almona monolayer PP-R pipes ($\alpha = 0.15mm/mK$)

Pipe length (m)	Temperature difference ΔT							
	10°C	20°C	30°C	40°C	50°C	60°C	70°C	80°C
	Length change ΔL (mm)							
1	1.5	3	5	6	8	9	11	12
2	3	6	9	12	15	18	21	24
3	5	9	14	18	23	27	32	36
4	6	12	18	24	30	36	42	48
5	8	15	23	30	38	45	53	60
6	9	18	27	36	45	54	63	72
7	11	21	32	42	53	63	74	84
8	12	24	36	48	60	72	84	96
9	14	27	41	54	68	81	95	108
10	15	30	45	60	75	90	105	120
15	23	45	68	90	113	135	158	150

Length extension for almona multilayer PP-R pipes ($\alpha = 0.05mm/mK$)

Pipe length (m)	Temperature difference Δt							
	10°C	20°C	30°C	40°C	50°C	60°C	70°C	80°C
	Length change ΔL (mm)							
1	1	1	2	2	3	3	4	4
2	1	2	3	4	5	6	7	8
3	2	3	5	6	8	9	11	12
4	2	4	6	8	10	12	14	16
5	3	5	8	10	13	15	18	20
6	3	6	9	12	15	18	21	24
7	4	7	11	14	18	21	25	28
8	4	8	12	16	20	24	28	32
9	5	9	14	18	23	27	32	36
10	5	10	15	20	25	30	35	40
15	8	15	23	30	38	45	53	60

6.5 Expansion compensation

Variations in length caused by temperature differences shall be taken into account during the planning stage to prevent subsequent damage to almona PP-R pipes, fixing elements and the building structure. In order to keep the occurring stress impacts within acceptable ranges, the variation in length must be compensated appropriately. There are two options available to achieve this compensation:

- Expansion compensation using bending legs and a U-pipe bends ("natural" expansion compensation).
- Expansion compensation using compensators ("artificial" expansion compensation).

In most cases, directional changes in the pipe routing can be utilized to absorb the variation in length. If the directional changes are not sufficient to absorb the variation in length, then a U-pipe bend shall be used.

6.5.1 Bending legs

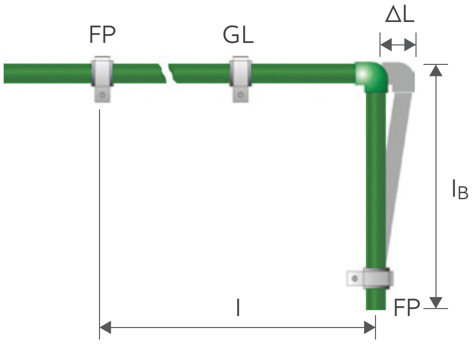
In order to determine the specific direction in which the expansion compensation is steered, the directional change is installed between two fixed points. Generally, the pipes are arranged in right angles at the points where the direction changes. A variation in the length of one leg produces bending in the other leg. Provided that all legs have appropriate length to prevent the resulting flexural strain from becoming too great, the system can flexibly absorb the variation in length.

	$l_B = K \times \sqrt{d \times \Delta L}$	
l_B	length of the bending leg	mm
K	material-dependent constant (15.0 for PP)	
d	outside pipe diameter	mm
ΔL	variation in length	mm

Example of l_B calculation for an almona PP-R pipe with an outside diameter of 75mm and a variation in length of 84mm.

