MOLECOR® tech

T•M

The New Generation of PVC-O Pipes
Excellence in high-pressure water piping

Philippine Exclusive Distributor

ATLANTA INDUSTRIES, INC.

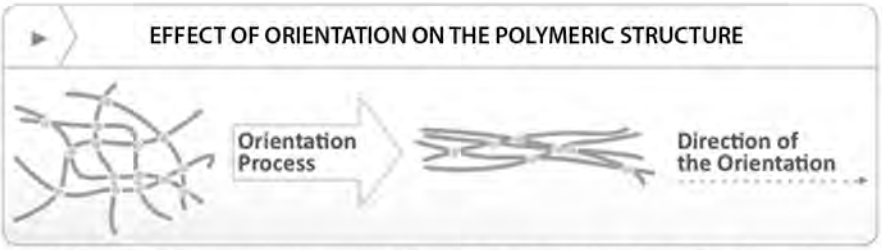
Molecular Orientation, a revolution in PVC

When PVC with its amorphous structure (lower section) is subjected to the orientation process, a laminate structure is obtained (upper section).

TOM® PVC-O pipes are the most advanced pipes for the conveyance of high-pressure water currently available on the market, with a number of exceptional features for this kind of application, thanks to the process of Molecular Orientation.

PVC is essentially an amorphous polymer in which the molecules are located randomly. However, under certain conditions of pressure, temperature and speed, by stretching the material, it is possible to orient the polymer molecules in the same direction as which the material has been stretched.

Depending on the process parameters used and mostly stretch ratio, a higher or lower orientation degree will be obtained. The result is a plastic with a layered structure which layers can be seen at a glance.



The Molecular Orientation process modifies the PVC's structure by giving the polymer's molecules a linear orientation.

A plastic with unbeatable properties

TOM® pipes

The process of Molecular Orientation greatly enhances PVC's physical and mechanical properties and gives it a number of exceptional features, without altering the advantages and properties of the original polymer. Thereby it is obtained a plastic with unbeatable qualities in terms of **resistance to traction and fatigue, flexibility and impact resistance.**

When used in high-pressure water pipelines **this type of piping has a high resistance and an extremely long lifetime.** Moreover, the pipe is highly energy-efficient and eco-friendly not only for the way it is made but also because of its subsequent use. Other advantages include reductions in costs and installation times.

For all these reasons, **TOM® PVC-O pipes are the best solution** for medium and high pressure water networks for irrigation systems, potable water supply, fire extinguishing networks and pumping systems, among other applications.

R & D

Molecor Tecnologia is a **company committed to research and development,** with clear **international vocation,** which markets products and technology developed entirely in Spain. Molecor firm commitment to R&D, goes beyond technology development and has been recognized with various **WIPO PCT** registered worldwide and with deals with the most reputable public research and development entities.

100% specialization

Molecor is dedicated exclusively to the development of the latest **technology applying Molecular Orientation** to PVC and to the implementation of **highly efficient solutions** for the conveyance of water under pressure. Throughout his trajectory **Molecor** has received several awards and recognitions that have contributed significantly to consolidate its presence and global leadership as a company dedicated to developing technology for the manufacture of **Oriented PVC pipes.**

Know How

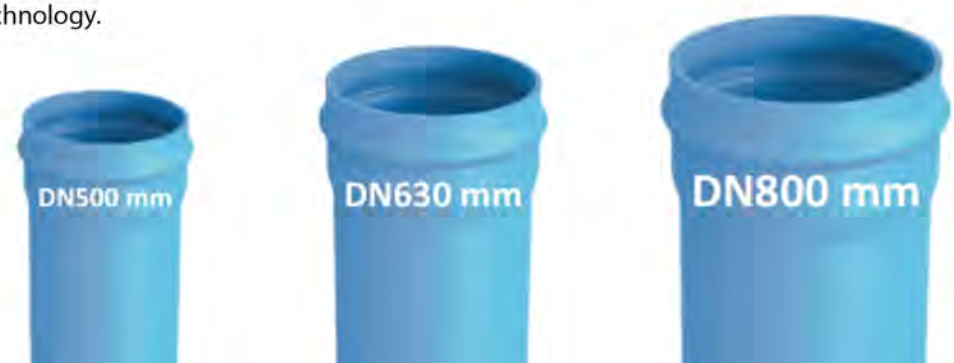
The effort of the company in R&D as well as its exclusive dedication to PVC-O, have made the company **fully acquainted of the sector** thus being able to provide support in all phases of the manufacturing and installation processes of the product.

360° support:

- Certification & Standardization
- Promotion & Sales
- On-line and off-line supporting tools
- Full support during installation
- Industrial support

Exclusive products

Thanks to its worldwide unique technology, Molecor has exclusive products available to the market. In its range of products, there are some outstanding diameters such as the **DN500 mm**, the **DN630 mm** or the **DN800 mm** PVC-O pipes; products that have been turning points in the sector since their manufacturing was unthinkable before the
apparition of the Molecor technology.



Cutting-edge technology for water

TOM® PVC-O pipes have been developed by MOLECOR©, the only company in the world conceived and dedicated entirely to researching and manufacturing PVC-O pipes. Our manufacturing process is absolutely innovative and uses the most advanced and most 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 shortcomings of those processes in terms of efficiency 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 TOM® pipes.

Manufacturing process developed by Molecor© uses most advanced technologies and it is completely automatized. This gives TOM® pipes maximum guarantee and quality.

The technology developed by MOLECOR© means that these limitations have now been overcome and it has also helped to make considerable **improvements** in TOM® pipes.

- Molecular Orientation is achieved by applying the precise and homogenous distribution of temperature and high pressures (up to 35 bars) thanks to **quality control checks** carried out on each individual pipe and throughout the entire manufacturing process.

- The TOM® pipes manufacturing process is continuous and fully- automated (as opposed to the traditional discontinuous method), providing **greater control over the end product and ensuring the uniform quality of each pipe.**

Maximum Reliability and Security

Thanks to the extraordinary technical advances of MOLECOR's manufacturing system, TOM® pipes offer the maximum reliability and security, as well as other attractive advantages over other products:

- **Maximum Molecular Orientation:** Class 500, according to the ISO 16422:2014 Standard, the highest orientation degree offering the best mechanical properties.

- **Greater reliability** of the end product.

- Strict dimensional tolerances.

- Homogeneous behavior of the materials used.

- Reinforced socket, shaped during the orientation process.

The most eco-friendly pipes with the environment

The environmental impact of a piping system depends on its composition and application thereof, being the type of raw material used, the production process, the finished product and the pipe's life expectancy, the main factors that determine the efficiency and sustainability throughout their life cycle.

TOM® PVC-O is the most environmentally friendly solution existing on the market, due to its best contribution to the correct sustainable development of the planet, as it has been demonstrated by different studies worldwide, since they present **environmental benefits at all stages of their life cycle; thus resulting in the most efficient from the energy point of view.**

Life cycle of the PVC-O pipes

Resources efficiency

•The exceptional mechanical properties of these pipes allow considerable savings in raw materials. For the same external nominal diameter, TOM® requires less PVC.

•Only 43% of the PVC composition depends on oil. Therefore, the required consumption of this resource is lower than in other plastic solutions.

•Energy consumption is lower in all phases of the life cycle: raw material extraction, pipe manufacturing and use.
Throughout its lifetime, TOM® prevents unnecessary consumption of energy resources and reduces CO2 emissions into the atmosphere.

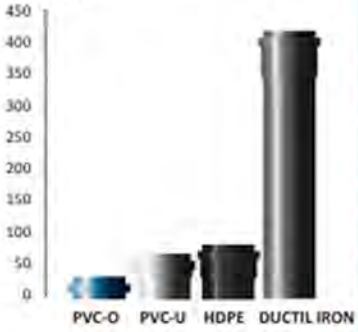
Resources efficiency

Thanks to their long usefullife and optimum water-tightness, TOM® pipes are the best ally for the rational use of water resources.

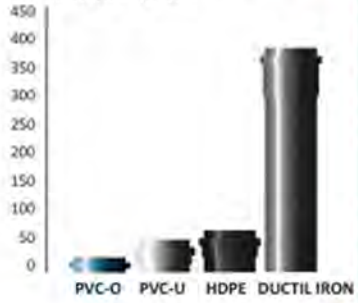
Water supply networks installed with traditional materials are currently registering a leakage rate of up to 25% of channeled water and, the latter's chemical deterioration means that some water conduits are currently being replaced despite having been laid only a few years ago.

Water pipes must not only be resistant to pressure, must also carry the maximum amount of water **consuming the least quantity of energy.** The extreme smoothness of the inner wall of the TOM® pipe minimizes pressure loss, so the energy required for transport is lower.

Energy consumed by pipes (raw materials + manufacture) (kWh)

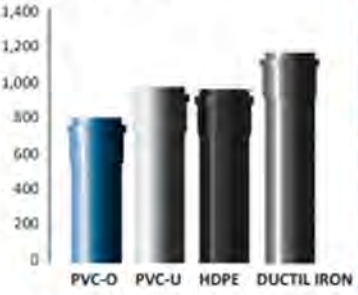


Energy consumed by raw materials (kWh)



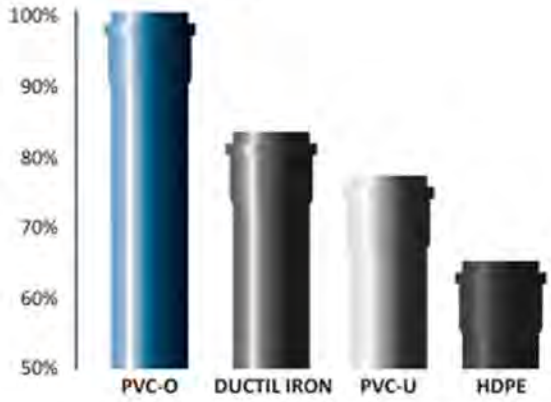
Energy consumed in manufacturing (kWh)

Energy consumed by pumping (kWh)



Estimated energy consumption by PVC-O, PVC-U, HDPE and Ductile Iron piping production and use. Polytechnic University of Catalonia, Spain, December 2005.

Hydraulic capacity



ISO 16422. For a 1m DN250 mm PN16 bar

The infrastructures created with TOM® pipes are **an excellent tool for managing water resources for generations.**

Waste Management Efficiency

PVC is a **100% recyclable material.**

It can be milled and processed as recycled material to be used in the manufacture of other plastic applications with less technical requirements.

Sustainability

TOM® is a sustainable pipe, in which design it has been taken into account the preservation of the environment considering aspects such as energy saving, sustainable use of natural resources, durability of the works and environmental friendliness of the materials used.

As always at the forefront, Molecor, following the last common methodology for calculating the Recommendation 179/2013/EC proposed by the European Commission for the Study of **Product Environmental Footprint (PEF)** has evaluated the environmental impact of the TOM® pipe at all stages of its life cycle from cradle to grave, ie from the extraction of raw materials to the final disposal of the product, through manufacture, distribution and use of the pipes.

According to this, it has been studied the effect of the TOM® pipe on 14 environmental impacts that are grouped based on the condition to the different means:

Air and atmosphere

Climate change, acidification, depletion of the ozone layer and photochemical ozone formation.

Water

Resource depletion (water), freshwater toxicity and water eutrophication.

Soil

Depletion of resources (minerals), land eutrophication and ground use.

Human health

Inorganic respiratory elements, ionizing radiation, effects on human health (cancer-causing) and effects on human health (non-cancerous).

