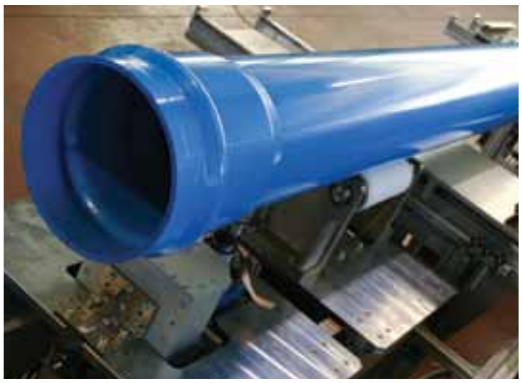
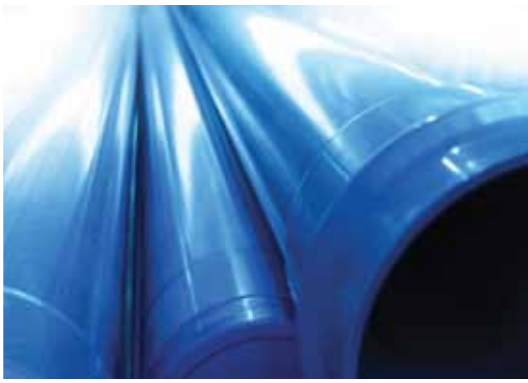
MOLECOR
South East Asia

HYPRO

The Pipe Revolution

Member of the FITTERS group

Molecor, the best technology applied to molecular orientation

Molecor Technologia S.L. is a pioneer company specialized in the development of the latest technology applying molecular orientation to pipeline solutions, with astonishing mechanical properties.

It was founded in 2006 by highly skilled engineers in this field with a proven experience in the plastic pipe division. Molecor's revolutionary process provides reliable and user friendly systems that widen the pipe global business possibilities.

Molecor (SEA) Sdn Bhd

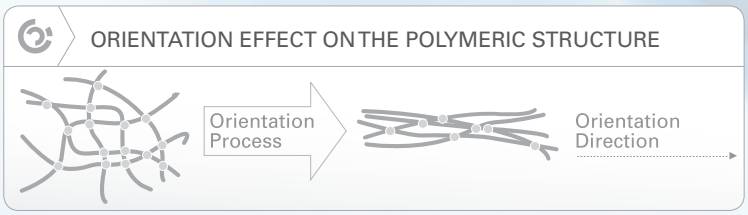
Molecor (SEA) Sdn Bhd, incorporated in 2013 to manufacture and distribute PVC-O pipes in South East Asia. Our HQ is in Kuala Lumpur and our first plant is in Gebeng, Kuantan, Malaysia. The plant is strategically located at Kuantan Port for ease of imports and exports and also connected seamlessly by a network of highways for convenient and efficient distribution of our PVC-O pipes throughout Malaysia.

Molecor (SEA) Sdn Bhd is led by a team of talented men and women, whose expertise and enthusiasm drive our vision for excellence. Molecor's Board of Directors sets the direction and our executive leaders motivate, manage and inspire our workforce to improve continuously in everything we do.

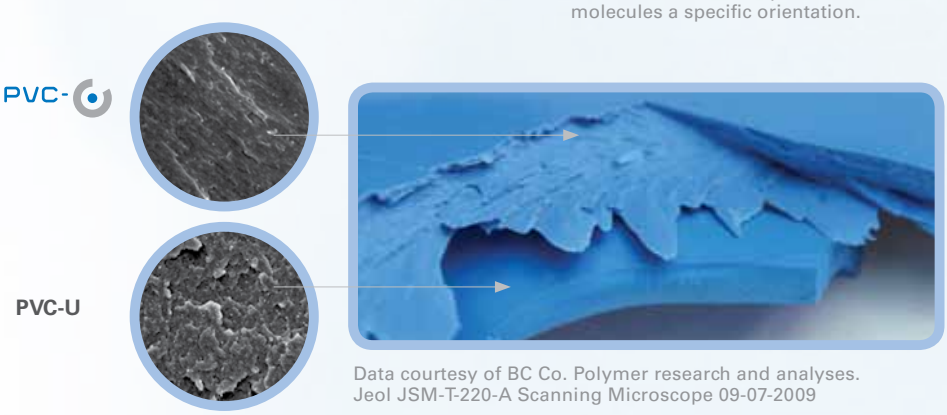
We are committed to manufacturing and delivering products and services of the highest possible quality, on time, guaranteed to meet or exceed our customer's expectations at the most economical level.