$l_B = 15 \times \sqrt{75mm x 84mm} = 1191mm$

FP - Fixed Point
GL - 2D Linear Support



6.5.2 Expansion loop

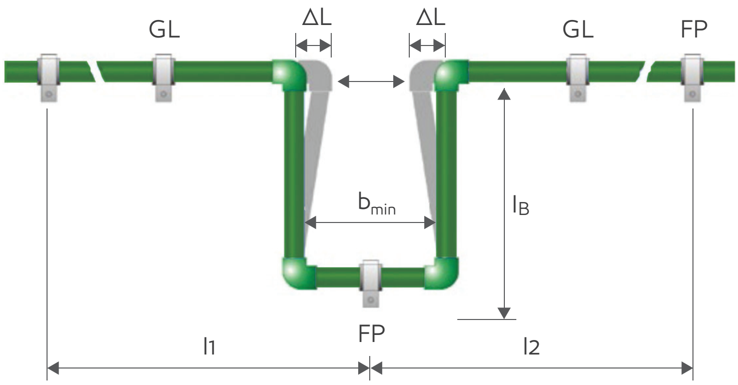
If it is not possible to compensate for the variation in length by introducing directional changes into the pipe routing, an expansion loop shall be used instead. For the implementation of the expansion bend, the length l_B of the bending leg and the width bmin of the expansion bend shall be considered. It is advisable to position the expansion bend in such a way that the lengths l_1 and l_2 are equal.

	$b_{min} = 2 \times \Delta L + SA$	
b_{min}	minimum width of the expansion	mm
ΔL	variation in length	mm
SA	safety clearance = 150	mm

Example of bmin calculation for an almona PP-R pipe with a length variation ΔL = 84mm.

b_{min} = 2 x 84mm +150mm = 842mm

FP - Fixed Point
GL - 2D Linear Support



6.5.3 Pre-tensioning

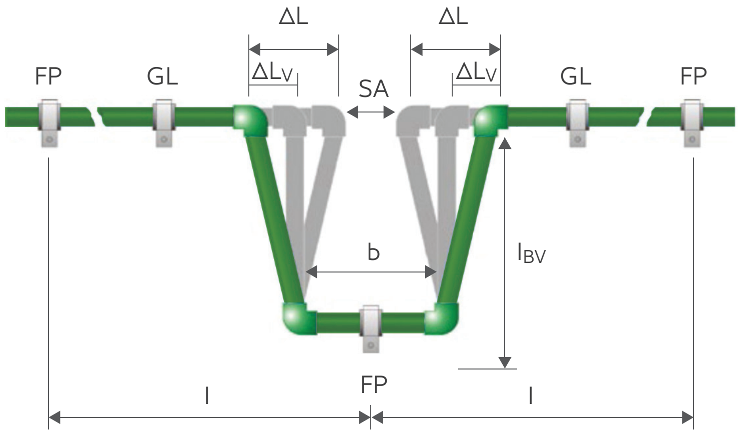
If, during installation, an expansion loop is already pre-stretched by the length ΔL_V against the subsequent length variation and is thus "pre-tensioned", the length of the bending leg l_{BV} can be reduced.

	$l_{BV} = l_B \times \sqrt{1 - \frac{\Delta LV}{\Delta L}}$	
ΔL_V	variation in length with pre-tensioning	mm
ΔL	variation in length	mm
l_{BV}	length of bending leg with pre-tensioning	mm
l_B	length of bending leg	mm

Example of l_{BV} calculation for an almona PP-R pipe with a length variation ΔL = 84mm and pre-tensioning ΔL_V = 42mm

$$l_{BV} = 1191\text{mm} \times \sqrt{1 - \frac{42}{84}}\text{mm} = 842\text{mm}$$

FP - Fixed Point
GL - 2D Linear Support



6.6 Insulation

Almona PP-R systems can be insulated to improve the overall performance of the systems and to protect the pipes from external factors. The aim of the pipe insulation is to:

- Protect the pipes against condensation
- Protect the cold-water pipes against exposure to heat
- Minimize heat losses
- Reduce the transfer of heat to structural components
- Reduce sound transmission
- Protect against UV radiation
- Absorb variations in length caused by temperature
- Protect against mechanical stresses

Foamed polyethylene is the most commonly used form of thermal insulation. The minimun proposed thermal insulation thickness should be provided along the entire length of pipe. It is recommended that the thickness of all insulation at crossing locations and at locations where cold and hot water lines are installed next to each other (in installation ducts) is increased by 30%.

Insulation thickness is always determined by calculation in accordance with the corresponding national regulations, while considering the given thermal resistance (λ) of the insulation that is going to be used. The following tables demonstrate only the most common situations.

