

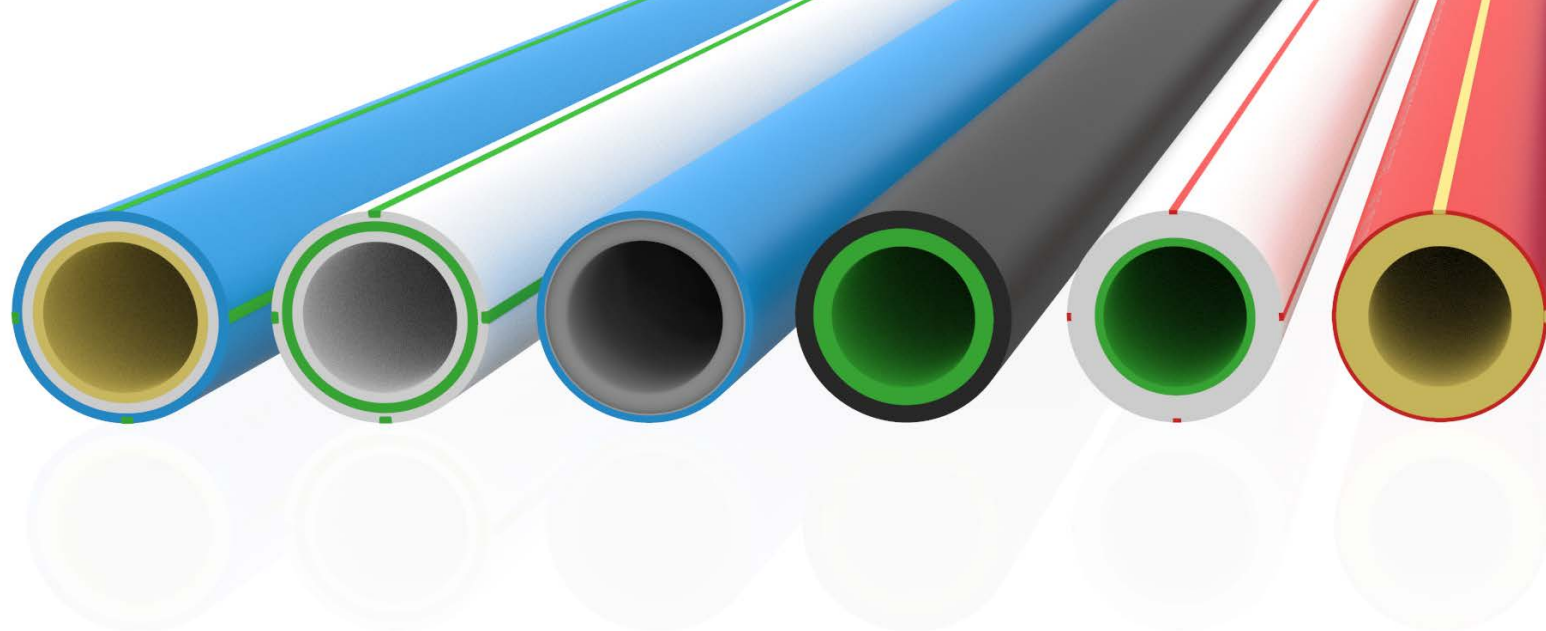


PP-R PIPING SYSTEMS

HOT & COLD WATER | CHILLED & HEATING

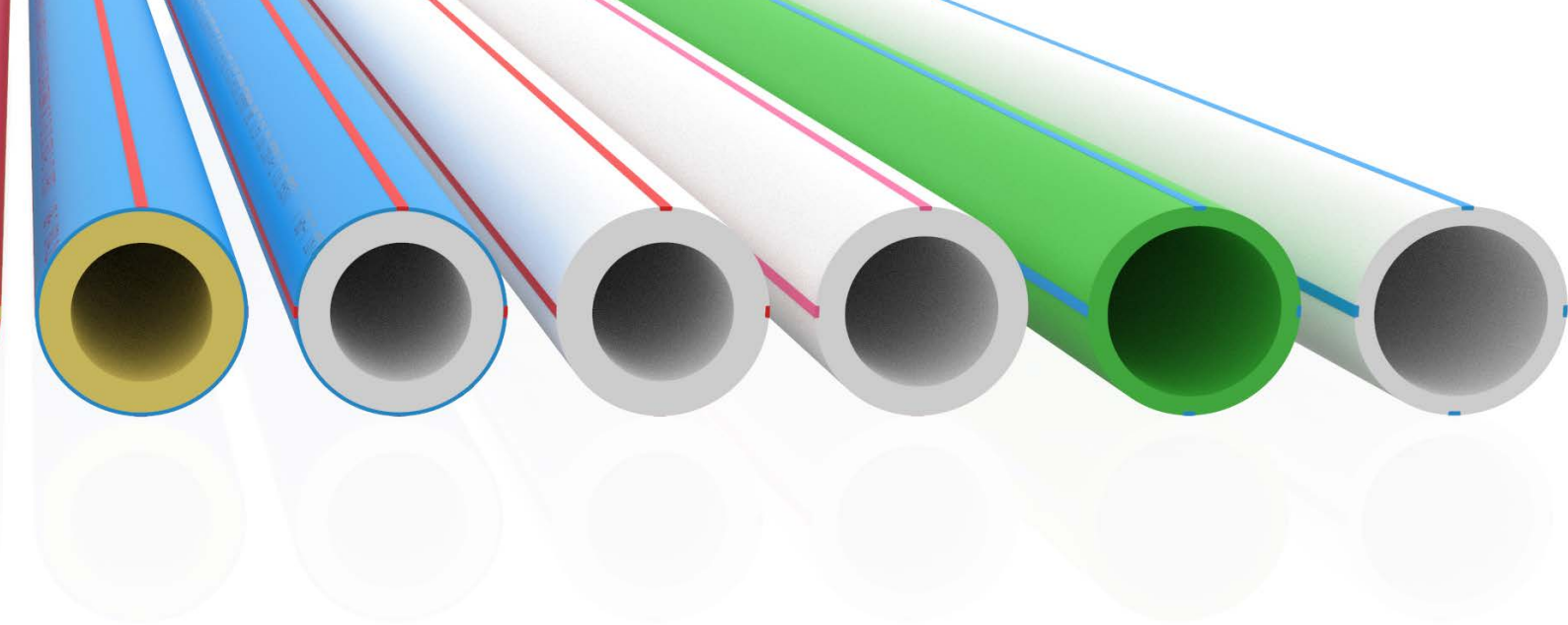
TECHNICAL CATALOGUE



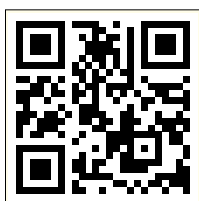


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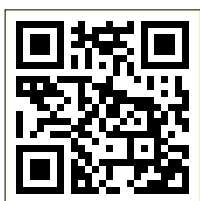
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***Welcome to scan and view our corporate branding
videos on YouTube:***



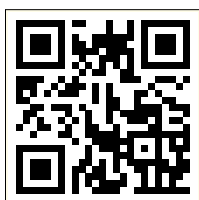
VESBO – Life flows
(English version)



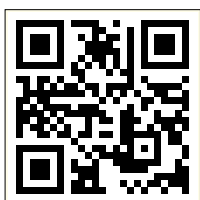
VESBO – Life flows
(Viet version)



VESBO – Commitment
to Sustainability



VESBO Vietnam TV
Advertisement



Fusion Welding with
Basic Welding Set



Fusion Welding with
Desktop Welding Set

01 ABOUT VESBO®

► *A Leading Brand in Thermoplastic Piping*

VESBO® is a leading brand in the thermoplastic (PP-R) piping industry for more than 20 years. With offices located in Europe, Middle East, Asia Pacific and distribution networks across 5 continents in more than 75 countries, VESBO sets the trend for research and development, manufacturing, and sales volumes in the industry.

VESBO® is committed to the betterment of housing and living needs and the advancement of wellbeing. A house is not a home till it is made safe, healthy and comfortable for dwelling. Since the realisation of our first product, we have always focused on listening to market and customer needs to create durable quality piping solutions for homes and cities we live in. We are committed to plastics management and 100% recycling, reprocessing and reuse of materials to make our community greener and great living more sustainable. We are motivated to the better use of resources with constant innovations that create better piping solutions for generations to come.

At VESBO®, we have but one mission in mind—to keep life flowing.





VESBO Global Headquarters and Plant

Established in Istanbul, Turkey in 1992, Novaplast Plastik Sanayi ve Ticaret A.S. is a subsidiary of Kar Group of Companies in the manufacturing of VESBO Polypropylene Random Co-polymer (PP-R) pipes and fittings. Novaplast Plastik also produces a full range of thermoplastic piping products in extrusion and injection moulding such as PE-X, U-PVC, PE, Spira and Incola.

As VESBO global headquarters, Novaplast Plastik is responsible for strategic planning, corporate governance, government relations, management policies and Health, Safety and Environment policies of the company, as well as Total Quality Management and product development for VESBO worldwide. VESBO export department is responsible for European, Mediterranean and Middle East markets.



VESBO ASIA Pacific Head Office

Located in Singapore, VESBO ASIA Pte. Ltd. is a subsidiary of KAR Group of Companies, and is the Asia Pacific headquarters and marketing arm of VESBO. It is responsible for strategic planning, business development, marketing, distributorship and operations of Novaplast manufactured VESBO products in the Asia Pacific region.

VESBO worldwide. VESBO export department is responsible for European, Mediterranean and Middle East markets.



VESBO's Asia Pacific Plant

As VESBO's first manufacturing facility outside Turkey, Novaplast Plastik Sdn. Bhd. (Novaplast Malaysia) is located in the Iskandar Region of Johor, Malaysia – about an hour's drive from Vesbo Asia Pacific head office in Singapore. The plant offers a full range of VESBO PP-R pipes and fittings with a total annual capacity of 10,000 metric tonnes of processed products. It is driven by a core team of experienced managers and technical supervisors from VESBO headquarters in Europe.

This regional facility with its head office in Singapore, is part of Vesbo's strategic long term development to deliver consistent quality products to regional customers.



German Engineering Arm of VESBO

Located in Munich, Germany, Arcon Handels GmbH has undergone a company restructuring and name change. It is now known as Novaplast Plastik GmbH. It is responsible for product development of Vesbo products and may in the near future be a production facility in Germany.



THE VESBO® STORY

VESBO® thermoplastic piping systems has its roots in 1987 when Mr. Asim Ülker, grandfather of Vesbo's current CEO Mr. Mehmet Sinan Berksan, established Kar Group of Companies in Istanbul, Turkey with a diverse portfolio ranging from construction materials to food, agriculture, financial and social services.

In 1992, Kar Group of Companies established Novaplast Plastik in Istanbul, Turkey and commissioned its Munich, Germany based technology arm, Arcon Handels GmbH, to establish a manufacturing facility in Izmit, Turkey



Mr. Asim Ülker Mr. Selcuk Berksan Mr. Faruk Berksan Mr. Sinan Berksan

Fig. 1: KAR Group of Companies, Istanbul Turkey was established in 1987 by Mr. Asim Ülker (1911-2001) and his two sons Mr. Selcuk Berksan and Mr. Faruk Berksan. His grandson Mr. Sinan Berksan is now the CEO of Novaplast Plastik.



to continually research, develop and produce PP-R and plastic related products for the European and subsequently worldwide markets, based on German and Swiss technologies and in collaboration with the Turkish government, research institutes and universities.

In 1994, Novaplast Plastik began to distribute its PP-R pipes and fittings in Europe and worldwide under the registered trademark of VESBO®, and established Vesbo Asia Pte. Ltd. in Singapore to market and distribute VESBO® branded products as well as to strategise and manage the investments of Kar Group of Companies in the emerging Asian markets.

In 2011, Arcon, together with Novaplast and Vesbo Asia, set up Novaplast Plastik Sdn Bhd in Johor, Malaysia as VESBO's Far East production facility—with engineering and management quality standards identical of its parent facility in Izmit, Turkey.

VESBO® PP-R pipes and fittings is honoured to be amongst the few branded piping products in Europe certified by South Germany Plastics Centre and authorised to use the prestigious SKZ logo on the products. In addition, VESBO®

products are proud to be in compliance with a full range of international quality standards and certifications such as from Germany and major European countries, USA, Canada and China, and Singapore.

Under Kar Group of Companies, Arcon continues to drive market-oriented R&D efforts for Novaplast and VESBO®. Registered patents include:

- Fibreglass filled PP composite pipe for hot fluid transfers (2007)
- Timer controlled welding machines (2006)
- Anti-abrasion plastic threads (2006)
- Double layer UV protected pipe (2001)

For more than 20 years, VESBO® has been a celebrated household name, serving pipelines to the world in more than 75 countries. We will remain committed to innovate and produce piping solutions for residential and infrastructural projects—to keep life flowing.

02 CHARACTERISTICS

► General – Raw Materials

VESBO® PP-R pipes and fittings are manufactured from high quality, **Polypropylene Random Co-polymer (PP-R Type 3) resins**. Its physical and chemical properties make VESBO® a versatile piping system in a wide range of applications in different industries.

Its advantages over PP types 1 or 2 and other thermoplastic pipes in potable water industries are its high impact strength and resistance to high temperatures during long-term internal hoop stress.

► Application Areas

- Potable water, hot and cold water, chemicals, irrigation
- Residential apartments, condominiums, public housing
- Commercial and office buildings, shopping malls
- Industrial plants dealing with chemicals, food processing, semiconductors
- Hospitals
- Schools, laboratories and chemical sewerage
- Hotels and resorts
- Chilled water and heating systems



► Mechanical & Thermal Properties

Property		Test Method	Unit	Value
Melt Flow Rate	MFR 190/5	ISO 1133	g/10min	0.5
	MFR 230/2.16	ISO 1133	g/10min	0.3
	MFR 230/5	-	g/10min	1.5
Density at 23°C		ISO 1183	g/cm ³	0.900
Tensile Stress at Yield		ISO 527	MPa	25
Elongation at Break		ISO 527	%	> 50
Modulus of Elasticity, Tensile Test		ISO 527	N/mm ²	900
Impact Strength (Charpy)	23°C	ISO 179/1eU	kJ/m ²	no failure
	0°C	ISO 179/1eU	kJ/m ²	no failure
	-10°C	ISO 179/1eU	kJ/m ²	no failure
Notched Impact Strength (Charpy)	23°C	ISO 179/1eA	kJ/m ²	20
	0°C	ISO 179/1eA	kJ/m ²	4
	-10°C	ISO 179/1eA	kJ/m ²	3
Coefficient of Linear Thermal Expansion		DIN 53 752	K ⁻¹	1.5x10 ⁻⁴
Thermal Conductivity at 20°C		DIN 52 612	W/mK	0.24
Specific Heat at 20°C		Adiabatic Calorimeter	kJ/kg K	2.0

Table 1: Mechanical & Thermal Properties of PP-R Type 3 Resins

► Behaviour of VESBO® According to DIN 8078 Under Long Term Hoop Stress

The **service life** of a VESBO® PP-R product depends on the internal hoop stress over time subject to the temperature.

Hoop stress is defined as follows:

$$\delta = \frac{P \times (d-s)}{20 \times s}$$

where

δ = Hoop stress (N/mm² or MPa)

P = Internal pressure (bar)

d = Outer diameter of pipe (mm)

s = Wall thickness of pipe (mm)

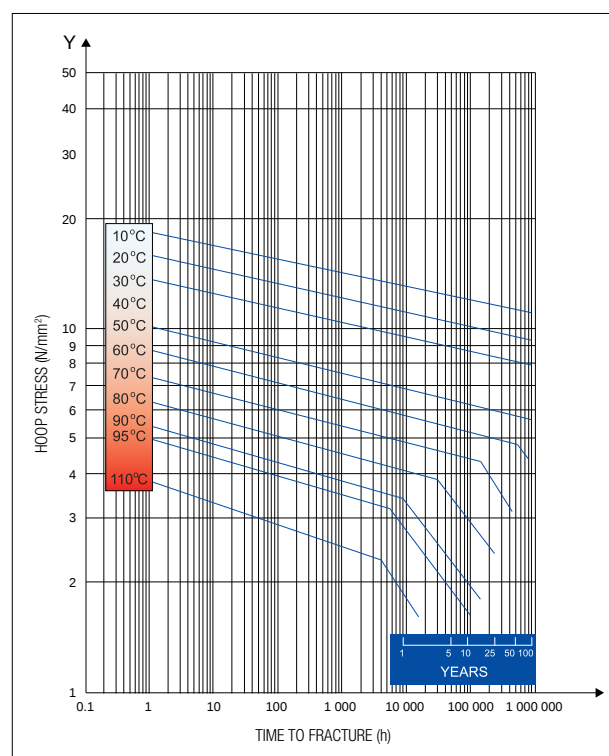


Fig. 2: Time-Hoop Stress Chart

► Standards Compliance

Standards	Requirements
ISO 15874-1: 2013	Plastic piping systems for hot and cold water installations - Polypropylene (PP)
ISO 15874-2: 2013	Plastic piping systems for hot and cold water installations - Polypropylene (PP) - Part 2: Pipes
ISO 15874-3: 2013	Plastic piping systems for hot and cold water installations - Polypropylene (PP) - Part 3: Fittings
DIN 8077: 2008	Polypropylene (PP) pipes –PP-H, PP-B, PP-R, PP-RCT –Dimensions
DIN 8078: 2008	Polypropylene (PP) pipes –PP-H, PP-B, PP-R, PP-RCT –General Quality Requirements and Testing
DIN 16962	Pipe Joints and Elements for Polypropylene Pressure Pipes
DIN 16928	Pipe Joints, Elements for Pipes, Laying – General Conditions
DIN 1988	Drinking Water Supply Systems, Materials, Components, Appliances, Design and Installation
DIN 2999	Threads for Pipes and Fittings
DVGW W 542	Composite Pipes for Drinking Water Installations – Quality Requirements and Testing
DVGW W 270	Reproduction of Microorganisms on Materials for Drinking Water Applications
KTW Requirements	Plastics Used for Drinking Water
DVS 2207	Welding of Thermoplastic Materials
DVS 2208	Machines and Instruments for Welding of Thermoplastic Materials
ASTM F2389	Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
CSA B 137:11	Polypropylene (PP-R) pipe and fittings for pressure applications

Table 2: VESBO® PP-R Pipes and Fittings Compliance to Industry Standards

► Permissible Operating Pressures

Projected Service Life

The table on the right provides more detailed information on permissible pressures of various pipe pressure ratings at various temperatures. These values are derived from the hoop stress chart (Fig. 2) and formula.

Under normal working pressures and conditions, the average service life of VESBO® pipes is projected to be 50 years or more.

Examples

A PN10 cold water pipe, transporting water at a temperature of 20°C is projected to last more than 100 years under normal operating conditions with a operating pressure of 12.5 bars.

A PN20 hot water pipe, transporting water at a temperature of 70°C is projected to last more than 50 years under normal operating conditions with an operating pressure of 8.5 bars.

SDR = Standard Dimension Ratio (Diameter / Wall Thickness Ratio) $SDR = d/s$ (s = Pipes series index form ISO 4065)

Temperature	Service Life, Years	For Water Installations According to DIN 8077 Safety Factor of 1.5			
		VESBO® Pipe SDR11	VESBO® Pipe SDR7.4	VESBO® Pipe SDR6	VESBO® STABLE Pipe
		Nominal Pressure (bars)			
		PN10 Cold Water	PN16 Hot & Cold Water	PN20 Hot & Cold Water	PN25 Hot & Cold Water
		Permissible Working Pressure at Various Temperatures (bars)			
10	1	17.5	27.8	35.1	44.1
	5	16.5	26.2	33.0	41.6
	10	16.1	25.6	32.2	40.5
	25	15.6	24.7	31.1	39.2
	50	15.2	24.1	30.3	38.2
	100	14.8	23.5	29.6	37.2
20	1	15.0	23.7	29.9	37.7
	5	14.1	22.3	28.1	35.4
	10	13.7	21.7	27.4	34.5
	25	13.2	21.0	26.4	33.3
	50	12.9	20.4	25.7	32.4
	100	12.5	20.4	25.7	32.4
30	1	12.7	20.2	25.4	32.0
	5	11.9	18.9	23.8	30.0
	10	11.6	18.4	23.2	29.2
	25	11.2	17.7	22.3	28.1
	50	10.9	17.2	21.7	27.4
	100	10.6	16.8	21.1	27.4
40	1	10.8	17.1	21.6	27.2
	5	10.1	16.0	20.2	25.4
	10	9.8	15.5	19.6	24.7
	25	9.4	15.0	18.8	23.7
	50	9.2	14.5	18.3	23.1
	100	8.9	14.1	17.8	22.4
50	1	9.1	14.5	18.2	23.0
	5	8.5	13.5	17.0	21.4
	10	8.2	13.1	16.5	20.8
	25	7.9	12.6	15.9	20.0
	50	7.7	12.2	15.4	19.4
	100	7.5	11.8	14.9	18.8
60	1	7.7	12.2	15.4	19.4
	5	7.1	11.3	14.3	18.0
	10	6.9	11.0	13.9	17.5
	25	6.6	10.5	13.3	16.7
	50	6.4	10.2	12.9	16.2
	100	6.2	9.9	12.5	15.7
70	1	6.5	10.3	12.9	16.3
	5	6.0	9.5	12.0	15.1
	10	5.8	9.2	11.6	14.6
	25	5.0	8.0	10.0	12.7
	50	4.2	6.7	8.5	10.7
	100	3.8	6.1	7.6	9.6
80	1	5.4	8.6	10.8	13.7
	5	4.8	7.6	9.6	12.1
	10	4.0	6.4	8.1	10.2
	25	3.2	5.1	6.5	8.1
95	1	3.8	6.1	7.6	9.6
	5	2.6	4.1	5.2	6.5

Table 3: Permissible Pressures of Various Pipe Pressure Ratings at Various Temperatures

► Hygiene & Health Concerns

Health is a major consideration in the production of VESBO® pipes and fittings. **Connection of pipes does not require additives such as cement solvent, fluxes or solder.**

To ensure the safety of VESBO® pipes and fittings for usage relating to human contact and consumption with potable water, the following standards are strictly adhered to:

Standards	Requirements
DIN 1988 Part 2	Drinking Water Supply Systems, Materials, Components, Appliances, Design and Installation
KTW	- Recommendations - Federal Health Office, Germany
DVGW	Test Certificate based on KTW recommendations for Materials in Contact with Drinking Water
WRc	- Test Certificate - Water Bylaws Scheme / WRc, Tests of Effect on Water Quality based on BS 6920
SS375	- Singapore Standard - Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of water

Table 4: VESBO® Compliance to Standards and Requirements for Potable Water Pipes and Fittings

► UV Resistance

VESBO® products are produced with UV stabilisers. However, like all other piping systems including metal pipe works, VESBO® products should not be exposed to direct sunlight without insulation or protection against sunlight or UV radiation.

For applications where constant UV exposure is expected, VESBO® UV/Solar pipes should be used. For prolonged lifespan, a protective paint in black or a jacket is recommended.

► Fire Classification

VESBO® pipes and fittings comply with and are classified under the requirements of the following fire classifications:

- Class B2 according to DIN 4102
- Class 2 or B according to ASTM E84
- Class E in accordance with EN13501-1: 2007+A1: 2009

Under such classifications, it is normally inflammable and is capable of resisting, for a short period, a small flame attack without substantial flame spread.

In case of a fire outbreak of temperatures above 800°C, under ideal conditions and with sufficient oxygen, only carbon dioxide and water vapour are produced as the raw material of Polypropylene Random Co-polymer is of a hydrocarbon chain. Toxic fumes or dioxin will not be emitted.

► Sound Insulation

Compared with metal pipes, VESBO® products do not need further insulation to reduce decibel levels when water flows at relatively high speeds. While metals transmit noises quicker and louder, plastics dampen noises. Hence “whistling” and noises resulting from water hammer effect are largely reduced to none.

Why Choose VESBO® PP-R Piping

1. Not detrimental to human health
2. Rust and corrosion free
3. Rupture free
4. No scaling
5. High resistance to acids and chlorides
6. Noise free at high flow rates
7. High pressure tolerances and rating
8. Insulation is not necessary for interior applications
9. Lightweight
10. Speed and ease of fusion technology
11. Extensive savings in time and labour

03 QUALITY ASSURANCE

► *Quality as a Strategic Focus*

Quality process is an integral part of everything VESBO® does. Quality action teams of VESBO® throughout the world are committed to continually improving products, processes and procedures to better meet customer requirements.

We have learned and adapted many of the best practices of successful quality management systems in developing our own VESBO® Quality System. VESBO® Quality System is designed to be a continuous and unceasing cycle:

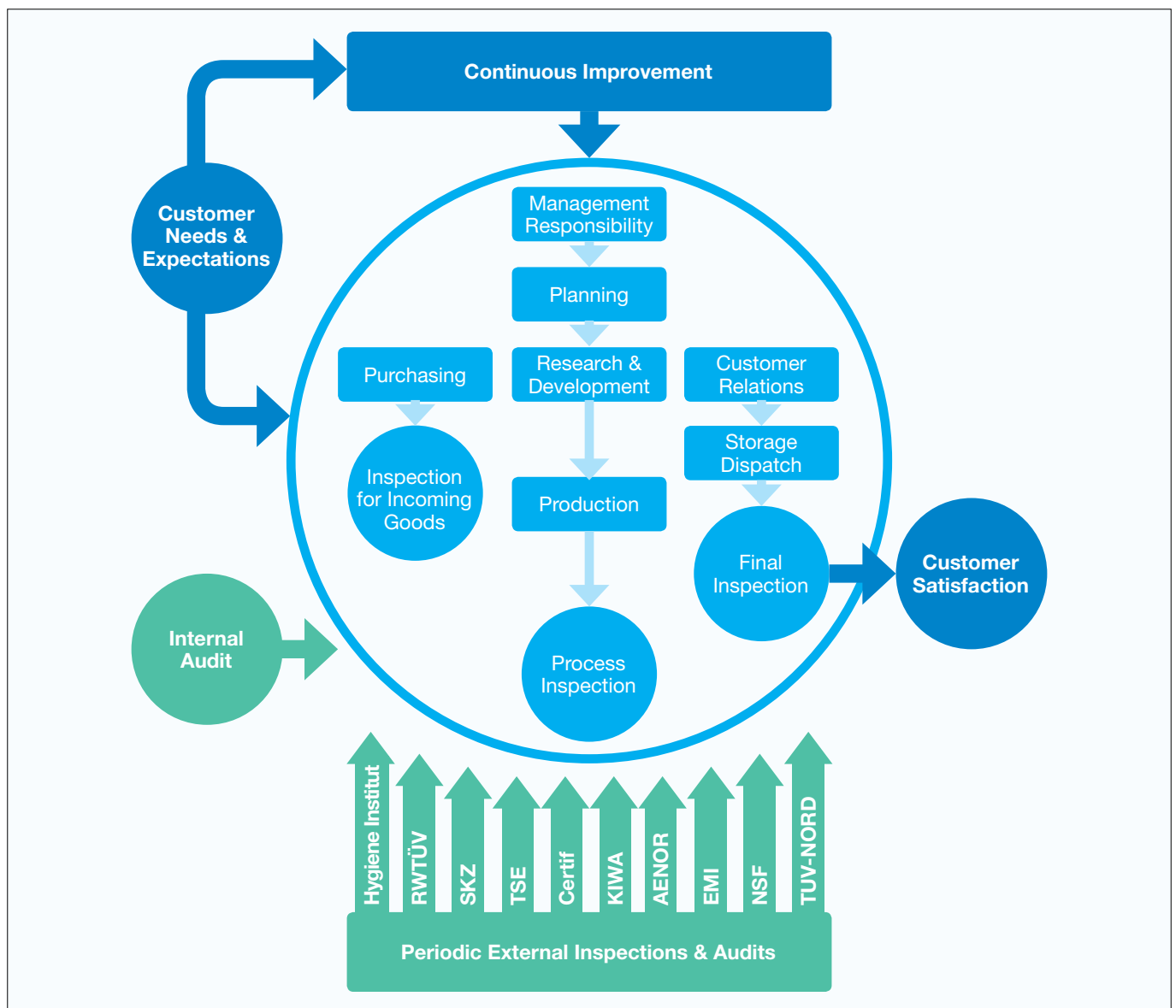


Fig. 3: VESBO® Quality System Cycle

Quality is engineered into VESBO® products throughout the entire manufacturing process. The three phases of quality control involve the incoming raw material, the pipe production, and the finished product. The combination of such ensures that the final product will fulfill requirements and meet desired specifications with complete customer satisfaction.

► Internal Control

VESBO® pipes and fittings are periodically subjected to the following extensive standards based test programs.

Material Characterisation Tests

Testing the incoming resin is the first step in the quality control program. Resins are checked for contamination, melt index and density. Resins that do not meet raw material specifications will not be used for production.



Fig. 4: VESBO® Material Characterisation Test Equipment

Thermal Reversion Properties Tests

Thermal properties of plastic materials are as important as mechanical properties. Unlike metals, plastics are extremely sensitive to changes in temperature. This difference in the coefficient of thermal expansion develops internal stresses and stress concentrations in the polymer. Pipes are subjected to thermal stresses inside a thermostatic chamber with continuous air circulation to observe shrinkage in accordance with **ISO 15874** standards.



Fig. 5: VESBO® Thermostatic Chamber

Dimensional Tests

Pipe diameter, wall thickness, ovality, and length are measured on a regular basis to insure compliance with the prevailing specification. The outside diameter wall thickness shall comply with **ISO 15874** specifications.



Fig. 6: VESBO® Dimensional Test Caliper

Mechanical Tests

Mechanical properties, among all properties of plastic materials, are often the most important because virtually all service conditions and the majority of end-use applications involve some degree of mechanical loading.