Environmental impacts	Absolute	
Climate change	8.3E+01	kg CO2e
Ozone depletion	5.3E-06	kg CFC-11e
Ecotoxicity – aquatic, fresh water	1.8E+02	CTUe
Human toxicity – cancer effects	4.8E-06	CTUe
Human toxicity - non-cancer effects	8.6E-06	CTUh
Particulate matter / Respiratory inorganics	1.3E-02	kg PM2.5e
Ionising radiation – human health effects	5.3E+00	kg U235e
Photochemical ozone formation	4.1E-01	kg NMVOC
Acidification	4.1E-01	mol H+e
Eutrophication - terrestrial	1.0E+00	mol Ne
Eutrophication – aquatic, fresh water	1.6E-03	kg Pe
Eutrophication – aquatic, sea water	9.5E-02	kg Ne
Resource depletion – water	1.9E-01	m^3 SWU
Resource depletion – mineral, fossil	3.8E-03	kg Sbe
Land transformation	1.6E+02	kg Cdef

Class 500 TOM® PVC-O pipes environmental footprint according to Recommendation 179/2013/EC

The best known environmental parameter is the Carbon Footprint, which takes into account the greenhouse gas emissions into the atmosphere expressed as CO2, and corresponds to the result of the environmental aspect of climate change.

TOM® pipes have the eco-label Environmental Footprint FVS Seal, promoted by the Sustainable Life Foundation and the General Directorate of Social Responsibility of the Company's Ministry of Employment and Social Security.

TOM®: The best choice for high-pressure fluid transport

The impact of a 500 kg rock dropped from a height of 3 metres leaves a TOM® pipe completely unscathed.

Unbeatable impact resistance

TOM® pipes have a **high resistance to shock**. This means that are minimized breakages during installation or during on-site trials caused by dropping or by impacts from stones.

Furthermore, Molecular Orientation prevents the propagation of cracks and scratches and eliminates the risk of rapid crack behaviour. The result is a spectacular increase in the product's useful life.

High short- and long-term hydrostatic resistance

TOM® pipes offer a resistance to internal pressure of up to **two times the nominal pressure** (32 bars in PN16 bar pipes or 400 psi in PN200 psi), which means they can bear sporadic excessive pressure such as water hammers and other malfunctions in the network.

Moreover, the material creep behaviour of the pipe is very low, ensuring the durability of the pipe working at nominal pressure for over a hundred years.

Excellent response to water hammers

TOM® pipes offer lower celerity than other piping systems (four times less than ductile iron pipes), which means less water hammers caused by sudden variations in water volume and pressure. This reduces and almost **eliminates the possibility of breakage** during opening and closing in the water network and when pumping gets under way, protecting every component of the network.

Increased hydraulic capacity

Molecular Orientation widens the inner section of the pipe, giving TOM® pipes a **higher internal diameter and greater 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, TOM® pipes offer between **15% - 40% more hydraulic capacity** than pipes from other materials and with the same external dimensions.

Maximum flexibility

Thanks to their excellent elasticity, TOM® pipes can **bear big deformations of their internal diameter**. When crushed, or in the event of a mechanical accident, TOM® pipes immediately go back to its original shape, thus minimizing the risk of potential breakage by soil subsidence or sharp edges on rocks or machinery, for example. And thanks to their considerable capacity for bearing heavy loads, TOM® pipes ensure **optimum performance once laid underground**.

Completely corrosion-resistant

Oriented PVC is immune to corrosion and to natural chemical substances, as well as to aggression from micro- and macro-organisms. **TOM® pipes, therefore, are not degradable**. Moreover, they do not require any type of special protection or coating, which means cost-savings.

Total water quality

The quality of the fluid that circulates in **TOM® pipes will always remain unaltered**, given that the material neither suffers corrosion nor migrations within the pipes or in their coating. Mandatory tests such as those made according to the Spanish Law, RD 140/2003, show that the excellent qualities of these pipes comply with the required health standards for water for human consumption. Also TOM® pipes have the ACS (Sanitary Certification) according French legislation.

Consequently, TOM® pipes are considered the best application for **high-pressure water transport, particularly drinking water, for water supply networks**.

Completely water-tight

Joints are 100 percent watertight and are guaranteed not to displace once the pipes have been installed. TOM® pipes **are easy to join** and can be installed by lower-qualified workers.

Lower cost and easier installation

TOM® PVC-O pipes are **lighter and easier to handle** than other pipes made from other materials: in most cases, handling does not require machinery. Beside this, due to the easiness of their union, flexibility and impact resistance these pipes allow higher **cost effectiveness, performance and installation speed in comparision with pipes of other materials**.

TOM® pipes will take any kind of deformation without suffering structural damage.

Locked-in ring seals ensure a perfect water-tight fit.

TOM® pipes are extremely light-weight.

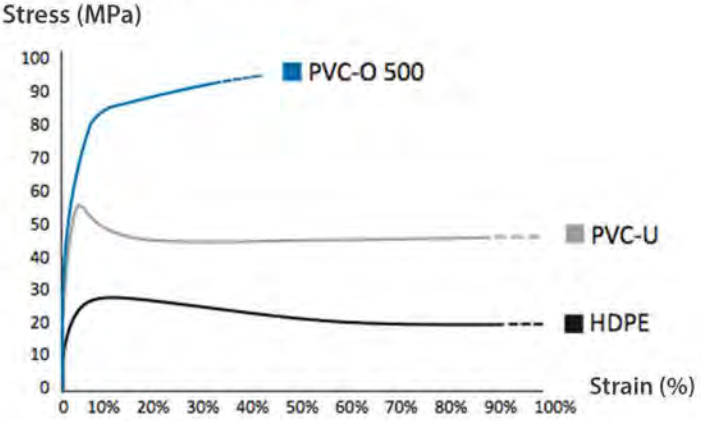
The best mechanical properties

Tensile resistance

The PVC-O stress strain curve changes significantly compared to conventional plastics behaviour coming very close to the metal ones.

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

STRAIN-STRESS BEHAVIOUR

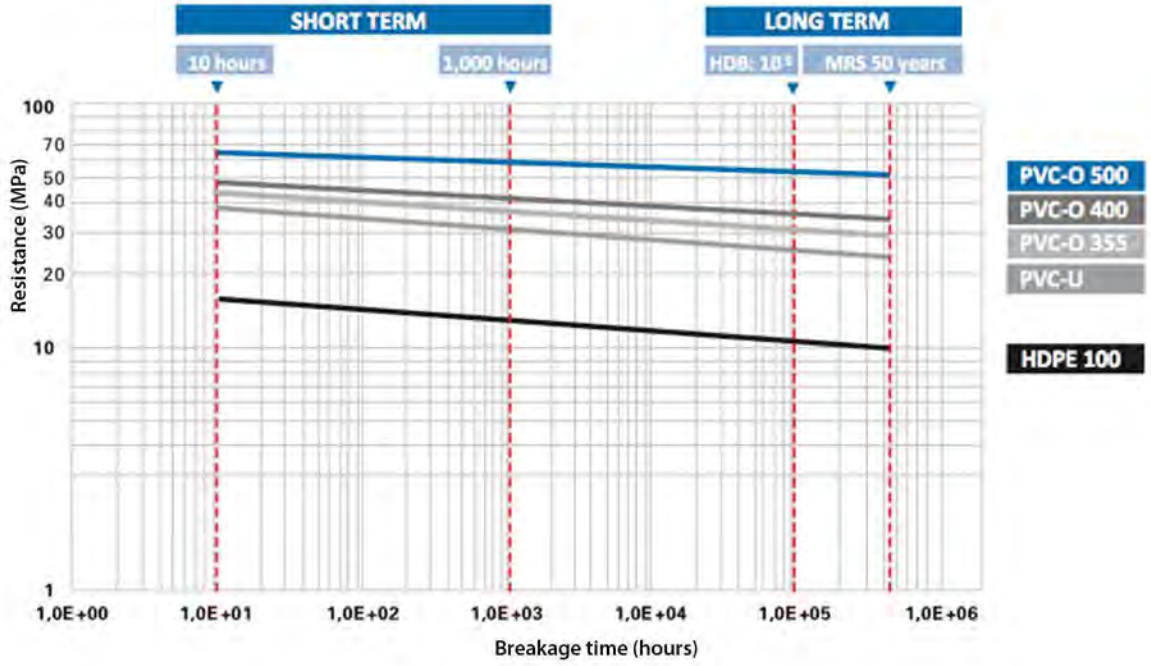


* Circumferential tension values

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 over the long term. Bearing in mind that PVC-O is exceptionally reisistant to fatigue and has a very good chemical resistance, in common with conventional PVC, it is no exaggeration to say that this kind of piping is capable of withstanding the pressures of work for over a hundred years.

STRESS REGRESSION LINE



Piping and material mechanical properties

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

		TOM® 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
Overal 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 hoop traction	MPa	>85	>48	19	19
Shore hardness D	-	81 - 85	70 - 85	60	65

(1) For pipes with a DN ≥110.

Other material characteristic

The table below shows other, non-mechanical characteristics of PVC-O 500.

CHARACTERISTIC	UNITS	VALUE
Density	kg/dm³	1.35 - 1.46 (1)
PVC Resin K value	-	>64
Shore hardness D at 20 °C	-	81 - 85
Poisson coefficient	-	0.35 - 0.41
Vicat temperature	°C	>80
Lineal expansion coefficient	°C⁻¹	$0.8 \cdot 10^{-4}$
Thermal conductivity	Kcal/mh°C	0.14 - 0.18
Specific heat at 20 °C	cal/g°C	0.20 - 0.28
Dielectric stiffness	kV/mm	20 - 40
Dielectric constant at 60 Hz	-	3.2 - 3.6
Transverse resistivity at 20 °C	Ω/cm	$>10^{16}$
Absolute roughness (ka)	mm	0.007
Absolute roughness (Hazen Williams)	-	150
Manning roughness coefficient (n)	-	0.009

(1) Although the standard allowance includes this range. TOM® PVC-O pipe is between 1.37 and 1.43 kg/dm³.

Characteristics of the water-tight joint

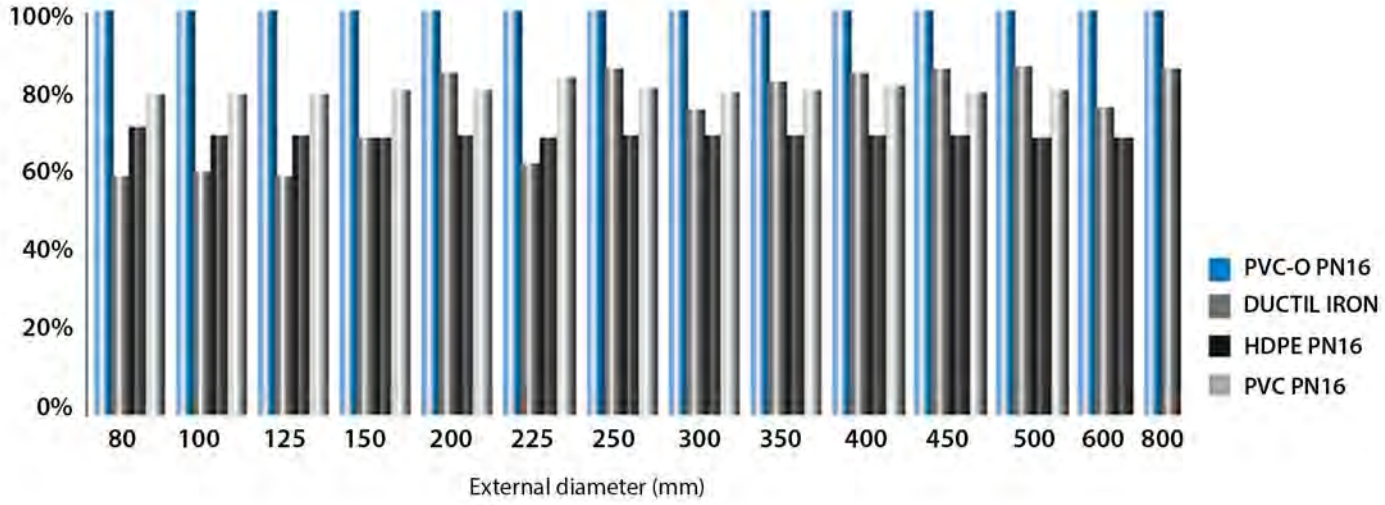
CHARACTERISTIC	UNITS	VALUE
Elastomer hardness	IRHD	60 ±5

