ALL IN ONE SYSTEM NO GRAVEL IS NEEDED

drenotube®

Golf Course Subsoil Drainage

GEOSYNTHETIC AGGREGATE AND GEOTEXTILE FILTER INCLUDED

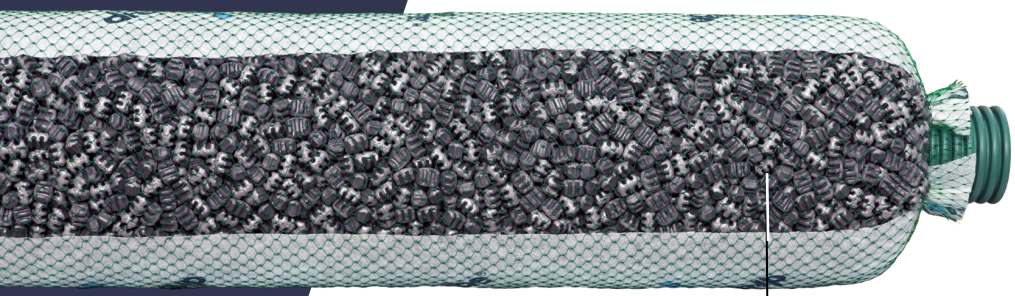
DIMENSIONS AND FLOW RATES ACCORDING TO SLOPE (i)

TOP VIEW

Ø 300 / 370 mm

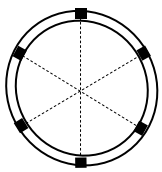
L = 3 / 6 m

BOTTOM VIEW



Ø 110 / 160 mm

There is an opening along the bottom side to avoid clogging and to extend service life over 25 years.



Corrugated pipe with 6 slits around the perimeter

FRONT VIEW

Geosynthetic aggregate

Tube Ø mm	Bundle Ø mm	Length m	Flow rate i 0,5%	Flow rate i 1,5%	Flow rate i 2,5%
90/110	300mm	3 or 6	2,5 litres / sec	4,3 litres / sec	5,6 litres/sec
140/160	370mm	3 or 6	7,5 litres / sec	13 litres / sec	16,5 litres/sec

drenotube® is a factory-assembled unit that can be used for both underground drainage or infiltration applications.

drenotube® preassembled drainage segments consist of a double wall slotted corrugated pipe surrounded by a geo-synthetic aggregate enclosed in a high strength polyethylene netting that is clamped to both ends of the pipe.

There is a fabric geotextile filter in between the netting and aggregate. The fabric is used to prevent soil intrusion.

- No gravel is needed.
- 100 times lighter than gravel.
- Available in SN4 or SN8 ring stiffness
- Length 3 or 6 meters
- Placement rate 10 meters per minute.
- Joined with a fast click fit connector included.
- Superior water flow rate and higher storage capacity.
- Slotted (drainage) or drilled holes (infiltration) pipe

FIELD OF USE & CERTIFICATIONS

NF P 16-351 DRAINAGE NORM

drenotube® DR system (only available on request) is certified according TECHNICAL NOTICE (Avis Technique—France) Reference 17.2 / 19-346_V1

Intended uses:

Construction of subsurface drainage networks to protect infrastructures from interstitial overpressures.

- Road & Highways
- Public Works
- Infrastructures
- Other Civil Engineering Works

SUB-SURFACE DRAINAGE

Intended uses according to European Assessment Document EAD 280001-00-0704

ETA 15/0201

- Retaining walls
- Foundations around Buildings and Houses
- Railway
- Landscaping & Gardening
- Sport Fields— football, golf
- Agriculture
- Roads & Highways

ENVIRONMENTAL AND HEALTH PERFORMANCE

In accordance with standard NF EN 15804 + A1 and its national supplement NF EN 15804 / CN

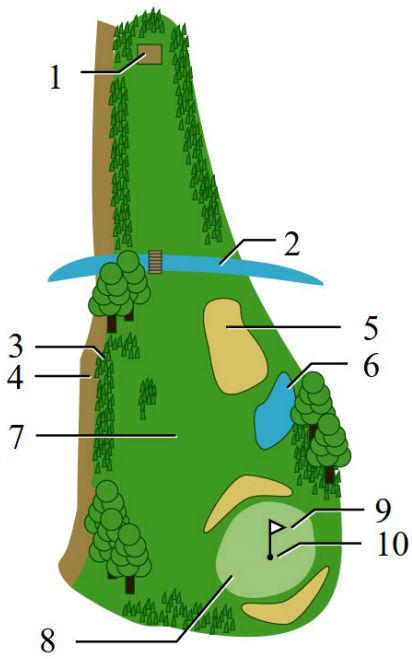
Verification No: 7-418: 2019

drenotube® FDES is a document that shows the results of a product's life cycle analysis (the extraction of raw materials, transport, implementation and performance to its end of life), as well as health information, used to calculate the environmental and health performance of the drainage networks.