Impact Strength

Impact resistance is the ability of a material to resist breaking under a shock loading. Standard test specimens prepared from VESBO® pipes are subjected to a pendulum-type impact load in accordance with **ISO 15874** standards.



Fig. 7: VESBO® Pendulum-type Impact Test Equipment

Creep Strength Test

VESBO® pipes are subjected to creep tests according to **ISO 15874** standards to determine service life and obtain required information about mechanical characteristics of pipes. The long-term burst strength of pipes is determined by subjecting the pipes to constant internal pressure and observing time-to-failure data.

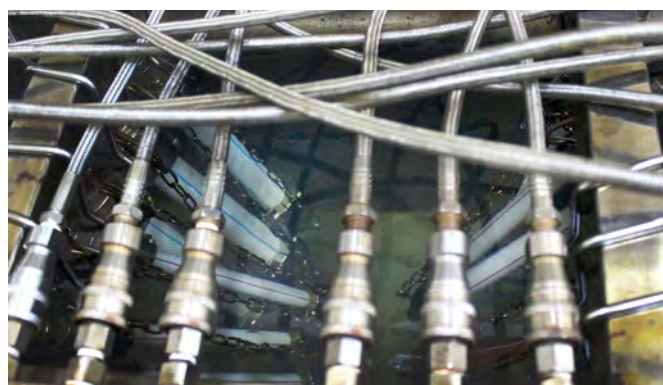


Fig. 8: VESBO® Creep Test Water Bath

Separation Test

The strength of the binding layers between the internal and aluminium layer of VESBO® STABLE Pipes is examined by separation test.

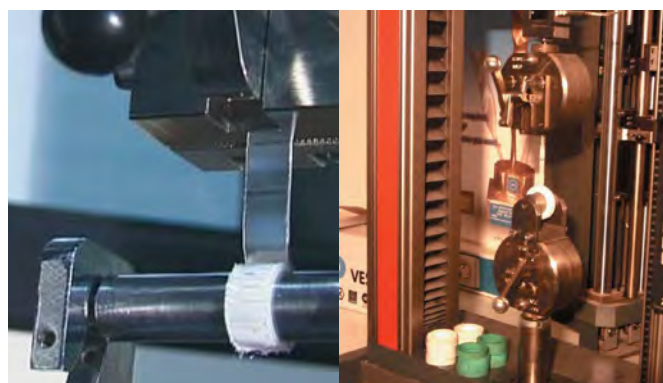


Fig. 9: VESBO® Separation Test Equipment

► External Control

Apart from internal controls planned and maintained by qualified VESBO® technical departments, there are also periodic external controls carried out by independent international organisations such as RWTÜV, SKZ, Hygiene Institut, TUV-NORD, AENOR, EMI and NSF. These controls include both product testing according to specific and relevant standards and complete quality system controls. Therefore external controls are our essential tools to ensure the highest quality products and, consequently, satisfy our customers' expectations.

► Locate & Trace Tools

Locate and Trace Tools make easier handling (H), loading (L), storing (S) and tracing (T) processes with visual locating and comprehensive feedback data.

Barcode Packaging Box Label for Fittings (H, L, S, T)

You will find a labelling tag on every VESBO® fittings packaging box specifying the article's dimensions, code, quantity and SN (Anti-Counterfeit code to trace if contents are genuinely produced by VESBO®).

The article's name in different languages are also printed on the label.



Fig. 10: Barcode Label for VESBO® Fittings Packaging Box

Packaging Box



Fig. 11: Packaging Box with Barcode Label

Barcode Packaging Label for Pipes (H, L, S, T)

Each package or bundle of pipes is tagged with a new color code and barcode label for ease of pipe identification. Information found on this label, such as, article codes, dimensions, size.

Possible quality problems, shortage of goods during the packaging or dispatching process can be eliminated.

Packaging & Labelling for Pipes



Fig. 12: Packaging and Pipe Labels



Fig. 13: Caution and Handling Label

CAUTION AND HANDLING			
1 DO NOT directly contact with hazardous chemical materials	2 DO NOT subject the pipe ends to shock or impact	3 DO NOT use pipes that are damaged or cracked at the interfaces	4 DO NOT twist pipes or fittings after joining
5 DO NOT use conical threads	6 DO NOT expose VESBO® products to UV radiation for prolonged period	7 DO NOT use metal plugs as connectors	8 DO NOT subject VESBO® products to heavy shocks or falling stones
9 DO NOT use excessive amounts of hemp when sealing in fittings	10 DO NOT heat with a naked flame	11 DO NOT bind up contaminated pipes or fittings	12 DO NOT toss VESBO® products when unloading

Pipe Markings

VESBO® pipes come with one marking line as well as four marking lines for special orders only. Mr VBO, VESBO® **Ilb** logo and “ARCON” are featured on all pipe markings. SN (Anti-Counterfeit codes) are printed at the end of the markings



Fig. 14: Pipe Markings



Fig. 15: Code Marking Machine

► Quality Assurance & Health Certifications

Production Quality Certificates

- DIN EN ISO 9001: 2008 Design, Production, Marketing and Sales of VESBO® Plastic Pipes and Fittings and Miscellaneous Parts
- BS OHSAS 18001: 2007 Occupational Health and Safety Management Systems
- EN ISO 14001: 2005 Environmental Management Systems

Country	Certifications
 GERMANY	• SKZ German Plastic Institute • KTW Federal Health Office • DVGW German Technical and Scientific Association for Gas and Water – Test Certificate based on KTW recommendations for materials in contact with drinking water
 UK	• WRC Water Byelaws Scheme / Wrc, Test Effect on Water Quality based on BS 6920
 SPAIN	• AENOR The Spanish Association for Standardisation and Certification
 RUSSIAN FEDERATION	• GOST-R State Committee of the Russian Federation for Standardisation and Metrology • Russian Federation Ministry of Health – Sewerage Department, Recommendations for materials in contact with drinking water
 ROMANIA	• ICECON Test Approval Certificate
 POLAND	• TIN • PZH
 TURKEY	• TSE Turkish Standards Institute

Country	Certifications
 THE NETHERLANDS	• KIWA Test Report on Oxygen Permeability of PE-X Pipes
 PHILIPPINES	• Industrial Technology Development Institute Standards and Testing Division
 SINGAPORE	• PSB TUV SUD Productivity and Standards Board • SGBC, Singapore Green Building Council
 MALAYSIA	• SIRIM, Product Certification • SPAN, Malaysia National Water Services Commission, Approved Product Supplier
 CHINA	• Shanghai Building Material Quality and Inspection Testing Center Certification • Shanghai Health Bureau Approval
 VIETNAM	• Trung Tam Do Luong (Vietnam Metrology Institute, Directorate For Standards And Quality)
 INDONESIA	• BPPT, Badan Pengkajian Dan Penerapan Teknologi • ITS, Institute Teknologi Sepuluh



Fig. 16: VESBO® Certifications Around the World

04 COMMITMENT TO SUSTAINABILITY

► Responsibility Towards a Safe and Healthy Environment

At VESBO®, we conduct our manufacturing operations in an environmentally acceptable manner, and we seek continual advancements in production processes, management policies and systems for environment, health and safety, as well as pollution prevention. We are fully dedicated to delivering products and services that are environmentally friendly and safe.

We take pride in VESBO's high standards of hygiene – a result of our persistent strive for the better. Our standards meet the requirements of most countries and regions. Our direction indeed is to constantly raise the bar from a global viewpoint, and this is consistent with our commitment to the **Responsible Care initiative for plastics management**.



RESPONSIBLE CARE®
OUR COMMITMENT TO SUSTAINABILITY

► Making a Difference

Manufactured from high quality PP-R Type 3 resins, VESBO® PP-R piping products possess high impact strength and high heat resistance, and are warrantied **50 years of service life** under normal working conditions and pressures.

Compared with pipes made from conventional PE-X, PB multilayer, stainless steel and copper materials, VESBO® PP-R pipe materials are corrosion-free, supports heat fusion and 100% recycling, and leave a low carbon footprint.

Category	PP-R	PE-X	PB	STAINLESS STEEL	COPPER
Material	Polypropylene Random Copolymer	Cross-linked Polyethylene	Polybutene-1	Stainless (304)	Copper
Durability	>50 years	>50 years	>50 years	>50 years	>50 years
Ease of Installation	Good	Good	Satisfactory	Satisfactory	Satisfactory
Joining Method	Heat fusion	Mechanical Connector	Mechanical or heat	Mechanical or welding	Mechanical or welding
Corrosion	None	None	None	Possible corrosion	Possible corrosion
Recyclability	Possible	Impossible	Possible	Possible	Possible
Major Functions	Cold and hot water supplying pipes Under floor heating pipes Chemical pipes	Normally used for under floor heating pipes	Cold and hot water supplying pipes Under floor heating pipes	Cold and hot water supplying pipes	Cold and hot water supplying pipes Under floor heating pipes

Effective environmental protection is as quintessential as efficient manufacturing operations. We will consistently maintain a high sense of care and responsibility towards resources deployed in the course of our operations. By doing so, we believe we will contribute towards a greener and better built environment, and make a difference in the communities we live and work in.

Table 5: Comparison of PP-R Against Other Conventional Piping Materials

► 100% Recycle, Reprocess and Reuse

VESBO® takes responsibility and pride in managing our manufacturing process to ensure total recycling, reprocessing and reusing of our PP-R piping materials.

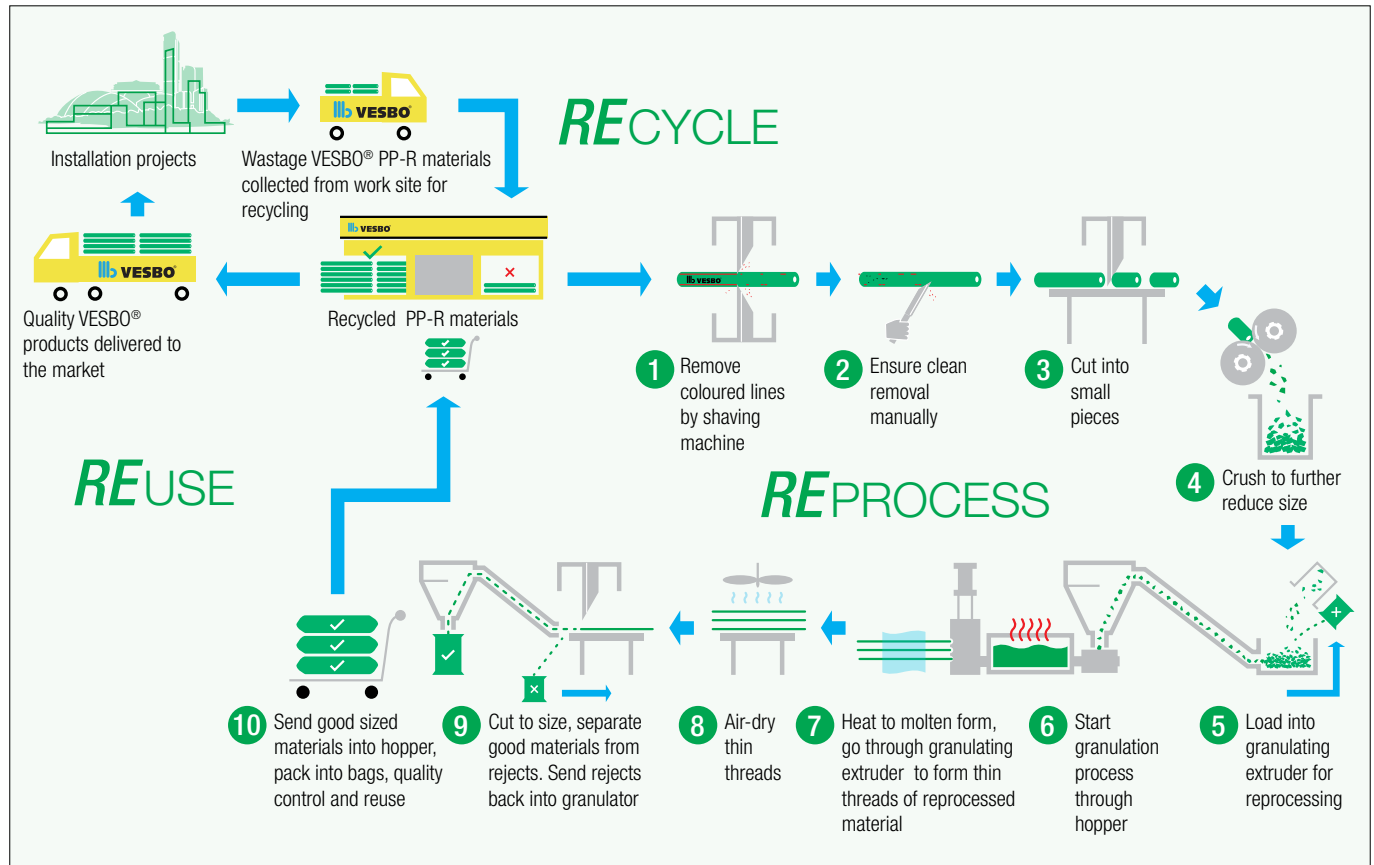


Fig. 17: VESBO® 10-Step Recycle, Reprocess and Reuse Cycle

► SGBC Certification & Membership

VESBO® is awarded Singapore Green Building Council (SGBC) Development Category certification for producing **Green Building Products**:

- PP-R Cold Water Pipes
- PP-R Hot & Cold Water Pipes
- PP-R Fittings

VESBO® Asia is an active member of SGBC in promoting resource efficiency, lowering carbon footprint, reducing waste and pollution, and promoting environmental stewardship.



SGBP 2016-661

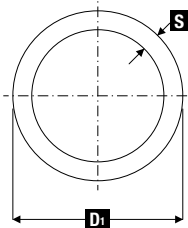
05 VESBO® PP-R

PRODUCT RANGE

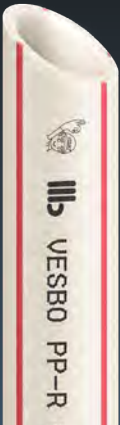
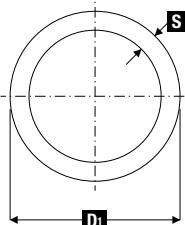
► VESBO® PP-R Pipes



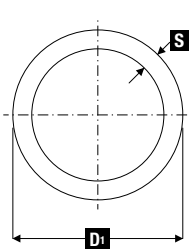
PN10 (SDR11) PP-R Cold Water Pipe

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	M/PACK	D _i	S	TECHNICAL DRAWING
	111.1B.A15.EC4	20 x 2.3	100	20.0	2.3	
	111.1B.A15.FC4	25 x 2.3	100	25.0	2.3	
	111.1B.A15.GC4	32 x 2.9	100	32.0	2.9	
	111.1B.A15.HC4	40 x 3.7	60	40.0	3.7	
	111.1B.A15.IC4	50 x 4.6	40	50.0	4.6	
	111.1B.A15.JC4	63 x 5.8	28	63.0	5.8	
	111.1B.A15.KC4	75 x 6.8	20	75.0	6.8	
	111.1B.A15.LC4	90 x 8.2	12	90.0	8.2	
	111.1B.A15.MC4	110 x 10.0	8	110.0	10.0	
	111.1B.A15.NC4	125 x 11.4	8	125.0	11.4	
	111.1B.A15.PC4	160 x 14.6	4	160.0	14.6	
	VESBO® PN10 (SDR 11) Pipes are suitable for cold water installations and low pressure systems.					

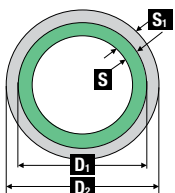
PN16 (SDR7.4) PP-R Cold Water Pipe

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	M/PACK	D _i	S	TECHNICAL DRAWING
	111.1B.A13.EC4	20 x 2.8	100	20.0	2.8	
	111.1B.A13.FC4	25 x 3.5	100	25.0	3.5	
	111.1B.A13.GC4	32 x 4.4	100	32.0	4.4	
	111.1B.A13.HC4	40 x 5.5	60	40.0	5.5	
	111.1B.A13.IC4	50 x 6.9	40	50.0	6.9	
	111.1B.A13.JC4	63 x 8.6	28	63.0	8.6	
	111.1B.A13.KC4	75 x 10.3	20	75.0	10.3	
	111.1B.A13.LC4	90 x 12.3	12	90.0	12.3	
	111.1B.A13.MC4	110 x 15.1	8	110.0	15.1	
	111.1B.A13.NC4	125 x 17.1	8	125.0	17.1	
	111.1B.A13.PC4	160 x 21.9	4	160.0	21.9	
	VESBO® PN16 (SDR 7.4) Pipes are used for both hot and cold water installations and medium pressure systems.					

PN20 (SDR6) PP-R Hot & Cold Water Pipe

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	M/PACK	D ₁	S	TECHNICAL DRAWING
	111.1B.A12.EC4	20 x 3.4	100	20.0	3.4	
	111.1B.A12.FC4	25 x 4.2	100	25.0	4.2	
	111.1B.A12.GC4	32 x 5.4	100	32.0	5.4	
	111.1B.A12.HC4	40 x 6.7	60	40.0	6.7	
	111.1B.A12.IC4	50 x 8.3	40	50.0	8.3	
	111.1B.A12.JC4	63 x 10.5	28	63.0	10.5	
	111.1B.A12.KC4	75 x 12.5	20	75.0	12.5	
	111.1B.A12.LC4	90 x 15.0	12	90.0	15.0	
	111.1B.A12.MC4	110 x 18.3	8	110.0	18.3	
	111.1B.A12.NC4	125 x 20.8	8	125.0	20.8	
	111.1B.A12.PC4	160 x 26.6	4	160.0	26.6	
VESBO® PN20 (SDR6) Pipes are used for both hot and cold water installations and higher pressure systems.						

PN20 (SDR6) UV PP-R Pipes for Hot & Cold Water

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	M/PACK	D ₁	D ₂	S	S ₁	TECHNICAL DRAWING
	111.1Z.N42.EC4	20 x 3.4	100	19.0	20.0	2.9	3.4	
	111.1Z.N42.FC4	25 x 4.2	100	24.0	25.0	3.7	4.2	
	111.1Z.N42.GC4	32 x 5.4	100	31.0	32.0	4.9	5.4	
	111.1Z.N42.HC4	40 x 6.7	60	39.0	40.0	6.2	6.7	
	111.1Z.N42.IC4	50 x 8.3	40	49.0	50.0	7.8	8.3	
	111.1Z.N42.JC4	63 x 10.5	28	62.0	63.0	10.0	10.5	
	111.1Z.N42.KC4	75 x 12.5	20	74.0	75.0	12.0	12.5	
	111.1Z.N42.LC4	90 x 15.0	12	89.0	90.0	14.5	15.0	
	111.1Z.N42.MC4	110 x 18.3	8	109.0	110.0	17.8	18.3	
	VESBO® UV Pipes are used for pipe installations under direct sunlight or UV radiation. PN10 and PN16 UV PP-R Pipes are also available upon request							

► Other PP-R Pipe Range

VESBO PP-R are also available in a wide variety of colors, layers and composition to suit various markets and applications.



MONO CLASSIC SERIES



MULTILAYER-2 SERIES



MULTILAYER-3 SERIES



UV SERIES



MULTILAYER-STABLE SERIES



MULTILAYER-FASER SERIES

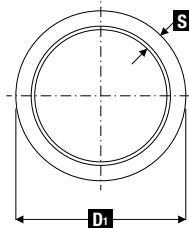


PP-RCT ENHANCE SERIES

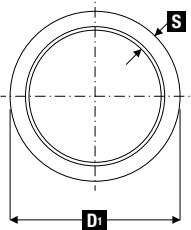


► VESBO® PP-R BioCote Pipes with Anti-Microbial

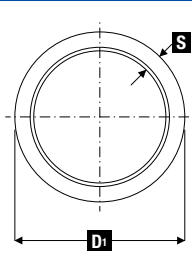
PN10 (SDR11) PP-R Cold Water Anti-Microbial Pipe

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	M/PACK	D _i	S	TECHNICAL DRAWING
	111.1B.A95.EC4	20 x 2.3	100	20.0	2.3	
	111.1B.A95.FC4	25 x 2.3	100	25.0	2.3	
	111.1B.A95.GC4	32 x 2.9	100	32.0	2.9	
	111.1B.A95.HC4	40 x 3.7	60	40.0	3.7	
	111.1B.A95.IC4	50 x 4.6	40	50.0	4.6	
	111.1B.A95.JC4	63 x 5.8	28	63.0	5.8	
	111.1B.A95.KC4	75 x 6.8	20	75.0	6.8	
	111.1B.A95.LC4	90 x 8.2	12	90.0	8.2	
	111.1B.A95.MC4	110 x 10.0	8	110.0	10.0	
	111.1B.A95.NC4	125 x 11.4	8	125.0	11.4	
	111.1B.A95.PC4	160 x 14.6	4	160.0	14.6	
	VESBO® PN10 (SDR 11) Pipes are suitable for cold water installations and low pressure systems, inner layer with anti-microbial additives to eradicate bacteria and microbes.					

PN16 (SDR7.4) PP-R Cold Water Anti-Microbial Pipe

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	M/PACK	D _i	S	TECHNICAL DRAWING
	111.1B.A93.EC4	20 x 2.8	100	20.0	2.8	
	111.1B.A93.FC4	25 x 3.5	100	25.0	3.5	
	111.1B.A93.GC4	32 x 4.4	100	32.0	4.4	
	111.1B.A93.HC4	40 x 5.5	60	40.0	5.5	
	111.1B.A93.IC4	50 x 6.9	40	50.0	6.9	
	111.1B.A93.JC4	63 x 8.6	28	63.0	8.6	
	111.1B.A93.KC4	75 x 10.3	20	75.0	10.3	
	111.1B.A93.LC4	90 x 12.3	12	90.0	12.3	
	111.1B.A93.MC4	110 x 15.1	8	110.0	15.1	
	111.1B.A93.NC4	125 x 17.1	8	125.0	17.1	
	111.1B.A93.PC4	160 x 21.9	4	160.0	21.9	
	VESBO® PN16 (SDR 7.4) Pipes are used for both hot and cold water installations and medium pressure systems, inner layer with anti-microbial additives to eradicate bacteria and microbes.					

PN20 (SDR6) PP-R Hot & Cold Water Anti-Microbial Pipe

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	M/PACK	D _i	S	TECHNICAL DRAWING
	111.1B.A92.EC4	20 x 3.4	100	20.0	3.4	
	111.1B.A92.FC4	25 x 4.2	100	25.0	4.2	
	111.1B.A92.GC4	32 x 5.4	100	32.0	5.4	
	111.1B.A92.HC4	40 x 6.7	60	40.0	6.7	
	111.1B.A92.IC4	50 x 8.3	40	50.0	8.3	
	111.1B.A92.JC4	63 x 10.5	28	63.0	10.5	
	111.1B.A92.KC4	75 x 12.5	20	75.0	12.5	
	111.1B.A92.LC4	90 x 15.0	12	90.0	15.0	
	111.1B.A92.MC4	110 x 18.3	8	110.0	18.3	
	111.1B.A92.NC4	125 x 20.8	8	125.0	20.8	
	111.1B.A92.PC4	160 x 26.6	4	160.0	26.6	
VESBO® PN20 (SDR6) Pipes are used for both hot and cold water installations and higher pressure systems, inner layer with anti-microbial additives to eradicate bacteria and microbes.						

► Other PP-R Pipe Range

VESBO PP-R are also available in a wide variety of colors, layers and composition to suit various markets and applications.



MONO CLASSIC SERIES



MULTILAYER-2 SERIES



MULTILAYER-3 SERIES



UV SERIES



MULTILAYER-STABLE SERIES



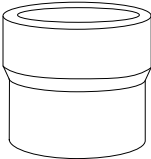
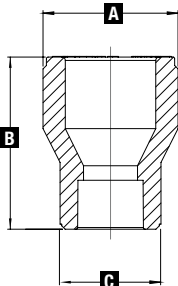
MULTILAYER-FASER SERIES



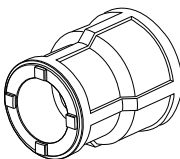
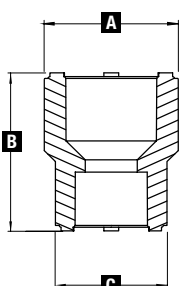
PP-RCT ENHANCE SERIES

► VESBO® PP-R Fittings

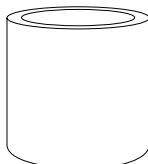
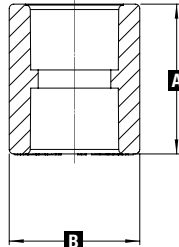
Reducer

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
	112.1B.A06.FEO	25/20	250	Ø 29.5	40.0	Ø 25.3	
	112.1B.A06.GEO	32/20	180	Ø 31.0	43.5	Ø 30.0	
	112.1B.A06.GFO	32/25	120	Ø 35.0	45.0	Ø 32.0	
	112.1B.A06.HEO	40/20	100	Ø 40.5	52.0	Ø 29.0	
	112.1B.A06.HFO	40/25	100	Ø 40.5	52.5	Ø 35.0	
	112.1B.A06.HGO	40/32	105	Ø 42.5	52.5	Ø 40.0	
	112.1B.A06.IEO	50/20	60	Ø 50.5	56.0	Ø 29.7	
	112.1B.A06.IFO	50/25	60	Ø 52.0	55.0	Ø 35.0	
	112.1B.A06.IG0	50/32	60	Ø 50.8	55.0	Ø 43.0	
	112.1B.A06.IHO	50/40	60	Ø 53.3	56.0	Ø 50.2	
	112.1B.A06.JEO	63/20	48	Ø 63.0	66.0	Ø 29.8	
	112.1B.A06.JFO	63/25	40	Ø 63.3	65.0	Ø 34.9	
	112.1B.A06.JGO	63/32	40	Ø 64.0	66.0	Ø 43.0	
	112.1B.A06.JHO	63/40	30	Ø 62.7	65.0	Ø 52.4	
	112.1B.A06.JIO	63/50	36	Ø 65.0	66.0	Ø 63.0	
	112.1B.A06.KHO	75/40	16	Ø 75.6	67.0	Ø 65.5	
	112.1B.A06.KIO	75/50	16	Ø 75.6	67.0	Ø 66.1	
	112.1B.A06.KJO	75/63	16	Ø 83.0	72.5	Ø 76.0	
	112.1B.A06.LIO	90/50	12	Ø 90.0	75.8	Ø 80.5	
	112.1B.A06.LJO	90/63	12	Ø 90.7	75.8	Ø 81.4	
	112.1B.A06.LKO	90/75	12	Ø 101.5	79.0	Ø 90.3	
	112.1B.A06.MKO	110/75	6	Ø 121.5	97.0	Ø 111.0	
	112.1B.A06.MLO	110/90	6	Ø 121.0	102.5	Ø 111.0	
	112.1B.A06.NMO	125/110	2	Ø 167.6	115.0	Ø 147.7	
	112.1B.A06.PMO	160/110	2	Ø 212.0	124.4	Ø 147.2	
	112.1B.A06.PNO	160/125	2	Ø 213.1	119.0	Ø 167.6	
Colors Available: 	VESBO® Reducers are used for joining bigger size pipelines to smaller size pipelines.						

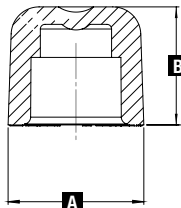
Direct Reducer

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.A06.FE1	25/20	180	Ø 36.0	43.0	Ø 30.0	
	112.1B.A06.GF1	32/25	100	Ø 44.0	47.1	Ø 36.0	
	112.1B.A06.HF1	40/25	60	Ø 53.2	54.0	Ø 36.0	
	112.1B.A06.IF1	50/25	48	Ø 67.6	61.9	Ø 36.0	
	VESBO® Direct Reducers are used for joining bigger size pipelines to smaller size pipelines.						

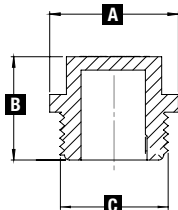
Socket

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	TECHNICAL DRAWING
 Colors Available: 	112.1B.A01.E00	20	280	33.5	30.0	
	112.1B.A01.F00	25	180	38.0	34.5	
	112.1B.A01.G00	32	108	43.5	43.5	
	112.1B.A01.H00	40	60	48.0	52.0	
	112.1B.A01.I00	50	36	52.5	65.0	
	112.1B.A01.J00	63	16	61.0	84.5	
	112.1B.A01.K00	75	16	65.0	100.0	
	112.1B.A01.L00	90	7	77.0	120.5	
	112.1B.A01.M00	110	4	84.0	140.0	
	112.1B.A01.N00	125	2	103.73	167.0	
	112.1B.A01.P00	160	2	123.1	213.6	
	VESBO® Sockets are used to join two pipes.					

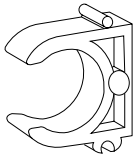
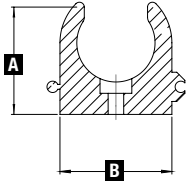
Cap

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	TECHNICAL DRAWING
 Colors Available:	112.1B.A07.E00	20	350	Ø 29.0	25.0	
	112.1B.A07.F00	25	270	Ø 34.5	27.5	
	112.1B.A07.G00	32	150	Ø 41.8	32.0	
	112.1B.A07.H00	40	90	Ø 52.0	37.5	
	112.1B.A07.I00	50	50	Ø 66.0	44.0	
	112.1B.A07.J00	63	24	Ø 83.0	51.0	
	112.1B.A07.K00	75	16	Ø 100.0	56.0	
	112.1B.A07.L00	90	9	Ø 119.0	65.5	
	112.1B.A07.M00	110	4	Ø 146.0	80.0	
	112.1B.A07.N00	125	2	Ø 165.0	86.0	
	112.1B.A07.P00	160	3	Ø 213.0	90.0	
	VESBO® Caps are used as stoppers at pipeline ends.					