Molecular orientation, the PVC revolution

Molecular structure of PVC is the main feature that confers its mechanical properties. PVC is a polymer which represents an amorphous molecular structure, where chains are arranged at random directions.



Molecular orientation process modifies the PVC structure by giving the polymers molecules a specific orientation.



Data courtesy of BC Co. Polymer research and analyses.
Jeol JSM-T-220-A Scanning Microscope 09-07-2009

However, when stretching the material and under certain conditions of pressure, temperature and speed, the polymer molecules are aligned in the same direction as the stretching, resulting in a laminar structure.

The most advanced **technology** for water transport

Molecor is a company conceived and entirely dedicated to researching and manufacturing PVC-O pipes. Our manufacturing process is absolutely innovative and uses the most advanced and reliable technologies currently available.

Up until now, although PVC-O pipes are recognized as providing the highest specifications, the technical limitations of the different manufacturing processes and the low efficiency of these were a barrier to the extensive use of this kind of pipes.

The technology developed by MOLECOR means that these limitations have now been overcome and it has also helped to make **considerable improvements** in HYPRO PVC-O pipes.

The innovative attitude is expressed through the patents PCT that Molecor has registered at the World Intellectual Property Organization (WIPO).

Total Dry System

- **Efficiency and cleanness:** easy maintenance, start-up and diameter change
- **Safety:** the absence of boiling water prevents from leakage risks
- **Cost effectiveness:** energy applied just to the pipe through specific air distribution

The Highest degree of orientation

- Greater reliability of the end-product
- The best mechanical properties
- Maximum material savings
- A real competitive advantage, the best properties at the best price

Integrated Socket System

- Socket conformed at the same time as the orientation process
- Guarantee of no orientation degree loss during later processes

High Pressure Applications

- Working pressures from 12.5 bar to PN 25 bar.
- Suitable for demanding pressure projects and special applications.
- Extra quality for conventional water pipelines.

Largest range of diameters

- DN: from 90 mm to 800 mm.
- Complying with worldwide standards.
- Application for water conveyance of water mains.

HYPRO PVC-O pipes:
The best choice for high pressured fluid transport

Unbeatable impact resistance

HYPRO PVC-O pipes are not easily destroyed by impact. Breakages during installation or during on-site trials caused by dropping or by impacts from stones are minimal.
Furthermore, Molecular Orientation prevents the propagation of cracks and scratches and minimizes the risk of rapid crack behavior. The result is a spectacular increase in the product's useful life.




High short-term and long-term hydrostatic resistance

HYPRO PVC-O pipes offer a resistance to internal pressure of up to **two times the nominal pressure** (32 bars in PN16 bar pipes), which means that they can bear sporadic excessive pressure such as water hammers and other malfunctions in the network. Moreover, the material creep behavior is very low, ensuring the durability of the pipe working at nominal pressure for over 50 years.

Increased hydraulic capacity

Molecular Orientation reduces the pipe wall thickness, giving HYPRO PVC-O pipes a **greater internal diameter and flow section.** Also, the internal surface is extremely smooth, reducing load loss and making it more difficult for deposits to be formed on the inner walls.
As a result, HYPRO PVC-O pipes offer between **15% - 40% more hydraulic capacity** than pipes made from other materials and with the same external dimensions.