It certifies that the **drenotube®** makes a structure more sustainable, with limited impacts on the environment.

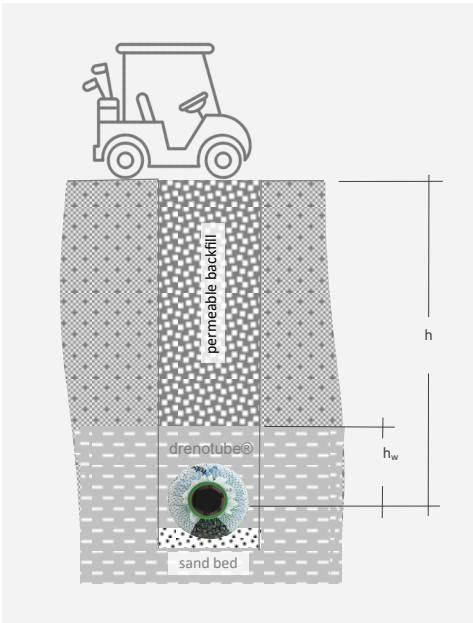
Golf Course Drainage

The most common causes of drainage issues on golf courses are impermeable soil conditions, side-hill seepage, and high water tables. Providing firm, consistent playing surfaces requires good drainage.



1 Teeing ground / Tee box
2 Water hazard
3 Rough
4 Cart Path
5 Bunker
6 Water hazard
7 Fairway
8 Green / Putting Green
9 Pin / Flag
10 Hole

Depth and Pressure figures applied on drenotube®



Depth (h) m	5 kN wheel force	h_w m	Total pressure acting on drenotube® kN/m^2
0,5	7	0	18
1	3,3	0 / 1	22 / 24
1,5	2	0 / 1	30 / 32
2	1,3	0 / 1	39 / 41
2,5	0,9	0 / 1	48 / 50
3	0,5	0 / 1	56 / 58

The above data is for orientative purposes only. It is considered a parallel trench with a backfill soil density of 1900 kg/m^3 , and a live load wheel force of 5 kN (510 Kg/m^2)- dynamic factor 1.75 The example show 2 figures. Groundwater level (h_w) = 0 (below drenotube®) h_w = 1 (1 m above). Trench width is drenotube Ø + 20 / 40 mm. If there is no live load then substract the "5 kN wheel force" column from the Total pressure.

To find a more accurate results will depend on the soil density, porosity, water content, nature of different layers and cohesive forces amongst others.

drenotube® is a modular preassembled drainage system. Replaces traditional gravel by using engineered geosynthetic particles. drenotube® improves drainage performance eliminating fines and reducing compaction and embedding associated with crushed Stone.

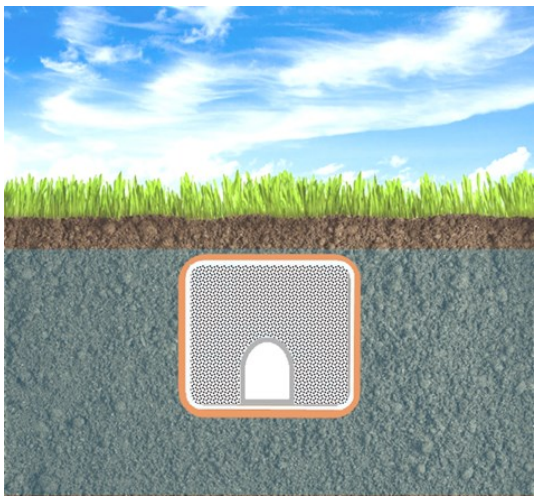
drenotube® drain at Aloha Golf Club Marbella - Spain

drenotube® bundles are distributed along the trench. They are kept in its original UV protected bags until placing into the trench. Connect the pipe with the external coupling being sure that they are fully inserted to insure proper coupling. **drenotube®** bundles are flexible and can fit in curved trenches.

drenotube® drainage system eliminates problems caused by gravel which blocks pipes and damages mower blades. Gravel contains fine particles that shorten the life of the drainage. Geosynthetic particles are fines free. The system is ideal for fairways, bunkers and greens draining wet areas along the terrain. **drenotube®** can be used in new installations or rebuilt greens.