Threaded Cap

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.A08.E00	20	300	Ø 25.5	36.5	Ø 20.5	
	112.1B.A08.F00	25	300	Ø 33.0	29.5	Ø 28.5	
	112.1B.A08.G00	32	200	Ø 38.5	31.0	Ø 32.7	
	VESBO® Threaded Caps are for sealing pipe ends during pressure tests.						

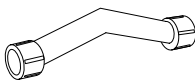
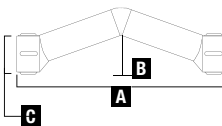
Sleeve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	TECHNICAL DRAWING
 Color Available: 	112.1B.A16.E00	20	400	31.00	31.50	
	112.1B.A16.F00	25	300	34.00	35.50	
	112.1B.A16.G00	32	200	43.00	44.50	
	112.1B.A16.H00	40	100	45.15	53.30	
	112.1B.A16.I00	50	50	55.75	67.25	
	112.1B.A16.J00	63	25	65.00	81.60	
	112.1B.A16.K00	75	20	75.80	91.10	
	112.1B.A16.L00	90	10	90.10	109.10	
	112.1B.A16.M00	110	10	100.10	134.10	
	VESBO® Sleeves are used to fix pipelines on grounds and walls.					

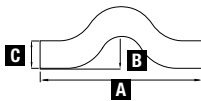
Flange

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	TECHNICAL DRAWING

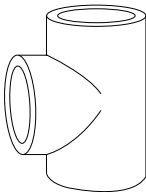
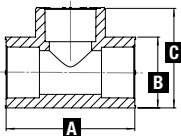
V Pipe Bridge

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	113.1B.K12.E00	20	50	159.5	25.6	Ø 28.5	
	113.1B.K12.F00	25	40	195.0	32.8	Ø 32.5	
	113.1B.K12.G00	32	16	215.0	43.1	Ø 46.0	
	VESBO® V Pipe Bridges are used where a pipeline is required to pass over another pipeline.						

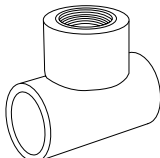
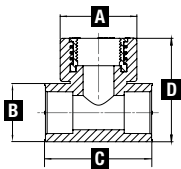
Pipe Bridge

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PGS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	113.1B.M12.E00	20	50	26.5	22.0	Ø 20	
	113.1B.M12.F00	25	40	26.5	29.0	Ø 25	
	113.1B.M12.G00	32	25	31.0	32.0	Ø 32	
	VESBO® Pipe Bridges are used where a pipeline is required to pass over the other pipeline.						

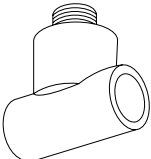
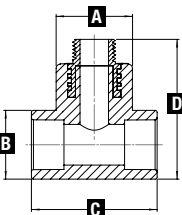
T-Part

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.A04.E00	20	150	52.5	Ø 28.8	41.5	
	112.1B.A04.F00	25	75	63.0	Ø 34.0	49.0	
	112.1B.A04.G00	32	48	71.5	Ø 43.0	59.0	
	112.1B.A04.H00	40	30	84.0	Ø 52.5	69.0	
	112.1B.A04.I00	50	12	101.5	Ø 65.0	81.0	
	112.1B.A04.J00	63	8	121.5	Ø 84.0	101.5	
	112.1B.A04.K00	75	4	139.5	Ø 100.6	119.0	
	112.1B.A04.L00	90	2	160.0	Ø 122.0	140.5	
	112.1B.A04.M00	110	1	189.0	Ø 150.0	166.0	
	112.1B.A04.N00	125	1	246.2	Ø 168.9	206.3	
	112.1B.A04.P00	160	2	279.9	Ø 214.2	243.8	
	VESBO® T-Parts are used to join branches on a main pipeline.						

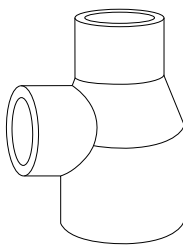
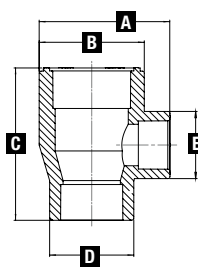
T-Part Female

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	112.1B.B13.EQ0	20 x 1/2 x 20	90	Ø 37.5	Ø 28.6	60.5	50.0	
	112.1B.B13.ER0	20 x 3/4 x 20	60	Ø 43.5	Ø 28.6	63.0	56.5	
	112.1B.B13.FQ0	25 x 1/2 x 25	60	Ø 37.5	Ø 34.3	62.5	55.5	
	112.1B.B13.FR0	25 x 3/4 x 25	50	Ø 45.0	Ø 34.3	63.0	60.0	
	112.1B.B13.GR0	32 x 3/4 x 32	32	Ø 45.0	Ø 43.1	72.5	70.4	
	VESBO® Female T-Parts are used in joints between VESBO® pipelines and metal threaded parts.							

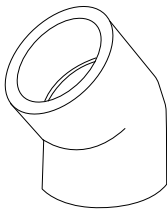
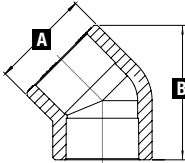
T-Part Male

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	112.1B.B23.EQ0	20 x 1/2 x 20	75	Ø 37.5	Ø 28.8	61.0	63.0	
	112.1B.B23.FQ0	25 x 1/2 x 25	60	Ø 37.8	Ø 34.0	61.9	75.8	
	112.1B.B23.FR0	25 x 3/4 x 25	48	Ø 44.5	Ø 34.4	61.9	76.0	
	112.1B.B23.GS0	32 x 1 x 32	24	Ø 60.3	Ø 43.1	72.5	100.5	
VESBO® Male T-Parts are used in joints between VESBO® pipelines and metal threaded parts.								

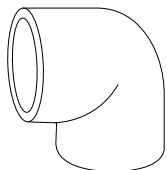
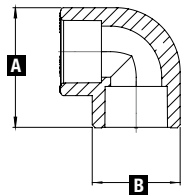
Unequal T

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	E	TECHNICAL DRAWING
	112.1B.A05.EFE	20 x 25 x 20	75	46.0	Ø 28.6	62.0	Ø 28.6	Ø 34.0	
	112.1B.A05.FEE	25 x 20 x 20	75	48.1	Ø 34.4	63.0	Ø 29.3	Ø 29.3	
	112.1B.A05.FEF	25 x 20 x 25	75	48.0	Ø 34.0	62.5	Ø 34.0	Ø 29.3	
	112.1B.A05.FFE	25 x 25 x 20	75	48.1	Ø 34.3	61.9	Ø 29.3	Ø 34.0	
	112.1B.A05.GEE	32 x 20 x 20	45	57.0	Ø 43.5	73.0	Ø 30.2	Ø 30.0	
	112.1B.A05.GEF	32 x 20 x 25	45	57.0	Ø 42.6	73.0	Ø 34.4	Ø 29.3	
	112.1B.A05.GEG	32 x 20 x 32	50	53.0	Ø 43.0	76.5	Ø 43.0	Ø 28.4	
	112.1B.A05.GFE	32 x 25 x 20	60	52.0	Ø 41.7	72.0	Ø 29.4	Ø 34.1	
	112.1B.A05.GFG	32 x 25 x 32	48	55.0	Ø 43.2	75.0	Ø 43.2	Ø 34.6	
	112.1B.A05.HEH	40 x 20 x 40	36	67.5	Ø 53.0	75.5	Ø 53.0	Ø 29.2	
	112.1B.A05.HFG	40 x 25 x 32	36	66.0	Ø 53.2	77.0	Ø 42.6	Ø 34.0	
	112.1B.A05.HFH	40 x 25 x 40	36	65.5	Ø 52.7	75.0	Ø 52.7	Ø 34.6	
	112.1B.A05.HGF	40 x 32 x 25	36	67.0	Ø 53.2	77.0	Ø 34.2	Ø 42.0	
	112.1B.A05.HGH	40 x 32 x 40	30	67.5	Ø 53.0	76.0	Ø 53.0	Ø 42.5	
	112.1B.A05.IEI	50 x 20 x 50	15	77.2	Ø 67.0	99.6	Ø 67.0	Ø 30.5	
	112.1B.A05.IFI	50 x 25 x 50	15	81.5	Ø 66.5	100.0	Ø 66.5	Ø 36.1	
	112.1B.A05.IGI	50 x 32 x 50	15	80.0	Ø 66.4	99.6	Ø 66.5	Ø 44.2	
	112.1B.A05.IHI	50 x 40 x 50	12	82.5	Ø 67.1	100.5	Ø 67.1	Ø 55.1	
	112.1B.A05.JEJ	63 x 20 x 63	8	91.0	Ø 84.0	120.0	Ø 84.0	Ø 31.6	
	112.1B.A05.JFJ	63 x 25 x 63	8	90.0	Ø 84.0	120.0	Ø 84.0	Ø 37.3	
	112.1B.A05.JGJ	63 x 32 x 63	8	95.0	Ø 84.0	120.0	Ø 84.0	Ø 46.2	
	112.1B.A05.JHJ	63 x 40 x 63	8	94.0	Ø 84.0	120.0	Ø 84.0	Ø 57.5	
	112.1B.A05.JIJ	63 x 50 x 63	8	100.0	Ø 84.0	120.0	Ø 84.0	Ø 69.9	
	112.1B.A05.KEK	75 x 20 x 75	5	104.5	Ø 100.5	135.5	Ø 100.5	Ø 29.0	
	112.1B.A05.KFK	75 x 25 x 75	5	108.5	Ø 100.5	135.5	Ø 100.5	Ø 36.2	
	112.1B.A05.KGK	75 x 32 x 75	5	111.0	Ø 100.5	135.5	Ø 100.5	Ø 45.5	
	112.1B.A05.KHK	75 x 40 x 75	5	112.5	Ø 100.5	135.5	Ø 100.5	Ø 57.4	
	112.1B.A05.KIK	75 x 50 x 75	4	114.5	Ø 100.5	135.5	Ø 100.5	Ø 71.2	
	112.1B.A05.KJK	75 x 63 x 75	4	118.5	Ø 100.5	135.5	Ø 100.5	Ø 87.6	
	112.1B.A05.LHL	90 x 40 x 90	3	128.0	Ø 122.3	158.0	Ø 122.3	Ø 54.5	
	112.1B.A05.LIL	90 x 50 x 90	3	133.0	Ø 122.3	156.5	Ø 122.3	Ø 70.8	
	112.1B.A05.LJL	90 x 63 x 90	2	137.0	Ø 122.3	157.0	Ø 122.3	Ø 85.4	
	112.1B.A05.LKL	90 x 75 x 90	2	140.0	Ø 122.3	158.5	Ø 122.3	Ø 100.2	
	112.1B.A05.MIM	110 x 50 x 110	2	158.0	Ø 148.0	180.0	Ø 148.0	Ø 71.6	
	112.1B.A05.MJM	110 x 63 x 110	2	158.0	Ø 148.0	180.5	Ø 148.0	Ø 86.8	
	112.1B.A05.MKM	110 x 75 x 110	2	156.5	Ø 148.0	180.0	Ø 148.0	Ø 100.0	
	112.1B.A05.MLM	110 x 90 x 110	2	163.0	Ø 148.0	181.0	Ø 148.0	Ø 121.0	
	112.1B.A05.NMN	125 x 110 x 125	2	200.0	Ø 168.0	227.0	Ø 168.0	Ø 148.0	
	112.1B.A05.PMP	160 x 110 x 160	1	233.0	Ø 213.0	226.0	Ø 213.0	Ø 148.0	
Colors Available: 	VESBO® Unequal T-Parts are used for both joining branches on pipelines and for transitions to pipelines of different diameters such as via reducer parts.								

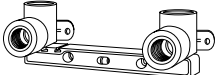
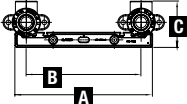
45° Elbow

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	TECHNICAL DRAWING
 Colors Available: 	112.1B.A03.E00	20	200	Ø 29.0	43.5	
	112.1B.A03.F00	25	120	Ø 34.0	50.0	
	112.1B.A03.G00	32	75	Ø 44.0	56.0	
	112.1B.A03.H00	40	48	Ø 53.5	71.0	
	112.1B.A03.I00	50	25	Ø 66.0	85.0	
	112.1B.A03.J00	63	12	Ø 86.0	102.5	
	112.1B.A03.K00	75	5	Ø 100.0	122.0	
	112.1B.A03.L00	90	3	Ø 120.3	138.0	
	112.1B.A03.M00	110	2	Ø 147.1	165.0	
	112.1B.A03.N00	125	1	Ø 168.7	191.0	
	112.1B.A03.P00	160	1	Ø 214.7	255.0	
VESBO® Elbows are used where pipelines are required to make 45-degree bends.						

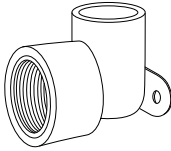
90° Elbow

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	TECHNICAL DRAWING
 Colors Available: 	112.1B.A02.E00	20	200	40.0	Ø 28.5	
	112.1B.A02.F00	25	125	48.0	Ø 34.5	
	112.1B.A02.G00	32	75	56.0	Ø 41.5	
	112.1B.A02.H00	40	32	70.5	Ø 53.0	
	112.1B.A02.I00	50	20	81.5	Ø 66.0	
	112.1B.A02.J00	63	10	101.0	Ø 84.0	
	112.1B.A02.K00	75	5	117.5	Ø 100.0	
	112.1B.A02.L00	90	2	138.0	Ø 122.0	
	112.1B.A02.M00	110	2	161.0	Ø 144.4	
	112.1B.A02.N00	125	1	199.0	Ø 169.4	
	112.1B.A02.P00	160	1	243.1	Ø 215.6	
VESBO® Elbows are used where pipelines are required to make 90-degree bends.						

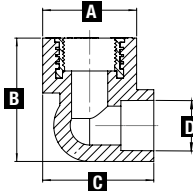
Double Elbow Female

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.BD14.EQ0	20 x 1/2	15	180.0	150 / 130 / 100	60.3	
	112.1B.BD14.FQ0	25 x 1/2	15	180.0	150 / 130 / 100	62.4	
	VESBO® Female Double Elbows are used for easy installations of mixer connections and also function as levellers. The distance between the two elbows are adjustable to 15, 13 and 10cm.						

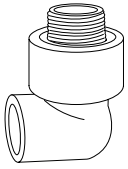
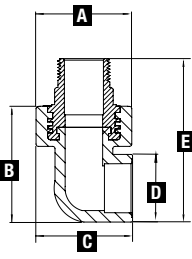
Wall Connection Elbow

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	E	F	TECHNICAL DRAWING
 <										

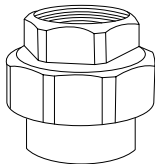
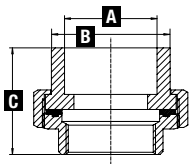
Elbow Female

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: ● ● ● ● ○ ● ● ●	112.1B.B12.EQ0	20 x 1/2	120	Ø 37.5	51.0	50.6	Ø 29.5	
	112.1B.B12.FQ0	25 x 1/2	90	Ø 38.0	58.0	51.6	Ø 34.6	
	112.1B.B12.FR0	25 x 3/4	60	Ø 47.0	61.0	54.0	Ø 35.0	
	112.1B.B12.GS0	32 x 1	30	Ø 61.0	88.0	61.3	Ø 43.3	
	VESBO® Female Elbows are used in transition between VESBO® pipelines and metal threaded parts.							

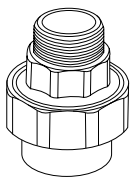
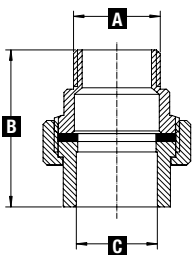
Elbow Male

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	E	TECHNICAL DRAWING
 Colors Available: 	112.1B.B22.EQ0	20 x 1/2	105	Ø 37.3	50.0	52.0	Ø 28.0	63.0	
	112.1B.B22.FQ0	25 x 1/2	80	Ø 37.3	57.0	49.0	Ø 34.0	71.0	
	112.1B.B22.FR0	25 x 3/4	60	Ø 47.0	60.5	N/A	Ø 35.0	75.5	
	112.1B.B22.GS0	32 x 1	24	Ø 62.0	74.2	N/A	Ø 43.3	104.2	
VESBO® Male Elbows are used in transition between VESBO® pipelines and metal threaded parts.									

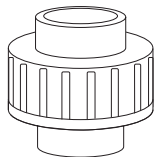
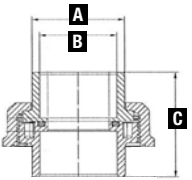
Union Female

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.G12.EQ0	20 x 1/2	160	Ø 19.0	27.0	39.0	
	112.1B.G12.FR0	25 x 3/4	90	Ø 24.0	35.0	43.5	
	112.1B.G12.GS0	32 x 1	60	Ø 31.0	41.0	45.0	
	112.1B.G12.HT0	40 x 1 1/4	30	Ø 39.0	50.0	56.5	
	112.1B.G12.IU0	50 x 1 1/2	16	Ø 48.8	62.0	55.8	
	112.1B.G12.JV0	63 x 2	10	Ø 62.0	79.0	71.0	
VESBO® Female Unions are used in transitions between fixed VESBO® pipelines and metal ones. These fittings are preferred mainly in installations in which ease of maintenance is necessary.							

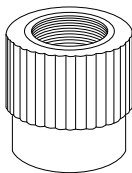
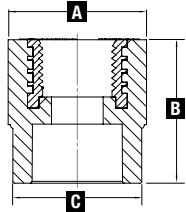
Union Male

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.G22.EQ0	20 x 1/2	120	1/2"	48.0	Ø 19	
	112.1B.G22.FR0	25 x 3/4	80	3/4"	58.0	Ø 24	
	112.1B.G22.GS0	32 x 1	48	1"	60.0	Ø 31	
	112.1B.G22.HI0	40 x 1 1/4	36	1 1/4"	66.0	Ø 39	
	112.1B.G22.IU0	50 x 1 1/2	12	1 1/2"	73.20	Ø 49	
VESBO® Male Unions are used in transitions between fixed VESBO® pipelines and metal ones. These fittings are preferred mainly in installations in which ease of maintenance is necessary.							

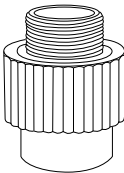
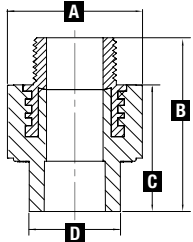
PP Union

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	212.1B.A17.E00	20	50	27.0	20.0	40.0	
	212.1B.A17.F00	25	40	33.0	25.0	46.0	
	212.1B.A17.G00	32	20	41.0	21.0	52.0	
	212.1B.A17.H00	40	15	50.0	40.0	60.0	
	212.1B.A17.I00	50	10	61.0	50.0	72.0	
	212.1B.A17.J00	63	5	76.0	63.0	87.0	
	212.1B.A17.K00	75	2	90.0	75.0	100.0	
	212.1B.A17.L00	90	2	108.0	90.0	117.0	
	212.1B.A17.M00	110	1	131.0	110.0	136.0	
VESBO® PP UNIONS, preferred for cold water systems for ease of joining parts as well as maintenance. Only for cold water lines.							

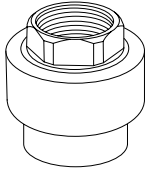
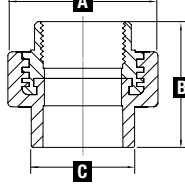
Adaptor Female

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.B11.EQ0	20 x 1/2	150	Ø 37.0	39.0	29.0	
	112.1B.B11.ER0	20 x 3/4	120	Ø 45.0	43.0	29.0	
	112.1B.B11.FQ0	25 x 1/2	120	Ø 37.5	40.5	34.0	
	112.1B.B11.FR0	25 x 3/4	105	Ø 44.5	42.5	34.0	
	VESBO® Female Adaptors are used as transition parts between VESBO® pipelines and metal ones, and are preferred mostly for permanent joints.						

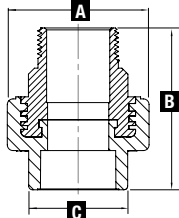
Adaptor Male

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	112.1B.B21.EQ0	20 x 1/2	140	Ø 38.0	36.0	50.0	Ø 29.0	
	112.1B.B21.ER0	20 x 3/4	90	Ø 43.5	55.0	40.0	Ø 29.0	
	112.1B.B21.FQ0	25 x 1/2	120	Ø 38.5	51.0	37.0	Ø 34.0	
	112.1B.B21.FR0	25 x 3/4	90	Ø 44.5	55.0	40.0	Ø 34.0	
	VESBO® Male Adaptors are used as transition parts between VESBO® pipelines and metal ones, and are preferred mostly for permanent joints.							

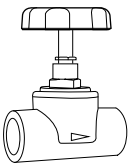
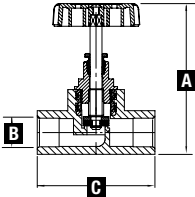
Hex. Female Adaptor

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.B11.GS0	32 x 1	40	Ø 61.0	58.0	Ø 45.0	
	112.1B.B11.HT0	40 x 1 1/4	25	Ø 73.0	62.0	Ø 51.2	
	112.1B.B11.IU0	50 x 1 1/2	16	Ø 86.0	66.0	Ø 66.0	
	112.1B.B11.JV0	63 x 2	12	Ø 100.1	77.0	Ø 83.9	
	112.1B.B11.KW0	75 x 2 1/2	6	Ø 122.0	84.0	Ø 98.0	
	VESBO® Hexagonal Female Adaptors are used as transition parts between VESBO® pipelines and metal ones, and are preferred mostly for permanent joints.						

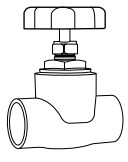
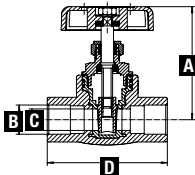
Hex. Male Adaptor

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.B21.GS0	32 x 1	36	Ø 60.0	76.0	Ø 42.0	
	112.1B.B21.HT0	40 x 1 1/4	20	Ø 74.5	86.0	Ø 51.2	
	112.1B.B21.IU0	50 x 1 1/2	16	Ø 75.0	87.0	Ø 66.0	
	112.1B.B21.JV0	63 x 2	12	Ø 85.0	102.0	Ø 84.8	
	112.1B.B21.KW0	75 x 2 1/2	8	Ø 100.0	108.0	Ø 99.0	
	VESBO® Hexagonal Male Adaptors are used in transitions from VESBO® pipelines to metal threaded parts and pipelines. These fittings are preferred mostly for permanent joints.						

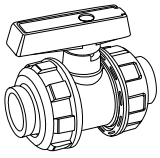
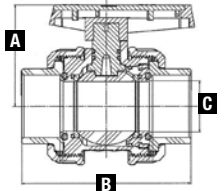
Valve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.C10.EQ0	20	33	85.0	Ø 19.0	78.0	
	112.1B.C10.FR0	25	30	85.0	Ø 24.0	77.0	
	112.1B.C10.GS0	32	18	90.0	Ø 31.0	82.0	
	112.1B.C10.HT0	40	15	98.0	Ø 39.0	83.0	
	112.1B.C10.IU0	50	10	102.0	Ø 49.0	99.0	
	112.1B.C10.JV0	63	4	114.0	Ø 62.0	120.0	
VESBO® Valves are used as on/off turns and flow regulating units in pipelines. For hot and cold water lines.							

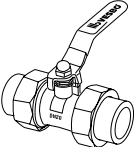
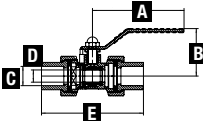
Valve Special

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	112.1B.C10.EQ1	20	27	73.5	Ø 19	Ø 14	78.0	
	112.1B.C10.FR1	25	24	79.0	Ø 24	Ø 18	79.0	
	112.1B.C10.GS1	32	18	86.5	Ø 31	Ø 22	86.5	
	112.1B.C10.HT1	40	15	101.0	Ø 39	Ø 28	88.0	
	112.1B.C10.IU1	50	10	110.5	Ø 49	Ø 33	99.0	
	112.1B.C10.JV1	63	4	121.0	Ø 62	Ø 39	115.0	
	VESBO® Valves Special are used as on/off turns and flow regulating units in pipelines. For hot and cold water lines.							

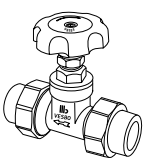
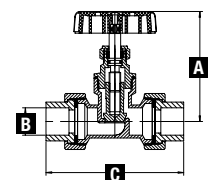
PP Ball Valve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	212.1B.A18.E00	20	30	48.0	83.0	15.0	
	212.1B.A18.F00	25	24	55.0	95.0	20.0	
	212.1B.A18.G00	32	16	65.0	105.0	25.0	
	212.1B.A18.H00	40	8	76.0	122.0	32.0	
	212.1B.A18.I00	50	6	87.0	143.0	40.0	
	212.1B.A18.J00	63	3	101.0	167.0	50.0	
	212.1B.A18.K00	75	2	113.0	202.0	65.0	
	212.1B.A18.L00	90	1	144.0	246.0	80.0	
	212.1B.A18.M00	110	1	157.0	284.0	100.0	
VESBO® PP Ball Valves are used as flow regulating units in cold water systems.							

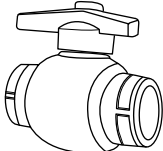
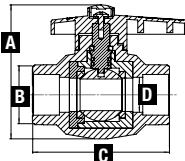
PP-R Brass Union Ball Valve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	E	TECHNICAL DRAWING
 Colors Available: 	212.1B.C50.EQ0	20	30	90.0	47.0	Ø 19.0	Ø 12.0	88.0	
	212.1B.C50.FR0	25	24	90.0	52.0	Ø 24.0	Ø 17.0	102.0	
	212.1B.C50.GS0	32	18	99.0	57.0	Ø 31.0	Ø 21.0	108.0	
	VESBO® PPR Brass Union Ball Valves serve the double functions of a union and a ball valve at the same time. For hot and cold water lines.								

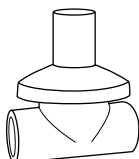
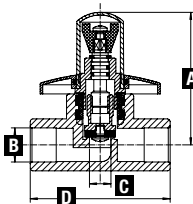
PP-R Brass Union Stop Valve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	212.1B.D10.EQ0	20	12	76.5	Ø 19.0	98.0	
	212.1B.D10.FR0	25	12	85.0	Ø 24.0	114.0	
	212.1B.D10.GS0	32	12	92.5	Ø 31.0	124.0	
	212.1B.D10.HT0	40	6	103	Ø 39.0	149.0	
VESBO® PPR Brass Union Stop Valves serve the double functions of a union and a stop valve at the same time. For hot and cold water lines.							

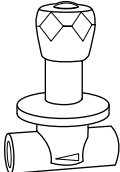
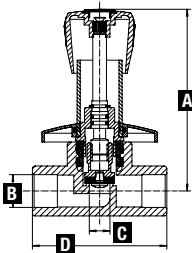
Plastic Ball Valve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	112.1B.C20.EQ0	20 x 1/2	40	72.0	Ø 28.5	76.0	Ø 16.6	
	112.1B.C20.FR0	25 x 3/4	32	80.0	Ø 34.6	82.0	Ø 21.0	
	112.1B.C20.GS0	32 x 1	18	95.0	Ø 44.7	98.0	Ø 27.0	
	VESBO® Ball Valves are preferred for their practical handles to regulate water flows. For hot and cold water lines.							

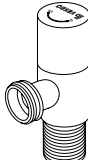
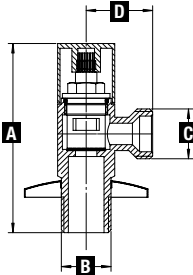
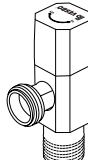
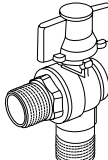
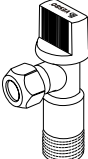
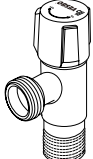
Chromium Valve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	112.1B.C30.EQ0	20 x 1/2	21	74.0	Ø 19.0	Ø 12.0	78.0	
	112.1B.C30.FR0	25 x 3/4	21	74.0	Ø 24.0	Ø 14.0	77.0	
	112.1B.C30.GS0	32 x 1	20	81.0	Ø 31.0	Ø 18.0	82.0	
	VESBO® Chromium Valves are stop valves preferred mostly for installations where aesthetics are important. For hot and cold water lines.							

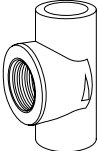
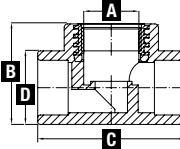
Chromium Valve - Long

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	112.1B.C40.EQ0	20	21	105.0	Ø 19.0	Ø 12.0	78.0	
	112.1B.C40.FR0	25	21	105.0	Ø 24.0	Ø 14.0	77.0	
	112.1B.C40.GS0	32	18	112.0	Ø 31.0	Ø 18.0	82.0	
	VESBO® Long Chromium Valves are stop valves preferred mostly for installations where aesthetics are important. For hot and cold water lines.							