Maximum flexibility

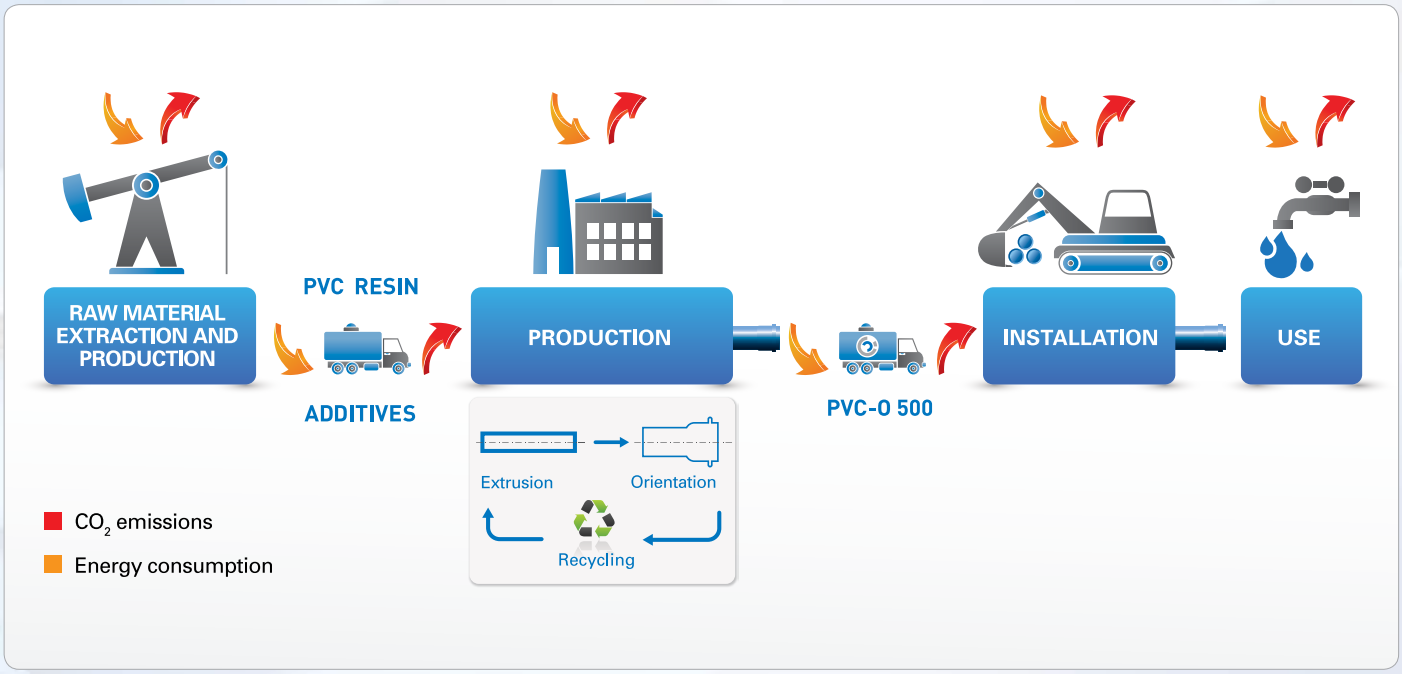
Thanks to their excellent elasticity, HYPRO PVC-O pipes can bear **deformation of up to 100 percent of their internal diameter.** When crushed, or in the event of a mechanical accident, HYPRO PVC-O pipes immediately go back to their original shape, thus eliminating the risk of potential breakage by soil subsidence or sharp edges on rocks or machinery, for example. And their considerable capacity for bearing heavy loads ensures **optimum performance once laid underground.**

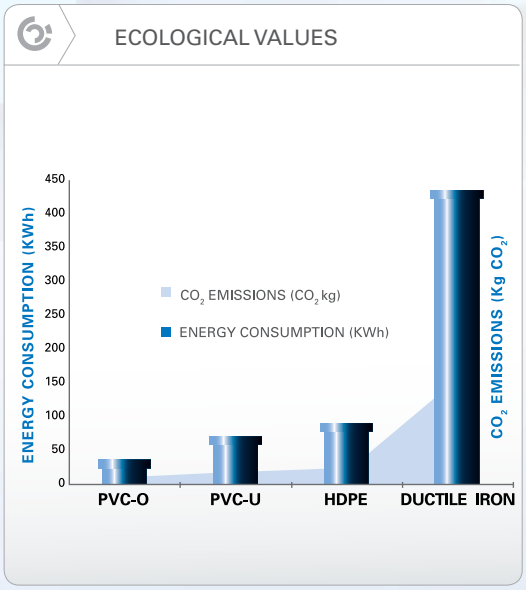
Lower cost and easier installation

HYPRO PVC-O pipes are **lighter and easier to handle** than other pipes made from other materials; in most cases, handling does not require machinery. What's more, due to the easiness in union, flexibility and impact resistance, they stand out in terms of **cost, performance and installation speed compared to other pipes.**

Environment: the most eco-friendly pipe

The environmental advantages of HYPRO PVC-O pipes relate to their chemical nature, to the improvement in the mechanical properties achieved during the molecular orientation process, and to its energy efficiency all along its useful life.