Unbeatable Hydraulic Properties

Hydraulic capacity

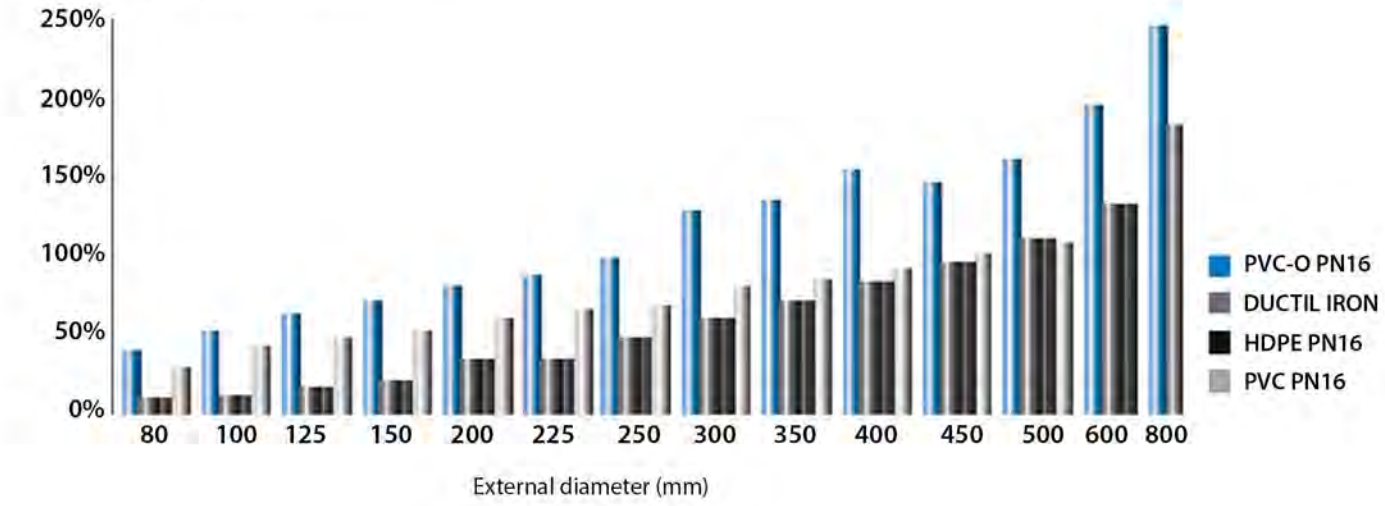
Water pipes requirements are not only related to pressure resistance; they have also have to **transport the highest amount of water while consuming the least energy**. TOM® pipes walls are thinner than conventional plastic ones and are on their inside smoother than metals, which means that a greater hydraulic capacity is attained.

Comparison of hydraulic capacity: TOM® PVC-O PN16 pipes vs other materials (constant load loss)



Using pipes with a lower hydraulic capacity involves necessarily using a larger nominal diameter, which has a negative effect on both profitability and infrastructure investment costs. **Using TOM® means you get more hydraulic capacity from your investment costs.**

Hydraulic capacity/Piping costs compared to TOM® PVC-O PN16 DN250



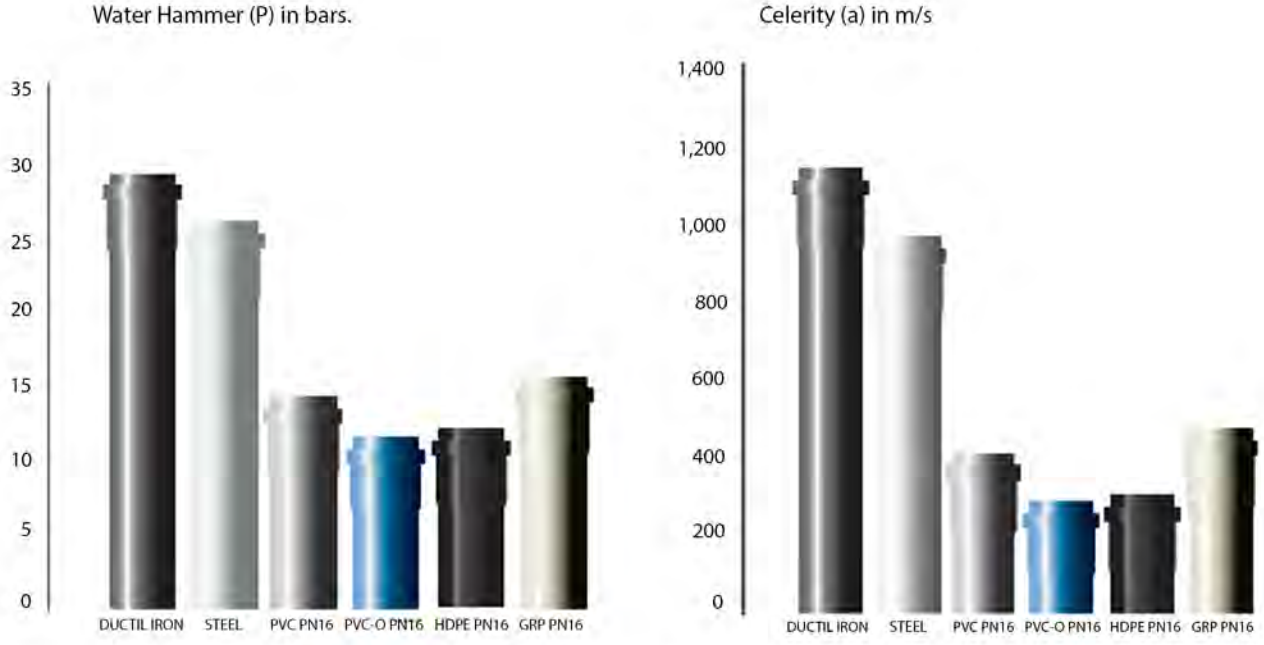
Water Hammer

Water hammers occur when liquid flowing through piping stops suddenly when a valve is opened or closed, if a pump is stopped or started or by airlocks shifting within the pipe. Water hammers can result in an **higher overpressure than the pipe's working pressure and lead it to breakage**, specially when the pipe has already been damaged by impacts or corrosion.

Water hammers (P) depend on the celerity (a), which is the wave speed, and the fluid's change of speed (V). The celerity depends basically on the pipe's dimensions (the relationship between the external diameter and the minimum thickness) and the specifications of the material with which the tube is made (Young's modulus, E).

$$P = \frac{a \cdot V}{g}; \; a = \frac{1420}{\sqrt{1 + \left(\frac{k}{E}\right) \cdot \left(\frac{De}{e_{min}} - 2\right)}}$$

TOM®'s, PVC-O pipes have a significantly lower celerity than pipes made from other materials, particularly so with metal piping. It is particularly significant the difference with pipes made of metal materials, in which the water hammers effects can be very high.



Overpressure produced by sudden pipe shutdown with water flowing at 2.5 m/s.

A range for all **kinds of applications**

TOM® offers a broad range of piping covering all medium- and high--pressure needs.

Applicable Laws and Standards

TOM® PVC-O pipes are manufactured in accordance with ISO 16422:2014 standards, applied to *"Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure"* and also according to the French Standard NF T54-948:2010 *"Tubes en poly(chlorure de vinyle) orienté biaxial (PVC-BO) et leurs assemblages"* (Pipes and joints made of biaxially oriented polyvinyl chloride (PVC-BO).

Other international standards applicable to PVC-O are as follows. Molecor® could manufacture pipes according to these standards under request.

- **USA: ASTM F1483-05** *"Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe"*; and "ANSI/AWWA C909-02 *"Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe for Water Distribution."*

- Australia: **AS/NZS 4441:2008** *"Oriented PVC (PVC-O) pipes for pressure applications."*
  South Africa: **SANS 16422:2007** *"Pipes and joints made of oriented unplasticized pol(vinyl) chloride (PVC-O) for the conveyance of water under pressure".*
- Spain: **UNE-ISO 16422** standard applicable to "Tubos y uniones de poli(cloruro de vinilo) orientado (PVC-O) para una conducción de agua a presión".
- Canada: **CSA B137,3,1-09** "Molecularly oriented polyvinychoride (PVCO) pipe for pressure applications".

Material classification

ISO 16422:2014 standard covers several types of PVC-O material, classified according to their MRS (Minimum Required Strenght), because Molecular Orientation can be achieved to a greater or lesser extent through different manufacturing processes. **TOM® PVC-O pipe is manufactured only in the highest class (PVC-O 500)**, which offers the highest degree of orientation and thus ensures the best mechanical performance. Subsequently, TOM® pipes **present higher advantages** compared to other materials.

	TOM® PVC-O 500 PIPE			
	PN12.5	PN16	PN20	PN25
Material Class	500	500	500	500
MRS (Mpa)	50.0	50.0	50.0	50.0
Nominal pressure (bars)	12.5	16.0	20.0	25.0
Burst Pressure over 50 years (bars) (1)	17.5	22.4	28.0	35.0
Burst Pressure over 10 hours (bars) (1)	25.0	30.0	37.0	48.0
Maximum trial pressure onsite (bars) (2)	17.5	21.0	25.0	30.0
Circumferential stiffness (kN/m²) (3)	> 5	> 7	> 11	> 20
Colour (4)	blue/purple	blue/purple	blue/purple	blue/purple

(1) With a temperature of 20° C.
(2) According to EN 805:2000 standard with estimated water hammer.
(3) Average stiffness per pipe.
(4) Available in blue (supply), purple (reuse) and white (resistant to UV rays). For other colours, please contact us.

Dimensions

TOM® PVC-O 500 PIPE										
Nominal Pressure (bar)			PN12.5		PN16		PN20		PN25	
Nominal Diameter (DN)	Outside Diameter (OD)		Inside Diameter (ID)	Wall Tickness (e)	Inside Diameter (ID)	Wall Tickness (e)	Inside Diameter (ID)	Wall Tickness (e)	Inside Diameter (ID)	Wall Tickness (e)
	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
125	125.0	125.4	118.8	2.5	117.8	2.8	117.0	3.5	115.2	4.3
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
355	355.0	356.1	337.4	7.1	336.0	7.8	332.4	9.8	327.2	12.2
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	427.6	8.9	426.0	9.9	421.4	12.4	415.0	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
800	800.0	802.0	760.4	16.3	757.8	17.4	750.4	21.6	-	-

TOM® PVC-O pipes are supplied in total length of 5,95 metres (socket included). For other lengths for special projects, price on request.