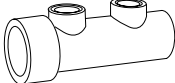
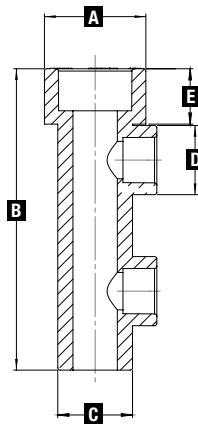
Angle Valve

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 101	212.10.H05.000	1/2 x 1/2	12	79.5	1/2"	1/2"	29.0	
	212.10.H06.000	1/2 x 1/2	12	79.5	1/2"	1/2"	29.0	
	212.10.H07.000	1/2 x 1/2	12	80.0	1/2"	1/2"	29.0	
	212.10.H04.000	1/2 x 1/2	12	79.5	1/2"	1/2"	29.0	
	212.10.H08.000	1/2 x 3/8	12	81.5	1/2"	Ø 10.5	31.0	
	212.10.H09.000	1/2 x 1/2	12	89.0	1/2"	1/2"	36.0	
VESBO® Angle Valves are designed for throttling or regulating angled flows in piping systems.								
 103								
 104								
 105								
 106								

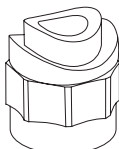
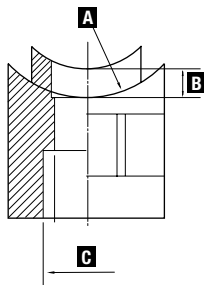
Valve T-Part

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	TECHNICAL DRAWING
 Colors Available: 	614.1B.B01.EQ0	20 x 1/2	60	38.15	29.10	76.75	44.55	
	614.1B.B01.FR0	25 x 3/4	40	45.00	34.05	77.95	44.70	
	614.1B.B01.GS0	32 x 1	32	53.00	42.00	82.40	56.10	
	VESBO® Valve T-Parts are used as valve houses.							

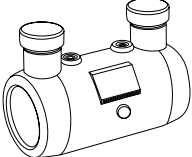
Collector

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	D	E	TECHNICAL DRAWING
 Colors Available: 	112.1B.A09.GE0	32-20	30	Ø 43.4	129.0	Ø 32.0	Ø 30.0	24.0	
	112.1B.A09.HE0	40-20	20	Ø 52.4	135.0	Ø 40.6	Ø 30.0	26.6	
	VESBO® Collectors provide direct installation of pipes to consumption points and minimise the use of fittings.								

Saddle

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX	A	B	C	TECHNICAL DRAWING
 Colors Available: 	112.1B.A12.IE0	50/20	180	Ø 50	6.0	Ø 19	
	112.1B.A12.IF0	50/25	180	Ø 50	6.0	Ø 24	
	112.1B.A12.JE0	63/20	150	Ø 63	8.0	Ø 19	
	112.1B.A12.JF0	63/25	150	Ø 63	8.0	Ø 24	
	112.1B.A12.KE0	75/20	150	Ø 75	10.0	Ø 19	
	112.1B.A12.KF0	75/25	150	Ø 75	10.0	Ø 24	
VESBO® Saddles are used to branch off or add auxiliary equipment, such as water meters or pressure gauges.							

E-fit Electro Socket

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
 Colors Available: 	212.1B.D01.E00	20	50
	212.1B.D01.F00	25	40
	212.1B.D01.G00	32	20
	212.1B.D01.H00	40	15
	212.1B.D01.I00	50	10
	212.1B.D01.J00	63	5
	212.1B.D01.K00	75	2
	212.1B.D01.L00	90	2
	212.1B.D01.M00	110	1
VESBO® EF Sockets are used to join two pipes with electrofusion method. This method is preferred at difficult-to-reach points where welding through hand fusion sets is a challenge, such as high points, corners, inside ducts and risers.			

► Tools & Accessories

Fusion Welding Machine

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
 	214.20.1D0.A00	Small Welding Set 20-32mm	1
	214.20.1D0.B00	Classic Welding Set 20-40mm	1
	214.10.1D0.E00	Maxi Welding Set 50-110mm	1
	214.10.1D0.F00	Desktop Welding Set 20-160mm	1
Fusion Welding Machines are used for joining pipes and fittings with socket fusion method. Desktop Welding Kits are recommended for pipe sizes of diameters >50mm.			

Welding Adaptor

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	214.10.1A0.E00	20	50
	214.10.1A0.F00	25	50
	214.10.1A0.G00	32	50
	214.10.1A0.H00	40	40
	214.10.1A0.I00	50	30
	214.10.1A0.J00	63	20
	214.10.1A0.K00	75	10
	214.10.1A0.L00	90	4
	214.10.1A0.M00	110	2
Welding Adaptors are used for heating and preparing pipe ends and fittings to be welded.			

Borer

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	192.10.A51.E00	20	1
	192.10.A51.F00	25	1
VESBO® Borers are used for drilling holes on pipes for welding of welds in saddles.			

Plastic Foil Shaver

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	214.10.3A0.EF0	20 - 25	1
	214.10.3A0.GH0	32 - 40	1
	214.10.3A0.HI0	40 - 50	1
Plastic Foil Shavers are used to remove the outer PP-R layer and the aluminium foil of the tips of VESBO® STABLE Pipes to be welded.			

Aluminium Foil Shaver

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	214.10.3B0.EF0	20 - 25	1
	214.10.3B0.GH0	32 - 40	1
	214.10.3B0.HI0	40 - 50	1
	214.10.3B0.IJ0	50 - 63	1
	214.10.3B0.KL0	75 - 90	1
	214.10.3B0.LM0	90 - 110	1
	Aluminium Foil Shavers are used to remove the outer PP-R layer and the aluminium foil of the tips of VESBO® STABLE Pipes to be welded.		

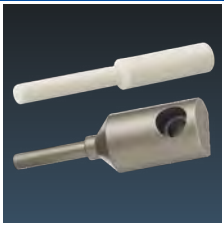
Pipe Weld Depth Template

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	114.1B.1I0.000	100mm / 4"	300
	VESBO® Pipe Weld Depth Templates are used to accurately mark weld lengths and depths of pipes.		
Color Available: 			

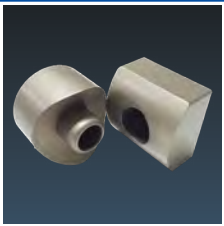
Cutters & Blades

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	214.10.2A0.E00	20 - 40	1
	214.10.2A0.H00	40 - 63	1
	214.10.2D0.P00	40-160	1
	214.10.2A4.000	Cutter Blade	
 Cutters are used to shorten pipes to required lengths.			

Pipe Repair Kits

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	214.10.1A0.020	Pipe Repair Adaptor 6mm	1
	214.10.1A0.010	Pipe Repair Adaptor 10mm	1
	112.1B.A11.000	PP-R Patching Stick	100
Pipe Repair Kits are used for repairing holes accidentally drilled on pipe surfaces.			

Saddle Welding Adaptor

PRODUCT PICTURE	ITEM CODE	SIZE (MM)	PCS/BOX
	192.10.A52.E00	20	1
	192.10.A52.F00	25	1
Saddle Welding Adaptors are used for welding of welds in saddles.			



06 JOINTS, FUSION & REPAIRS

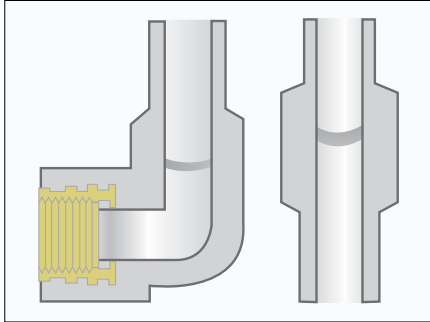


Fig. 18: VESBO® Homogeneous Joint and Fusion

► *Homogeneous Joint*

The result of a socket fusion or electrofusion joint is a homogeneous joint. This is one of the biggest advantages of using a VESBO® system:

- 100% leak-proof
- No maintenance
- Visual inspection possible
- Perfect for concealed installation that needs corrosion-free joining system

► *Fusion Tools*

- Socket Fusion Welding Tool
- Desktop Welding Machine
- Electrofusion Welding Kit

Please refer to respective operating manuals for specific welding applications.

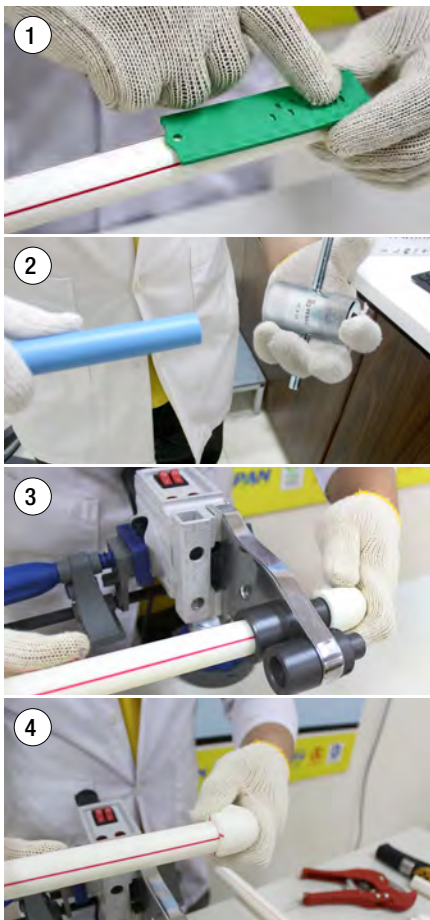


Fig. 19: VESBO® Four-step Fusion Process

► *Four-Step Fusion Process*

Step 1

Cut pipe to the required length using a cutter, mark the welding depth on the pipe, ensure that the indicator light on the welding tool signals that the tool is hot enough (260°C) for welding.

Step 2

The tip of the pipe to be welded is shaved by a special VESBO® shaver to remove the outside PP-R layer and the aluminium foil. (This step is applicable only to STABLE Pipes with aluminium foil.)

Step 3

Push the pipe and fitting into the welding adaptors, applying even strength at both ends. Do not twist or turn the pipe and fitting while pushing. Wait until heating time is reached. Refer to the table on section 6.5 for timing advice.

Step 4

When the welding time is reached, remove both the pipe and the fitting together, again without twisting or turning while pulling out of the welding adaptors. Almost immediately, push both the pipe and the fitting together until the depth is reached. It is possible to adjust the joints for more than 5 degrees during this time. The fusion process is now complete.

► Welding Depth, Heating, Welding and Cooling Time

The table below provides the necessary information for a good welding joint for various VESBO® pipe and fitting sizes. (It also applies to STABLE Pipes.)

T= 250-270°C

Pipe Diameter (mm)	Welding Depth (mm)	Heating Time (sec)	Welding Time(sec)	Cooling Time(min)
20	14.0	5	4	2
25	15.0	7	4	2
32	16.5	8	6	4
40	18.0	12	6	4
50	20.0	18	6	4
63	24.0	24	8	6
75	26.0	30	8	8
90	29.0	40	8	8
110	32.5	50	10	8
125	46	65	12	12
160	47	80	15	15

Table 6: VESBO® Pipe Diameters, Recommended Welding Joint Depths and Timing References

Note: **Heating time** starts when both the pipe and the fitting are pushed into the correct depth. **Welding time** begins when the joints are connected. **Cooling time** is the time taken for the joint to be completely cured. Never try to reduce cooling time by pouring water or any other means. At outdoor temperatures below +5°C heating time should be increased approximately by 50%.

► Pipe Repairs

Pipe with Nail Holes (Not Concealed)

If the damaged part of the pipe is not concealed (before a pressure test is conducted), it is advisable to cut and replace it with a new part through normal welding of a socket.

Pipe Concealed with Two Through Holes

Using electrofusion fittings (see Fig. 20):

1. Cut the damaged pipe perpendicularly by a length equal to that of the corresponding electric socket with an additional 2cm.
2. Remove the section of the damaged pipe.
3. Carefully clean the surfaces of the two pipe sections to be joined with sandpaper and solvent and wait till the parts of the pipe are perfectly dry.
4. Remove the inner stops from 2 electric sockets.
5. Fully insert the electric sockets into the pipe sections.
6. Cut a pipe section of the same diameter and length as the damaged one.
7. Fit into place, and slide the two electric sockets toward the middle of the new pipe piece by a section half the length of the socket.
8. Weld the socket using an electrofusion welding kit.

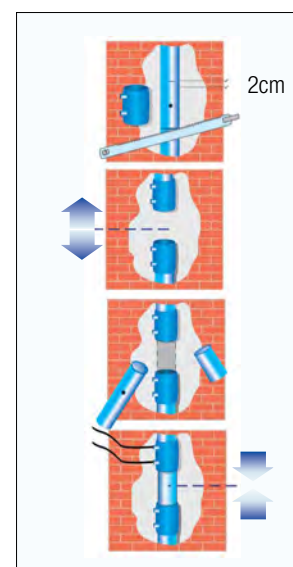


Fig. 20: Repair of Concealed Pipe with Electrofusion Welding

Pipe with One Nail Hole (Concealed)

With a pipe repair kit you can easily repair holes (max. 10mm diameter) on the surface of a pipe. This system makes the repairing process easier especially for pipes installed at places where it is difficult to reach. All you need are a welding kit, a pipe repairing socket, a pipe repairing stick and a drill with a 6mm or 10mm drill bit.



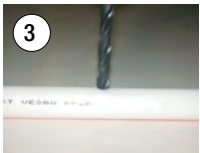
Step 1

Insert the repairing socket into the welding tool.



Step 2

Adjust the pipe clip on the socket according to the wall thickness of the pipe to be repaired. Adjust by adding a tolerance of +0.1mm to the wall thickness and moving the rings on the socket. The related data are given in Table 7.



Step 3

If the hole diameter on the pipe surface is equal to or smaller than 5mm, expand it with a 6mm drill bit. If it is equal to or smaller than 9mm, use a 10mm drill bit.



Step 4

Ensure that the welding tool is hot enough.



Step 5

Insert the hole to be repaired into the male part of the socket to heat the plastic around the hole, and insert the repairing stick into the female part of the socket to heat it.



Step 6

Adhere to heating, welding and cooling periods for a good welding joint. Increase the periods by 50% when the air temperature is below +5°C.



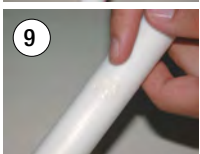
Step 7

Insert the pipe repairing stick without exceeding the pipe's wall thickness.



Step 8

Cut the remaining part after the stick cools down.



Step 9

After an hour, the pipe should be subjected to a pressure test with its normal operating pressure to leakages. If the pressure test is successful the repair is complete.

VESBO® Pipe	Outer Diameter (mm)	Wall Thick- ness (mm)	Depth of Socket Clip on the Socket (mm)
SDR 11	20	2.3	2.4
SDR 11	25	2.3	2.4
SDR 11	32	2.9	3.0
SDR 11	40	3.7	3.8
SDR 11	50	4.6	4.7
SDR 11	63	5.8	5.9
SDR 11	75	6.8	6.9
SDR 11	90	8.2	8.3
SDR 11	110	10.0	10.1
SDR 11	125	11.4	11.5
SDR 11	160	14.6	14.7
SDR 7.4	20	2.8	2.9
SDR 7.4	25	3.5	3.6
SDR 7.4	32	4.4	4.5
SDR 7.4	40	5.5	5.6
SDR 7.4	50	6.9	7.0
SDR 7.4	63	8.6	8.7
SDR 7.4	75	10.3	10.4
SDR 7.4	90	12.3	12.4
SDR 7.4	110	15.1	15.2
SDR 7.4	125	17.1	17.2
SDR 7.4	160	21.9	22.0
SDR 6	20	3.4	3.5
SDR 6	25	4.2	4.3
SDR 6	32	5.4	5.5
SDR 6	40	6.7	6.8
SDR 6	50	8.3	8.4
SDR 6	63	10.5	10.6
SDR 6	75	12.5	12.6
SDR 6	90	15.0	15.1
SDR 6	110	18.3	18.4
SDR 6	125	20.8	20.9
SDR 6	160	26.6	26.7

Table 7: Recommendations for Repairing VESBO® Pipes with One Nail Hole

07 INSTALLATION TECHNIQUE

► Installation

Installation for VESBO® piping system is similar to that for conventional piping systems, except for its superior **leakproof** fusion joining system.

However, there are finer points and guidelines that need special attention when installing VESBO® PP-R pipes.

► Support Intervals

For visible piping works that need aesthetic attention, proper support intervals are necessary. This will prevent unsightly but common “snaking” or sagging found in plastic pipe systems.

Temperature	Pipe Support Intervals (mm) for VESBO® Pipes PN10 (SDR11) & PN20 (SDR6)											Pipe Support Intervals (mm) for VESBO® Pipes PN25 (STABLE Pipes)									
	VESBO® Pipe Diameter (mm)											VESBO® Pipe Diameter (mm)									
	20	25	32	40	50	63	75	90	110	125	160	20	25	32	40	50	63	75	90	110	
20°C	600	750	900	1000	1200	1400	1500	1600	1800	1800	2000	1200	1300	1500	1700	1900	2100	2200	2300	2500	
30°C	600	750	900	1000	1200	1400	1500	1600	1800	1800	2000	1200	1300	1500	1700	1900	2100	2200	2300	2400	
40°C	600	700	800	900	1100	1300	1400	1500	1700	1700	1900	1100	1200	1400	1600	1800	2000	2100	2200	2300	
50°C	600	700	800	900	1100	1300	1400	1500	1700	1700	1900	1100	1200	1400	1600	1800	2000	2100	2200	2100	
60°C	550	650	750	850	1000	1150	1250	1400	1600	1600	1800	1000	1100	1300	1500	1700	1900	2000	2100	2000	
70°C	500	600	700	800	950	1050	1150	1250	1400	1400	1600	900	1000	1200	1400	1600	1800	1900	2000	2000	

Table 8: Pipe Support Intervals for VESBO® Pipes PN10 (SDR11), PN20 (SDR6) and PN25 (STABLE Pipes)

► Exposed Installation

Ducts / Cold Water Risers

Expansion joints are not necessary as **VESBO® cold water pipes have practically no linear expansion**. Vertical support is however necessary like any other piping system.

Ceilings & Walls

During the planning and laying of visible pipes for hot water on ceilings or walls, besides taking into account the support intervals, special attention must be given to linear expansion due to temperature variations. This will also prevent sagging and “snaking” of pipe lines. However **no consideration is necessary for VESBO® STABLE Pipes**. Hence, to prevent unsightly installations, an appropriate procedure must be observed (please see next page).

► Linear Expansion

For transportation of hot water, like all metal or plastic pipes, we have to deal with its linear expansion. This applies only to PN20 (SDR6) pipes for hot water applications. No consideration is necessary for PN25 STABLE Pipes as the coefficient of linear expansion is $3.0 \times 10^{-5} (K^{-1})$. **The coefficient of linear expansion for VESBO® PN20 (SDR6) pipes is $15.0 \times 10^{-5} (K^{-1})$.**

Step 1: Determine the Linear Expansion

By Calculation Formula

$$\Delta l = \alpha \times L \times \Delta t$$

Where

Δl = linear expansion, mm

α = coeff. of linear expansion, constant for VESBO® pipes, 0.15mm/mk

L = pipe length, m

Δt = temperature difference between normal water temperature and desired operating hot water temperature, k

Example:

Pipe of diameter 25mm, length 1.5m, normal cold water temperature is 25°C and hot water from water heater is set at 60°C.

$$\begin{aligned}\Delta l &= \alpha \times L \times \Delta t \\ &= 0.15 \times 1.5 \times 35\end{aligned}$$

Linear expansion is 7.88~8mm

By Reading Off Table PN20 (SDR6)

Pipe Length L (m)	Linear Expansion Δl (k) vs Difference in Temperatures Δt (k)									
	10	20	30	40	50	60	70	80	90	100
0.1	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50
0.2	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
0.3	0.45	0.90	1.35	1.80	2.25	2.70	3.15	3.60	4.05	4.50
0.4	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.5	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50
0.6	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
0.7	1.05	2.10	3.15	4.20	5.25	6.30	7.35	8.40	9.45	10.50
0.8	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80	12.00
0.9	1.35	2.70	4.05	5.40	6.75	8.10	9.45	10.80	12.15	13.50
1.0	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00
1.5	2.25	4.50	6.75	9.00	11.25	13.50	15.75	18.00	20.25	22.50
2.0	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00	27.00	30.00
2.5	3.75	7.50	11.25	15.00	18.75	22.50	26.25	30.00	33.75	37.50
3.0	4.50	9.00	13.50	18.00	22.50	27.00	31.50	36.00	40.50	45.00
3.5	5.25	10.50	15.75	21.00	26.25	31.50	36.75	42.00	47.25	52.50
4.0	6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00	60.00
4.5	6.75	13.50	20.25	27.00	33.75	40.50	47.25	54.00	60.75	67.50
5.0	7.50	15.00	22.50	30.00	37.50	45.00	52.50	60.00	67.50	75.00
5.5	8.25	16.50	24.75	33.00	41.25	49.50	57.75	66.00	74.25	82.50
6.0	9.00	18.00	27.00	36.00	45.00	54.00	63.00	72.00	81.00	90.00
6.5	9.75	19.50	29.25	39.00	48.75	58.50	68.25	78.00	87.75	97.50
7.0	10.50	21.00	31.50	42.00	52.50	63.00	73.50	84.00	94.50	105.00
7.5	11.25	22.50	33.75	45.00	56.25	67.50	78.75	90.00	101.25	112.50
8.0	12.00	24.00	36.00	48.00	60.00	72.00	84.00	96.00	108.00	120.00
8.5	12.75	25.50	38.25	51.00	63.75	76.50	89.25	102.00	114.75	127.50
9.0	13.50	27.00	40.50	54.00	67.50	81.00	94.50	108.00	121.50	135.00
9.5	14.25	28.50	42.75	57.00	71.25	85.50	99.75	114.00	128.25	142.50
10.0	15.00	30.00	45.00	60.00	75.00	90.00	105.00	120.00	135.00	150.00

Table 9: Table PN20 (SDR6) – Linear Expansion Δl (k) vs Difference in Temperatures Δt (k)

Note: For PN25 (STABLE), the above can be obtained by dividing corresponding figures by 5.

Step 2

Once the linear expansion is established, compensation for this expansion can be made either by an **Expansion Elbow** or an **Expansion Loop**.

The Expansion Elbow method uses the principle of directional change (elbow joint) to compensate for linear expansion. Where compensation with directional change is not possible, i.e., a straight pipe length passing through pipe sleeves and in between two beams, the Expansion Loop method is recommended.

Expansion Elbow

FS = Fixed Support SS = Sliding Support
EA = Elbow Arm

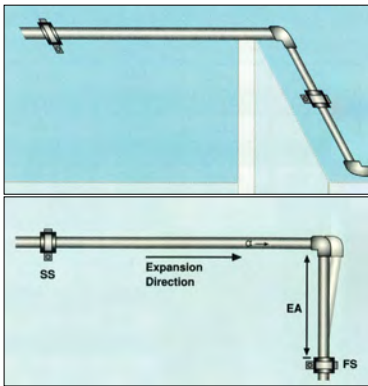


Fig. 21: Expansion Elbow Method

Formula to determine EA length:

$$EA = K \times (d \times \Delta l)^{1/2}$$

Where

K = constant, 15

Δl = linear expansion

d = pipe diameter

Note: In an elbow expansion joint, the FS must be located at the EA section and the EA perpendicular to direction of expansion.

Example:

Pipe of diameter 25mm, length of 1.5m, normal cold water temperature is 25°C and hot water from water heater is set at 60°C.

$$\begin{aligned} EA &= K \times (d \times \Delta l)^{1/2} \\ &= 15 \times (25 \times 8)^{1/2} \\ &= 212.13 \sim 212\text{mm} \end{aligned}$$

Expansion Loop

FS = Fixed Support SS = Sliding Support
EA = Elbow Arm

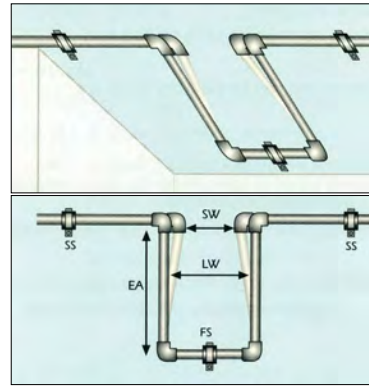


Fig. 22: Expansion Loop Method

Formula to determine Loop Width, LW:

$$LW = (2 \times \Delta l) + SW$$

Where

SW = Safety Width, assigned as 150mm

Δl = Linear expansion

Note: In an expansion loop, the FS is located at the pipe section of LW. All other pipe supports must be SS. Calculation of EA is the same as above Expansion elbow example.

Example:

Pipe of diameter 25mm, length of 1.5m, normal cold water temperature is 25°C and hot water from water heater is set at 60°C.

$$\begin{aligned} LW &= (2 \times \Delta l) + SW \\ &= (2 \times 8) + 150 \\ &= 166\text{mm} \end{aligned}$$

► Concealed Installation

In concealed installations for both cold and hot water pipelines, **linear expansion need not be taken into account.** VESBO® pipes may be encased or embedded in walls, concrete and plaster as with other metal pipes.

The expansion of a pipe due to temperature variations will not damage the wall plastering as the linear expansion is prevented by the compressive strain and tensile stress of concrete and plaster, which is absorbed by the material itself.

► Insulation

Hot Water System

Normally in tropical countries, it is not necessary to insulate VESBO® hot water piping systems for interior or concealed installations. This is due to the low thermal conductivity property of VESBO® pipe materials (0.24W/mk). Heat loss will be minimum. However, for applications where a central boiler used for distribution and continuous circulation of hot water, it is necessary to insulate distribution lines to prevent excessive heat loss and energy wastage. **Because of the low thermal conductivity of VESBO® pipes, insulation thickness is greatly reduced.**

Thermal Conductivity of Insulation Material (W/mk)	0.030	0.035
Dimension (mm)	Recommended Minimum Insulation Thickness	
20	6mm or 1/4"	10mm or 3/8"
25	6mm or 1/4"	10mm or 3/8"
32	10mm or 3/8"	13mm or 1/2"
40	10mm or 3/8"	13mm or 1/2"
50	10mm or 3/8"	13mm or 1/2"
63	13mm or 1/2"	20mm or 1/2"
75	20mm or 1/2"	20mm or 1/2"
90	20mm or 1/2"	25mm or 3/4"
110	25mm or 3/4"	32mm or 1"
125	32mm or 1"	40mm or 1 1/4"
160	50mm or 2"	63mm or 2 1/2"

Table 10: Recommended Insulation Thicknesses for Exposed VESBO® Pipes in Hot Water Systems

Chilled Water System

For VESBO® piping systems working with chilled water of temperatures less than 10°C, **insulation against condensation is necessary but thickness is reduced considerably** as compared with metal pipes. Heat loss for hot water pipe is reduced to a minimum.

Table 12 shows the recommended insulation thicknesses for VESBO® pipes of various dimensions in cold countries and chilled water systems to prevent condensation.

OD (mm)	Materials and Layers	PE Overcoat OD (mm) × S (mm)	PUR Isolation Thickness (mm)
Ø 20	PP-R Pipe, PUR Insulation, PE/GS Jacket	75 × 2.2	25.3
Ø 25	PP-R Pipe, PUR Insulation, PE/GS Jacket	75 × 2.2	22.8
Ø 32	PP-R Pipe, PUR Insulation, PE/GS Jacket	90 × 2.2	26.8
Ø 40	PP-R Pipe, PUR Insulation, PE/GS Jacket	110 × 2.5	32.5
Ø 50	PP-R Pipe, PUR Insulation, PE/GS Jacket	110 × 2.5	27.5
Ø 63	PP-R Pipe, PUR Insulation, PE/GS Jacket	125 × 2.5	28.5
Ø 75	PP-R Pipe, PUR Insulation, PE/GS Jacket	140 × 3	29.5
Ø 90	PP-R Pipe, PUR Insulation, PE/GS Jacket	160 × 3	32.0
Ø 110	PP-R Pipe, PUR Insulation, PE/GS Jacket	200 × 3.2	41.8
Ø 125	PP-R Pipe, PUR Insulation, PE/GS Jacket	200 × 3.2	41.8
Ø 160	PP-R Pipe, PUR Insulation, PE/GS Jacket	225 × 3.5	29.0

Table 11: Recommended Insulation Thicknesses for Exposed VESBO® Pipes in Chilled Water Systems

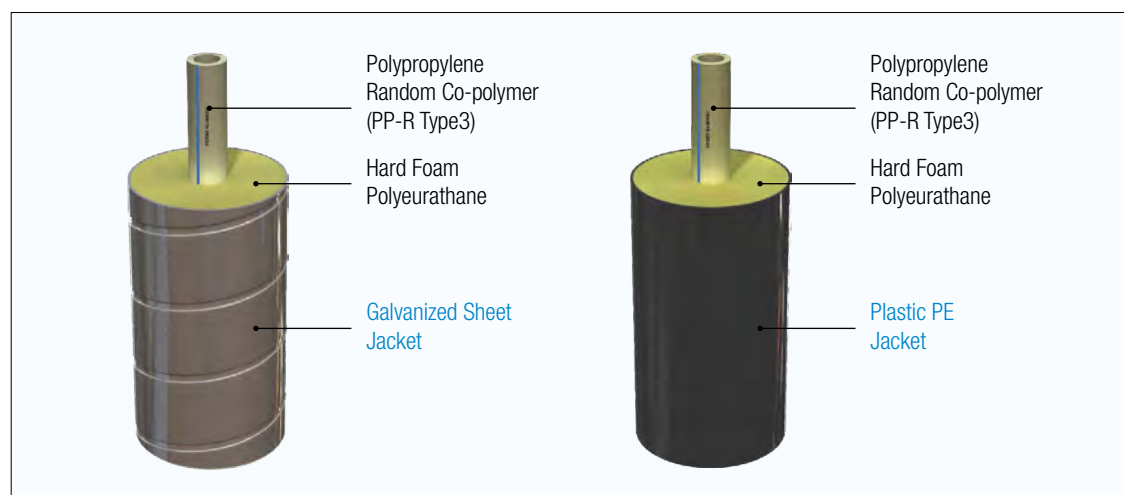


Fig. 23: Common Insulation Materials for VESBO® Pipes in Chilled Water Systems

► Pressure Test

It is necessary to subject a VESBO® piping system to a pressure test after a completed installation. VESBO® piping systems, unlike metal ones but similar to all other plastic ones, need to follow a specific pressure test procedure owing to mechanical properties of expansion when subjected to pressure temperature differences and coefficient of expansion.