Cold water: insulation thickness examples for λ = 0,035 W/mK

Pipe Installation Situation	Insulation Thickness (mm)
Freely installed in unheated rooms	4
Freely installed in heated rooms	9
In installation ducts, not installed side by side with a hot pipeline	4
In installation ducts, installed side by side with a hot pipeline	13
In grooves under plaster, installed separately	4
In grooves under plaster, installed side by side with a hot pipeline	13
In concrete	4

Hot water: insulation thickness examples

Pipe diameter (mm)	Insulation Thickness (mm)	
	λ = 0,030	λ = 0,035
20	6	10
25	6	10
32	10	13
40	10	13
50	10	13
60	13	20
75	20	20
90	20	25
110	25	32
125	25	32

6.7 Pressure test

Upon completion of the installation work the almona systems shall be tested to hydraulic pressure. This must be carried out while the pipe system is fully accessible. In accordance with Part 4 of EN 806, the test can be carried out using water or, if national regulations permit, with oil-free clean air or inert gases at low pressure.

The choice of method to be applied shall take into consideration the factors relating to hygiene and corrosion and shall be determined in relation to the design of the system and the time schedule of the construction project.

For pressure test using water, the completed pipelines shall be gradually filled with drinking water that do not contain particles ≥ 150µm, and shall then be vented. The drinking water system shall be put into operation immediately after the pressure test with water and the subsequent flushing of the system. If this is not possible, the flushing process shall be repeated regularly, with no more than 7 days between repetitions. If the system is due to be put into operation at a later stage, in the interest of hygiene, the pressure test shall be conducted with air or inert gas.

Example of a pressure testing protocol:

Pressure testing protocol with water

Construction project: ....

Construction stage: ....

Client represented by: ....

Contractor represented by: ....

Admissible operating pressure = 10 bar .... bar (if higher)

Water temperature .... °C Ambient temperature .... °C

System inspection as

- complete system
- in .... section

Preliminary arrangements:

- The pipe system is made of PP, and, if applicable, with combined installations made of metal and multi-layer composite pipelines.
- All pipes have been sealed by metal plugs, caps, blanking plates or blank flanges.
- Equipment and valves that do not meet the required test pressure, have been separated from the lines.
- Expert laying of the piping.
- Filling water has been filtered. Filter mesh < 150μm
- The system has been filled, flushed and de-aerated.

Leak test

	Testing	Results	Notes
☐	Preliminary test Test pressure 15 bar Test duration 30 min	A maximum pressure drop of 0.5 bar Test pressure after 30 min .... bar	
☐	Main test Test pressure 10 bar Test duration 30 min	A maximum pressure drop of 0.2 bar Test pressure after 30 min .... bar	
☐	Final test Test pressure 10 bar Test duration 60 min	No pressure drop Test pressure after 60 min .... bar	

☐ Visual inspection of pipe system has been carried out.

☐ No leaks were determined during the testing period.

☐ The pipe system is leak-proof .

Place .... Date ....

Client .... Contractor ....

Once the pressure tests have been completed, the responsible technician shall produce a formal record, which includes an assessment of the test. The impermeability of the system shall be confirmed in writing.

Section VII

7. Storage and Handling of almona PP-R systems

7.1 Storage

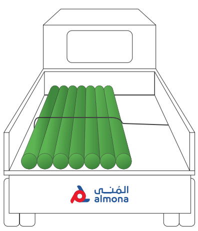
During storage almona PP-R systems without a UV black protection layer shall be protected from extended exposure to direct sunlight. This will prevent the effects of ultraviolet-rays and heat buildup.

- If the pipe is stored in racks, it should be continuously supported along its length.
- Pipes shall be stored inside to prevent damage.
- When pipes are stacked, ensure that the weight of upper units does not cause deformation to pipes in the bottom of the stack.
- Pipes shall not be stored close to heat sources or hot objects.
- Pipes and fittings shall always be protected from dirt and moisture.

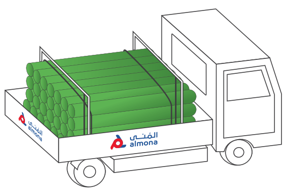
7.2 Transportation

Almona PP-R systems proves its robustness during transport and at the construction site, however, the pipes shall be handled with reasonable care to avoid breakage or damage.