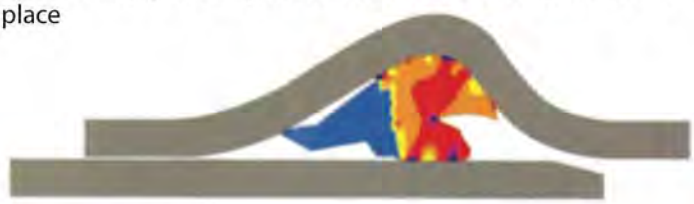
Packaging

DN	Pipes/ Pallet	Pallet/ Truck	Pipes/ Truck	Metres [1]/ Truck	Pallet Width	Pallet Height	Pallet Length	Pallet Weight		
								PN16	PN20	PN25
mm	pipes	pallet	pipes	m	mm	mm	mm	kg	kg	kg
90	81	16	1296	7711	1220	670	6110	590	590	750
110	76	12	912	5426	1220	850	6130	750	770	940
125	60	12	720	4284	1220	850	6135	710	790	960
140	45	12	540	3213	1220	850	6140	690	740	900
160	33	12	396	2356	1220	800	6150	650	710	870
200	24	12	288	1714	1220	870	6185	690	790	970
225	14	16	224	1333	1220	700	6190	520	480	730
250	11	12	132	785	1100	800	6215	500	580	700
315	13	8	104	619	2200	700	6260	950	1080	1320
355	11	6	66	393	2200	800	6295	1000	1160	1410
400	11	6	66	393	2400	850	6325	1270	1460	1780
450	5	10	50	298	2200	550	6330	740	850	1060
500	4	8	32	190	1950	600	6335	730	840	1020
630	3	6	18	107	1950	730	6410	870	990	1220
800	3	6	18	107	2200	900	6425	1380	1590	-

(1) Nominal meters (5,95 metres per pipe). The effective length is the total length minus the socket length. Other packagings or lengths, on request.

Joints and Watertight Seals

The connection is done by introducing the male part of the pipe in the socket of the other where the elastic joint is placed. The watetight seal includes a Polypropylene ring and a synthetic rubber lip which allows the seal to be integrated with the pipe , avoiding joint displacement or movement while the installation is taking place



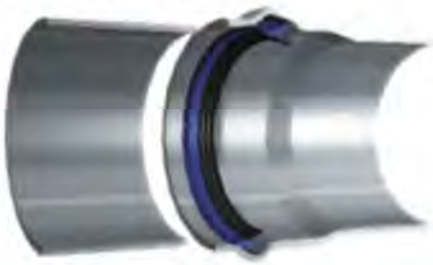
Apply lubricant on the chamfer of the spigot end and in the rubber ring joint.

Align the pipe and place the spigot end inside the socket or bell.

Firmly push the free end into the other pipe. Introduce until the end marked is no longer seen.

Nominal Diameter (DN)	Socket Length (SL)	Maximum Diameter (D max)	Socket limit mark (1)
mm	mm	mm	mm
90	160	117	125
110	180	140	140
125	185	154	140
140	190	174	145
160	200	197	160
200	235	243	170
225	240	271	180
250	265	301	225
315	310	374	240
355	345	419	275
400	375	472	290
450	380	527	310
500	385	587	315
630	460	734	340
800	475	925	400

(1) TOM® pipes have a mark in the spigot, being the socket limit mark to facilitate the process of assembly during installation.



Assembly

In order to do the assembly is necessary to apply lubricant on the chamfer of the spigot end and in the rubber ring joint, and push by hand until the mark of the spigot end is no longer seen.

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 screws ends and flange ends.

The saddle must become in solidarity with the pipe. Multidiameter saddles must not be used, but specific PVC saddles for each DN.

ANTI-TRACTION SYSTEM FLANGE

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

Anti-traction system makes the pipe absolutely fixed to the flange.

EURO TYPE PLUG FITTINGS

Connecting the fitting directly to the pipe allows us to have deviations, reductions and connections on the net (elbows, tees, DN reductions, etc).

It is very important to fix the fitting to the ground in order to guaranty the net structural resistance.

A wide range of fittings can be used with TOM® pipes. Consult our technical service to receive advise on the fittings that may be used.

Applications

SUPPLYING (blue TOM®)

Conduits for potable water transport. It includes water abstraction and water distribution network to city centers, urban network and industrial areas, and water transfer to tanks and reservoirs.

RECLAIMED WATER (purple TOM®)

Pipelines for transport of water that have been treated to remove impurities.

IRRIGATION (blue TOM®)

Water transport pipes for irrigation purposes. It includes irrigated land pipelines, water transfer to tanks and reservoirs.

OTHER APPLICATIONS

Sewage
Fire Protection Nets
Industrial Applications
Infrastructural Nets

Key Factors for **Optimizing Design**

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.

Flow-volume (l/s)= speed (m/s) · section · (m2) 103

Hazen-Williams Formula

$$V = 0.355 \cdot C \cdot D_i^{0.63} \cdot J^{0.54}$$

Prandtl -Colebrook-White Formula

$$V = -2\sqrt{2 \cdot g \cdot D_i \cdot J} \cdot \log\left(\frac{k_a}{3.71 \cdot D_i} + \frac{2.51\ v}{D_i\sqrt{2 \cdot g \cdot D_i \cdot J}}\right)$$

V = Average Speed in m/s
Di = Internal Diameter in m
J = Pressure loss in m/m
C = Hazen-Williams Roughness Constant (for PVC-O; C = 150)
g = Gravity acceleration in m/s2 (9.81 m/s2)
ka = Absolute roughness in metres (for PVC-O; ka = 0.007·10-3 m)
v = Kinematic viscosity of the fluid (m2/s) (for water at 20 °C; v = 1.0·10-6)

Another factor to be taken into account is the heat loss produced by fittings (elbows, reducers, tees, etc.) and valves.

There are tables available for calculating heat loss, flow and speeds using the Hazen-Williams formula.

Flow speed must be determinated taking into account different economical factors (optimization of the investment in terms of water pumping) and the admissible values for water hammers.

In general, it is established as the minimum value for avoiding sediments 0.5 m/s and as the maximun values between 2.0 m/s and 2.5 m/s, depending on the diameter of the pipe.

Pressure loss tables

TOM® PVC-O 500 PN16

Pipe head loss is the energy of a hydraulic fluid that is lost along itself due to friction. Below is the calculation of estimated water speeds depending on the selected pipe for installation.

INTERNAL DIAMETER	DN90 PN16 84.0		DN110 PN16 104.0		DN125 PN16 117.8		DN140 PN16 132.4		DN160 PN16 151.4		DN200 PN16 189.2		DN225 PN16 212.8	
Speed (m/s)	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km
0.1	0.55	0.16	0.85	0.13	1.09	0.11	1.38	0.09	1.80	0.08	2.80	0.06	3.56	0.05
0.2	1.11	0.58	1.70	0.45	2.18	0.39	2.75	0.34	3.60	0.29	5.62	0.22	7.11	0.20
0.3	1.66	1.23	2.55	0.96	3.27	0.83	4.13	0.72	5.40	0.62	8.43	0.48	10.70	0.42
0.4	2.22	2.09	3.40	1.63	4.36	1.41	5.51	1.23	7.20	1.05	11.20	0.81	14.20	0.71
0.5	2.77	3.17	4.25	2.47	5.45	2.13	6.88	1.86	9.00	1.59	14.10	1.23	17.80	1.07
0.6	3.33	4.44	5.10	3.46	6.54	2.99	8.26	2.61	10.80	2.23	16.90	1.72	21.30	1.50
0.7	3.88	5.90	5.95	4.60	7.63	3.98	9.64	3.47	12.60	2.97	19.70	2.29	24.90	1.99
0.8	4.43	7.56	6.80	5.89	8.72	5.09	11.00	4.44	14.40	3.80	22.50	2.93	28.50	2.55
0.9	4.99	9.40	7.65	7.33	9.81	6.34	12.40	5.53	16.20	4.73	25.30	3.64	32.00	3.18
1.0	5.54	11.43	8.49	8.91	10.90	7.70	13.80	6.72	18.00	5.75	28.11	4.43	35.60	3.86
1.1	6.10	13.60	9.34	10.60	12.00	9.20	15.10	8.02	19.80	6.85	30.90	5.28	39.10	4.61
1.2	6.70	16.00	10.20	12.50	13.10	10.80	16.50	9.42	21.60	8.05	33.70	6.21	42.70	5.41
1.3	7.20	18.60	11.00	14.50	14.20	12.50	17.90	10.92	23.40	9.34	36.50	7.20	46.20	6.28
1.4	7.80	21.30	11.90	16.60	15.30	14.40	19.30	12.50	25.20	10.70	39.40	8.26	49.80	7.20
1.5	8.30	24.20	12.70	18.90	16.30	16.30	20.70	14.20	27.00	12.20	42.22	9.39	53.30	8.18
1.6	8.90	27.30	13.60	21.30	17.40	18.40	22.00	16.00	28.80	13.70	44.00	10.60	56.90	9.22
1.7	9.40	30.50	14.40	23.80	18.50	20.60	23.40	18.00	30.60	15.40	47.80	11.80	60.50	10.32
1.8	10.00	33.90	15.30	26.40	19.60	22.90	24.80	20,0	32.40	17.10	50.60	13.20	64.00	11.50
1.9	10.50	37.50	16.10	29.20	20.70	25.30	26.20	22.10	34.20	18.90	53.40	14.50	67.60	12.70
2.0	11.10	41.20	17.00	32.10	21.80	27.80	27.50	24.30	36.00	20.70	56.20	16.00	71.10	13.90
2.1	11.60	45.10	17.80	35.20	22.90	30.40	28.90	26.50	37.80	22.70	59.00	17.50	74.70	15.30
2.2	12.20	49.20	18.70	38.40	24.00	33.20	30.30	28.90	39.60	24.70	61.90	19.10	78.20	16.60
2.3	12.70	53.40	19.50	41.60	25.10	36.00	31.70	31.40	41.40	26.90	64.70	20.70	81.80	18.10
2.4	13.30	57.80	20.40	45.10	26.20	39.00	33.00	34.00	43.20	29.10	67.50	22.40	85.40	19.50
2.5	13.90	62.40	21.20	48.60	27.20	42.00	34.40	36.70	45.00	31.40	70.30	24.20	88.90	21.10
2.6	14.40	67.10	22.10	52.30	28.30	45.20	35.80	39.40	46.80	33.70	73.10	26.00	92.50	22.70
2.7	15.00	71.90	22.90	56.00	29.40	48.50	37.20	42.30	48.60	36.20	75.90	27.90	96.00	24.30
2.8	15.50	76.90	23.80	59.90	30.50	51.80	38.50	45.20	50.40	38.70	78.72	29.80	99.60	26.00
2.9	16.10	82.10	24.60	64.00	31.60	55.30	39.90	48.30	52.20	41.30	81.50	31.80	103.10	27.70
3.0	16.60	87.40	25.50	68.10	32.70	58.90	41.30	51.40	54.00	43.90	84.30	33.90	106.70	29.50
3.1	17.20	92.90	26.30	72.40	33.80	62.60	42.70	54.60	55.80	46.70	87.20	36.00	110.30	31.40
3.2	17.70	98.50	27.20	76.80	34.90	66.40	44.10	57.90	57.60	49.50	90.00	38.20	113.80	33.30
3.3	18.30	104.30	28.00	81.30	36.00	7030,0	45.40	61.30	59.40	52.40	92.80	40.40	117.40	35.20
3.4	18.80	110.20	28.90	85.90	37.10	74.30	46.80	64.80	61.20	55.40	95.60	42.70	120.90	37.20
3.5	19.40	116.30	29.70	90.60	38.10	78.40	48.20	68.40	63.00	58.50	98.40	45.10	124.50	39.30
3.6	20.00	122.50	30.60	95.50	39.20	82.60	49.60	72.00	64.80	61.60	101.20	47.50	128.00	41.40
3.7	20.50	128.90	31.40	100.50	40.30	86.90	50.90	75.80	66.60	64.80	104.00	50.00	131.60	43.60
3.8	21.10	135.40	32.30	105.50	41.40	91.30	52.30	79.60	68.40	68.10	106.80	52.50	135.20	45.80
3.9	21.60	142.10	33.10	110.70	42.50	95.80	53.70	83.50	70.20	71.44	109.60	55.10	138.70	48.00
4.0	22.20	148.90	34.00	116.10	43.60	100.30	55.10	87.60	72.00	74.90	112.50	57.70	142.30	50.30

The values for TOM® PN12.5 are very similar to those for the previous ones which means that the same table may be used for calculations.
Shaded values: estimation of recommended water speeds to avoid sedimentation, water hammer, noises, erosion and high values of head loss according to Manning formula.