A change in temperature of 10k corresponds to a pressure change of 0.5-1.0 bar. Thus, the test medium shall as far as possible be kept at a constant temperature throughout the test.

The test is to be conducted according to **DIN 1988 Part 2 or BS 6700: 2006**.

Preparation for Filling & Testing the System

1. For pressure testing, pressure gauges that allow reading of changes in pressure of 0.1 bar shall be used, fitted at the lowest possible point in the system.
2. Pressure testing for leakages must be conducted while pipe works are still accessible and before concealing or plastering.
3. Finished pipe work must be completely fitted with filtered water and vented.

Test Procedure

After the pipe work is filled with water and completely vented to release air locks in the system, testing may begin:

Step 1

Produce the test pressure (=permissible working pressure + 5 bars), two times within 30 minutes at 10-minute intervals.

Note: If there is a pressure drop, restore by hand pump to the required test pressure after the 10 minute-interval. leakage is detected, rectify the leakage area and repeat the procedure.

Step 2

If no leakage is detected, for the next 30 minutes check if the pressure has dropped by more than 0.6 bars and if there is any visible signs of leakage.

Note: if leakage is detected, rectify the leakage area and repeat the procedure. If pressure drops by more than 0.6 bars within this period, leakage must have occurred. Detect and rectify.

Step 3

If pressure drop is within 0.6 bars and no leakage is detected, continue the test without restoring the required pressure for the next 120 minutes. During this time, check if the pressure drop is more than 0.2 bars and no leakage is detected.

Note: if leakage is detected, rectify the leakage area and repeat the procedure. If pressure drops by more than 0.2 bars within this period, leakage must have occurred. Detect, rectify and repeat procedure.

Step 4

Pressure test is successful when all the above are met and readings recorded.

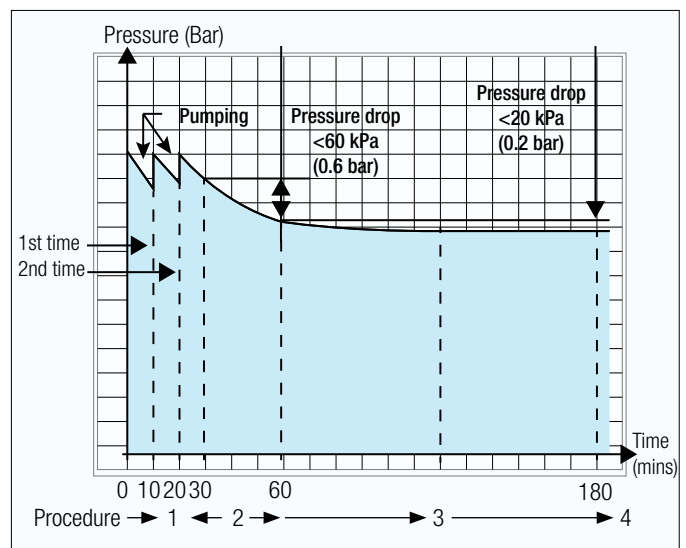


Fig. 24: Graphical Representation of Pressure Test Procedure

► Test Record

Below is a recommended record format for pressure test:

VESBO® System Installation – Pressure Test Record				
Development:				
Client / Owner:		Date of Installation:		
Address:		Date of Pressure Test:		
	Pressure Reading (Bar / P.S.I.)	Results (Pass / Fail)	Test Criteria	Remarks
Test Procedure (1)				
Pump to required test pressure, check for leakage			Check for leakage	
1st 10 min. record reading, restore to test pressure			Check for leakage	
2nd 10 min. record reading, restore to test pressure			Check for leakage	
Test Procedure (2)				
Next 30 min. record reading, do not restore to test pressure			Pressure drop <0.6 Bars and no leakage	
Test Procedure (3)				
Next 120 min. record reading			Pressure drop <0.2 Bars and no leakage	

Fig. 25: Pressure Test Record Format



08 SPECIFICATION & PLANNING

► Product Specification

Trade name: **VESBO®**

Materials

Polypropylene Random Copolymer (PP-R Type 3). Abbreviation: PP-R 80 or PP-R or PP-RC

Materials for pipes and fittings for hot and cold water supply shall be tested with proof and certification for long-term hydrostatic tests at 110°C for 8,760 hours.

Standards

- DIN 8077:2008
- DIN 8078:2008
- DIN 16962-1 TO 12
- ISO 15874-1: 2013
- ISO 15874-2: 2013
- ISO 15874-3: 2013
- ISO 15874-5: 2013
- ISO 15874-7: 2003
- GBT 18742-1: 2002
- GBT 18742-2: 2002
- GBT 18742-3: 2002
- BS 6920: 2000
- AS/NZS 4020: 2005
- BS EN 12163: 1998

To interface with other fittings, VESBO® PP-R threaded male or female fittings with brass inserts comply with BS 6920 for use on drinking water. These brass fittings are injection moulded, and threads are of BS parallel and plated with nickel chrome plating or without can be requested. All fittings shall be produced in accordance with descriptions in the prescribed standards.

Descriptions and Dimensions of Pipes

Application: Hot and Cold Water
Description: **PN20 (SDR6) Pipe**
Pressure Rating: 20 Bar or 290 p.s.i

Dimension, OD (mm)	Thickness (mm)
20	3.4
25	4.2
32	5.4
40	6.7
50	8.3
63	10.5
75	12.5
90	15.0
110	18.3
125	20.8
160	26.6

Application: Cold Water
Description: **PN10 (SDR11) Pipe**
Pressure Rating: 10 Bar or 145 p.s.i

Dimension, OD (mm)	Thickness (mm)
20	1.9
25	2.3
32	2.9
40	3.7
50	4.6
63	5.8
75	6.8
90	8.2
110	10.0
125	11.4
160	14.6

Application: Hot and Cold Water
Description: **PN16 (SDR7.4) Pipe**
Pressure Rating: 16 Bar or 232 p.s.i

Dimension, OD (mm)	Thickness (mm)
20	2.8
25	3.5
32	4.4
40	5.5
50	6.9
63	8.6
75	10.3
90	12.3
110	15.1
125	17.1
160	21.9

Table 12: Descriptions and Dimensions of VESBO® PP-R Pipes

Fittings

All VESBO® pipes must be used in conjunction with VESBO® PP-R fittings and VESBO® PP-R fittings with DZR brass inserts.

Thermal Conductivity

The thermal conductivity of pipes and fittings shall not exceed 0.24 W/mk at 20°C for water.

Installation

VESBO® PP-R pipes and fittings must be installed in accordance with the instructions given by the manufacturer's recommendations and those as stated in:

- **DIN 16928:** Pipes of Thermoplastic, Pipe Fittings, Elements of Pipes Laying
- **DVS 2207, PART 11:** Welding of Thermoplastic Materials, PP Pipes and Fittings
- **DVS 2208, PART 1:** Machines and Equipment for Welding of PP

Pressure Test and Requirement

Before the commissioning of pipe works, procedures and requirements specified by relevant local water authorities must be adhered to. For pressure test, **DIN 1988 Part 2** or **BS 6700** is used.

► Other Pipe Equivalents

VESBO PP-R Pipes O.D. (mm)	Equivalence (inches)	Copper Tubes Nom. DIA (mm)
20	1/2	15
25	5/8	20
32	3/4	22
40	1	25
50	1 1/4	32
63	1 1/2	40
75	2	50
90	2 1/2	65
110	3	80
125	3 1/2	90
160	5	125

Table 13: VESBO® PP-R Pipe Equivalents

► Pipe Sizing

During the design stage, pipe sizes are determined by types of pipe to be used, flow rate required, and pressure loss due to piping system for both pipes and fittings. The information in the following pages will assist the engineer to optimise the usage of VESBO® PP-R piping system.

VESBO® Pipe SDR11 (PN10)

Pipe friction factor **R** and calculated flow rate $\dot{V}$
in dependence of the flow velocity **V**

Roughness: 0.0070mm

Temperature: **20°C**

Density: **998.00 kg/m³**

Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR11 (PN10)

$\dot{V}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d x s ▶		20 x1.9	25x2.3	32x2.9	40x3.7	50x4.6	63x5.8	75x6 .8	90x8.2	110x10.0	125x11.4	160x14.6
$\dot{V}$	d _i ▶	15.4mm	20.4mm	26.2mm	32.6mm	40.8mm	51.4mm	61.4mm	73.6mm	90.0mm	102.2mm	130.8mm
0.01	R	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
0.02	R	0.16	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.10	0.06	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00
0.03	R	0.31	0.10	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.15	0.09	0.06	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.00
0.04	R	0.50	0.17	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.19	0.12	0.07	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00
0.05	R	0.74	0.25	0.08	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.24	0.15	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.01	0.00
0.06	R	1.01	0.34	0.10	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.29	0.18	0.11	0.07	0.05	0.03	0.02	0.01	0.01	0.01	0.00
0.07	R	1.31	0.44	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.34	0.21	0.13	0.08	0.05	0.03	0.02	0.02	0.01	0.01	0.01
0.08	R	1.65	0.55	0.17	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.39	0.24	0.15	0.10	0.06	0.04	0.03	0.02	0.01	0.01	0.01
0.09	R	2.03	0.68	0.21	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.44	0.28	0.17	0.11	0.07	0.04	0.03	0.02	0.01	0.01	0.01
0.10	R	2.43	0.81	0.25	0.09	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.49	0.31	0.19	0.12	0.08	0.05	0.03	0.02	0.02	0.01	0.01
0.12	R	3.35	1.12	0.34	0.12	0.04	0.01	0.01	0.00	0.00	0.00	0.00
	v	0.58	0.37	0.22	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01
0.16	R	5.54	1.84	0.56	0.20	0.07	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.78	0.49	0.30	0.19	0.12	0.08	0.05	0.04	0.03	0.02	0.01
0.18	R	6.82	2.27	0.69	0.24	0.08	0.03	0.01	0.01	0.00	0.00	0.00
	v	0.87	0.55	0.33	0.22	0.14	0.09	0.06	0.04	0.03	0.02	0.01
0.20	R	8.22	2.73	0.83	0.29	0.10	0.03	0.01	0.01	0.00	0.00	0.00
	v	0.97	0.61	0.37	0.24	0.15	0.10	0.07	0.05	0.03	0.02	0.01
0.30	R	16.90	5.57	1.68	0.59	0.20	0.07	0.03	0.01	0.00	0.00	0.00
	v	1.46	0.92	0.56	0.36	0.23	0.14	0.10	0.07	0.05	0.04	0.02
0.40	R	28.31	9.30	2.80	0.98	0.34	0.11	0.05	0.02	0.01	0.00	0.00
	v	1.94	1.22	0.74	0.48	0.31	0.19	0.14	0.09	0.06	0.05	0.03
0.50	R	42.36	13.86	4.15	1.46	0.50	0.17	0.07	0.03	0.01	0.01	0.00
	v	2.43	1.53	0.93	0.60	0.38	0.24	0.17	0.12	0.08	0.06	0.04
0.60	R	58.99	19.24	5.75	2.01	0.69	0.23	0.10	0.04	0.02	0.01	0.00
	v	2.91	1.84	1.11	0.72	0.46	0.29	0.20	0.14	0.09	0.07	0.04
0.70	R	78.16	25.41	7.57	2.65	0.90	0.30	0.13	0.05	0.02	0.01	0.00
	v	3.40	2.14	1.30	0.84	0.54	0.34	0.24	0.16	0.11	0.09	0.05
0.80	R	99.83	32.37	9.62	3.36	1.14	0.38	0.16	0.07	0.03	0.01	0.00
	v	3.88	2.45	1.48	0.96	0.61	0.39	0.27	0.19	0.13	0.10	0.06

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm
Temperature: **20°C**
Density: **998.00 kg/m³**
Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR11 (PN10)

		$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)				v = flow velocity (m/s)				
d x s ▶		20 x1.9	25x2.3	32x2.9	40x3.7	50x4.6	63x5.8	75x6 .8	90x8.2	110x10.0	125x11.4	160x14.6
$\dot{v}$	d _i ▶	15.4mm	20.4mm	26.2mm	32.6mm	40.8mm	51.4mm	61.4mm	73.6mm	90.0mm	102.2mm	130.8mm
0.90	R	123.97	40.10	11.90	4.14	1.41	0.47	0.20	0.08	0.03	0.02	0.01
	v	4.37	2.75	1.67	1.08	0.69	0.43	0.30	0.21	0.14	0.11	0.07
1.00	R	150.58	48.60	14.39	5.00	1.70	0.56	0.24	0.10	0.04	0.02	0.01
	v	4.85	3.06	1.85	1.20	0.76	0.48	0.34	0.24	0.16	0.12	0.07
1.20	R	211.10	67.87	20.02	6.94	2.35	0.78	0.33	0.14	0.05	0.03	0.01
	v	5.82	3.67	2.23	1.44	0.92	0.58	0.41	0.28	0.19	0.15	0.09
1.40	R	281.32	90.12	26.49	9.17	3.10	1.02	0.44	0.18	0.07	0.04	0.01
	v	6.79	4.28	2.60	1.68	1.07	0.67	0.47	0.33	0.22	0.17	0.10
1.60	R	361.15	115.34	33.81	11.67	3.94	1.30	0.55	0.23	0.09	0.05	0.01
	v	7.76	4.90	2.97	1.92	1.22	0.77	0.54	0.38	0.25	0.20	0.12
1.80	R	450.55	143.49	41.95	14.45	4.87	1.60	0.68	0.29	0.11	0.06	0.02
	v	8.7 3	5.51	3.34	2.16	1.38	0.87	0.61	0.42	0.28	0.22	0.13
2.00	R	549.50	174.56	50.90	17.51	5.89	1.93	0.82	0.34	0.13	0.07	0.02
	v	9.70	6.12	3.71	2.40	1.53	0.96	0.68	0.47	0.31	0.24	0.15
2.20	R	657.95	208.53	60.67	20.83	7.00	2.29	0.98	0.41	0.16	0.08	0.03
	v	10.67	6.73	4.08	2.64	1.68	1.06	0.74	0.52	0.35	0.27	0.16
2.40	R	775.89	245.39	71.25	24.42	8.20	2.68	1.14	0.48	0.18	0.10	0.03
	v	11.64	7.34	4.45	2.88	1.84	1.16	0.81	0.56	0.38	0.29	0.18
2.60	R	903.30	285.14	82.62	28.28	9.48	3.10	1.32	0.55	0.21	0.11	0.04
	v	12.61	7.95	4.82	3.11	1.99	1.25	0.88	0.61	0.41	0.32	0.19
2.80	R	1,040.16	327.76	94.79	32.40	10.85	3.54	1.50	0.63	0.24	0.13	0.04
	v	13.58	8.57	5.19	3.35	2.14	1.35	0.95	0.66	0.44	0.34	0.21
3.00	R	1,186.48	373.24	107.76	36.78	12.30	4.01	1.70	0.71	0.27	0.15	0.05
	v	14.55	9.18	5.56	3.59	2.29	1.45	1.01	0.71	0.47	0.37	0.22
3.20	R	1,342.23	421.59	121.52	41.42	13.84	4.51	1.91	0.80	0.30	0.17	0.05
	v	15.52	9.79	5.94	3.83	2.45	1.54	1.08	0.75	0.50	0.39	0.24
3.40	R	1,507.41	472.79	136.07	46.33	15.46	5.03	2.13	0.89	0.34	0.18	0.06
	v	16.50	10.40	6.31	4.07	2.60	1.64	1.15	0.80	0.53	0.41	0.25
3.60	R	1,682.01	526.85	151.41	51.49	17.16	5.58	2.36	0.99	0.37	0.20	0.06
	v	17.47	11.01	6.68	4.31	2.75	1.73	1.22	0.85	0.57	0.44	0.27
3.80	R	1,866.03	583.75	167.53	56.91	18.95	6.16	2.60	1.09	0.41	0.22	0.07
	v	18.44	11.63	7.05	4.55	2.91	1.83	1.28	0.89	0.60	0.46	0.28
4.00	R	2,059.46	643.50	184.44	62.58	20.82	6.76	2.86	1.19	0.45	0.25	0.08
	v	19.41	12.24	7.42	4.79	3.06	1.93	1.35	0.94	0.63	0.49	0.30
4.20	R	2,262.30	706.09	202.12	68.51	22.77	7.39	3.12	1.30	0.49	0.27	0.08
	v	20.38	12.85	7.79	5.03	3.21	2.02	1.42	0.99	0.66	0.51	0.31
4.40	R	2,474.55	771.52	220.59	74.70	24.81	8.04	3.40	1.41	0.54	0.29	0.09
	v	21.35	13.46	8.16	5.27	3.37	2.12	1.49	1.03	0.69	0.54	0.33
4.60	R	2,696.19	839.79	239.84	81.14	26.92	8.72	3.68	1.53	0.58	0.32	0.10
	v	22.32	14.07	8.53	5.51	3.52	2.22	1.55	1.08	0.72	0.56	0.34

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm
Temperature: **20°C**
Density: **998.00 kg/m³**
Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR11 (PN10)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d x s ▶		20 x1.9	25x2.3	32x2.9	40x3.7	50x4.6	63x5.8	75x6 .8	90x8.2	110x10.0	125x11.4	160x14.6
$\dot{v}$	d _i ▶	15.4mm	20.4mm	26.2mm	32.6mm	40.8mm	51.4mm	61.4mm	73.6mm	90.0mm	102.2mm	130.8mm
4.80	R	2,927.24	910.89	259.86	87.84	29.12	9.43	3.98	1.65	0.63	0.34	0.10
	v	23.29	14.69	8.90	5.75	3.67	2.31	1.62	1.13	0.75	0.59	0.36
5.00	R	3,167.68	984.83	280.67	94.79	31.40	10.16	4.28	1.78	0.68	0.37	0.11
	v	24.26	15.30	9.27	5.99	3.82	2.41	1.69	1.18	0.79	0.61	0.37
5.20	R	3,417.51	1,061.60	302.25	101.99	33.76	10.91	4.60	1.91	0.72	0.39	0.12
	v	25.23	15.91	9.65	6.23	3.98	2.51	1.76	1.22	0.82	0.63	0.39
5.40	R	3,676.74	1,141.21	324.60	109.44	36.20	11.69	4.93	2.05	0.78	0.42	0.13
	v	26.20	16.52	10.02	6.47	4.13	2.60	1.82	1.27	0.85	0.66	0.40
5.60	R	3,945.36	1,223.64	347.73	117.15	38.72	12.50	5.26	2.19	0.83	0.45	0.14
	v	27.17	17.13	10.39	6.71	4.28	2.70	1.89	1.32	0.88	0.68	0.42
5.80	R	4,223.36	1,308.90	371.63	125.10	41.32	13.33	5.61	2.33	0.88	0.48	0.15
	v	28.14	17.75	10.76	6.95	4.44	2.80	1.96	1.36	0.91	0.71	0.43
6.00	R	4,510.76	1,396.99	396.31	133.31	44.00	14.19	5.97	2.48	0.94	0.51	0.16
	v	29.11	18.36	11.13	7.19	4.59	2.89	2.03	1.41	0.94	0.73	0.45
6.20	R	4,807.54	1,487.91	421.76	141.77	46.76	15.07	6.34	2.63	0.99	0.54	0.16
	v	30.08	18.97	11.50	7.43	4.74	2.99	2.09	1.46	0.97	0.76	0.46
6.40	R	5,113.71	1,581.66	447.99	150.48	49.60	15.97	6.71	2.79	1.05	0.57	0.17
	v	31.05	19.58	11.87	7.67	4.90	3.08	2.16	1.50	1.01	0.78	0.48
6.60	R	5,429.26	1,678.23	474.98	159.44	52.52	16.90	7.10	2.95	1.11	0.60	0.18
	v	32.02	20.19	12.24	7.91	5.05	3.18	2.23	1.55	1.04	0.80	0.49
6.80	R	5,754.19	1,777.62	502.75	168.65	55.52	17.86	7.50	3.11	1.18	0.64	0.19
	v	32.99	20.80	12.61	8.15	5.20	3.28	2.30	1.60	1.07	0.83	0.51
7.00	R	6,088.51	1,879.84	531.29	178.11	58.59	18.84	7.91	3.28	1.24	0.67	0.20
	v	33.96	21.42	12.98	8.39	5.35	3.37	2.36	1.65	1.10	0.85	0.52
7.50	R	6,965.36	2,147.74	606.00	202.86	66.63	21.39	8.97	3.72	1.40	0.76	0.23
	v	36.39	22.95	13.91	8.99	5.74	3.61	2.53	1.76	1.18	0.91	0.56
8.00	R	7,900.83	2,433.28	685.53	229.16	75.17	24.10	10.10	4.18	1.58	0.85	0.26
	v	38.81	24.48	14.84	9.58	6.12	3.86	2.70	1.88	1.26	0.98	0.60
9.00	R	9,947.63	3,057.26	859.00	286.42	93.71	29.98	12.54	5.18	1.95	1.06	0.32
	v	43.66	27.54	16.69	10.78	6.88	4.34	3.04	2.12	1.41	1.10	0.67
10.00	R		3,751.74	1,051.68	349.88	114.21	36.45	15.23	6.29	2.37	1.28	0.39
	v		30.59	18.55	11.98	7.65	4.82	3.38	2.35	1.57	1.22	0.74
12.00	R		5,352.08	1,494.56	495.34	161.05	51.20	21.34	8.79	3.30	1.78	0.54
	v		36.71	22.26	14.38	9.18	5.78	4.05	2.82	1.89	1.46	0.89
14.00	R		7,234.15	2,014.06	665.47	215.64	68.33	28.40	11.67	4.37	2.36	0.71
	v		42.83	25.97	16.77	10.71	6.75	4.73	3.29	2.20	1.71	1.04
16.00	R			2,610.11	860.21	277.95	87.81	36.43	14.94	5.59	3.01	0.91
	v			29.68	19.17	12.24	7.71	5.40	3.76	2.52	1.95	1.19
18.00	R			3,282.66	1,079.54	347.96	109.65	45.40	18.59	6.94	3.73	1.13
	v			33.39	21.56	13.77	8.67	6.08	4.23	2.83	2.19	1.34

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm
Temperature: **20°C**
Density: **998.00 kg/m³**
Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR11 (PN10)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d x s ▶		20 x1.9	25x2.3	32x2.9	40x3.7	50x4.6	63x5.8	75x6 .8	90x8.2	110x10.0	125x11.4	160x14.6
$\dot{v}$	d _i ▶	15.4mm	20.4mm	26.2mm	32.6mm	40.8mm	51.4mm	61.4mm	73.6mm	90.0mm	102.2mm	130.8mm
20.00	R			4031.69	1,323.42	425.65	133.82	55.31	22.61	8.43	4.53	1.37
	v			37.10	23.96	15.30	9.64	6.75	4.70	3.14	2.44	1.49
22.00	R			4857.17	1,591.85	511.01	160.32	66.16	27.00	10.05	5.40	1.62
	v			40.81	26.36	16.83	10.60	7.43	5.17	3.46	2.68	1.64
24.00	R			5,759.09	1,884.80	604.03	189.14	77.94	31.77	11.81	6.34	1.90
	v			44.52	28.75	18.36	11.57	8.11	5.64	3.77	2.93	1.79
26.00	R				2,202.27	704.71	220.29	90.66	36.90	13.70	7.35	2.21
	v				31.15	19.89	12.53	8.78	6.11	4.09	3.17	1.93
28.00	R				2,544.25	813.03	253.75	104.30	42.40	15.72	8.42	2.53
	v				33.55	21.42	13.49	9.46	6.58	4.40	3.41	2.08
30.00	R				2,910.74	928.99	289.53	118.87	48.27	17.87	9.57	2.87
	v				35.94	22.95	14.46	10.13	7.05	4.72	3.66	2.23

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

VESBO Pipe SDR6 (PN20)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm
Temperature: **20°C**
Density: **998.00 kg/m³**
Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR6 (PN20)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d x s ▶		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15	110x18.3	125x20.8	160x26.6
$\dot{v}$	d _i ▶	13.2mm	16.6mm	21.2mm	26.6mm	33.4mm	42.0mm	50.0mm	60.0mm	73.4mm	83.4mm	106.8mm
0.01	R	0.13	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.07	0.05	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.02	R	0.28	0.10	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.15	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00
0.03	R	0.79	0.27	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.22	0.14	0.08	0.05	0.03	0.02	0.02	0.01	0.01	0.00	0.00
0.04	R	1.36	0.42	0.13	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.30	0.18	0.11	0.07	0.05	0.03	0.02	0.02	0.01	0.01	0.00

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm
Temperature: **20°C**
Density: **998.00 kg/m³**
Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR6 (PN20)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d x s ▶		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15	110x18.3	125x20.8	160x26.6
$\dot{v}$	d _i ▶	13.2mm	16.6mm	21.2mm	26.6mm	33.4mm	42.0mm	50.0mm	60.0mm	73.4mm	83.4mm	106.8mm
0.05	R	1.96	0.64	0.20	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.37	0.23	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01	0.01
0.06	R	2.65	0.90	0.28	0.10	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.44	0.28	0.17	0.11	0.07	0.04	0.03	0.02	0.01	0.01	0.01
0.07	R	3.44	1.14	0.37	0.13	0.04	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.51	0.32	0.20	0.13	0.08	0.05	0.04	0.03	0.02	0.01	0.01
0.08	R	4.31	1.47	0.47	0.15	0.05	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.58	0.37	0.23	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01
0.09	R	5.40	1.84	0.55	0.19	0.06	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.66	0.42	0.25	0.16	0.10	0.07	0.05	0.03	0.02	0.02	0.01
0.10	R	6.44	2.15	0.67	0.23	0.07	0.03	0.01	0.00	0.00	0.00	0.00
	v	0.73	0.46	0.28	0.18	0.11	0.07	0.05	0.04	0.02	0.02	0.01
0.12	R	8.93	2.95	0.94	0.33	0.11	0.04	0.02	0.01	0.00	0.00	0.00
	v	0.88	0.55	0.34	0.22	0.14	0.09	0.06	0.04	0.03	0.02	0.01
0.14	R	11.56	3.95	1.24	0.41	0.14	0.05	0.02	0.01	0.00	0.00	0.00
	v	1.02	0.65	0.40	0.25	0.16	0.10	0.07	0.05	0.03	0.03	0.02
0.16	R	14.70	4.95	1.53	0.53	0.17	0.06	0.03	0.01	0.00	0.00	0.00
	v	1.17	0.74	0.45	0.29	0.18	0.12	0.08	0.06	0.04	0.03	0.02
0.18	R	18.16	6.05	1.90	0.63	0.23	0.07	0.03	0.01	0.01	0.00	0.00
	v	1.32	0.83	0.51	0.32	0.21	0.13	0.09	0.07	0.04	0.03	0.02
0.20	R	21.66	7.25	2.31	0.78	0.27	0.09	0.04	0.02	0.01	0.00	0.00
	v	1.46	0.92	0.57	0.36	0.23	0.15	0.10	0.07	0.05	0.04	0.02
0.30	R	44.03	14.92	4.65	1.58	0.53	0.19	0.08	0.03	0.01	0.01	0.00
	v	2.19	1.39	0.85	0.54	0.34	0.22	0.16	0.11	0.07	0.05	0.03
0.40	R	72.85	24.61	7.65	2.62	0.90	0.30	0.13	0.05	0.02	0.01	0.00
	v	2.92	1.85	1.13	0.72	0.46	0.29	0.21	0.14	0.10	0.07	0.04
0.50	R	107.65	36.30	11.41	3.87	1.31	0.44	0.19	0.08	0.03	0.02	0.01
	v	3.65	2.31	1.42	0.90	0.57	0.36	0.26	0.18	0.12	0.09	0.06
0.60	R	148.12	49.88	15.64	5.32	1.83	0.60	0.26	0.11	0.04	0.02	0.01
	v	4.38	2.77	1.70	1.08	0.69	0.43	0.31	0.21	0.14	0.11	0.07
0.70	R	194.64	65.27	20.42	6.97	2.37	0.80	0.35	0.15	0.06	0.03	0.01
	v	5.12	3.23	1.98	1.26	0.80	0.51	0.36	0.25	0.17	0.13	0.08
0.80	R	245.78	82.79	25.93	8.81	2.97	1.01	0.44	0.18	0.07	0.04	0.01
	v	5.85	3.70	2.27	1.44	0.91	0.58	0.41	0.28	0.19	0.15	0.09
0.90	R	301.94	101.63	31.79	10.82	3.69	1.24	0.54	0.23	0.09	0.05	0.01
	v	6.58	4.16	2.55	1.62	1.03	0.65	0.46	0.32	0.21	0.16	0.10
1.00	R	362.97	122.10	38.15	13.01	4.40	1.48	0.65	0.27	0.11	0.06	0.02
	v	7.31	4.62	2.83	1.80	1.14	0.72	0.51	0.36	0.24	0.18	0.11
1.20	R	499.19	167.78	52.59	17.90	6.07	2.06	0.89	0.38	0.14	0.08	0.02
	v	8.77	5.54	3.40	2.16	1.37	0.87	0.61	0.43	0.28	0.22	0.13

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm
Temperature: **20°C**
Density: **998.00 kg/m³**
Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR6 (PN20)