BETTER RESOURCE EFFICIENCY IN PIPES:

- Raw material savings.
- Do not contain toxic substances on its formulation, such as heavy metals
- 100% recyclable.

INSTALLATION PERFORMANCE:

- The weight reduction eliminates the need of heavy machinery.
- The plug-in socket system enables fast and easy installation.

ENERGY EFFICIENCY:

- The wall thickness reduction leads to an increase in the hydraulic capacity.
- Smooth inner surface, which entails a reduction in the load losses, and a lower energetic consumption.

LONG USEFUL LIFE:

- Guaranteed minimum lifetime of 50 years.
- Resistant to chemical attack, so there is no corrosion during its useful life and there is no need for coating solutions.
- The assembly of PVC-O pipes ensures perfect tightness, avoiding load losses and the waste of water resources.
- Great performance against water hammer.

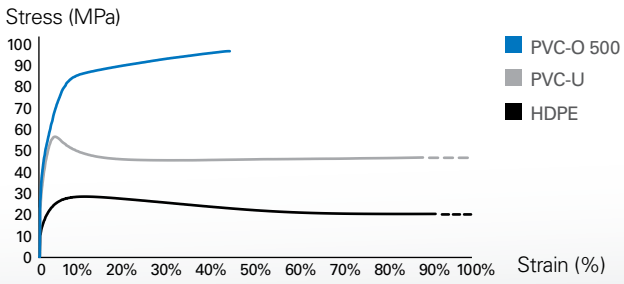
The best mechanical properties

Tensile resistance

In terms of performance, PVC-O shows a very different stress-strain curve when compared to conventional plastics and comes very close to the curve of metals.

The complete transformation of PVC-O Mechanical properties compared to conventional PVC can only be achieved in the higher PVC-O class, **class 500**, such as in HYPRO PVC-O pipes .

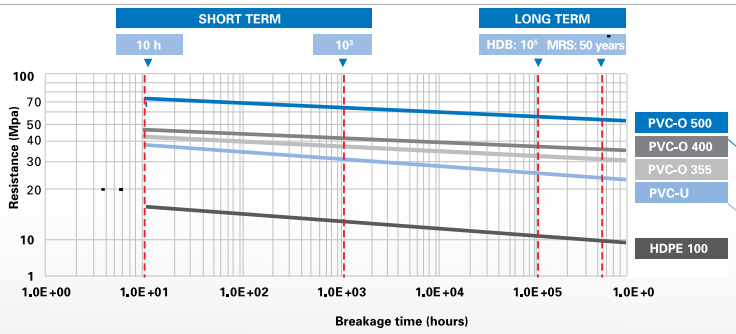
STRAIN-STRESS BEHAVIOUR



Long-term hydrostatic resistance

Materials lose their mechanical properties when they are subjected to strain over a long period of time. This characteristic, known as creep , appears to a far lesser extent in PVC-O 500 than in conventional plastics, which means better properties in the long term. Bearing in mind that PVC-O is exceptionally resistant to fatigue and has a very good chemical resistance, which is common to conventional PVC, it is no exaggeration to say that this kind of piping is capable of withstanding the work pressure for over 50 years.

STRESS REGRESSION LINE



Class	MRS
500	50
400	40
355	35
300	30
250	25

$$\sigma = \frac{MRS}{C_s}$$

$$\sigma = \frac{50}{1.4} = 36$$

$$\sigma = \frac{25}{2} = 12{,}5$$

Piping and material mechanical properties

The following table summarizes the technical characteristics of HYPRO PVC-O pipes in comparison with other plastic pipes.

		HYPRO PVC-O 500	PVC	HDPE-100	HDPE-80
Product Standard	**Units**	**ISO 16422**	**EN 1452**	**EN 12201**	**EN 12201**
Minimum required strength (MRS)	MPa	50.0	25.0	10.0	8.0
Overall service coefficient (C)	[]	1.4	2.0(1)	1.25	1.25
Design Stress (σ)	MPa	36.0	12.5	8.0	6.3
Short-term elasticity modulus (E)	MPa	> 4,000	> 3,000	1,100	900
Resistance to axial traction	MPa	> 48	> 48	19	19
Resistance to tangential traction	MPa	> 90	> 48	19	19
Shore Hardness D	[]	81 - 85	70 - 85	60	65

(1) For pipes with a DN ≥110.