TOM® PVC-O 500 PN16

Pipe head loss is the energy of a hydraulic fluid that is lost along itself due to friction. Below is the calculation of estimated water speeds depending on the selected pipe for installation.

DN250 PN16 236.4		DN315 PN16 298.0		DN355 PN16 336.0		DN400 PN16 378.4		DN450 PN16 426.0		DN500 PN16 472.8		DN630 PN16 595.8		DN710 PN16 671.4		DN800 PN16 757.8	
Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km
4.39	0.05	6.97	0.04	8.87	0.03	11.20	0.03	14.30	0.02	17.60	0.02	27.90	0.02	35.40	0.01	45.10	0.01
8.78	0.17	13.90	0.13	17.70	0.12	22.50	0.10	28.50	0.09	35.10	0.08	55.80	0.06	70.80	0.05	90.20	0.04
13.20	0.37	20.90	0.28	26.60	0.24	33.70	0.21	42.80	0.18	52.70	0.16	83.60	0.12	106.20	0.11	135.30	0.09
17.60	0.63	27.90	0.48	35.50	0.42	45.00	0.36	57.00	0.31	70.20	0.28	111.50	0.21	141.60	0.19	180.40	0.16
21.90	0.95	34.90	0.72	44.30	0.63	56.20	0.55	71.30	0.48	87.80	0.42	139.40	0.32	177.00	0.28	225.50	0.24
26.30	1.33	41.80	1.01	53.20	0.88	67.50	0.77	85.50	0.67	105.30	0.59	167.30	0.45	212.40	0.39	270.60	0.34
30.70	1.76	48.80	1.35	62.10	1.17	78.70	1.02	99.80	0.89	122.90	0.79	195.20	0.60	247.80	0.52	315.70	0.45
35.10	2.26	55.80	1.72	70.90	1.50	90.00	1.30	114.00	1.14	140.50	1.01	223.00	0.77	283.20	0.67	360.80	0.58
39.50	2.81	62.80	2.14	79.80	1.86	101.20	1.62	128.30	1.41	158.00	1.25	250.90	0.96	318.60	0.83	405.90	0.72
43.90	3.42	69.70	2.61	88.70	2.27	112.50	1.97	142.50	1.72	175.60	1.52	278.80	1.16	354.00	1.01	451.00	0.88
48.30	4.08	76.70	3.11	97.50	2.70	123.70	2.35	156.80	2.05	193.10	1.81	306.70	1.39	389.40	1.21	496.13	1.05
52.70	4.79	83.70	3.65	106.40	3.18	135.00	2.77	171.00	2.41	210.70	2.13	334.60	1.63	424.80	1.42	541.20	1.23
57.10	5.55	90.70	4.24	115.30	3.68	146.20	3.21	185.30	2.79	228.20	2.47	362.40	1.89	460.30	1.64	586.30	1.43
61.40	6.37	97.60	4.86	124.10	4.23	157.40	3.68	199.50	3.20	245.80	2.84	390.30	2.17	495.70	1.88	631.40	1.64
65.80	7.24	104.60	5.52	133.00	4.80	168.70	4.18	213.80	3.64	263.40	3.22	418.20	2.46	531.10	2.14	676.50	1.86
70.20	8.16	111.60	6.23	141.90	5.41	179.90	4.71	228.00	4.10	280.90	3.63	446.10	2.77	566.50	2.41	721.60	2.09
74.60	9.13	118.60	6.96	150.70	6.05	191.20	5.27	242.30	4.59	298.50	4.06	474.00	3.10	601.90	2.70	766.70	2.34
79.00	10.10	125.50	7.74	159.60	6.73	202.40	5.86	256.60	5.10	316.00	4.52	501.80	3.45	637.30	3.00	811.80	2.61
83.40	11.20	132.50	8.56	168.50	7.44	213.70	6.48	270.80	5.64	333.60	4.99	529.70	3.81	672.70	3.32	856.90	2.88
87.80	12.30	139.50	9.41	177.30	8.18	224.90	7.12	285.10	6.20	351.10	5.49	557.60	4.19	708.10	3.65	902.00	3.17
92.20	13.50	146.50	10.30	186.20	8.95	236.20	7.79	299.30	6.79	368.70	6.01	585.50	4.59	743.50	3.99	947.10	3.47
96.60	14.70	153.40	11.20	195.10	9.76	247.40	8.50	313.60	7.40	386.20	6.55	613.40	5.00	778.90	4.35	992.30	3.78
101.0	16.0	160.40	12.20	203.90	10.60	258.70	9.23	327.80	8.03	403.80	7.11	641.20	5.43	814.30	4.72	1037.4	4.10
105.30	17.30	167.40	13.20	212.80	11.50	269.90	9.98	342.10	8.69	421.40	7.70	669.10	5.88	849.70	5.11	1082.5	4.44
109.70	18.60	174.40	14.20	221.70	12.40	281.10	10.80	356.30	9.38	438.90	8.30	697.00	6.34	885.10	5.51	1127.6	4.79
114.10	20.00	181.30	15.30	230.50	13.30	292.40	11.60	370.60	10.10	456.50	8.93	724.90	6.82	920.50	5.93	1172.7	5.15
118.50	21.50	188.30	16.40	239.40	14.30	303.60	12.40	384.80	10.80	474.00	9.57	752.80	7.31	955.90	6.36	1217.8	5.52
122.90	23.00	195.30	17.50	248.30	15.30	314.90	13.30	399.10	11.60	491.60	10.20	780.60	7.82	991.30	6.80	1262.9	5.91
127.30	24.50	202.30	18.70	257.10	16.30	326.10	14.20	413.30	12.30	509.10	10.90	808.50	8.34	1026.7	7.26	1308.0	6.30
131.70	26.10	209.20	19.90	266.00	17.30	337.40	15.10	427.60	13.10	526.70	11.60	836.40	8.88	1062.1	7.73	1353.1	6.71
136.10	27.80	216.20	21.20	274.90	18.40	348.60	16.00	441.80	14.00	544.30	12.40	864.30	9.44	1097.5	8.21	1398.2	7.13
140.50	29.40	223.20	22.50	283.70	19.50	359.90	17.10	456.10	14.80	561.80	13.10	892.20	10.00	1132.9	8.70	1443.3	7.60
144.80	31.20	230.20	23.80	292.60	20.70	371.10	18.00	470.40	15.70	579.40	13.90	920.00	10.60	1168.3	9.20	1488.4	8.00
149.20	32.90	237.10	25.10	301.50	21.90	382.40	19.00	484.60	16.60	596.90	14.70	947.90	11.20	1203.7	9.70	1533.5	8.50
153.60	34.80	244.10	26.50	310.30	23.10	393.60	20.10	498.90	17.50	614.50	15.50	975.80	11.80	1239.1	10.30	1578.6	8.90
158.01	36.60	251.10	27.95	319.20	24.30	404.90	21.20	513.10	18.40	632.00	16.30	1003.7	12.50	1274.5	10.80	1623.7	9.40
162.40	38.50	258.06	29.40	328.10	25.60	416.10	22.30	527.40	19.40	649.60	17.20	1031.6	13.10	1309.9	11.40	1668.8	9.90
166.80	40.50	265.00	30.90	336.90	26.90	427.30	23.40	541.60	20.40	667.20	18.00	1059.4	13.80	1345.4	12.00	1713.9	10.40
171.20	42.50	272.00	32.40	345.80	28.20	438.60	24.50	555.90	21.40	684.70	18.90	1087.3	14.40	1380.8	12.60	1759.0	10.90
175.60	44.50	279.00	34.00	354.70	29.50	449.80	25.70	570.10	22.40	702.30	19.80	1115.2	15.10	1416.2	13.20	1804.1	11.40

The values for TOM® PN12.5 are very similar to those for the previous ones which means that the same table may be used for calculations. Shaded values: estimation of recommended water speeds to avoid sedimentation, water hammer, noises, erosion and high values of head loss according to Manning formula.

Pressure loss tables

TOM® PVC-O 500 PN20

Pipe head loss is the energy of a hydraulic fluid that is lost along itself due to friction. Below is the calculation of estimated water speeds depending on the selected pipe for installation.