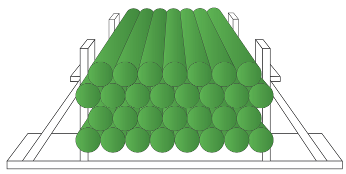
- The pipe shall never be pushed or thrown from a delivery truck.
- The pipe without UV black protection layer shall be protected from direct sunlight at all times.
- The pipe shall be kept away from sharp objects (rocks, irons...etc.) to prevent damage.
- Lifting of pipes requires extra care as the extended pipe weight can cause excessive deformation and can lead to cracking or breakage.
- Pipes and fittings should be treated with special caution attempera-tures below 0°C.



- Lay pipes flat on the tray truck
- Do not throw pipes on the tray



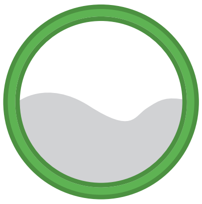
- Keep pipes strapped down in order not to roll around and to remain supported.
- Do not overtighten with ratchet
- Unsupported pipes can bend



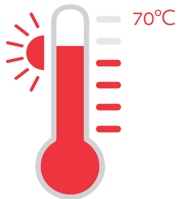
- If pipes are stored in racks, they shall be continuously supported along their length.
- Ensure that the weight of upper units do not cause deformation to pipes at the bottom of the stack.

ADVANTAGES

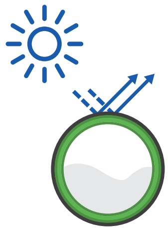
8. Of almona PP-R Systems



High strength and improved dimensional stability due to 3-layer technology

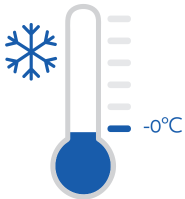


High temperature and pressure resistance up to +70°C



UV resistance due to co-extrusion almona technology of UV resistant layer

Fast and easy installation due to advanced welding technologies



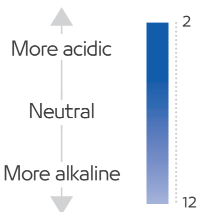
Low temperatures (above 0°C) operation and installation

Leak free due to advanced welding technologies

Resistant to building settlement and earthquakes due to high pipe flexibility

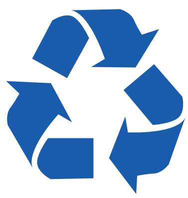
Noise reduction without insulation due to 3-layer almona technology

Maintenance free 50 years lifetime



Chemical resistance ranging from pH2 to pH12

Corrosion free system



100% recyclable and sustainable systems

APPENDIX

9. Chemical resistance list PP-R

The data in this list is intended only as a guide. Considerable deviations can occur depending on type of exposure and contamination of the chemical medium. almona cannot be held liable for any damages. No warranty can be derived concerning the data given below.

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Acetic acid	up to 40%	S	S	-
Acetic acid	50%	S	S	L
Acetic acid, glacial	>96%	S	L	NS
Acetic anhydride	100%	S	-	-
Acetone	100%	S	S	-
Aceptophenone	100%	S	L	-
Acrylonitrile	100%	S	-	-
Air	-	S	S	S
Allyl alcohol	100%	S	S	-
Almond oil	-	S	-	-
Alum	Sol	S	S	-
Ammonia, aqueous	Sat. sol	S	S	-
Ammonia, dry gas	100%	S	-	-
Ammonia, liquid	100%	S	-	-
Ammonium acetate	Sat. sol	S	S	-
Ammonium chloride	Sat. sol	S	S	-
Ammonium fluoride	up to 20%	S	S	-
Ammonium hydrogen carbonate	Sat. sol	S	S	-
Ammonium metaphosphate	Sat. sol	S	S	S
Ammonium nitrate	Sat. sol	S	S	S
Ammonium persulphate	Sat. sol	S	S	-
Ammonium phosphate	Sat. sol	S	-	-
Ammonium sulphate	Sat. sol	S	S	S
Ammonium sulphide	Sat. sol	S	S	-
Amyl acetate	100%	L	-	-
Amyl alcohol	100%	S	S	S
Aniline	100%	S	S	-
Apple juice	-	S	-	-
Aqua regia	HCl/HNOF3	NS	NS	NS
Barium bromide	Sat. sol	S	S	S
Barium carbonate	Sat. sol	S	S	S
Barium chloride	Sat. sol	S	S	S
Barium hydroxide	Sat. sol	S	S	S
Barium sulphide	Sat. sol	S	S	S
Beer	-	S	S	-