		$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)			
d x s ▶		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15	110x18.3	125x20.8	160x26.6
$\dot{v}$	d _i ▶	13.2mm	16.6mm	21.2mm	26.6mm	33.4mm	42.0mm	50.0mm	60.0mm	73.4mm	83.4mm	106.8mm
1.40	R	653.59	220.13	68.98	23.45	7.97	2.67	1.18	0.49	0.19	0.10	0.03
	v	10.23	6.47	3.97	2.52	1.60	1.01	0.72	0.50	0.33	0.26	0.16
1.60	R	825.46	277.80	86.89	29.62	10.08	3.38	1.48	0.62	0.24	0.13	0.04
	v	11.69	7.39	4.53	2.88	1.83	1.16	0.82	0.57	0.38	0.29	0.18
1.80	R	1,014.24	341.84	106.92	36.40	12.40	4.16	1.81	0.77	0.29	0.16	0.05
	v	13.15	8.32	5.10	3.24	2.06	1.30	0.92	0.64	0.43	0.33	0.20
2.00	R	1,219.43	410.70	128.70	43.77	14.81	5.01	2.19	0.92	0.35	0.19	0.06
	v	14.61	9.24	5.67	3.60	2.28	1.45	1.02	0.71	0.47	0.37	0.22
2.20	R	1,442.19	485.75	151.77	51.71	17.52	5.92	2.58	1.09	0.42	0.23	0.07
	v	16.08	10.17	6.23	3.96	2.51	1.59	1.12	0.78	0.52	0.40	0.25
2.40	R	1,679.08	562.57	176.89	60.22	20.42	6.86	3.01	1.27	0.49	0.26	0.08
	v	17.54	11.06	6.80	4.32	2.74	1.73	1.23	0.85	0.57	0.44	0.27
2.60	R	1,931.25	649.84	203.65	69.27	23.52	7.93	3.46	1.45	0.56	0.30	0.09
	v	19.00	12.01	7.37	4.68	2.97	1.88	1.33	0.92	0.62	0.48	0.29
2.80	R	2,198.39	740.44	231.50	78.87	26.80	9.00	3.93	1.65	0.64	0.35	0.11
	v	20.46	12.94	7.93	5.04	3.20	2.02	1.43	0.99	0.66	0.51	0.31
3.00	R	2,480.23	835.00	261.40	88.99	30.13	10.20	4.45	1.86	0.72	0.39	0.12
	v	21.92	13.86	8.50	5.40	3.42	2.17	1.53	1.06	0.71	0.55	0.34
3.20	R	2,776.51	935.51	292.84	99.63	33.73	11.38	4.97	2.09	0.80	0.44	0.14
	v	23.38	14.79	9.07	5.76	3.65	2.31	1.63	1.13	0.76	0.59	0.36
3.40	R	3,089.17	1,039.71	325.21	110.78	37.54	12.66	5.52	2.33	0.89	0.49	0.15
	v	24.85	15.71	9.63	6.12	3.88	2.46	1.73	1.20	0.81	0.62	0.38
3.60	R	3,413.75	1,148.59	359.64	122.43	41.52	13.99	6.11	2.57	0.99	0.54	0.17
	v	26.31	16.63	10.20	6.48	4.11	2.60	1.84	1.28	0.85	0.66	0.40
3.80	R	3,752.13	1,263.34	395.54	134.58	45.67	15.39	6.71	2.83	1.09	0.59	0.18
	v	27.77	17.56	10.77	6.84	4.34	2.75	1.94	1.35	0.90	0.70	0.42
4.00	R	4,104.13	1,381.44	432.24	147.22	49.99	16.84	7.36	3.09	1.18	0.65	0.20
	v	29.23	18.48	11.33	7.20	4.57	2.89	2.04	1.42	0.95	0.73	0.45
4.20	R	4,469.56	1,505.38	471.00	160.34	54.48	18.29	8.00	3.36	1.29	0.70	0.22
	v	30.69	19.41	11.90	7.56	4.80	3.03	2.14	1.49	0.99	0.77	0.47
4.40	R	4,848.28	1,632.46	510.48	173.94	58.92	19.90	8.67	3.66	1.40	0.76	0.24
	v	32.15	20.33	12.46	7.92	5.02	3.18	2.24	1.56	1.04	0.81	0.49
4.60	R	5,240.11	1,763.93	552.04	188.01	63.73	21.46	9.39	3.95	1.52	0.83	0.26
	v	33.61	21.25	13.03	8.28	5.25	3.32	2.35	1.63	1.09	0.84	0.51
4.80	R	5,647.74	1,901.23	594.99	202.55	68.69	23.13	10.10	4.26	1.63	0.89	0.27
	v	35.08	22.18	13.60	8.64	5.48	3.47	2.45	1.70	1.14	0.88	0.54
5.00	R	6,065.49	2,041.38	638.53	217.55	73.82	24.85	10.88	4.57	1.75	0.96	0.30
	v	36.54	23.10	14.16	9.00	5.71	3.61	2.55	1.77	1.18	0.92	0.56
5.20	R	6,495.94	2,187.37	684.18	233.01	79.10	26.62	11.63	4.89	1.88	1.02	0.32
	v	38.00	24.03	14.73	9.36	5.94	3.76	2.65	1.84	1.23	0.95	0.58

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm
Temperature: **20°C**
Density: **998.00 kg/m³**
Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR6 (PN20)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d x s ▶		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15	110x18.3	125x20.8	160x26.6
$\dot{v}$	d _i ▶	13.2mm	16.6mm	21.2mm	26.6mm	33.4mm	42.0mm	50.0mm	60.0mm	73.4mm	83.4mm	106.8mm
5.40	R	6,938.47	2,336.02	731.19	248.92	84.54	28.45	12.41	5.22	2.01	1.10	0.34
	v	39.46	24.95	15.30	9.72	6.17	3.90	2.75	1.91	1.28	0.99	0.60
5.60	R	7,397.37	2,490.52	778.66	265.27	90.13	30.32	13.25	5.56	2.14	1.17	0.36
	v	40.93	25.88	15.86	10.08	6.40	4.05	2.86	1.98	1.33	1.03	0.63
5.80	R	7,863.68	2,647.52	828.29	282.07	95.62	32.25	14.08	5.92	2.28	1.24	0.38
	v	42.38	26.80	16.43	10.44	6.62	4.19	2.96	2.05	1.37	1.06	0.65
6.00	R	8,342.16	2,808.61	879.23	299.31	101.51	34.16	14.92	6.29	2.41	1.31	0.41
	v	43.84	27.72	17.00	10.80	6.85	4.33	3.06	2.12	1.42	1.10	0.67
6.20	R	8,838.09	2,975.58	930.54	316.99	107.55	36.26	15.83	6.66	2.56	1.39	0.43
	v	45.31	28.65	17.56	11.16	7.08	4.48	3.16	2.20	1.47	1.14	0.69
6.40	R	9,340.71	3,144.80	984.04	335.10	113.74	38.26	16.72	7.04	2.70	1.47	0.45
	v	46.76	29.57	18.13	11.52	7.31	4.62	3.26	2.27	1.51	1.17	0.71
6.60	R	9,860.86	3,319.92	1,038.82	353.64	120.08	40.39	17.67	7.42	2.85	1.55	0.48
	v	48.24	30.50	18.70	11.88	7.54	4.77	3.37	2.34	1.56	1.21	0.74
6.80	R	10,387.26	3,497.15	1,093.87	372.61	126.27	42.57	18.60	7.82	3.00	1.64	0.51
	v	49.69	31.42	19.26	12.24	7.76	4.91	3.47	2.41	1.61	1.24	0.76
7.00	R	10,925.35	3,678.31	1,151.15	392.00	132.90	44.79	19.55	8.23	3.16	1.72	0.53
	v	51.15	32.34	19.83	12.60	7.99	5.06	3.57	2.48	1.66	1.28	0.78
7.50	R	12,327.38	4,150.34	1,299.26	442.30	150.24	50.52	22.06	9.29	3.57	1.94	0.60
	v	54.80	34.65	21.25	13.50	8.57	5.42	3.82	2.66	1.77	1.37	0.84
8.00	R	13,804.60	4,647.68	1,454.42	495.19	168.16	56.54	24.70	10.39	3.99	2.18	0.67
	v	58.46	36.97	22.67	14.40	9.14	5.78	4.08	2.83	1.89	1.47	0.89
9.00	R	16,964.04	5,711.39	1,787.57	608.54	206.38	69.55	30.36	12.78	4.90	2.67	0.83
	v	65.77	41.59	25.50	16.20	10.28	6.50	4.59	3.19	2.13	1.65	1.00
10.00	R	20,399.47	6,868.02	2,149.07	731.39	248.30	83.58	36.52	15.37	5.90	3.22	0.99
	v	73.08	46.21	28.33	18.00	11.42	7.22	5.10	3.54	2.37	1.83	1.12
15.00	R	41,509.70	13,975.34	4,373.01	1,488.29	504.75	170.00	74.26	31.24	11.99	6.54	2.02
	v	109.67	69.34	42.52	27.01	17.13	10.83	7.64	5.31	3.55	2.75	1.68
20.00	R	68,674.01	23,120.92	7,234.75	2,462.24	835.07	281.24	122.86	51.68	19.84	10.81	3.34
	v	146.22	92.46	56.69	36.01	22.84	14.44	10.19	7.08	4.73	3.66	2.23
25.00	R	101,481.05	34,166.28	10,690.94	3,638.51	1,234.00	415.60	181.55	76.36	29.31	15.98	4.94
	v	182.78	115.57	70.86	45.01	28.55	18.05	12.74	8.85	5.91	4.58	2.79
30.00	R	139,621.44	47,007.25	14,708.99	5,006.00	1,697.78	571.80	249.79	105.07	40.33	21.99	6.79
	v	219.33	138.69	85.03	54.01	34.26	21.66	15.29	10.62	7.09	5.49	3.35

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

VESBO Pipe SDR6 (PN20)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 60°C

Density: **983.20 kg/m³**

Viscosity: **0.47×10⁻⁶ m²/s**

VESBO® Pipe SDR6 (PN20)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15	110x18.3	125x20.8	160x26.6
$\dot{v}$	d _i ▶	13.2mm	16.6mm	21.2mm	26.6mm	33.4mm	42.0mm	50.0mm	60.0mm	73.4mm	83.4mm	106.8mm
0.01	R	0.06	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.07	0.05	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.02	R	0.33	0.10	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.15	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00
0.03	R	0.64	0.22	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.22	0.14	0.08	0.05	0.03	0.02	0.02	0.01	0.01	0.00	0.00
0.04	R	1.11	0.34	0.11	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.30	0.18	0.11	0.07	0.05	0.03	0.02	0.02	0.01	0.01	0.00
0.05	R	1.60	0.52	0.16	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.37	0.23	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01	0.01
0.06	R	2.16	0.74	0.23	0.08	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.44	0.28	0.17	0.11	0.07	0.04	0.03	0.02	0.01	0.01	0.01
0.07	R	2.80	0.93	0.30	0.11	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.51	0.32	0.20	0.13	0.08	0.05	0.04	0.03	0.02	0.01	0.01
0.08	R	3.51	1.20	0.38	0.12	0.04	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.58	0.37	0.23	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01
0.09	R	4.40	1.50	0.44	0.15	0.05	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.66	0.42	0.25	0.16	0.10	0.07	0.05	0.03	0.02	0.02	0.01
0.10	R	5.25	1.76	0.54	0.19	0.06	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.73	0.46	0.28	0.18	0.11	0.07	0.05	0.04	0.02	0.02	0.01
0.12	R	7.28	2.40	0.76	0.27	0.09	0.03	0.01	0.01	0.00	0.00	0.00
	v	0.88	0.55	0.34	0.22	0.14	0.09	0.06	0.04	0.03	0.02	0.01
0.14	R	9.42	3.22	1.01	0.34	0.12	0.04	0.02	0.01	0.00	0.00	0.00
	v	1.02	0.65	0.40	0.25	0.16	0.10	0.07	0.05	0.03	0.03	0.02
0.16	R	11.98	4.04	1.24	0.43	0.14	0.05	0.02	0.01	0.00	0.00	0.00
	v	1.17	0.74	0.45	0.29	0.18	0.12	0.08	0.06	0.04	0.03	0.02
0.18	R	14.80	4.93	1.55	0.52	0.19	0.06	0.03	0.01	0.00	0.00	0.00
	v	1.32	0.83	0.51	0.32	0.21	0.13	0.09	0.07	0.04	0.03	0.02
0.20	R	17.65	5.91	1.88	0.63	0.22	0.07	0.03	0.01	0.01	0.00	0.00
	v	1.46	0.92	0.57	0.36	0.23	0.15	0.10	0.07	0.05	0.04	0.02
0.30	R	35.89	12.16	3.79	1.29	0.43	0.15	0.07	0.03	0.01	0.01	0.00
	v	2.19	1.39	0.85	0.54	0.34	0.22	0.16	0.11	0.07	0.05	0.03
0.40	R	59.37	20.06	6.24	2.13	0.73	0.25	0.11	0.04	0.02	0.01	0.00
	v	2.92	1.85	1.13	0.72	0.46	0.29	0.21	0.14	0.10	0.07	0.04
0.50	R	87.73	29.58	9.30	3.15	1.07	0.36	0.16	0.07	0.03	0.01	0.00
	v	3.65	2.31	1.42	0.90	0.57	0.36	0.26	0.18	0.12	0.09	0.06
0.60	R	120.71	40.65	12.74	4.34	1.49	0.49	0.22	0.09	0.04	0.02	0.01
	v	4.38	2.77	1.70	1.08	0.69	0.43	0.31	0.21	0.14	0.11	0.07
0.70	R	158.63	53.19	16.64	5.68	1.93	0.65	0.28	0.12	0.05	0.02	0.01
	v	5.12	3.23	1.98	1.26	0.80	0.51	0.36	0.25	0.17	0.13	0.08

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 60°C

Density: **983.20 kg/m³**

Viscosity: **0.47×10⁻⁶ m²/s**

VESBO® Pipe SDR6 (PN20)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15	110x18.3	125x20.8	160x26.6
$\dot{v}$	d _i ▶	13.2mm	16.6mm	21.2mm	26.6mm	33.4mm	42.0mm	50.0mm	60.0mm	73.4mm	83.4mm	106.8mm
0.80	R	200.30	67.47	21.13	7.18	2.42	0.83	0.36	0.15	0.06	0.03	0.01
	v	5.85	3.70	2.27	1.44	0.91	0.58	0.41	0.28	0.19	0.15	0.09
0.90	R	246.07	82.82	25.91	8.82	3.00	1.01	0.44	0.19	0.07	0.04	0.01
	v	6.58	4.16	2.55	1.62	1.03	0.65	0.46	0.32	0.21	0.16	0.10
1.00	R	295.81	99.51	31.09	10.60	3.59	1.21	0.53	0.22	0.09	0.05	0.01
	v	7.31	4.62	2.83	1.80	1.14	0.72	0.51	0.36	0.24	0.18	0.11
1.20	R	406.82	136.74	42.86	14.59	4.95	1.68	0.73	0.31	0.12	0.06	0.02
	v	8.77	5.54	3.40	2.16	1.37	0.87	0.61	0.43	0.28	0.22	0.13
1.40	R	532.64	179.40	56.21	19.11	6.49	2.18	0.96	0.40	0.15	0.08	0.03
	v	10.23	6.47	3.97	2.52	1.60	1.01	0.72	0.50	0.33	0.26	0.16
1.60	R	672.71	226.39	70.81	24.14	8.21	2.76	1.20	0.50	0.19	0.11	0.03
	v	11.69	7.39	4.53	2.88	1.83	1.16	0.82	0.57	0.38	0.29	0.18
1.80	R	826.56	278.58	87.14	29.66	10.10	3.39	1.47	0.62	0.24	0.13	0.04
	v	13.15	8.32	5.10	3.24	2.06	1.30	0.92	0.64	0.43	0.33	0.20
2.00	R	993.79	334.71	104.89	35.67	12.07	4.08	1.78	0.75	0.29	0.16	0.05
	v	14.61	9.24	5.67	3.60	2.28	1.45	1.02	0.71	0.47	0.37	0.22
2.20	R	1,175.32	395.87	123.68	42.14	14.28	4.82	2.10	0.89	0.34	0.19	0.06
	v	16.08	10.17	6.23	3.96	2.51	1.59	1.12	0.78	0.52	0.40	0.25
2.40	R	1,368.38	459.92	144.16	49.08	16.64	5.59	2.46	1.03	0.40	0.22	0.07
	v	17.54	11.08	6.80	4.32	2.74	1.73	1.23	0.85	0.57	0.44	0.27
2.60	R	1,573.89	529.59	165.97	56.45	19.17	6.47	2.82	1.19	0.46	0.25	0.08
	v	19.00	12.01	7.37	4.68	2.97	1.88	1.33	0.92	0.62	0.48	0.29
2.80	R	1,791.60	603.42	188.66	64.27	21.84	7.33	3.20	1.35	0.52	0.28	0.09
	v	20.46	12.94	7.93	5.04	3.20	2.02	1.43	0.99	0.66	0.51	0.31
3.00	R	2,021.28	680.49	213.03	72.52	24.66	8.31	3.63	1.52	0.59	0.32	0.10
	v	21.92	13.86	8.50	5.40	3.43	2.17	1.53	1.06	0.71	0.55	0.34
3.20	R	2,263.73	762.40	238.65	81.19	27.49	9.27	4.05	1.71	0.65	0.36	0.11
	v	23.38	14.79	9.07	5.76	3.65	2.31	1.63	1.13	0.76	0.59	0.36
3.40	R	2,517.54	847.32	265.03	90.28	30.59	10.31	4.50	1.90	0.73	0.40	0.12
	v	24.85	15.71	9.63	6.12	3.88	2.46	1.73	1.20	0.81	0.62	0.38
3.60	R	2,782.06	936.05	293.09	99.78	33.84	11.40	4.98	2.10	0.81	0.44	0.14
	v	26.31	16.63	10.20	6.48	4.11	2.60	1.84	1.28	0.85	0.66	0.40
3.80	R	3,057.83	1,029.57	322.35	109.68	37.22	12.54	5.47	2.30	0.88	0.48	0.15
	v	27.77	17.56	10.77	6.84	4.34	2.75	1.94	1.35	0.90	0.70	0.42
4.00	R	3,344.69	1,125.81	352.25	119.98	40.74	13.72	6.00	2.52	0.97	0.53	0.16
	v	29.23	18.48	11.33	7.20	4.57	2.89	2.04	1.42	0.95	0.73	0.45
4.20	R	3,642.50	1,226.82	383.85	130.67	44.40	14.91	6.52	2.74	1.05	0.57	0.18
	v	30.69	19.41	11.90	7.56	4.80	3.03	2.14	1.49	0.99	0.77	0.47
4.40	R	3,951.14	1,330.39	416.02	141.76	48.19	16.22	7.06	2.98	1.14	0.62	0.19
	v	32.15	20.33	12.46	7.92	5.03	3.18	2.24	1.56	1.04	0.81	0.49

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 60°C

Density: **983.20 kg/m³**

Viscosity: **0.47×10⁻⁶ m²/s**

VESBO® Pipe SDR6 (PN20)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15	110x18.3	125x20.8	160x26.6
$\dot{v}$	d _i ▶	13.2mm	16.6mm	21.2mm	26.6mm	33.4mm	42.0mm	50.0mm	60.0mm	73.4mm	83.4mm	106.8mm
4.60	R	4,270.47	1,437.53	449.89	153.22	51.94	17.49	7.65	3.21	1.24	0.67	0.21
	v	33.61	21.25	13.03	8.28	5.25	3.32	2.35	1.63	1.09	0.84	0.51
4.80	R	4,602.67	1,549.42	484.89	165.07	55.98	18.85	8.23	3.47	1.33	0.73	0.22
	v	35.08	22.18	13.60	8.64	5.48	3.47	2.45	1.70	1.14	0.88	0.54
5.00	R	4,943.11	1,663.64	520.37	177.29	60.16	20.25	8.86	3.73	1.43	0.78	0.24
	v	36.54	23.10	14.16	9.00	5.71	3.61	2.55	1.77	1.18	0.92	0.56
5.20	R	5,293.91	1,782.61	557.58	189.89	64.46	21.70	9.48	3.99	1.53	0.83	0.26
	v	38.00	24.03	14.73	9.36	5.94	3.76	2.65	1.84	1.23	0.95	0.58
5.40	R	5,739.67	1,903.76	595.89	202.86	68.74	23.18	10.12	4.26	1.64	0.89	0.28
	v	39.46	24.95	15.30	9.72	6.16	3.90	2.75	1.91	1.28	0.99	0.60
5.60	R	6,119.29	2,029.67	634.58	216.19	73.45	24.71	10.80	4.53	1.74	0.95	0.29
	v	40.93	25.88	15.86	10.08	6.40	4.05	2.86	1.98	1.33	1.03	0.63
5.80	R	6,505.03	2,157.61	675.02	229.88	77.93	26.28	11.47	4.82	1.85	1.01	0.31
	v	42.38	26.80	16.43	10.44	6.62	4.19	2.96	2.05	1.37	1.06	0.65
6.00	R	6,900.84	2,288.89	716.54	243.93	82.73	27.84	12.16	5.12	1.96	1.07	0.33
	v	43.84	27.72	17.00	10.80	6.85	4.33	3.06	2.12	1.42	1.10	0.67
6.20	R	7,311.08	2,424.97	758.35	258.33	87.54	29.55	12.90	5.43	2.08	1.13	0.35
	v	45.31	28.65	17.56	11.16	7.08	4.48	3.16	2.20	1.47	1.13	0.69
6.40	R	7,726.87	2,562.88	801.95	273.09	92.69	31.18	13.62	5.74	2.20	1.20	0.37
	v	46.76	29.57	18.13	11.52	7.31	4.62	3.26	2.27	1.51	1.17	0.71
6.60	R	8,157.15	2,705.59	846.60	288.20	97.86	32.92	14.40	6.05	2.32	1.27	0.39
	v	48.24	30.50	18.70	11.88	7.54	4.77	3.37	2.34	1.56	1.21	0.74
6.80	R	8,592.60	2,850.02	891.46	303.66	102.91	34.69	15.16	6.37	2.45	1.33	0.41
	v	49.69	31.42	19.26	12.24	7.76	4.91	3.47	2.41	1.61	1.25	0.76
7.00	R	9,037.72	2,997.66	938.14	319.46	108.30	36.50	15.93	6.71	2.57	1.40	0.43
	v	51.15	32.34	19.83	12.60	7.99	5.06	3.57	2.48	1.66	1.28	0.78
7.50	R	10,197.51	3,382.35	1,058.84	366.46	122.19	41.17	17.98	7.57	2.90	1.58	0.49
	v	54.80	34.65	21.25	13.50	8.56	5.42	3.82	2.66	1.77	1.37	0.84
8.00	R	11,419.51	3,788.56	1,185.75	403.56	137.04	46.08	20.13	8.47	3.25	1.77	0.55
	v	58.46	36.97	22.67	14.40	9.14	5.78	4.08	2.83	1.89	1.47	0.89
9.00	R	14,033.08	4,655.52	1,456.79	495.93	168.34	56.68	24.75	10.41	3.99	2.18	0.67
	v	65.77	41.59	25.50	16.20	10.28	6.50	4.59	3.19	2.13	1.65	1.00
10.00	R	16,874.94	5,597.14	1,751.40	596.35	202.35	68.12	29.76	12.53	4.81	2.62	0.81
	v	73.08	46.21	28.33	18.00	11.42	7.22	5.10	3.54	2.37	1.83	1.12
15.00	R	34,337.85	11,389.30	3,563.82	1,212.89	411.35	138.54	60.52	25.46	9.77	5.33	1.65
	v	109.67	69.34	42.52	27.01	17.13	10.83	7.64	5.31	3.55	2.75	1.68
20.00	R	56,808.84	18,842.56	5,896.01	2,006.62	680.55	229.20	100.13	42.11	16.17	8.81	2.72
	v	146.22	92.46	56.69	36.01	22.84	14.44	10.19	7.08	4.73	3.66	2.23
25.00	R	83,947.63	27,844.06	8,712.66	2,965.23	1,005.66	338.70	147.96	62.23	23.89	13.02	4.02
	v	182.78	115.57	70.86	45.01	28.55	18.05	12.74	8.85	5.91	4.58	2.79
30.00	R	115,498.30	38,308.90	11,987.20	4,079.67	1,383.62	465.99	203.57	85.62	32.87	17.92	5.53
	v	219.33	138.69	85.03	54.01	34.26	21.66	15.29	10.62	7.09	5.49	3.35

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 60°C

Density: **983.20 kg/m³**

Viscosity: **0.47×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
0.01	R	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.06	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0.02	R	0.21	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.12	0.08	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
0.03	R	0.43	0.15	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.18	0.12	0.07	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00
0.04	R	0.70	0.24	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.25	0.16	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.01	0.00
0.05	R	1.04	0.36	0.11	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.31	0.20	0.12	0.08	0.05	0.03	0.02	0.01	0.01	0.01	0.00
0.06	R	1.43	0.49	0.15	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.37	0.24	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01	0.01
0.07	R	1.87	0.64	0.19	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.43	0.28	0.17	0.11	0.07	0.04	0.03	0.02	0.01	0.01	0.01
0.08	R	2.37	0.81	0.24	0.08	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.49	0.31	0.19	0.12	0.08	0.05	0.03	0.02	0.02	0.01	0.01
0.09	R	2.92	1.00	0.30	0.10	0.04	0.01	0.01	0.00	0.00	0.00	0.00
	v	0.55	0.35	0.21	0.14	0.09	0.05	0.04	0.03	0.02	0.01	0.01
0.10	R	3.52	1.20	0.36	0.12	0.04	0.01	0.01	0.00	0.00	0.00	0.00
	v	0.61	0.39	0.24	0.15	0.10	0.06	0.04	0.03	0.02	0.02	0.01
0.12	R	4.87	1.66	0.49	0.17	0.06	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.74	0.47	0.28	0.18	0.12	0.07	0.05	0.04	0.02	0.02	0.01
0.16	R	8.16	2.77	0.82	0.28	0.10	0.03	0.01	0.01	0.00	0.00	0.00
	v	0.98	0.63	0.38	0.24	0.16	0.10	0.07	0.05	0.03	0.02	0.02
0.18	R	10.10	3.43	1.01	0.35	0.12	0.04	0.02	0.01	0.00	0.00	0.00
	v	1.11	0.71	0.43	0.27	0.17	0.11	0.08	0.05	0.04	0.03	0.02
0.20	R	12.22	4.14	1.22	0.42	0.14	0.05	0.02	0.01	0.00	0.00	0.00
	v	1.23	0.79	0.47	0.30	0.19	0.12	0.09	0.06	0.04	0.03	0.02
0.30	R	25.60	8.60	2.51	0.86	0.30	0.10	0.04	0.02	0.01	0.00	0.00
	v	1.84	1.18	0.71	0.45	0.29	0.18	0.13	0.09	0.06	0.05	0.03
0.40	R	43.49	14.53	4.22	1.43	0.49	0.16	0.07	0.03	0.01	0.01	0.00
	v	2.46	1.57	0.95	0.61	0.39	0.24	0.17	0.12	0.08	0.06	0.04
0.50	R	65.82	21.88	6.33	2.14	0.73	0.24	0.10	0.04	0.02	0.01	0.00
	v	3.07	1.96	1.18	0.76	0.49	0.30	0.22	0.15	0.10	0.08	0.05
0.60	R	92.54	30.64	8.82	2.98	1.02	0.33	0.14	0.06	0.02	0.01	0.00
	v	3.68	2.36	1.42	0.91	0.58	0.36	0.26	0.18	0.12	0.09	0.06
0.70	R	123.62	40.78	11.70	3.94	1.34	0.43	0.19	0.08	0.03	0.02	0.01
	v	4.30	2.75	1.66	1.06	0.68	0.42	0.30	0.21	0.14	0.11	0.07
0.80	R	159.04	52.30	14.96	5.02	1.71	0.55	0.24	0.10	0.04	0.02	0.01
	v	4.91	3.14	1.89	1.21	0.78	0.49	0.34	0.24	0.16	0.12	0.08