INTERNAL DIAMETER	DN90 PN20 84.0		DN110 PN20 103.2		DN125 PN20 117.0		DN140 PN20 131.2		DN160 PN20 150.0		DN200 PN20 187.4		DN225 PN20 210.8	
Speed (m/s)	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km
0.1	0.55	0.16	0.84	0.13	1.08	0.11	1.35	0.10	1.77	0.08	2.76	0.06	3.49	0.05
0.2	1.11	0.58	1.67	0.46	2.15	0.39	2.70	0.34	3.53	0.29	5.52	0.23	6.98	0.20
0.3	1.66	1.23	2.51	0.97	3.23	0.83	4.06	0.73	5.30	0.62	8.27	0.48	10.50	0.42
0.4	2.22	2.09	3.35	1.65	4.30	1.42	5.41	1.24	7.07	1.06	11.00	0.82	14.00	0.72
0.5	2.77	3.17	4.18	2.49	5.38	2.15	6.76	1.88	8.84	1.61	13.80	1.24	17.50	1.08
0.6	3.33	4.44	5.02	3.49	6.45	3.01	8.11	2.64	10.60	2.26	16.50	1.74	20.90	1.52
0.7	3.88	5.90	5.86	4.64	7.53	4.01	9.46	3.51	12.40	3.00	19.30	2.31	24.40	2.02
0.8	4.43	7.56	6.69	5.94	8.60	5.13	10.80	4.49	14.10	3.84	22.10	2.96	27.90	2.58
0.9	4.99	9.40	7.53	7.39	9.68	6.39	12.20	5.59	15.90	4.78	24.80	3.69	31.40	3.21
1.0	5.54	11.43	8.36	8.99	10.75	7.76	13.50	6.79	17.70	5.81	27.60	4.48	34.90	3.90
1.1	6.10	13.60	9.20	10.70	11.83	9.30	14.90	8.10	19.40	6.93	30.30	5.34	38.40	4.66
1.2	6.70	16.00	10.00	12.60	12.90	10.90	16.20	9.52	21.20	8.14	33.10	6.28	41.90	5.47
1.3	7.20	18.60	10.90	14.60	14.00	12.60	17.60	11.00	23.00	9.44	35.90	7.28	45.40	6.35
1.4	7.80	21.30	11.70	16.80	15.10	14.50	18.90	12.70	24.70	10.80	38.60	8.35	48.90	7.28
1.5	8.30	24.20	12.50	19.00	16.10	16.40	20.30	14.40	26.50	12.30	41.40	9.49	52.40	8.27
1.6	8.90	27.30	13.40	21.50	17.20	18.50	21.60	16.20	28.30	13.90	44.10	10.70	55.80	9.32
1.7	9.40	30.50	14.20	24.00	18.30	20.70	23.00	18.10	30.00	15.50	46.90	12.00	59.30	10.43
1.8	10.00	33.90	15.10	26.70	19.40	23.10	24.30	20.20	31.80	17.30	49.60	13.30	62.80	11.60
1.9	10.50	37.50	15.90	29.50	20.40	25.50	25.70	22.30	33.60	19.10	52.40	14.70	66.30	12.80
2.0	11.10	41.20	16.70	32.40	21.50	28.00	27.00	24.50	35.30	21.00	55.20	16.20	69.80	14.10
2.1	11.60	45.10	17.60	35.50	22.60	30.70	28.40	26.80	37.10	22.90	57.90	17.70	73.30	15.40
2.2	12.20	49.20	18.40	38.70	23.70	33.40	29.70	29.20	38.90	25.00	60.70	19.30	76.80	16.80
2.3	12.70	53.40	19.20	42.00	24.70	36.30	31.10	31.80	40.60	27.20	63.40	20.90	80.30	18.30
2.4	13.30	57.80	20.10	45.50	25.80	39.30	32.40	34.40	42.40	29.40	66.20	22.70	83.80	19.80
2.5	13.90	62.40	20.90	49.00	26.90	42.40	33.80	37.10	44.20	31.70	69.00	24.40	87.30	21.30
2.6	14.40	67.10	21.70	52.70	28.00	45.50	35.20	39.90	45.90	34.10	71.70	26.30	90.70	22.90
2.7	15.00	71.90	22.60	56.60	29.00	48.80	36.50	42.70	47.70	36.60	74.50	28.20	94.20	24.60
2.8	15.50	76.90	23.40	60.50	30.10	52.30	37.90	45.70	49.50	39.10	77.20	30.20	97.70	26.30
2.9	16.10	82.10	24.30	64.60	31.20	55.80	39.20	48.80	51.20	41.70	80.00	32.20	101.20	28.00
3.0	16.60	87.40	25.10	68.70	32.30	59.40	40.60	51.90	53.00	44.40	82.70	34.30	104.70	29.90
3.1	17.20	92.90	25.90	73.00	33.30	63.10	41.90	55.20	54.80	47.20	85.50	36.40	108.20	31.70
3.2	17.70	98.50	26.80	77.50	34.40	66.90	43.30	58.50	56.50	50.10	88.30	38.60	111.70	33.70
3.3	18.30	104.30	27.60	82.00	35.50	70.80	44.60	62.00	58.30	53.00	91.00	40.90	115.20	35.60
3.4	18.80	110.20	28.40	86.70	36.60	74.90	46.00	65.50	60.10	56.00	93.80	43.20	118.70	37.70
3.5	19.40	116.30	29.30	91.40	37.60	79.00	47.30	69.10	61.90	59.10	96.50	45.60	122.20	39.70
3.6	20.00	122.50	30.10	96.30	38.70	83.20	48.70	72.80	63.60	62.30	99.30	48.00	125.60	41.90
3.7	20.50	128.90	30.90	101.40	39.80	87.60	50.00	76.60	65.40	65.50	102.10	50.50	129.10	44.00
3.8	21.10	135.40	31.80	106.50	40.80	92.00	51.40	80.50	67.20	68.80	104.80	53.10	132.60	46.30
3.9	21.60	142.10	32.60	111.70	41.90	96.50	52.70	84.40	68.90	72.20	107.60	55.70	136.10	48.60
4.0	22.20	148.90	33.50	117.10	43.00	101.20	54.10	88.50	70.70	75.70	110.30	58.40	139.60	50.90

Shaded values: estimation of recommended water speeds to avoid sedimentation, water hammer, noises, erosion and high values of head loss according to Manning formula.

TOM® PVC-O 500 PN20

Pipe head loss is the energy of a hydraulic fluid that is lost along itself due to friction. Below is the calculation of estimated water speeds depending on the selected pipe for installation.

DN250 PN20 234.2		DN315 PN20 295.2		DN355 PN20 332.4		DN400 PN20 374.8		DN450 PN20 421.4		DN500 PN20 468.6		DN630 PN20 590.4		DN800 PN20 750.4	
Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km
4.31	0.05	6.84	0.04	8.68	0.03	11.00	0.03	13.90	0.02	17.20	0.02	27.40	0.02	44.20	0.01
8.62	0.18	13.70	0.13	17.40	0.12	22.10	0.10	27.90	0.09	34.50	0.08	54.80	0.06	88.50	0.05
12.90	0.37	20.50	0.28	26.00	0.25	33.10	0.21	41.80	0.19	51.70	0.17	82.10	0.13	132.70	0.10
17.20	0.63	27.40	0.48	34.70	0.42	44.10	0.37	55.80	0.32	69.00	0.28	109.50	0.22	176.90	0.16
21.50	0.96	34.20	0.73	43.40	0.64	55.20	0.55	69.70	0.48	86.20	0.43	136.90	0.33	221.10	0.25
25.80	1.34	41.10	1.02	52.10	0.89	66.20	0.77	83.70	0.68	103.50	0.60	164.30	0.46	265.40	0.34
30.20	1.78	47.90	1.36	60.70	1.19	77.20	1.03	97.60	0.90	120.70	0.79	191.60	0.61	309.60	0.46
34.50	2.28	54.80	1.74	69.40	1.52	88.30	1.32	111.60	1.15	138.00	1.02	219.00	0.78	353.80	0.59
38.80	2.84	61.60	2.17	78.10	1.89	99.30	1.64	125.50	1.43	155.20	1.26	246.40	0.97	398.00	0.73
43.10	3.45	68.40	2.64	86.80	2.29	110.30	1.99	139.50	1.74	172.46	1.54	273.80	1.17	442.30	0.89
47.40	4.12	75.30	3.14	95.50	2.74	121.40	2.38	153.40	2.08	189.70	1.83	301.10	1.40	486.50	1.06
51.70	4.84	82.10	3.69	104.10	3.22	132.40	2.80	167.40	2.44	207.00	2.15	328.50	1.65	530.70	1.24
56.00	5.61	89.00	4.28	112.80	3.73	143.40	3.24	181.30	2.83	224.20	2.50	355.90	1.91	574.90	1.44
60.30	6.44	95.80	4.92	121.50	4.28	154.50	3.72	195.30	3.24	241.40	2.87	383.30	2.19	619.20	1.65
64.60	7.32	102.70	5.58	130.20	4.86	165.50	4.23	209.20	3.69	258.70	3.26	410.70	2.49	663.40	1.88
68.90	8.25	109.50	6.29	138.80	5.48	176.50	4.76	223.20	4.15	275.90	3.67	438.00	2.80	707.60	2.12
73.20	9.23	116.40	7.04	147.50	6.13	187.60	5.33	237.10	4.65	293.20	4.11	465.40	3.14	751.80	2.37
77.50	10.30	123.20	7.83	156.20	6.82	198.60	5.92	251.00	5.17	310.40	4.57	492.80	3.49	796.10	2.64
81.80	11.30	130.00	8.65	164.90	7.53	209.60	6.55	265.00	5.71	327.70	5.05	520.20	3.85	840.30	2.91
86.20	12.50	136.90	9.52	173.60	8.28	220.70	7.20	278.90	6.28	344.90	5.55	547.50	4.24	884.50	3.20
90.50	13.60	143.70	10.40	182.20	9.07	231.70	7.88	292.90	6.87	362.20	6.07	574.90	4.64	928.70	3.51
94.80	14.90	150.60	11.40	190.90	9.88	242.70	8.59	306.80	7.49	379.40	6.62	602.30	5.06	973.00	3.82
99.10	16.10	157.40	12.30	199.60	10.70	253.80	9.33	320.80	8.14	396.70	7.19	629.70	5.49	1017.2	4.15
103.40	17.50	164.30	13.30	208.30	11.60	264.80	10.09	334.70	8.80	413.90	7.78	657.00	5.94	1061.4	4.49
107.70	18.80	171.10	14.40	216.90	12.50	275.80	10.90	348.70	9.49	431.20	8.39	684.40	6.41	1105.6	4.84
112.00	20.30	177.90	15.50	225.60	13.50	286.90	11.70	362.60	10.20	448.40	9.02	711.80	6.89	1149.9	5.21
116.30	21.70	184.80	16.60	234.30	14.40	297.90	12.60	376.60	10.90	465.60	9.67	739.20	7.39	1194.1	5.58
120.60	23.20	191.60	17.70	243.00	15.40	308.90	13.40	390.50	11.70	482.90	10.30	766.60	7.90	1238.3	5.97
124.90	24.80	198.50	18.90	251.70	16.50	320.00	14.30	404.50	12.50	500.10	11.00	793.90	8.43	1282.5	6.37
129.20	26.40	205.30	20.20	260.30	17.60	331.00	15.30	418.40	13.30	517.40	11.80	821.30	8.98	1326.8	6.79
133.50	28.10	212.20	21.40	269.00	18.70	342.00	16.20	432.40	14.10	534.60	12.50	848.70	9.54	1371.0	7.21
137.90	29.80	219.00	22.70	277.70	19.80	353.10	17.20	446.30	15.00	551.90	13.30	876.10	10.10	1415.2	7.60
142.20	31.50	225.90	24.10	286.40	20.90	364.10	18.20	460.20	15.90	569.10	14.00	903.40	10.70	1459.5	8.10
146.50	33.30	232.70	25.40	295.00	22.10	375.10	19.20	474.20	16.80	586.40	14.80	930.80	11.30	1503.7	8.60
150.80	35.10	239.50	26.80	303.70	23.40	386.20	20.30	488.10	17.70	603.60	15.60	958.20	11.90	1547.9	9.00
155.10	37.00	246.40	28.30	312.40	24.60	397.20	21.40	502.10	18.70	620.90	16.50	985.60	12.60	1592.1	9.50
159.40	39.00	253.20	29.70	321.10	25.90	408.20	22.50	516.00	19.60	638.10	17.30	1012.9	13.20	1636.4	10.00
163.70	40.90	260.10	31.20	329.80	27.20	419.20	23.60	530.00	20.60	655.40	18.20	1040.3	13.90	1680.6	10.50
168.00	42.90	266.90	32.80	338.40	28.50	430.30	24.80	543.90	21.60	672.60	19.10	1067.7	14.60	1724.8	11.00
172.30	45.00	273.80	34.30	347.10	29.90	441.30	26.00	557.90	22.70	689.80	20.00	1095.1	15.30	1769.0	11.60

Shaded values: estimation of recommended water speeds to avoid sedimentation, water hammer, noises, erosion and high values of head loss according to Manning formula.

Pressure loss tables

TOM® PVC-O 500 PN25

Pipe head loss is the energy of a hydraulic fluid that is lost along itself due to friction. Below is the calculation of estimated water speeds depending on the selected pipe for installation.