Legend
S = Satisfactory, **L** = Limited, **NS** = Not Satisfactory, **-** = No testing, unkown

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Benzene	100%	L	NS	NS
Benzoic acid	Sat. sol	S	S	-
Benzyl alcohol	100%	S	L	-
Borax	Sol	S	S	-
Boric acid	Sat. sol	S	-	-
Boron trifluoride	Sat. sol	S	-	-
Bormine, gas	-	NS	NS	NS
Bromine, liquid	100%	NS	NS	NS
Butane, gas	100%	S	-	-
Butanol	100%	S	L	L
Butyl acetate	100%	L	NS	NS
Butyl glycol	100%	S	-	-
Butil fenol	100%	S	L	L
Calcium carbonate	Sat. sol	S	S	S
Calcium chlorate	Sat. sol	S	S	-
Calcium chlorate	Sat. sol	S	S	S
Calcium hydroxide	Sat. sol	S	S	S
Calcium hypochlorite	Sol	S	-	-
Calcium nitrate	Sat. sol	S	S	-
Camphor oil	-	NS	NS	NS
Carbon dioxide, dry gas	-	S	S	-
Carbon dioxide, wet gas	-	S	S	-
Carbon disulphide	100%	S	NS	NS
Carbon monoxide, gas	-	S	S	-
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
Chloroacetic acid	100%	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	NS
Citric acid	Sat. sol	S	S	S
Coconut oil	-	S	-	-
Copper (II) chloride	Sat. sol	S	S	-
Copper (II) nitrate	Sat. sol	S	S	S
Copper (II)	Sat. sol	S	S	-
Corn oil	-	S	L	-
Cottonseed oil	-	S	S	L
Cresol	90%	S	-	-
Cyclohexane	100%	S	-	-
Cyclohexanol	100%	S	L	-
Cyclohexanone	100%	L	NS	NS

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Chemical or Product	Concentration	Temperature °C		
		20	60	100
Decalin	100%	NS	NS	NS
Dextrin	Sol	S	S	-
Dextrin Dextrose	Sol	S	S	S
Dibutyl phthalate	100%	S	L	NS
Dichloroacetic acid	100%	L	-	-
Dichloroethytene (A & B)	100%	L	-	-
Diethanolamine	100%	S	-	-
Diethyl ether	100%	S	L	-
Diethylene glycol	100%	S	S	-
Diglycolic acid	100%	S	-	-
Dimethyl amine, gas	-	S	-	-
Dimethyl formamide	100%	S	S	-
Dioctyl phthalate	100%	L	L	-
Dioxane	100%	L	L	-
Distilled water	100%	S	S	S
Ethyl alcohol	Up to 95%	S	S	S
Ethyl chloride, gas	-	NS	NS	NS
Ethylene chloride	-	L	L	-
Ethyl ether	100%	S	L	-
Ethylene glycol	100%	S	S	S
Ethanolamine	100%	S	-	-
Ethyl acetate	100%	L	NS	NS
Ferric chloride	Sat. sol	S	S	S
Ferric chloride	40%	S	-	-
Formic acid	10%	S	S	L
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	-	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	higher 48%	S	L	NS
Hydrochloric acid	higher 20%	S	S	S
Hydrochloric acid	30%	S	L	L
Hydrochloric acid	From 35-36%	S	-	-
Hydrofluoric acid	Dil.sol	S	-	-
Hydrofluoric acid	40%	S	-	-
Hydrogen	100%	S	-	-
Hydrogen chloride	100%	S	S	-
Hydrogen peroxide	Up to 10%	S	-	-
Hydrogen peroxide	Up to 30%	S	L	-
Hydrogen sulphide	100%	S	S	-