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 60°C

Density: **983.20 kg/m³**

Viscosity: **0.47×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
0.90	R	198.78	65.19	18.59	6.23	2.12	0.68	0.30	0.12	0.05	0.03	0.01
	v	5.53	3.54	2.13	1.36	0.87	0.55	0.39	0.27	0.18	0.14	0.08
1.00	R	242.84	79.44	22.59	7.55	2.56	0.82	0.36	0.15	0.06	0.03	0.01
	v	6.14	3.93	2.37	1.51	0.97	0.61	0.43	0.30	0.20	0.15	0.09
1.20	R	343.86	112.00	31.70	10.56	3.57	1.14	0.50	0.20	0.08	0.04	0.01
	v	7.37	4.72	2.84	1.82	1.17	0.73	0.52	0.36	0.24	0.19	0.11
1.40	R	462.05	149.97	42.27	14.04	4.74	1.51	0.66	0.27	0.10	0.06	0.02
	v	8.60	5.50	3.31	2.12	1.36	0.85	0.60	0.42	0.28	0.22	0.13
1.60	R	597.40	193.32	54.30	17.98	6.05	1.92	0.83	0.34	0.13	0.07	0.02
	v	9.82	6.29	3.78	2.42	1.55	0.97	0.69	0.48	0.32	0.25	0.15
1.80	R	749.88	242.05	67.78	22.38	7.52	2.38	1.03	0.42	0.16	0.09	0.03
	v	11.05	7.07	4.26	2.73	1.75	1.09	0.77	0.54	0.36	0.28	0.17
2.00	R	919.48	296.13	82.69	27.25	9.13	2.89	1.25	0.51	0.20	0.11	0.03
	v	12.28	7.86	4.73	3.03	1.94	1.21	0.86	0.60	0.40	0.31	0.19
2.20	R	1,106.20	355.57	99.05	32.57	10.89	3.44	1.49	0.61	0.23	0.13	0.04
	v	13.51	8.65	5.20	3.33	2.14	1.34	0.95	0.65	0.44	0.34	0.21
2.40	R	1,310.01	420.36	116.84	38.34	12.80	4.04	1.74	0.71	0.27	0.15	0.04
	v	14.74	9.43	5.68	3.63	2.33	1.46	1.03	0.71	0.48	0.37	0.23
2.60	R	1,530.92	490.49	136.06	44.57	14.85	4.68	2.02	0.83	0.32	0.17	0.05
	v	15.96	10.22	6.15	3.94	2.53	1.58	1.12	0.77	0.52	0.40	0.25
2.80	R	1,768.93	565.97	156.72	51.25	17.05	5.36	2.31	0.94	0.36	0.19	0.06
	v	17.19	11.00	6.62	4.24	2.72	1.70	1.20	0.83	0.56	0.43	0.26
3.00	R	2,024.03	646.79	178.80	58.38	19.39	6.09	2.62	1.07	0.41	0.22	0.07
	v	18.42	11.79	7.10	4.54	2.91	1.82	1.29	0.89	0.60	0.46	0.28
3.20	R	2,296.22	732.95	202.31	65.96	21.88	6.86	2.95	1.20	0.46	0.25	0.07
	v	19.65	12.58	7.57	4.84	3.11	1.94	1.38	0.95	0.64	0.22	0.30
3.40	R	2,585.49	824.44	227.25	73.99	24.51	7.67	3.30	1.35	0.51	0.27	0.08
	v	20.88	13.36	8.04	5.15	3.30	2.06	1.46	1.01	0.68	0.53	0.32
3.60	R	2,891.85	921.27	253.61	82.47	27.29	8.53	3.67	1.49	0.57	0.30	0.09
	v	22.10	14.15	8.52	5.45	3.50	2.19	1.55	1.07	0.72	0.56	0.34
3.80	R	3,215.30	1,023.43	281.40	91.40	30.21	9.43	4.05	1.65	0.63	0.34	0.10
	v	23.33	14.93	8.99	5.75	3.69	2.31	1.63	1.13	0.76	0.59	0.36
4.00	R	3,555.83	1,130.93	310.61	100.78	33.27	10.38	4.45	1.81	0.69	0.37	0.11
	v	24.56	15.72	9.46	6.06	3.89	2.43	1.72	1.19	0.80	0.62	0.38
4.20	R	3,913.44	1,243.75	341.24	110.60	36.47	11.37	4.88	1.98	0.75	0.40	0.12
	v	25.79	16.50	9.94	6.36	4.08	2.55	1.81	1.25	0.84	0.65	0.40
4.40	R	4,288.14	1,361.91	373.30	120.87	39.82	12.40	5.31	2.16	0.82	0.44	0.13
	v	27.02	17.29	10.41	6.66	4.28	2.67	1.89	1.31	0.88	0.68	0.41
4.60	R	46,79.91	1,485.40	406.78	131.59	43.31	13.47	5.77	2.34	0.89	0.47	0.14
	v	28.25	18.08	10.88	6.96	4.47	2.79	1.98	1.37	0.92	0.71	0.43

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 60°C

Density: **983.20 kg/m³**

Viscosity: **0.47×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
4.80	R	5,088.77	1,614.23	441.68	142.75	46.94	14.58	6.24	2.53	0.96	0.51	0.16
	v	29.47	18.86	11.35	7.27	4.66	2.91	2.07	1.43	0.96	0.74	0.45
5.00	R	5,514.70	1,748.38	478.00	154.36	50.71	15.74	6.73	2.73	1.03	0.55	0.17
	v	30.70	19.65	11.83	7.57	4.86	3.03	2.15	1.49	1.00	0.77	0.47
5.20	R	5,957.72	1,887.86	515.74	166.42	54.62	16.94	7.24	2.93	1.11	0.59	0.18
	v	31.93	20.43	12.30	7.87	5.05	3.16	2.24	1.55	1.04	0.80	0.49
5.40	R	6,417.82	2,032.67	554.90	178.92	58.68	18.18	7.77	3.15	1.19	0.64	0.19
	v	33.16	21.22	12.77	8.18	5.25	3.28	2.32	1.61	1.08	0.83	0.51
5.60	R	6,894.99	2,182.82	595.49	191.87	62.88	19.47	8.31	3.36	1.27	0.68	0.21
	v	34.39	22.01	13.25	8.48	5.44	3.40	2.41	1.67	1.12	0.86	0.53
5.80	R	7,389.25	2,338.29	637.49	205.26	67.21	20.80	8.88	3.59	1.36	0.72	0.22
	v	35.61	22.79	13.72	8.78	5.64	3.52	2.50	1.73	1.16	0.90	0.55
6.00	R	7,900.58	2,499.08	680.92	219.10	71.69	22.17	9.46	3.82	1.44	0.77	0.23
	v	36.84	23.58	14.19	9.08	5.83	3.64	2.58	1.79	1.20	0.93	0.57
6.20	R	8,428.99	2,665.21	725.76	233.38	76.32	23.58	10.05	4.06	1.53	0.82	0.25
	v	38.07	24.36	14.67	9.39	6.02	3.76	2.67	1.85	1.24	0.96	0.58
6.40	R	8,974.48	2,836.67	772.03	248.11	81.08	25.03	10.67	4.31	1.63	0.87	0.26
	v	39.30	25.15	15.14	9.69	6.22	3.88	2.75	1.91	1.28	0.99	0.60
6.60	R	9,537.05	3,013.45	819.71	263.29	85.98	26.52	11.30	4.56	1.72	0.92	0.28
	v	40.53	25.94	15.61	9.99	6.41	4.01	2.84	1.96	1.32	1.02	0.62
6.80	R	10,116.69	3,195.57	868.81	278.91	91.03	28.06	11.95	4.82	1.82	0.97	0.29
	v	41.75	26.72	16.09	10.29	6.61	4.13	2.93	2.02	1.36	1.05	0.64
7.00	R	10,713.42	3,383.01	919.34	294.97	96.21	29.64	12.61	5.09	1.92	1.02	0.31
	v	42.98	27.51	16.56	10.60	6.80	4.25	3.01	2.08	1.40	1.08	0.66
7.50	R	12,279.94	3,874.92	1,051.85	337.07	109.79	33.77	14.36	5.78	2.18	1.16	0.35
	v	46.05	29.47	17.74	11.35	7.29	4.55	3.23	2.23	1.50	1.16	0.71
8.00	R	13,953.20	4,400.13	1,193.24	381.96	124.25	38.16	16.21	6.52	2.45	1.31	0.39
	v	49.12	31.44	18.92	12.11	7.77	4.86	3.44	2.38	1.60	1.24	0.75
9.00	R	17,619.93	5,550.43	1,502.62	480.05	155.80	47.73	20.23	8.12	3.05	1.62	0.49
	v	55.26	35.37	21.29	13.63	8.74	5.46	3.87	2.68	1.80	1.39	0.85
10.00	R		6,833.92	1,847.46	589.25	190.87	58.34	24.68	9.89	3.71	1.97	0.59
	v		39.30	23.66	15.14	9.72	6.07	4.30	2.98	2.00	1.54	0.94
12.00	R		9,800.41	2,643.53	840.94	271.52	82.66	34.87	13.94	5.21	2.76	0.83
	v		47.16	28.39	18.17	11.66	7.28	5.16	3.57	2.40	1.85	1.13
14.00	R		13,299.58	3,581.42	1,137.00	366.18	111.13	46.77	18.64	6.95	3.68	1.10
	v		55.02	33.12	21.20	13.60	8.50	6.02	4.17	2.80	2.16	1.32
16.00	R			4,661.12	1,477.42	474.85	143.74	60.36	24.00	8.93	4.72	1.40
	v			37.85	24.22	15.55	9.71	6.88	4.76	3.20	2.47	1.51
18.00	R			5,882.62	1,862.20	597.51	180.47	75.65	30.02	11.14	5.88	1.75
	v			42.58	27.25	17.49	10.93	7.74	5.36	3.60	2.78	1.70

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 60°C

Density: **983.20 kg/m³**

Viscosity: **0.47×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
20.00	R			7,245.92	2,291.32	734.16	221.33	92.63	36.70	13.59	7.16	2.12
	v			47.31	30.28	19.43	12.14	8.60	5.95	4.00	3.09	1.89
22.00	R			8,751.01	2,764.79	884.80	266.31	111.30	44.02	16.28	8.57	2.54
	v			52.04	33.31	21.38	13.35	9.47	6.55	4.40	3.40	2.07
24.00	R			10,397.90	3,282.60	1,049.43	315.41	131.66	52.00	19.20	10.10	2.98
	v			56.77	36.34	23.32	14.57	10.33	7.14	4.80	3.71	2.26
26.00	R				3,844.75	1,228.04	368.63	153.71	60.63	22.35	11.74	3.46
	v				39.36	25.26	15.78	11.19	7.74	5.20	4.02	2.45
28.00	R				4,451.23	1,420.64	425.97	177.44	69.91	25.74	13.51	3.98
	v				42.39	27.21	17.00	12.05	8.34	5.60	4.32	2.64
30.00	R				5,102.06	1,627.21	487.43	202.86	79.84	29.36	15.40	4.53
	v				45.42	29.15	18.21	12.91	8.93	6.00	4.63	2.83

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 20°C

Density: **983.20 kg/m³**

Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d × s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
0.01	R	0.09	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.06	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0.02	R	0.27	0.10	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.12	0.08	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
0.03	R	0.54	0.19	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.18	0.12	0.07	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00
0.04	R	0.88	0.31	0.09	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	v	0.25	0.16	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.01	0.00
0.05	R	1.28	0.45	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.31	0.20	0.12	0.08	0.05	0.03	0.02	0.01	0.01	0.01	0.00
0.06	R	1.76	0.61	0.18	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.37	0.24	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01	0.01

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 20°C

Density: **983.20 kg/m³**

Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)					v = flow velocity (m/s)					
d x s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
0.07	R	2.29	0.80	0.24	0.08	0.03	0.01	0.00	0.00	0.00	0.00	0.00
	v	0.43	0.28	0.17	0.11	0.07	0.04	0.03	0.02	0.01	0.01	0.01
0.08	R	2.89	1.00	0.30	0.11	0.04	0.01	0.01	0.00	0.00	0.00	0.00
	v	0.49	0.31	0.19	0.12	0.08	0.05	0.03	0.02	0.02	0.01	0.01
0.09	R	3.55	1.23	0.37	0.13	0.05	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.55	0.35	0.21	0.14	0.09	0.05	0.04	0.03	0.02	0.01	0.01
0.10	R	4.27	1.48	0.44	0.15	0.05	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.61	0.39	0.24	0.15	0.10	0.06	0.04	0.03	0.02	0.02	0.01
0.12	R	5.87	2.03	0.61	0.21	0.07	0.02	0.01	0.00	0.00	0.00	0.00
	v	0.74	0.47	0.28	0.18	0.12	0.07	0.05	0.04	0.02	0.02	0.01
0.16	R	9.74	3.35	1.00	0.35	0.12	0.04	0.02	0.01	0.00	0.00	0.00
	v	0.98	0.63	0.38	0.24	0.16	0.10	0.07	0.05	0.03	0.02	0.02
0.18	R	12.00	4.12	1.23	0.43	0.15	0.05	0.02	0.01	0.00	0.00	0.00
	v	1.11	0.71	0.43	0.27	0.17	0.11	0.08	0.05	0.04	0.03	0.02
0.20	R	14.47	4.96	1.48	0.51	0.18	0.06	0.03	0.01	0.00	0.00	0.00
	v	1.23	0.79	0.47	0.30	0.19	0.12	0.09	0.06	0.04	0.03	0.02
0.30	R	29.85	10.17	3.01	1.04	0.36	0.12	0.05	0.02	0.01	0.00	0.00
	v	1.84	1.18	0.71	0.45	0.29	0.18	0.13	0.09	0.06	0.05	0.03
0.40	R	50.15	17.00	5.01	1.72	0.60	0.19	0.09	0.04	0.01	0.01	0.00
	v	2.46	1.57	0.95	0.61	0.39	0.24	0.17	0.12	0.08	0.06	0.04
0.50	R	75.21	25.40	7.45	2.55	0.88	0.29	0.13	0.05	0.02	0.01	0.00
	v	3.07	1.96	1.18	0.76	0.49	0.30	0.22	0.15	0.10	0.08	0.05
0.60	R	104.94	35.31	10.33	3.53	1.22	0.40	0.17	0.07	0.03	0.02	0.00
	v	3.68	2.36	1.42	0.91	0.58	0.36	0.26	0.18	0.12	0.09	0.06
0.70	R	139.27	46.72	13.62	4.64	1.60	0.52	0.23	0.10	0.04	0.02	0.01
	v	4.30	2.75	1.66	1.06	0.68	0.42	0.30	0.21	0.14	0.11	0.07
0.80	R	178.15	59.60	17.33	5.90	2.03	0.66	0.29	0.12	0.05	0.03	0.01
	v	4.91	3.14	1.89	1.21	0.78	0.49	0.34	0.24	0.16	0.12	0.08
0.90	R	221.55	73.92	21.45	7.28	2.50	0.81	0.36	0.15	0.06	0.03	0.01
	v	5.53	3.54	2.13	1.36	0.87	0.55	0.39	0.27	0.18	0.14	0.08
1.00	R	269.43	89.69	25.97	8.80	3.02	0.98	0.43	0.18	0.07	0.04	0.01
	v	6.14	3.93	2.37	1.51	0.97	0.61	0.43	0.30	0.20	0.15	0.09
1.20	R	378.58	125.51	36.19	12.23	4.19	1.35	0.59	0.25	0.09	0.05	0.02
	v	7.37	4.72	2.84	1.82	1.17	0.73	0.52	0.36	0.24	0.19	0.11
1.40	R	505.47	166.98	47.97	16.17	5.52	1.78	0.78	0.32	0.12	0.07	0.02
	v	8.60	5.50	3.31	2.12	1.36	0.85	0.60	0.42	0.28	0.22	0.13
1.60	R	650.00	214.05	61.29	20.61	7.03	2.26	0.99	0.41	0.16	0.09	0.03
	v	9.82	6.29	3.78	2.42	1.55	0.97	0.69	0.48	0.32	0.25	0.15
1.80	R	812.11	266.69	76.14	25.55	8.69	2.79	1.22	0.50	0.19	0.10	0.03
	v	11.05	7.07	4.26	2.73	1.75	1.09	0.77	0.54	0.36	0.28	0.17

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 20°C

Density: **983.20 kg/m³**

Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

		$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)				v = flow velocity (m/s)				
d x s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
2.00	R	991.77	324.88	92.51	30.97	10.52	3.37	1.47	0.61	0.23	0.13	0.04
	v	12.28	7.86	4.73	3.03	1.94	1.21	0.86	0.60	0.40	0.31	0.19
2.20	R	1,188.92	388.58	110.38	36.89	12.51	4.00	1.75	0.72	0.28	0.15	0.05
	v	13.51	8.65	5.20	3.33	2.14	1.34	0.95	0.65	0.44	0.34	0.21
2.40	R	1,403.55	457.79	129.75	43.28	14.66	4.68	2.04	0.84	0.32	0.17	0.05
	v	14.74	9.43	5.68	3.63	2.33	1.46	1.03	0.71	0.48	0.37	0.23
2.60	R	1,635.62	532.49	150.61	50.15	16.96	5.41	2.36	0.97	0.37	0.20	0.06
	v	15.96	10.22	6.15	3.94	2.53	1.58	1.12	0.77	0.52	0.40	0.25
2.80	R	1,885.14	612.68	172.95	57.51	19.42	6.19	2.69	1.11	0.43	0.23	0.07
	v	17.19	11.00	6.62	4.24	2.72	1.70	1.20	0.83	0.56	0.43	0.26
3.00	R	2,152.07	698.33	196.77	65.33	22.04	7.02	3.05	1.25	0.48	0.26	0.08
	v	18.42	11.79	7.10	4.54	2.91	1.82	1.29	0.89	0.60	0.46	0.28
3.20	R	2,436.42	789.45	222.07	73.63	24.81	7.89	3.43	1.41	0.54	0.29	0.09
	v	19.65	12.58	7.57	4.84	3.11	1.94	1.38	0.95	0.64	0.49	0.30
3.40	R	2,738.16	886.03	248.84	82.39	27.73	8.81	3.82	1.57	0.60	0.32	0.10
	v	20.88	13.36	8.04	5.15	3.30	2.06	1.46	1.01	0.68	0.53	0.32
3.60	R	3,057.30	988.06	277.08	91.63	30.80	9.78	4.24	1.74	0.67	0.36	0.11
	v	22.10	14.15	8.52	5.45	3.50	2.19	1.55	1.07	0.72	0.56	0.34
3.80	R	3,393.82	1,095.53	306.79	101.33	34.02	10.79	4.68	1.92	0.74	0.40	0.12
	v	23.33	14.93	8.99	5.75	3.69	2.31	1.63	1.13	0.76	0.59	0.36
4.00	R	3,747.73	1,208.45	337.96	111.50	37.40	11.85	5.13	2.11	0.81	0.43	0.13
	v	24.56	15.72	9.46	6.06	3.89	2.43	1.72	1.19	0.80	0.62	0.38
4.20	R	4,119.01	1,326.81	370.59	122.13	40.93	12.95	5.61	2.30	0.88	0.47	0.14
	v	25.79	16.50	9.94	6.36	4.08	2.55	1.81	1.25	0.84	0.65	0.40
4.40	R	4,507.66	1,450.61	404.68	133.23	44.60	14.10	6.11	2.50	0.96	0.51	0.16
	v	27.02	17.29	10.41	6.66	4.28	2.67	1.89	1.31	0.88	0.68	0.41
4.60	R	4,913.68	1,579.84	440.23	144.79	48.43	15.30	6.62	2.71	1.04	0.56	0.17
	v	28.25	18.08	10.88	6.96	4.47	2.79	1.98	1.37	0.92	0.71	0.43
4.80	R	5,337.07	1,714.51	477.24	156.81	52.40	16.54	7.15	2.93	1.12	0.60	0.18
	v	29.47	18.86	11.35	7.27	4.66	2.91	2.07	1.43	0.96	0.74	0.45
5.00	R	5,777.81	1,854.60	515.71	169.29	56.53	17.83	7.71	3.15	1.21	0.65	0.20
	v	30.70	19.65	11.83	7.57	4.86	3.03	2.15	1.49	1.00	0.77	0.47
5.20	R	6,235.92	2,000.12	555.63	182.23	60.80	19.16	8.28	3.39	1.29	0.69	0.21
	v	31.93	20.43	12.30	7.87	5.05	3.16	2.24	1.55	1.04	0.80	0.49
5.40	R	6,711.39	2,151.07	597.00	195.64	65.22	20.54	8.87	3.63	1.39	0.74	0.23
	v	33.16	21.22	12.77	8.18	5.25	3.28	2.32	1.61	1.08	0.83	0.51
5.60	R	7,204.21	2,307.44	639.83	209.50	69.78	21.96	9.48	3.87	1.48	0.79	0.24
	v	34.39	22.01	13.25	8.48	5.44	3.40	2.41	1.67	1.12	0.86	0.53
5.80	R	7,714.39	2,469.24	684.11	223.82	74.50	23.43	10.11	4.13	1.58	0.85	0.26
	v	35.61	22.79	13.72	8.78	5.64	3.52	2.50	1.73	1.16	0.90	0.55

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

Pipe friction factor **R** and calculated flow rate $\dot{v}$
in dependence of the flow velocity **v**

Roughness: 0.0070mm

Temperature: 20°C

Density: **983.20 kg/m³**

Viscosity: **1.0037×10⁻⁶ m²/s**

VESBO® Pipe SDR7.4 (PN16)

		$\dot{v}$ = flow rate (l/s)		R = pressure drop (mbar/m)				v = flow velocity (m/s)				
d x s ▶		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
$\dot{v}$	d _i ▶	14.4mm	18.0mm	23.0mm	29.0mm	36.2mm	45.8mm	54.4mm	65.4mm	79.8mm	90.8mm	116.2mm
6.00	R	8,241.92	2,636.46	729.84	238.60	79.36	24.94	10.76	4.39	1.68	0.90	0.27
	v	36.84	23.58	14.19	9.08	5.83	3.64	2.58	1.79	1.20	0.93	0.57
6.20	R	8,786.80	2,809.10	777.02	253.84	84.37	26.50	11.42	4.66	1.78	0.95	0.29
	v	38.07	24.36	14.67	9.39	6.02	3.76	2.67	1.85	1.24	0.96	0.58
6.40	R	9,349.04	2,987.16	825.65	269.53	89.52	28.10	12.11	4.94	1.88	1.01	0.31
	v	39.30	25.15	15.14	9.69	6.22	3.88	2.75	1.91	1.28	0.99	0.60
6.60	R	9,928.62	3,170.64	875.73	285.68	94.82	29.74	12.81	5.23	1.99	1.07	0.33
	v	40.53	25.94	15.61	9.99	6.41	4.01	2.84	1.96	1.32	1.02	0.62
6.80	R	10,525.55	3,359.54	927.25	302.29	100.27	31.43	13.53	5.52	2.10	1.13	0.34
	v	41.75	26.72	16.09	10.29	6.61	4.13	2.93	2.02	1.36	1.05	0.64
7.00	R	11,139.83	3,553.86	980.23	319.36	105.86	33.16	14.27	5.82	2.22	1.19	0.36
	v	42.98	27.51	16.56	10.60	6.80	4.25	3.01	2.08	1.40	1.08	0.66
7.50	R	12,751.43	4,063.35	1,119.00	364.01	120.49	37.69	16.21	6.60	2.51	1.34	0.41
	v	46.05	29.47	17.74	11.35	7.29	4.55	3.23	2.23	1.50	1.16	0.71
8.00	R	14,471.43	4,606.69	1,266.81	411.52	136.02	42.49	18.25	7.43	2.82	1.51	0.46
	v	49.12	31.44	18.92	12.11	7.77	4.86	3.44	2.38	1.60	1.24	0.75
9.00	R	18,236.63	5,794.90	1,589.53	515.05	169.80	52.90	22.69	9.22	3.50	1.87	0.57
	v	55.26	35.37	21.29	13.63	8.74	5.46	3.87	2.68	1.80	1.39	0.85
10.00	R		7,118.43	1,948.35	629.93	207.19	64.40	27.58	11.19	4.24	2.27	0.69
	v		39.30	23.66	15.14	9.72	6.07	4.30	2.98	2.00	1.54	0.94
12.00	R		10,171.36	2,774.23	893.66	292.78	90.64	38.70	15.66	5.92	3.16	0.96
	v		47.16	28.39	18.17	11.66	7.28	5.16	3.57	2.40	1.85	1.13
14.00	R		13,765.32	3,744.31	1,202.62	392.73	121.15	51.60	20.83	7.86	4.19	1.27
	v		55.02	33.12	21.20	13.60	8.50	6.02	4.17	2.80	2.16	1.32
16.00	R			4,858.51	1,556.75	506.99	155.92	66.27	26.69	10.05	5.35	1.61
	v			37.85	24.22	15.55	9.71	6.88	4.76	3.20	2.47	1.51
18.00	R			6,116.78	1,956.00	635.54	194.94	82.70	33.24	12.50	6.65	2.00
	v			42.58	27.25	17.49	10.93	7.74	5.36	3.60	2.78	1.70
20.00	R			7,519.10	2,400.35	778.35	238.19	100.87	40.48	15.19	8.07	2.43
	v			47.31	30.28	19.43	12.14	8.60	5.95	4.00	3.09	1.89
22.00	R			9,065.44	2,889.78	935.41	285.66	120.79	48.39	18.13	9.62	2.89
	v			52.04	33.31	21.38	13.35	9.47	6.55	4.40	3.40	2.07
24.00	R			10,755.78	3,424.28	1,106.72	337.35	142.44	56.98	21.32	11.31	3.39
	v			56.77	36.34	23.32	14.57	10.33	7.14	4.80	3.71	2.26
26.00	R				4,003.83	1,292.25	393.24	165.83	66.25	24.75	13.11	3.92
	v				39.36	25.26	15.78	11.19	7.74	5.20	4.02	2.45
28.00	R				46,28.43	1,492.01	453.33	190.94	76.18	28.43	15.05	4.50
	v				42.39	27.21	17.00	12.05	8.34	5.60	4.32	2.64
30.00	R				5,298.07	1,705.99	517.63	217.78	86.79	32.35	17.11	5.11
	v				45.42	29.15	18.21	12.91	8.93	6.00	4.63	2.83

d = outside diameter (mm)

s = wall thickness (mm)

d_i = inside diameter (mm)

► Pressure Drop Graphs at 20°

VESBO® Pipe PN10 (SDR11)

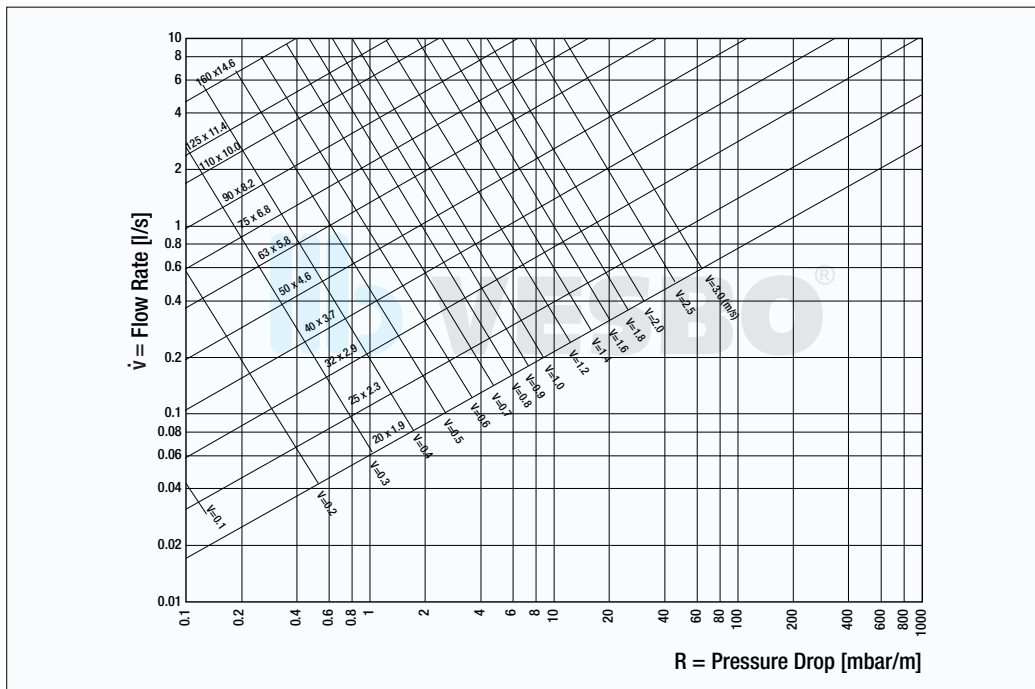


Fig. 26: Pressure Drop Graph at 20° for VESBO® Pipe PN10 (SDR11)

VESBO® PN16 (SDR 7.4) & PN20 (STABLE Pipe)

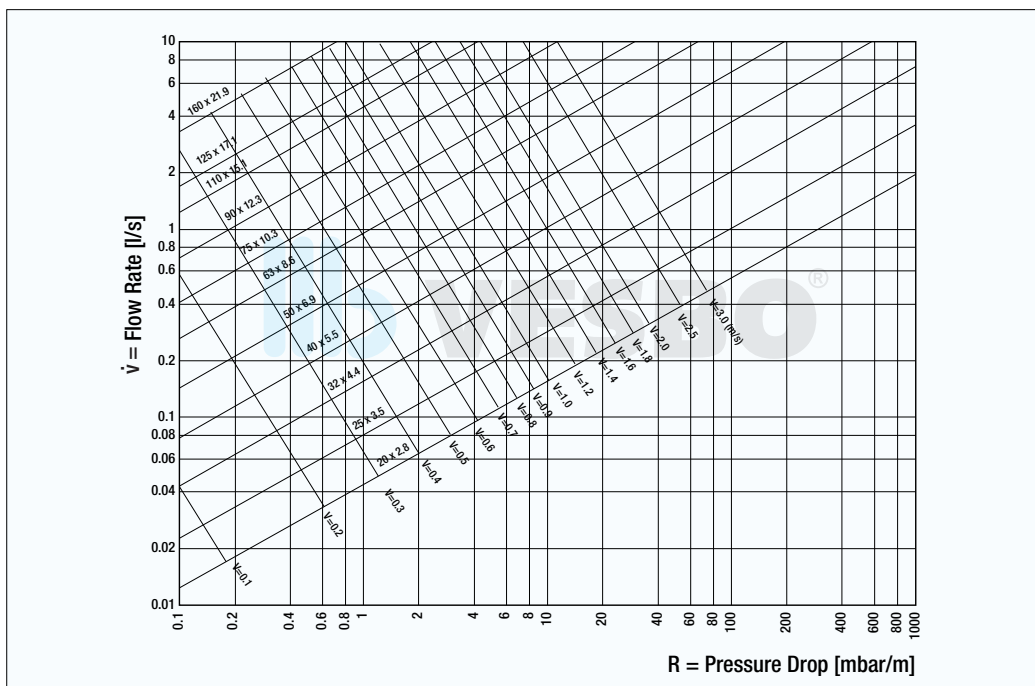


Fig. 27: Pressure Drop Graph at 20° VESBO® PN16 (SDR 7.4) & PN20 (STABLE Pipe)

VESBO® Pipe PN20 (SDR6) & PN25 (STABLE Pipe)