Unbeatable hydraulic properties

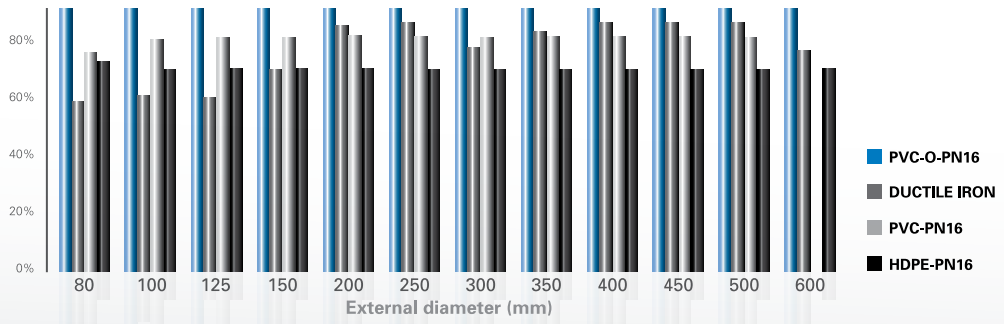
Hydraulic Design

Whether designing a pumping system or a gravity-enabled pipe system, deciding the dimensions of the pipes involves calculating losses in the terms of load, flow-volume and flow speed.
There are several methodologies for calculating these values. The most commonly used are the Hazen-Williams and Prandtl-Colebrook-White formulas.
Another factor to be taken into account is the load loss produced by accessories (elbows, reducers, tees etc) and valves.
When determining water speed, economic factors must be taken into account: (optimization of the investment in terms of water pumping) as well as the admissible values for water hammers.
Generally speaking, the minimum value used for avoiding sediments is 0.5 m/s, and the maximum values are between 2.0 and 2.5 m/s, depending on the diameter of the pipe.

Increased Hydraulic Capacity

Water pipe requirements are not only related to pressure resistance; they also have to **transport the highest amount of water while consuming the least energy.** HYPRO PVC-O pipe walls are thinner than conventional plastic ones and are smoother than metals inside, which means a greater hydraulic capacity.

COMPARISON OF HYDRAULIC CAPACITY:
PVC-O PN16 PIPES VS OTHER MATERIALS (CONSTANT LOAD LOSS)

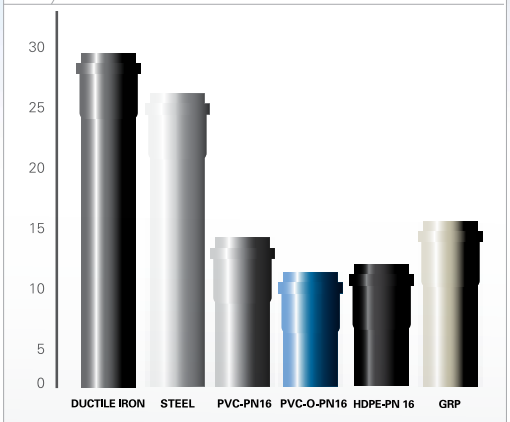


Water Hammer

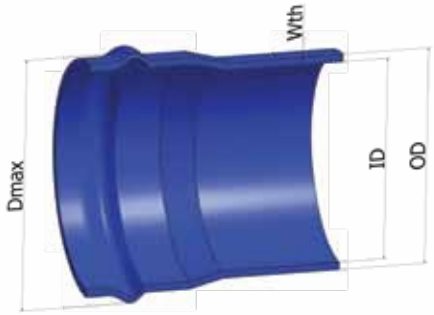
Water hammers can place greater pressure on a pipe's working pressure and lead to breakage, particularly when the pipe has already been damaged by impacts or corrosion.
Air locks in the pipes during filling can be highly damaging when water hammers arise and can cause an excess of pressure far beyond the levels established on the tables above. That is why it is important to follow the following recommendations:

- **Filling** the pipe should only be carried out at low speed and at the lowest point in the pipe system.
- **Installing** purging mechanisms at the highest points on each section of pipe.
- **During filling** it is important to leave open the elements capable of evacuating air and close them from bottom to top in the pipe as the pipe fills up with water.