INTERNAL DIAMETER	DN90 PN25 82.2		DN110 PN25 101.4		DN125 PN25 115.2		DN140 PN25 129.2		DN160 PN25 147.6		DN200 PN25 184.4		DN225 PN25 207.4	
Speed (m/s)	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km
0.1	0.53	0.16	0.81	0.13	1.04	0.11	1.31	0.10	1.71	0.08	2.67	0.06	3.38	0.06
0.2	1.06	0.59	1.62	0.47	2.08	0.40	2.62	0.35	3.42	0.30	5.34	0.23	6.76	0.20
0.3	1.59	1.26	2.42	0.99	3.13	0.85	3.93	0.74	5.13	0.64	8.00	0.49	10.10	0.43
0.4	2.12	2.15	3.23	1.68	4.17	1.45	5.24	1.27	6.84	1.08	10.70	0.84	13.50	0.73
0.5	2.65	3.25	4.04	2.54	5.21	2.19	6.56	1.92	8.56	1.64	13.40	1.26	16.90	1.10
0.6	3.18	4.55	4.85	3.56	6.25	3.07	7.87	2.68	10.30	2.30	16.00	1.77	20.30	1.55
0.7	3.71	6.05	5.65	4.74	7.30	4.08	9.18	3.57	12.00	3.06	18.70	2.36	23.60	2.06
0.8	4.25	7.75	6.46	6.07	8.34	5.23	10.50	4.57	13.70	3.91	21.40	3.02	27.00	2.63
0.9	4.78	9.64	7.27	7.55	9.38	6.50	11.80	5.69	15.40	4.87	24.00	3.76	30.40	3.27
1.0	5.31	11.72	8.08	9.17	10.42	7.90	13.10	6.91	17.10	5.92	26.70	4.56	33.80	3.98
1.1	5.84	14.00	8.88	10.90	11.47	9.40	14.40	8.25	18.80	7.06	29.40	5.45	37.20	4.75
1.2	6.40	16.40	9.70	12.90	12.50	11.10	15.70	9.69	20.50	8.30	32.00	6.40	40.50	5.58
1.3	6.90	19.00	10.50	14.90	13.50	12.80	17.00	11.20	22.20	9.62	34.70	7.42	43.90	6.47
1.4	7.40	21.90	11.30	17.10	14.60	14.70	18.40	12.90	24.00	11.00	37.40	8.51	47.30	7.42
1.5	8.00	24.80	12.10	19.40	15.60	16.70	19.70	14.60	25.70	12.50	40.10	9.67	50.70	8.43
1.6	8.50	28.00	12.90	21.90	16.70	18.90	21.00	16.50	27.40	14.10	42.70	10.90	54.10	9.50
1.7	9.00	31.30	13.70	24.50	17.70	21.10	22.30	18.50	29.10	15.80	45.40	12.20	57.40	10.63
1.8	9.60	34.80	14.50	27.20	18.80	23.50	23.60	20.50	30.80	17.60	48.10	13.60	60.80	11.80
1.9	10.10	38.50	15.30	30.10	19.80	25.90	24.90	22.70	32.50	19.40	50.70	15.00	64.20	13.10
2.0	10.60	42.30	16.20	33.10	20.80	28.50	26.20	25.00	34.20	21.40	53.40	16.50	67.60	14.40
2.1	11.10	46.30	17.00	36.20	21.90	31.20	27.50	27.30	35.90	23.40	56.10	18.00	70.90	15.70
2.2	11.70	50.50	17.80	39.50	22.90	34.00	28.80	29.80	37.60	25.50	58.80	19.70	74.30	17.10
2.3	12.20	54.80	18.60	42.90	24.00	37.00	30.20	32.30	39.40	27.70	61.40	21.30	77.70	18.60
2.4	12.70	59.30	19.40	46.40	25.00	40.00	31.50	35.00	41.10	29.90	64.10	23.10	81.10	20.10
2.5	13.30	64.00	20.20	50.10	26.10	43.10	32.80	37.70	42.80	32.30	66.80	24.90	84.50	21.70
2.6	13.80	68.80	21.00	53.80	27.10	46.40	34.10	40.60	44.50	34.70	69.40	26.80	87.80	23.40
2.7	14.30	73.70	21.80	57.70	28.10	49.70	35.40	43.50	46.20	37.20	72.10	28.70	91.20	25.00
2.8	14.90	78.90	22.60	61.70	29.20	53.20	36.70	46.50	47.90	39.80	74.80	30.70	94.60	26.80
2.9	15.40	84.20	23.40	65.90	30.20	56.80	38.00	49.70	49.60	42.50	77.40	32.80	98.00	28.60
3.0	15.90	89.60	24.20	70.20	31.30	60.50	39.30	52.90	51.30	45.30	80.10	34.90	101.4	30.40
3.1	16.50	95.30	25.00	74.60	32.30	64.20	40.60	56.20	53.00	48.10	82.80	37.10	104.70	32.30
3.2	17.00	101.00	25.80	79.10	33.40	68.10	42.00	59.60	54.80	51.00	85.50	39.30	108.10	34.30
3.3	17.50	106.90	26.60	83.70	34.40	72.10	43.30	63.10	56.50	54.00	88.10	41.70	111.50	36.30
3.4	18.00	113.00	27.50	88.50	35.40	76.20	44.60	66.70	58.20	57.10	90.80	44.00	114.90	38.40
3.5	18.60	119.30	28.30	93.30	36.50	80.40	45.90	70.40	59.90	60.20	93.50	46.50	118.20	40.50
3.6	19.10	125.60	29.10	98.30	37.50	84.70	47.20	74.10	61.60	63.50	96.10	48.90	121.60	42.70
3.7	19.60	132.20	29.90	103.50	38.60	89.20	48.50	78.00	63.30	66.80	98.80	51.50	125.00	44.90
3.8	20.20	138.90	30.70	108.70	39.60	93.70	49.80	81.90	65.00	70.10	101.50	54.10	128.40	47.20
3.9	20.70	145.70	31.50	114.10	40.60	98.30	51.10	86.00	66.70	73.60	104.20	56.80	131.80	49.50
4.0	21.20	152.70	32.30	119.50	41.70	103.00	52.40	90.10	68.40	77.10	106.80	59.50	135.10	51.90

Shaded values: estimation of recommended water speeds to avoid sedimentation, water hammer, noises, erosion and high values of head loss according to Manning formula.

TOM® PVC-O 500 PN25

Pipe head loss is the energy of a hydraulic fluid that is lost along itself due to friction. Below is the calculation of estimated water speeds depending on the selected pipe for installation.

DN250 PN25 230.6		DN315 PN25 290.6		DN355 PN25 327.2		DN400 PN25 369.0		DN450 PN25 415.0		DN500 PN25 461.2		DN630 PN25 581.0		DN800 PN25 737.8	
Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km	Flow l/s	J m/km
4.18	0.05	6.63	0.04	8.41	0.03	10.70	0.03	13.50	0.02	16.70	0.02	26.50	0.02	42.80	0.01
8.35	0.18	13.30	0.14	16.80	0.12	21.40	0.10	27.10	0.09	33.40	0.08	53.00	0.06	85.50	0.05
12.50	0.38	19.90	0.29	25.20	0.25	32.10	0.22	40.60	0.19	50.10	0.17	79.50	0.13	128.30	0.10
16.70	0.64	26.50	0.49	33.60	0.43	42.80	0.37	54.10	0.32	66.80	0.29	106.00	0.22	171.00	0.17
20.90	0.97	33.20	0.74	42.00	0.65	53.50	0.56	67.60	0.49	83.50	0.43	132.60	0.33	213.80	0.25
25.10	1.37	39.80	1.04	50.50	0.91	64.20	0.79	81.20	0.69	100.20	0.61	159.10	0.46	256.50	0.35
29.20	1.82	46.40	1.39	58.90	1.21	74.90	1.05	94.70	0.91	116.90	0.81	185.60	0.62	299.30	0.47
33.40	2.33	53.10	1.78	67.30	1.55	85.60	1.34	108.20	1.17	133.60	1.04	212.10	0.79	342.00	0.60
37.60	2.89	59.70	2.21	75.70	1.92	96.20	1.67	121.70	1.46	150.40	1.29	238.60	0.98	384.80	0.74
41.80	3.52	66.30	2.68	84.10	2.34	106.90	2.03	135.30	1.77	167.10	1.57	265.10	1.20	427.50	0.90
45.90	4.19	73.00	3.20	92.50	2.79	117.60	2.42	148.80	2.11	183.80	1.87	291.60	1.43	470.30	1.08
50.10	4.93	79.60	3.76	100.90	3.28	128.30	2.85	162.30	2.48	200.50	2.19	318.10	1.68	513.00	1.27
54.30	5.72	86.20	4.36	109.30	3.80	139.00	3.30	175.80	2.88	217.20	2.55	344.70	1.94	555.80	1.47
58.50	6.56	92.90	5.01	117.70	4.36	149.70	3.79	189.40	3.30	233.90	2.92	371.20	2.23	598.50	1.69
62.60	7.45	99.50	5.69	126.10	4.95	160.40	4.30	202.90	3.75	250.60	3.32	397.70	2.53	641.30	1.92
66.80	8.40	106.10	6.41	134.50	5.58	171.10	4.85	216.40	4.23	267.30	3.74	424.20	2.86	684.00	2.16
71.00	9.39	112.80	7.17	142.90	6.24	181.80	5.43	230.00	4.73	284.00	4.18	450.70	3.20	726.80	2.42
75.20	10.40	119.40	7.97	151.40	6.94	192.50	6.03	243.50	5.26	300.70	4.65	477.20	3.55	769.60	2.69
79.40	11.50	126.00	8.81	159.80	7.67	203.20	6.67	257.00	5.81	317.40	5.14	503.70	3.93	812.30	2.97
83.50	12.70	132.70	9.69	168.20	8.44	213.90	7.33	270.50	6.39	334.10	5.65	530.20	4.32	855.10	3.27
87.70	13.90	139.30	10.60	176.60	9.24	224.60	8.03	284.10	7.00	350.80	6.19	556.80	4.73	897.80	3.58
91.90	15.10	145.90	11.60	185.00	10.07	235.30	8.75	297.60	7.63	367.50	6.74	583.30	5.15	940.60	3.90
96.10	16.40	152.50	12.60	193.40	10.90	246.00	9.50	311.10	8.28	384.20	7.32	609.80	5.59	983.30	4.23
100.20	17.80	159.20	13.60	201.80	11.80	256.70	10.28	324.60	8.96	400.90	7.92	636.30	6.05	1026.1	4.58
104.40	19.20	165.80	14.70	210.20	12.80	267.40	11.10	338.20	9.67	417.60	8.55	662.80	6.53	1068.8	4.94
108.60	20.60	172.40	15.80	218.60	13.70	278.00	11.90	351.70	10.40	434.40	9.19	689.30	7.02	1111.6	5.31
112.80	22.10	179.10	16.90	227.00	14.70	288.70	12.80	365.20	11.10	451.10	9.85	715.80	7.53	1154.3	5.70
116.90	23.70	185.70	18.10	235.40	15.70	299.40	13.70	378.70	11.90	467.80	10.50	742.30	8.05	1197.1	6.09
121.10	25.30	192.30	19.30	243.80	16.80	310.10	14.60	392.30	12.70	484.50	11.20	768.80	8.59	1239.8	6.50
125.30	26.90	199.00	20.50	252.30	17.90	320.80	15.50	405.80	13.50	501.20	12.00	795.40	9.15	1282.6	6.92
129.50	28.60	205.60	21.80	260.70	19.00	331.50	16.50	419.30	14.40	517.90	12.70	821.90	9.72	1325.3	7.36
133.60	30.30	212.20	23.10	269.10	20.20	342.20	17.50	432.80	15.30	534.60	13.50	848.40	10.30	1368.1	7.80
137.80	32.10	218.90	24.50	277.50	21.30	352.90	18.50	446.40	16.20	551.30	14.30	874.90	10.90	1410.9	8.30
142.00	33.90	225.50	25.90	285.90	22.50	363.60	19.60	459.90	17.10	568.00	15.10	901.40	11.50	1453.6	8.70
146.20	35.80	232.10	27.30	294.30	23.80	374.30	20.70	473.40	18.00	584.70	15.90	927.90	12.20	1496.4	9.20
150.40	37.70	238.80	28.80	302.70	25.10	385.00	21.80	487.00	19.00	601.40	16.80	954.40	12.80	1539.10	9.70
154.50	39.70	245.40	30.30	311.10	26.40	395.70	22.90	500.50	20.00	618.10	17.70	980.90	13.50	1581.9	10.20
158.70	41.70	252.00	31.80	319.50	27.70	406.40	24.10	514.00	21.00	634.80	18.60	1007.5	14.20	1624.6	10.70
162.90	43.70	258.70	33.40	327.90	29.10	417.10	25.30	527.50	22.00	651.50	19.50	1034.0	14.90	1667.4	11.30
167.10	45.80	265.30	35.00	336.30	30.50	427.80	26.50	541.10	23.10	668.20	20.40	1060.5	15.60	1710.1	11.80

Shaded values: estimation of recommended water speeds to avoid sedimentation, water hammer, noises, erosion and high values of head loss according to Manning formula.