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Chemical or Product	Concentration	Temperature °C		
		20	60	100
Iodine, in alcohol	-	S	-	-
Isoctane	100%	L	NS	-
Isopropyl alcohol	100%	S	S	S
Isopropyl ether	100%	L	-	-
Lactic acid	-	S	S	-
Lanoline	-	S	L	-
Linseed oil	-	S	S	S
Magnesium carbonate	Sat. sol	S	S	S
Magnesium chloride	Sat. sol	S	S	-
Magnesium hydroxide	Sat. sol	S	S	-
Magnesium sulphate	Sat. sol	S	S	-
Maleic acid	Sat. 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	-
Methyl amine	Up to 32%	S	-	-
Methyl bromide	100%	NS	NS	NS
Methyl ethyl ketone	100%	S	-	-
Methylene chloride	100%	L	NS	NS
Milk	-	S	S	S
Monochloroacetic acid	<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	Up to 30%	S	NS	NS
Nitric acid	40 to 50%	L	NS	NS
Nitric acid	-	NS	NS	NS
Nitrobenzene	100%	S	L	-
Oleic acid	100%	S	L	-
Oleum	-	S	L	-
Olive oil	-	S	S	L
Oxalic acid	Sat. sol	S	L	NS
Oxygen, gas	-	S	-	-
Parafin oil (FL65)	-	S	L	NS
Peanut oil	-	S	S	-
Peppermint oil	-	S	L	-
Perchloric acid	(2N) 20%	S	-	-
Petroleum ether	-	L	L	-
Phenol	5%	S	S	-
Phenol	90%	S	-	-
Phosphine, gas	Up to 85%	S	S	S
Phosphorus oxychloride	100%	L	-	-

Legend
S = Satisfactory, **L** = Limited, **NS** = Not Satisfactory, **-** = No testing, unkown

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Picric acid	Sat. sol	S	-	-
Potassium bicarbonate	Sat. sol	S	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	S	-
Potassium chlorate	Sat. sol	S	S	-
Potassium chlorite	Sat. sol	S	S	-
Potassium chromate	Sol	S	S	-
Potassium cyanide	Sat. Sol	S	-	-
Potassium dichromate	Sat. Sol	S	S	S
Potassium ferricyanide	Sat. Sol	S	S	-
Potassium fluoride	Up to 50%	S	S	-
Potassium hydroxide	Sat. Sol	S	S	S
Potassium iodide	Sat. Sol	S	-	-
Potassium nitrate	10%	S	S	-
Potassium perchlorate	(2N) 30%	S	S	-
Potassium permanganate	Sat. sol	S	-	-
Succinic acid	Up to 10%	S	S	S
Sulphuric acid	100%	S	-	-
Sulphuric dioxide	100%	S	S	-
Sulphur acid	10 to 30%	S	S	-
Sulphur acid	50%	S	L	L
Sulphur acid	96%	S	L	NS
Sulphur acid	98%	L	NS	NS
Sulphurous acid	Up to 30%	S	-	-
Tartaric acid	Sat.sol	S	S	-
Tetrahydrofuran	100%	L	NS	NS
Tetralin	100%	NS	NS	NS
Thiophene	100%	S	L	-
Tin (IV) chloride	Sol	S	S	-
Tin (II) chloride	Sat. Sol	S	S	-
Toluene	100%	S	-	-
Trichloroacetic acid	Up to 50%	S	S	-
Trichloroethylene	100%	NS	NS	NS
Triethanolamine	Sol	S	-	-
Turpentine	-	NS	NS	NS
Urea	Sat. Sol	S	S	-
Vinegar	-	S	S	-
Water brackish, mineral, potable	-	S	S	S
Whiskey	-	S	S	-
Wines	100%	S	-	-
Xylene	100%	NS	NS	NS
Yeast	Sol	S	S	S
Zinc chloride	Sat. Sol	S	S	-
Zinc sulphate	Sat. Sol	S	S	-

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