WATER HAMMER (P) IN BARS



Dimensions



			HYPRO PVC-O pipes							
			PN12.5		PN16		PN20		PN25	
Nominal Diameter (DN)	Outside Diameter (OD)		Inside Diameter (ID)	Wall thickness (Wth)	Inside Diameter (ID)	Wall thickness (Wth)	Inside Diameter (ID)	Wall thickness (Wth)	Inside Diameter (ID)	Wall thickness (Wth)
	min.	max.	average	min.	average	min.	average	min.	average	min.
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
90	90.0	90.3	-	-	84.0	2.0	84.0	2.5	82.2	3.1
110	110.0	110.4	104.4	2.2	104.0	2.4	103.2	3.1	101.4	3.8
140	140.0	140.5	133.0	2.8	132.4	3.1	131.2	3.9	129.2	4.8
160	160.0	160.5	152.0	3.2	151.4	3.5	150.0	4.4	147.6	5.5
200	200.0	200.6	190.0	4.0	189.2	4.4	187.4	5.5	184.4	6.9
225	225.0	225.7	213.6	4.5	212.8	5.0	210.8	6.2	207.4	7.7
250	250.0	250.8	237.4	5.0	236.4	5.5	234.2	6.9	230.6	8.6
315	315.0	316.0	299.2	6.3	298.0	6.9	295.2	8.7	290.6	10.8
400	400.0	401.2	379.8	8.0	378.4	8.8	374.8	11.0	369.0	13.7
450	450.0	451.4	430.3	7.9	425.6	9.9	421.5	12.4	415.2	15.4
500	500.0	501.5	474.6	9.9	472.8	11.0	468.6	13.7	461.2	17.1
630	630.0	631.9	597.8	12.6	595.8	13.8	590.4	17.3	581.0	21.6

HYPRO PVC-O pipes are supplied in total lengths of 6 metres (socket included). For other lengths for special projects, price on request.

Applications

PVC-O pressure pipes are specified with confidence in the following applications:

WATER SUPPLY:
Potable water mains and distribution lines.

AGRICULTURE:
Irrigation, water supply and recycled water schemes.

INDUSTRIAL:
Conveyance of water to industrial plants.
Sewer effluent control and water purification.

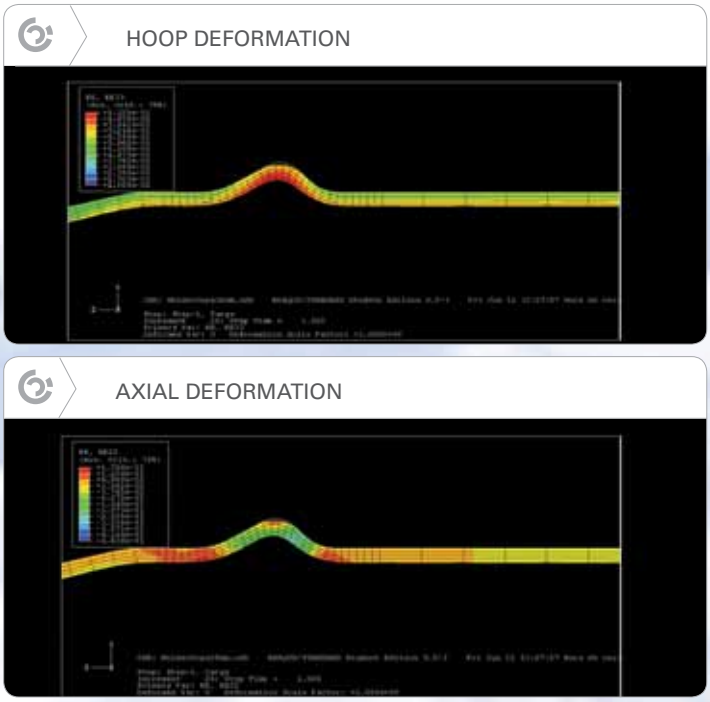
OTHERS:
Fire protection, urban water nets. Conveyance of water in underground. Use in desalination, treatment and recovery plants.

Integrated socket system

The socket's purpose is the union between pipes ensuring leak tightness and enabling a quick and easy installation on site. Sockets have to be designed so as to provide mechanical resistance.