Water Hammer

To **calculate possible excess pressures** (P) produced by water hammers, the celerity (α) must be first determinated. It is a characteristic of the pipe and the fluid that it transports, and it evaluates the change in the water speed (V) which can occurs in the valvel openings and closings or for startups or shutdowns of the pump.

$$P = \frac{a \cdot V}{g}; \quad a = \frac{1420}{\sqrt{1+\left(\frac{k}{E}\right)\cdot\left(\frac{De}{e_{min}}-2\right)}}$$

TOM® PN16 (230 psi) PIPES

V	a	P (water hammer)	
m/s	m/s	m	bar
0.5	293	15	1.5
1.0	293	30	3.0
1.5	293	45	4.5
2.0	293	60	6.0
2.5	293	75	7.5
3.0	293	90	9.0
3.5	293	105	10.5
4.0	293	119	11.9

K9 DUCTILE IRON PIPES

V	a	P (water hammer)	
m/s	m/s	m	bar
0.5	1100	56	5.6
1.0	1100	112	11.2
1.5	1100	168	16.8
2.0	1100	224	22.4
2.5	1100	280	28.0
3.0	1100	336	33.6
3.5	1100	392	39.2
4.0	1100	449	44.9

Air locks in the pipes during filling can be highly damaging when water hammers arise and can cause excess pressure far beyond the levels established in the tables above. Thus it is important to follow the following **recommendations:**

- **Filling the pipe** should only be carried out at low speed (approximately 0.05 m/s) and at the lowest point in the pipe system.
- **When installing purging mechanisms** (double effect suction mechanisms) at the highest points on each section of pipe.
- During filling it is important to leave opened the elements capable of **evacuating air** (valves), and close them from bottom to top in the pipe as the pipe fills up with water.

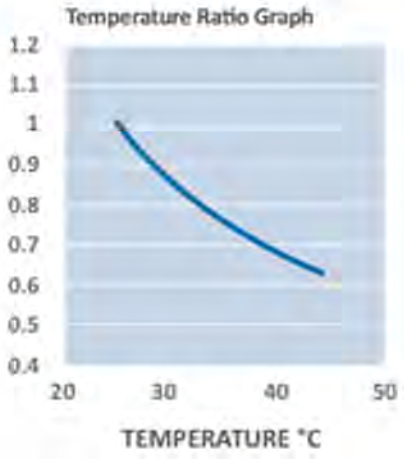
Reduction ratios: Temperature and Application

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

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

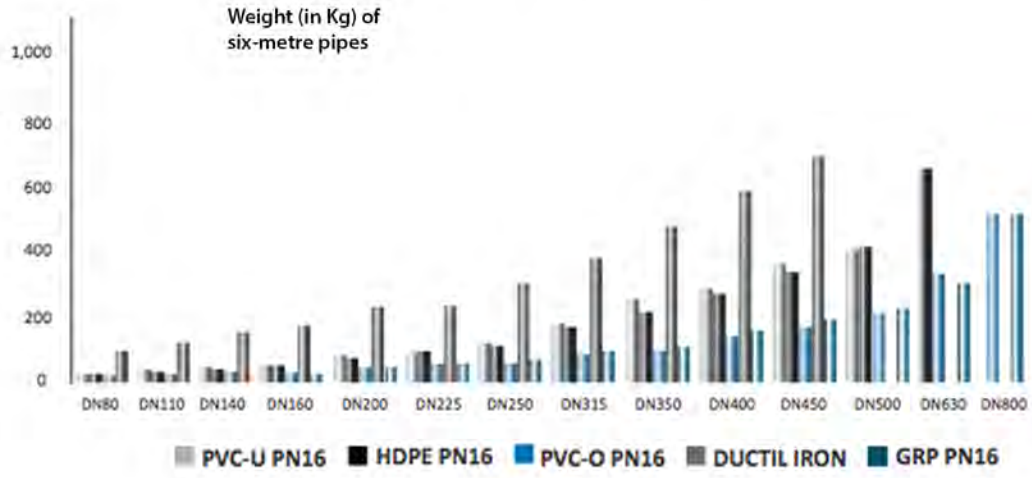
The derating factor (fT) as function of operating temperature can be obtained from the graph on the right. The derating factor related to application of the system (fA) must be determined by the Project Manager.

Note: Project design and execution is responsibility of the Project Manager and the Contractor, respectively.



Quick, low-priced installation

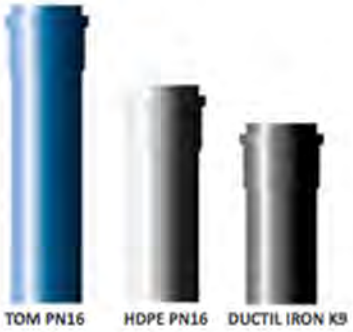
TOM® PVC-O pipes are less than half PVC and HDPE pipes weight: between six and twelve times less per linear metre than ductile iron pipes of the same nominal external diameter. Due to their lightness, **they can be lifted without mechanical assistance** (cranes, hoists, etc), up to a diameter of DN315 mm, which brings down the overall cost of installation.



Because TOM® pipes have a high resistance, they offer considerable **advantages in terms of unloading, installation in trenches and pipe- to-pipe connection.** Moreover, these pipes are so easy to connect to one another that they offer very high performance: they can be handled and installed by lower-qualified workers and without machinery (up to DN 315).

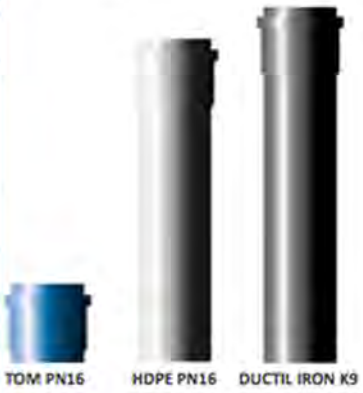
For all these reasons **TOM® pipes offer huge advantages in terms of installation in metres/installation-hours** compared to other solutions.

Installation performance (m/hour)



Figures for DN 200-250 mm

Installation Costs (euro/m)



Figures for DN 200-250 mm

Transport and Storage

TOM® pipes characteristics make them easy to transport and store, which means considerable savings in costs.

To optimize transport, it is advisable to stick to the following guidelines:

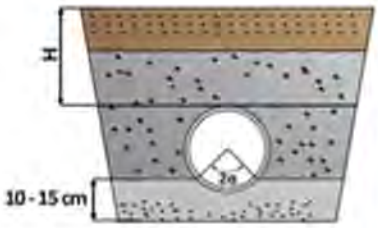
- If different diameters are going to be transported in the same batch, the biggest diameters must be placed below.
- Leave the sockets free, alternating sockets and free ends.

To avoid damaging pipes in storage, it is advisable to:

- Store the pipes horizontally on a flat surface, on supports spaced 1.5 metres apart, to keep the pipes from bowing.
- Do not stack higher than 1.5 metres.
- Leave the sockets free, alternating sockets and free ends.
- If the pipes are stored in direct sunlight, cover the pallets with Installation performance (m/hour) opaque material and with ventilation to prevent overheating.

Excavation

Trench dimensions



Although other types of applications are possible, **TOM® pipes are particularly recommended for underground installation.** The dimensions of the trench will depend on the loads to which pipes will be submitted (road traffic, soil types, etc). As a rule of thumb, when there is no road traffic involved, the pipes' crown will be at a minimum depth of 0.6 metres (60 cm); with road traffic, the minimum depth is 1 metre.

The minimum **width of the trench** can be calculated using the following tables:

DN (mm)	Minimum width of trench B (m)
90-250	0.60
315	0.85
355	1.00
400	1.10
450	1.15
500	1.20
630	1.35
800	1.65

Depth of trench H (m)	Minimum width of trench B (m)
h < 1.00	0.60
1.00 < h < 1.75	0.80
1.75 < h < 4.00	0.90
h > 4.00	1.00

The bottom of the trench should be homogeneous, uniform and ensure a solid support along the entire length of the pipe.

Assembly

- 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.

Angular Deviation

Angular deviations in the union system are allowed. This means that the piping can be channeled following a desired line.

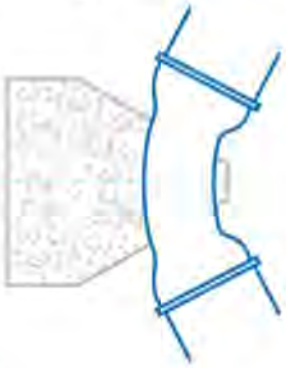
DN	Maximum angular deviation	Displacement between sockets
(mm)	Angle (°)	D (mm) (1)
90-800	2°	200

(1) Pipes not exceeding 5.95 metres in length.

Anchoring

Pipes that are subjected to internal hydrostatic pressure are also subjected to thrust forces at every point of change of direction (angular deviation of the pipe, elbows, curves, etc) and in parts and components that increase or reduce the pipe's cross-section, such as valves, branches, overflows, etc.

Anchoring at points of change of direction



These forces can be extremely strong and are even capable of moving the ground, causing pipes to uncouple. In general terms, the thrust forces can be gauged using the following formula:

$$Force(kg) = k \cdot Pressure\ (bars) \cdot Pipe\ Cross\text{-}Section\ (cm^2)$$

In caps and tees at 90°: k=1

In reducers: $k = \frac{Smallest\ cross\text{-}section}{Biggest\ cross\text{-}section}$

In changes of direction: $k = 2 \cdot sen\ \frac{\beta}{2}$

It is important to ensure that the concrete is poured directly into the previously positioned ground and that it has the required mechanical resistance. When designing the anchoring, bear in mind that **the joints must be left free** to enable its subsequent inspection during hydraulic trials.

Bedding and Filling the Trench

To analyze the optimal and most efficient way for the preparation of bedding on which to settle the pipe and the subsequent filling and compacting the ground on the sides and top of the pipe, see our installation instructions or contact with our technical and commercial service.

Fiels trials and Entry into Service

The EN 805:2000 Water Supply Standard is applicable to all aspects of on-site trials and Entry into Service. During installation, it is important to carry out trials on the lengths of completely laid pipeline (the length can vary between 500 and 1,000 metres). The ends of each length of pipeline will be sealed off using the appropriate components, and the pipeline must be partly filled with the joints in full view.

The trial pressure (STP) in N/mm2 (0.1 N/mm2 = 1 atm) will be as follows:
a) If the water hammer has been calculated precisely: STP = MDP + 0.1
b) If the water hammer is estimated, use the lesser of the following twovalues:STP=MDP+0.5 andSTP=1.5·MDP

MDP is the Maximum Design Pressure, i.e. the maximum allowable pressure in a pipe, including the effect of a water hammer. The Entry into Service of piping for drinking water must comply with the required health standards for water for human consumption.

Certificates

Quality System Certification according to UNE-EN ISO 9001:2008.

AENOR Product certification according to UNE ISO 16422:2015. Mark.

AFNOR Product certification according to NF T54-948:2010. Mark.

Approval test of RD 140/2003 "Criterios Sanitarios de la calidad del agua de consumo humano" (Sanitary Criteria for human water quality consumption).

Attestation de Conformité Sanitaire (ACS) according to French legislation.

Sanitary certificate HYDROCHECK (Belgium)

Water Regulations advisory scheme (WRAS) Material approval - materials which have passed full tests of effect on water quality.

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