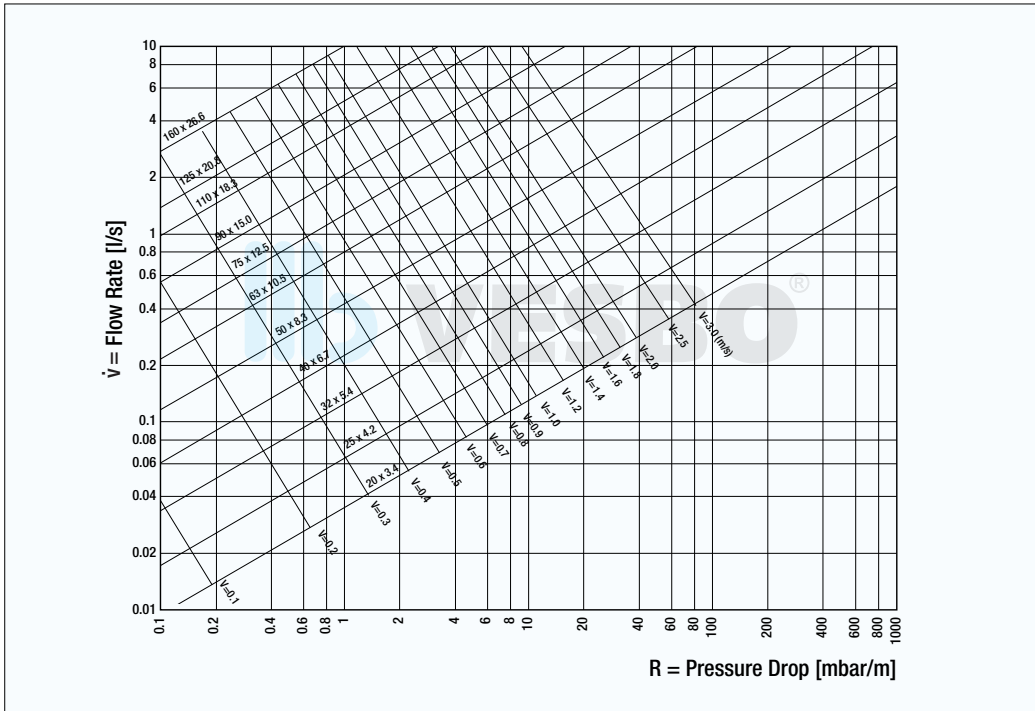


Fig. 28: Pressure Drop Graph at 20° for VESBO® Pipe PN20 (SDR6) & PN25 (STABLE Pipe)

► Pressure Drop Graphs at 60°

VESBO® Pipe PN16 (SDR7.4) & PN20 (STABLE Pipe)

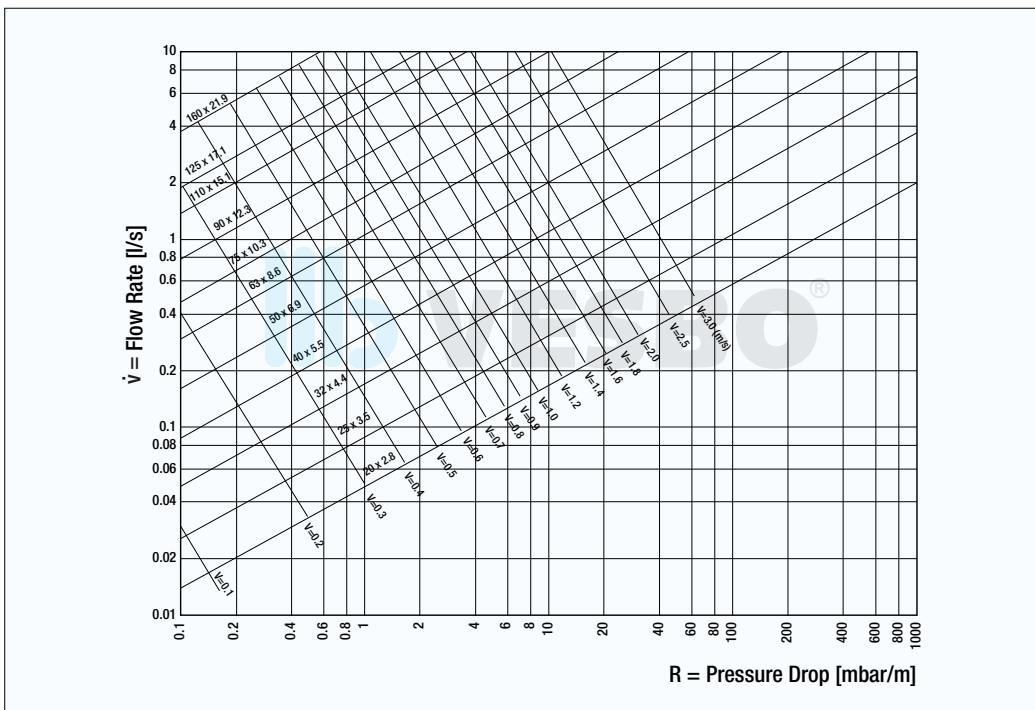


Fig. 29: Pressure Drop Graph at 20° for VESBO® Pipe PN20 (SDR6) & PN25 (STABLE Pipe)

VESBO® PN20 (SDR6) & PN25 (STABLE Pipe)

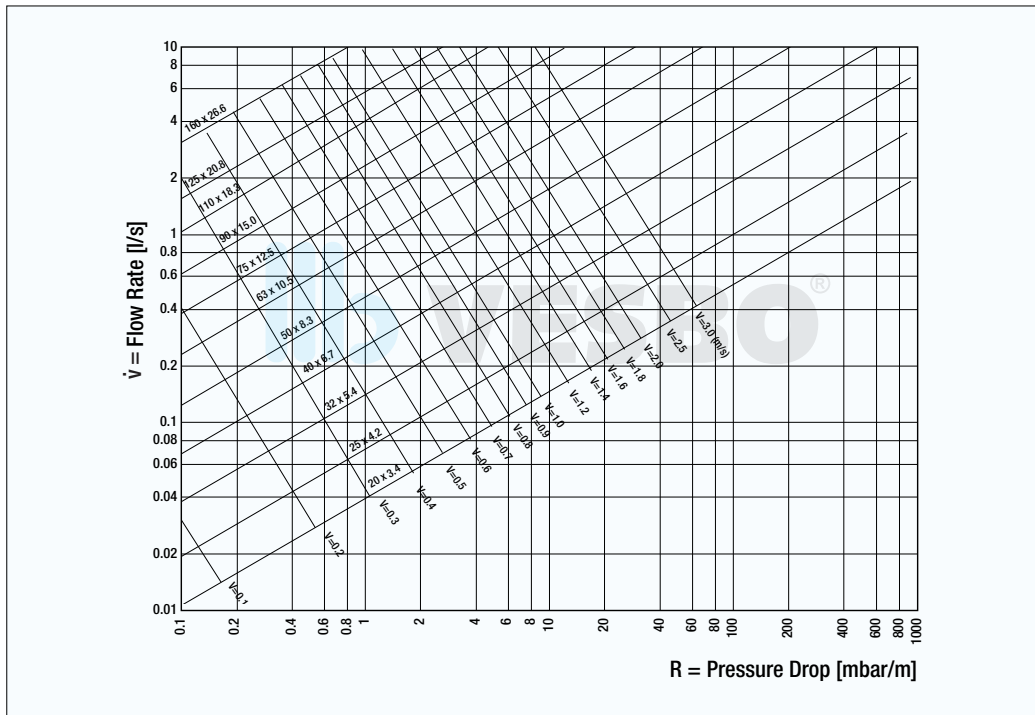


Fig. 30: Pressure Drop Graph at 60° for VESBO® Pipe PN20 (SDR6) & PN25 (STABLE Pipe)

► VESBO® Fittings Coefficient of Loss, ζ

VESBO® Fittings	Symbol	Consideration	Coeff. of Loss ζ	VESBO® Fittings	Symbol	Consideration	Coeff. of Loss ζ
Socket			0.25	Adaptor Female			0.50
Reducer		Reduce by 1 size	0.40	Adaptor Male			0.70
		Reduce by 2 size	0.50	Elbow Female			1.40
		Reduce by 3 size	0.60	Elbow Male			1.60
90° Elbow			1.20	T Part Female		20 x 3/4 x 20	1.40
45° Elbow			0.50			20 x 1/2 x 20	1.60
T Part		Passage	0.25			25 x 3/4 x 25	1.60
		Separation	1.20			25 x 1/2 x 25	1.80
		Conjunction	0.80	T Part Male		20 x 1/2 x 20	1.80
		Counter Separation	1.80	Valve		20	9.50
		Counter Conjunction	3.00			25	8.50
Unequal T		Sum of T Part and Reducer Values				32	7.60

Table 14: VESBO® Fittings Coefficient of Loss, ζ

09 ESSENTIAL PRECAUTIONARY MEASURES

► *Transportation & Storage*

- Store VESBO® pipes and fittings away from sun, rain and dirt.
- Do not expose to UV radiation for a long period.
- Handle VESBO® products with care at low temperatures. Do not store at temperatures below 0°C.
- Impacts can form cracks on pipes.
- Protect exposed pipes from damage; do not subject pipes to heavy shocks or falling stones.

► *Installation Tips & Techniques*

1. To reduce the diameter of a pipeline, i.e., joining a larger pipe to a smaller one, a socket must be used in conjunction with a reducer. For example, to reduce a pipe diameter from 50mm to 25mm, a 50mm socket must first be attached to the 50mm pipe, followed by a 50/25mm reducer, and finally the 25mm pipe.
2. When using VESBO® fittings with metal threaded parts, white Teflon sealing tapes must be applied adequately to prevent leakage from threads.
3. Over-tightening of fixtures to VESBO® fittings with metal parts may cause damages and leakage problems. Care must be taken to prevent over-tightening. Normal hand tightening with sealing or white teflon tapes is recommended at 20-30Nm. VESBO® metal inserts possess a maximum torque value of 80Nm and is sufficient to prevent normal tightening against leakages.
4. During fusion welding:
 - Fusion parts must be free from sand and particles.
 - Welding time and depths must be observed.
 - Do not twist and turn pipes and fittings while inserting and detaching from welding machine.
5. Metal plugs must be used during pressure tests.
6. Pressure test must be conducted BEFORE concealing pipe works.
7. Install VESBO® pipes and fittings according to pressure, temperature and expansion limitations indicated in VESBO's Technical Catalogue.
8. Do not use pipes that are damaged or cracked at interfaces. Use only special pipe cutters to shorten pipes.
9. If painting of the installation is required after welding, insulate the VESBO® pipeline to prevent the passage of chemicals in the paint, which will cause water contamination through the pipe wall or affect the service life of the installation. VESBO® does not warrant any responsibility regarding exposures to chemicals and paints. Customers are strictly recommended to consult our technical department before the design stage of a project.
10. Use only fittings with parallel threads, do not use conical threads and do not tighten too firmly.

11. Bending of pipes is not advisable. However, for hot bending of pipes, a hot air gun should be used. Never use an open flame. Hot air temperatures should not exceed 140°C.
12. Do not twist pipes or fittings after joining; correct by not more than 5°.
13. Insulate VESBO® exterior installations to prevent excessive heat loss and to protect against UV radiation.
14. Before welding commences, it is recommended to cut pipe ends by 4–5cm.
15. Temperatures of welding adaptors should be high enough for welding process, i.e., 250–260°C.

You must NOT	1 directly contact with hazardous chemical materials	2 subject the pipe ends to shock or impact	3 use pipes that are damaged or cracked at the interfaces
	4 twist pipe or fittings after joining	5 use conical threads	6 expose VESBO® to UV radiation for a long period
You must	7 use metal plugs as connectors	8 subject VESBO® to heavy shocks or falling stones	9 use excessive amounts of hemp when sealing in fittings
	10 heat with a naked flame	11 bind up contaminated pipes or fittings	
You must	1 only consider UV pipes for exposure to sun	2 handle VESBO® with care	3 only use sharp tools to cut the pipe
	4 not correct by more than 5° after joining	5 only use fittings with parallel threads, not tighten too firmly	6 store VESBO® sheltered from sun and rain
You must	7 use plastic plugs	8 protect exposed pipes from damage	9 only heat with hot air for bending, max bending temperature 140°C
	10 use sealing tape or sealing compound; apply hemp moderately	11 only install clean material	

Fig. 31: Caution and Handling

► *Cold Welding or Cold Joints*

Cold welded joints will typically cause crack lines to form on fittings, pipes or joint areas and result in leakages. Formation of such crack lines usually appear within 6 to 24 months especially for hot water systems where expansion is inevitable.

Causes:

- Welding tools operating at temperatures outside the range of 250–260°C.
- Exposure before joining pipes and fittings is too long causing welded parts to be “cold”.
- Welding depth is not reached.
- Reducing cooling time of welded areas by pouring water or other means.

Preventive measures:

- Ensure welding tools are operated within 250–260°C by constantly checking and keeping the temperature of welding tool to what is stipulated.
- Always adhere to VESBO's recommended welding depth, heating time and cooling time (Table 6).
- Cooling of joints should be gradual and natural under ambient temperatures.

► *Hot Water Reticulation Systems*

Exercise care in handling Hot Water Reticulation Systems (HWRS) to prevent PP-R material failure and service life reduction due to **oxidative stress cracking**. A combination of the following operating conditions may result in stress cracking due to oxidation:

- High internal and external pressure loads.
- Temperatures of more than 70°C.
- Excessive metal ions (eg. copper pipe erosion and corrosion).
- Improper pipe sizing resulting in high water velocities.

Preventive measures:

- Observe and adhere to permissible operating pressures (Table 3).
- For better service life of materials, temperatures in HWRS should not exceed 70°C.
- Use deactivator additives.
- Do not use metal pipes with polyolefin pipes.
- Observe proper pipe sizing to provide suitable water velocities that will not cause erosion.

► Usage of Chlorine Disinfectants

Excessive concentration of disinfecting products in a water system affects all materials found within the system. Oxidation from free chlorine is more profound when corroded metals are found in the system. The level of free chlorine in the water **should not exceed 0.30 mg/l**.

Corrosion caused by free chlorine oxidation acts as a catalyst for thermo-oxidative degradation of PP-R materials which will consequently shorten the system's service life.

Observe the following table as a general rule for using disinfecting products:

Discontinuous Disinfection Preventive Mode			Continuous Disinfection Preventive Mode	
Disinfectant	Healthcare premises	PP-R	Health care premises	PP-R
		Water temperature $T_{\max} < 25^{\circ}\text{C}$		
NaOCl	100 mg/l – 1h	Not recommended 50 mg/l – 12 h max.	0.3 mg/l < Cl < 1 mg/l	$\text{Cl} \leq 0.3 \text{ mg/l}$ and $T_{\max} < 60^{\circ}\text{C}$
	50 mg/l – 12 h			
	15 mg/l – 24 h			
$\text{Ca}(\text{OCl})_2$	100 mg/l – 1h	Not recommended 50 mg/l – 12 h max.	0.3 mg/l < Cl < 1 mg/l	$\text{Cl} \leq 0.3 \text{ mg/l}$ and $T_{\max} < 60^{\circ}\text{C}$
	50 mg/l – 12 h			
	15 mg/l – 24 h			
Hydrogen Peroxide H_2O_2	150 mg/l – 24h	Unknown	Unknown	Unknown

Table 15: General Rules for Using Disinfecting Products

► Usage of Pipe Clamps

Used in combination with hot water PP-R pipes, pipe clamps may cause external stress especially if they are not dimensioned for the Outside Diameter (OD) of the PP-R pipes and if they do not allow PP-R pipes to expand or contract.

PP-R pipes expand linearly and radially while hot water is running through it. Hence proper pipe clamps should be used to allow free movement of pipes due to expansion and contraction. This is to prevent excessive external loading-due mechanical stress especially for hot potable water and heating systems.

► Usage for Transportation of Chemicals

The chemical resistance table serves as a general guide.

When in doubt please consult the manufacturer.

Polypropylene Chemical Resistance Table

Introduction

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

Source: ISO/TR 10358

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

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

Scope and Field Application

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

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

Definitions, Symbols and Abbreviations

The criteria of classifications, definitions, symbols and abbreviations adopted in this document are as follows:

S = Satisfactory

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

L = Limited

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

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

NS = Not satisfactory

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

Also classified as "not satisfactory" are materials for which judgement "L" and "NS" are pronounced to an equal extent.

Sat.sol Saturated aqueous solution, prepared at 20°C

Sol Aqueous solution at a concentration higher than 10 % but not saturated

Dil.sol Dilute aqueous solution at a concentration equal to or lower than 10 %

Work.sol Aqueous solution having the usual concentration for industrial use

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

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

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

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	-
Acetophenone	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/HNO ₃ =3/1	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	-
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	-	-
Butyl phenols	Sat.sol	S	-	-
Butyl phthalate	100 %	S	L	L
Calcium carbonate	Sat.sol	S	S	S
Calcium chlorate	Sat.sol	S	S	-
Calcium chloride	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	-

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Carbon disulphide		S	NS	NS
Carbon monoxide, gas	100 %	S	S	-
Carbon tetrachloride		NS	NS	NS
Castor oil	100 %	S	S	-
Caustic soda	100 %	S	L	L
Chlorine, aqueous	Up to 50 %	S	L	-
Chlorine, dry gas	Sat.sol	NS	NS	NS
Chlorine, liquid	100 %	NS	NS	NS
Chloroacetic acid	100 % Sol	S	-	-
Chloroethanol	100 %	S	-	-
Chloroform	100 %	L	NS	NS
Chlorosulphonic acid	100 %	NS	NS	NS
Chrome alum	Sol	S	S	-
Chromic acid	Up to 40 %	S	L	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	-
Cresol	> 90 %	S	-	-
Cyclohexane	100 %	S	-	-
Cyclohexanol	100 %	S	L	-
Cyclohexanone	100 %	L	NS	NS
Decalin (decahydronaphthalene)	100 %	NS	NS	NS
Dextrin	Sol	S	S	-
Dextrose	Sol	S	S	S
Dibutyl phthalate	100 %	S	S	NS
Dichloroacetic acid	100 %	L	-	-
Dichloroethylene (A and B)	100 %	L	-	-
Diethanolamine	100 %	S	-	-
Diethyl ether	100 %	S	L	-
Diethylene glycol	100 % S	S	S	-
Diglycolic acid	at.sol	S	-	-
Diisooctyl	100 %	S	L	-
Dimethyl amine, gas		S	-	-
Dimethyl formamide	100 %	S	S	-
Diethyl phthalate	100 %	L	L	-
Dioxane	100 %	L	L	-
Distilled water	100 %	S	S	S
Ethanolamine	100 %	S	-	-
Ethyl acetate	100 %	L	NS	NS
Ethyl alcohol	Up to 95 %	S	S	S
Ethyl chloride, gas		NS	NS	NS
Ethylene chloride (mono and di)		L	L	-
Ethyl ether	100 %	S	L	-
Ethylene glycol	100 %	S	S	S
Ferric chloride	Sat.sol	S	S	S
Formaldehyde	40 %	-	-	-
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

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Gasoline, petrol (aliphatic hydrocarbons)		NS	NS	NS
Gelatine		S	S	-
Glucose	20 %	S	S	S
Glycerine	100 %	S	S	S
Glycolic acid	30 %	S	-	-
Heptane	100 %	L	NS	NS
Hexane	100 %	S	L	-
Hydrobromic acid	Up to 48 %	S	L	NS S
Hydrochloric acid	Up to 20 %	S	S	
Hydrochloric acid	30 %	S	L	L
Hydrochloric acid	35-36 %	S	-	-
Hydrofluoric acid	Dil.sol	S	-	-
Hydrofluoric acid	40 %	S	-	-
Hydrogen	100 %	S	-	-
Hydrogen chloride, dry gas	100 %	S	S	-
Hydrogen peroxide	Up to 10 %	S	-	-
Hydrogen peroxide	Up to 30 %	S	L	-
Hydrogen sulphide, dry gas	100 %	S	S	-
Iodine, in alcohol		S	-	-
Isoctane	100 %	L	NS	NS
Isopropyl alcohol	100 %	S	S	S
Isopropyl ether	100 %	L	-	-
Lactic acid	Up to 90 %	S	S	-
Lanoline		S	L	-
Linseed oil	Sat.sol	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	Sol	S	S	-
Mercury (II) cyanide	100 %	S	S	-
Mercury (I) nitrate	100 %	S	S	-
Mercury	5 %	S	S	-
Methyl acetate	Up to 32 %	S	S	-
Methyl alcohol	100 %	S	L	L
Methyl amine	100 %	S	-	-
Methyl bromide	100 %	NS	NS	NS
Methyl ethyl ketone		S	-	-
Methylene chloride		L	NS	NS
Milk	>85 %	S	S	S
Monochloroacetic acid		S	S	-
Naphtha	Sat.sol	S	NS	NS
Nickel chloride	Sat.sol	S	S	-
Nickel nitrate	Sat.sol	S	S	-
Nickel sulphate	Up to 30 %	S	S	-
Nitric acid	40-50 %	S	NS	NS
Nitric acid		L	NS	NS
Nitric acid, fuming (with nitrogen dioxide)		NS	NS	NS
Nitrobenzene	100%	S	L	-
Oleic acid	100 %	S	L	-
Oleum (sulphuric acid with 60 % of SO ₃)		S	L	-
Olive oil	Sat.sol		S	L

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Oxalic acid			L	NS
Oxygen, gas			-	-
Paraffin oil (FL65)			L	NS
Peanut oil			S	-
Peppermint oil			-	-
Perchloric acid	(2 N) 20 %	S	-	-
Petroleum ether (ligroine)		S	L	-
Phenol	5 %	S	S	-
Phenol	90 %		-	-
Phosphine, gas		S	S	-
Phosphoric acid	Up to 85 %	S	S	S
Phosphorus oxychloride	100 %	S	-	-
Picric acid	Sat.sol	S	-	-
Potassium bicarbonate	Sat.sol	L	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	L	S	-
Potassium chlorite	Sat.sol	S	S	-
Potassium chromate	Sat.sol	S	S	-
Potassium cyanide	Sol	S	-	-
Potassium dichromate	Sat.sol	S	S	S
Potassium ferricyanide	Sat.sol	S	S	-
Potassium fluoride	Sat.sol	S	S	-
Potassium hydroxide	Up to 50 %	S	S	S
Potassium iodide	Sat.sol	S	-	-
Potassium nitrate	Sat.sol	S	S	-
Potassium perchlorate	10 %	S	S	-
Potassium permanganate	(2 N) 30 %	S	-	-
Potassium persulphate	Sat.sol	S	S	-
Potassium sulphate	Sat.sol	S	S	-
Propane, gas	100 %	S	-	-
Propionic acid	>50 %	S	-	-
Pyridine	100 %	L	-	-
Seawater		S	S	S
Silicon oil		S	S	S
Silver nitrate	Sat.sol	S	S	L
Sodium acetate	Sat.sol	S	S	S
Sodium benzoate	35 %	S	L	-
Sodium bicarbonate	Sat.sol	S	S	S
Sodium carbonate	Up to 50 %	S	S	L
Sodium chlorate	Sat.sol	S	S	-
Sodium chloride	Sat.sol	S	S	-
Sodium chlorite	2 %	S	L	NS
Sodium chlorite	20 %	S	L	NS
Sodium dichromate	Sat.sol	S	S	S
Sodium hydrogen carbonate	Sat.sol	S	S	S
Sodium hydrogen sulphate	Sat.sol S	S	S	-
Sodium hydrogen sulphite	at.sol	S	-	-
Sodium hydroxide	1 %	S	S	S
Sodium hydroxide	10-60 %	S	S	S
Sodium hypochlorite	5 %	S	S	-
Sodium hypochlorite	10 % - 15 %	S	-	-
Sodium hypochlorite	20 %	S	L	-
Sodium metaphosphate	Sol	S	-	-
Sodium nitrate	Sat.sol	S	S	-
Sodium perborate	Sat.sol	S	S	-

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Sodium phosphate (neutral)		S	S	S
Sodium silicate	Sol	S	S	-
Sodium sulphate	Sat.sol	S	S	-
Sodium sulphide	Sat.sol	S	-	-
Sodium sulphite	40 %	S	S	S
Sodium thiosulphate (hypo)	Sat.sol	S	-	-
Soybean oil		S	L	-
Succinic acid	Sat.sol	S	S	-
Sulphuric acid	Up to 10 %	S	S	S
Sulphuric dioxide, dry or wet	100 %	S	S	-
Sulphur acid	10-30 %	S	S	S
Sulphuric acid	50 %	S	L	L
Sulphuric acid	96 %	S	L	L
Sulphuric 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 %	L	NS	NS
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		S	S	-
Xylene	100 %	NS	NS	NS
Yeast	Sol	S	S	S
Zinc chloride	Sat.sol	S	S	-
Zinc sulphate	Sat.sol	S	S	-

Table 16: Polypropylene Chemical Resistance Table

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- Fire, earthquake, flood, lightning, hurricane, tornado or other casualty or acts of God.
- Exposure to chemicals and many other local influences over which Vesbo® has no control.
- Any other cause not involving inherent manufacturing defects in the pipes and fittings supplied by Vesbo®.

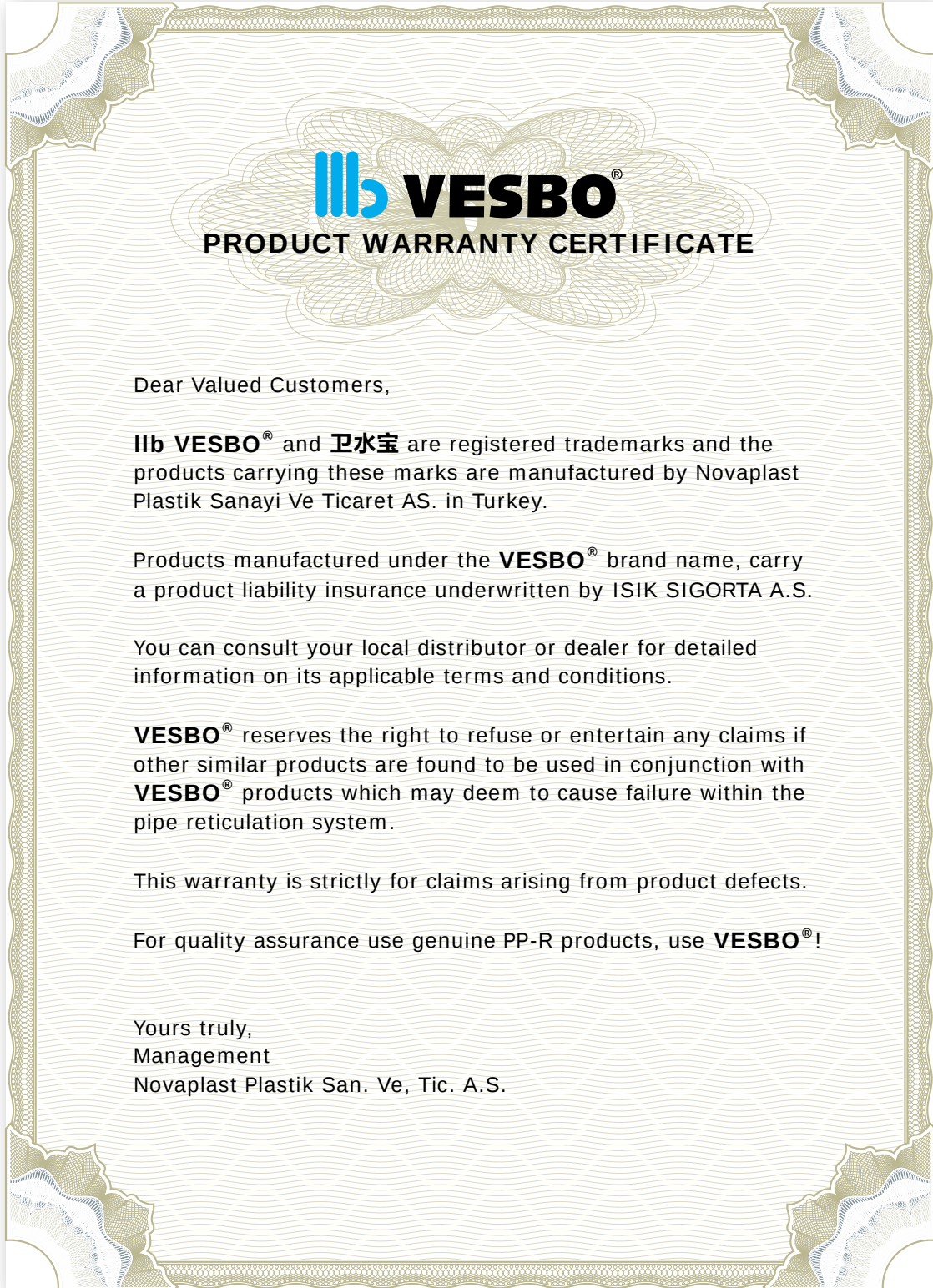
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Vesbo shall have the sole discretion to determine whether the pipes and fittings are suffering from normal weathering, the conclusion of which shall be based on reasonable criteria. In the event the material weathers to a degree which is determined by Vesbo® to be beyond normal, then Vesbo® shall either repair or replace at its option.

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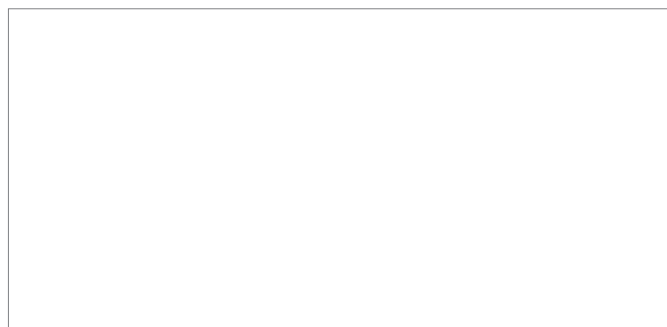
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