The socket's design in PVC-O pipes does not only depend on certain geometry criteria or thickness distribution. Sockets are expected to maintain the excellent properties attained during molecular orientation. For that reason it is important to attain the right orientation degree on each part of the socket, since it is known how stresses are different along the different sections of the socket.

The socketing system is prepared to provide different degrees of orientation in the required section, and even to give a special wall thickness distribution.



FEM simulation of a PVC-O pipe behaviour with axial and hoop orientation

Fittings

TAPPING SADDLES

Allow connecting the pipe in the perpendicular direction to all kinds of fittings (house connections, valves, purges, vents, etc). They are available with screw ends and flange ends.

FLANGE WITH ANTI-TRACTION SYSTEM

Allows connecting the spigot ends to all kinds of fittings with connection to a flange (valves, elbows, T´s, DN reductions, caps, etc).

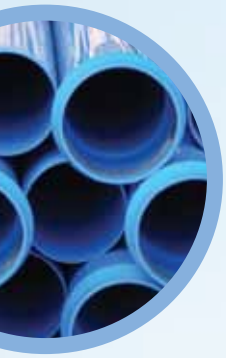
FITTINGS WITH PLUGS EURO TYPE

Connected directly to the pipe allowing for deviations, reductions and connections on the net (elbows, T´s, DN reductions, etc).

Worldwide regulations support

The general procedure to nationalize the standards that regulate PVC-O pipes for the conveyance of water is based whether in the adaptation of the international ISO 16422:2006 or the US standard ASTM 1483:05 to the local requirements. It can also occur that the PVC-O pipe product certification and recognition is issued by national Organisms based directly on the international standard.

In Malaysia, HYPRO PVC-O pipes will be tested and certified to ISO 16422:2006 by SIRIM QAS.



			HYDRAULIC DESIGN					
Country	Standard		CLASS	σ_s	Cs	HDB (psi)	(MPa)	MRS (MPa)
International	ISO 16422:2006		315	20-16	1,6-2			31,5
UK	BR-ISO 16422:2006		355	22-18	1,6-2			35,5
South Africa	SANS 16422:2007		400	25-20	1,6-2			40
Spain	UNE-ISO 16422:2008	AENOR	450	32-28-23	1,4-1,6-2			45
Saudi Arabia	SASO-ISO 16422:2009		500	36-32-25	1,4-1,6-2			50
Peru	NTP-ISO 16422:2012	indecopi						
			315	20				31,5
			355	22				35,5
Australia / New Zealand	AS/NZS 4441:2008		400	25				40
			450	28	1,6			45
			500	32		6.040	41,62	50
USA	ASTM 1483-05		PVCO 1131	21,7 (3.150 psi)	2	6.810	46,92	39,9 (stim.)
Colombia	NTC 5425:2012		PVCO 1135	24,5 (3.550 psi)	2	7.100	48.95	42,6 (stim.)
USA	AWWA C909-09			24.48 (3.550 psi)	2			42,6 (stim.)
Canada	CSA 137.3.1-09							
Brazil	ABNT NBR 15750:2009		400	25	1,6			40
			450	28				45
			355	22	1,6			35,5
France	AFNOR T 54-948:2010		400	25				40
			450	36	1,25			45
			500	40				50

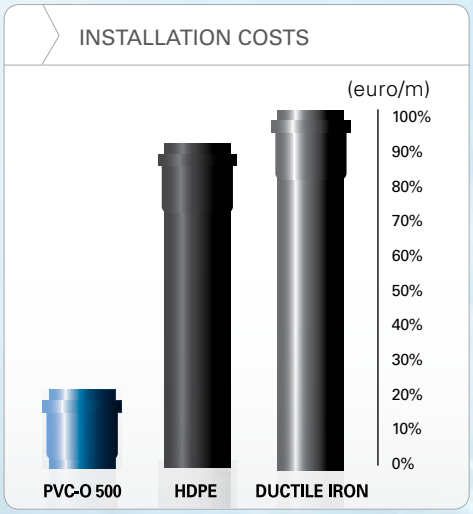
Installation Advantages

Easy to handle, fast to connect: cost savings

PVC-O 500 pipes weigh less than half the usual weight of PVC and HDPE, and are between six and twelve times lighter than ductile iron pipes of the same diameter. They are easy to handle and they can be lifted without mechanical assistance (for pipes up to DN 315 mm).

During the installation process, the connections between pipes are faster and there is no need for welded unions, thanks to the pipe's design and the PVC- O 500 properties.

Besides, due to the PVC-O 500 toughness, the scratches caused by impacts are minimal and the pipes present many advantages during unloading and burial.

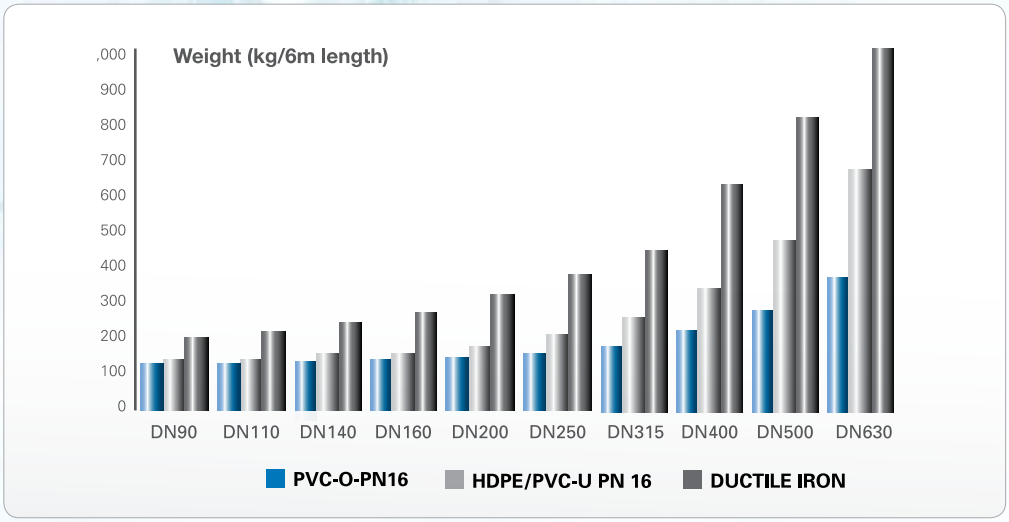


"Based on DN200-250 mm
PN16 installation in Europe"

EASY TO HANDLE: TRANSPORT AND STORAGE GUIDELINES:

- If different diameters are going to be transported in the same batch, the larger diameters must be placed below.
- Leave the sockets free, alternating sockets and free ends.
- To avoid damaging pipes in storage:
- Store the pipes horizontally on a flat surface, on supports spaced 1.5 meters apart, to keep the pipes from bowing.
- Do not stack higher than 1.5 m.
- If the pipes are stored in direct sunlight, cover the pallets with opaque material.

FAST TO CONNECT: ASSEMBLIES GUIDELINES:



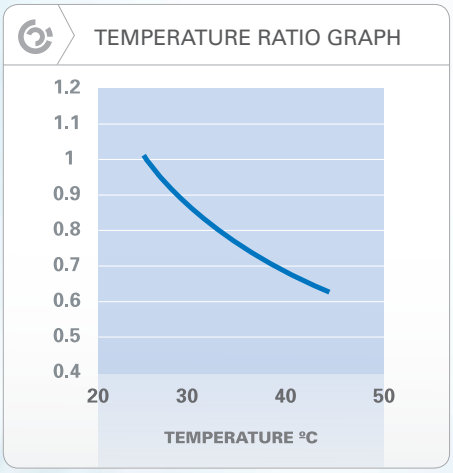
- Checks must be made to ensure that joints are clean both inside the pipe and outside.
- To facilitate assembly, it is advisable to lubricate the sockets and free ends using lubricating soap.
- Align the pipe-ends and slot the sockets into place.
- Pipes can be slotted into one another using levers (use only materials that will not damage the pipes, e.g. wood), or slings. With small diameters, however, owing to the elastic joint system and the lightness of the pipe, a short, sharp movement of the hand is enough to couple the pipes.

Reduction ratios: Temperature and application

High temperatures (over 25°C) or demanding or aggressive applications can reduce the Allowable Operating Pressure (PFA) of pipes in comparison to the Nominal Pressure (NP).

$$PFA = PN \cdot f_T \cdot f_A$$

The derating factor (fT) as function of operating temperature can be obtained from the graph on the right. The derating factor related to application of the system (fA) must be determined by the Project Manager.



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