Durability and performance of the conventional system versus drenotube®

Gravel envelope

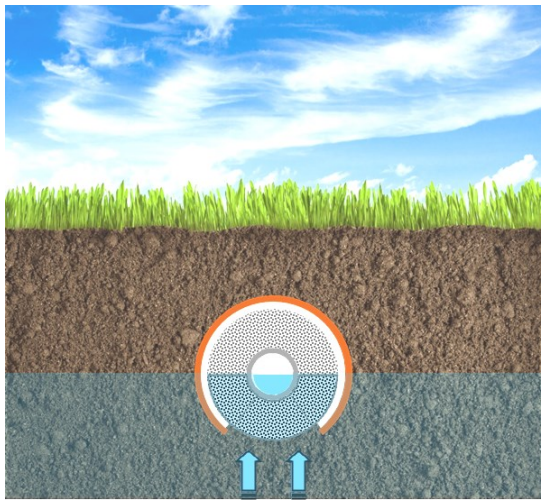


GEOTEXTILE IS WRAPPED ALL AROUND THE DRAIN

Over time a filter cake of fines will be develop and finally the geotextile will be clogged. Water will not flow.

Single wall drain with flat bottom slows water flow due to turbulence.

drenotube®



GEOTEXTILE COVERS THE UPPER 3/4

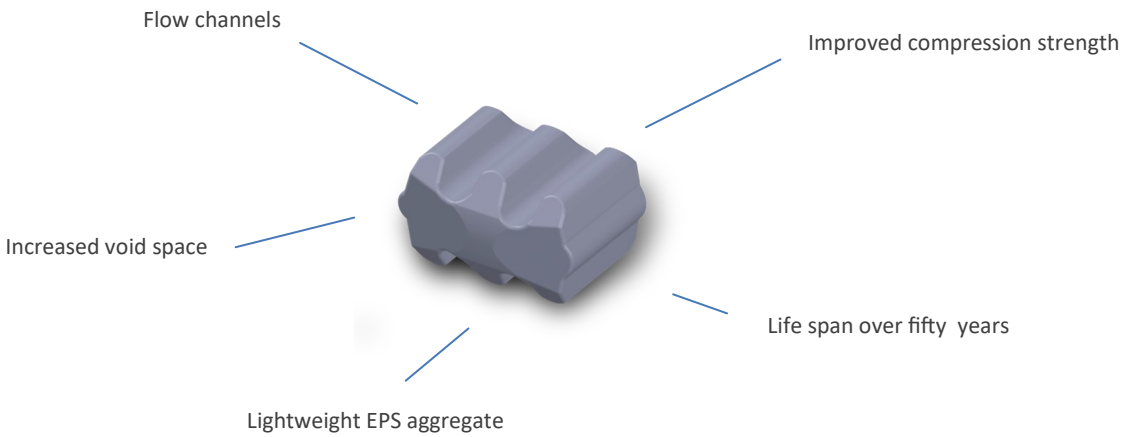
The bottom part of the **drenotube®** is open to increase durability ensuring the flow of water during many years.

Double wall 360^0 slotted corrugated HDPE pipe. Smooth inside avoids turbulence and speeds the water flow.

Geosynthetic EPS aggregate

The EPS aggregate can remain buried in a wet environment for decades without degradation.

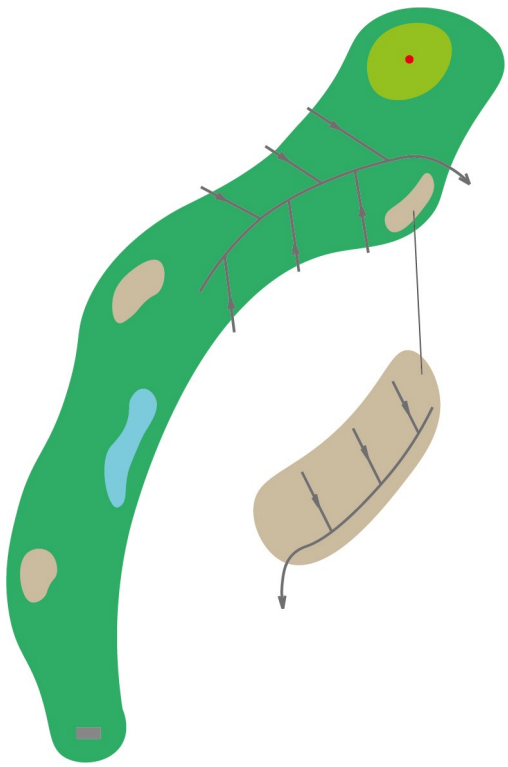
It is a thermoplastic that can be heated, melted and recycled. Energy efficient both in their manufacture & processing. Lightweight material. It is not attacked by fungi, mold and/or mildew.



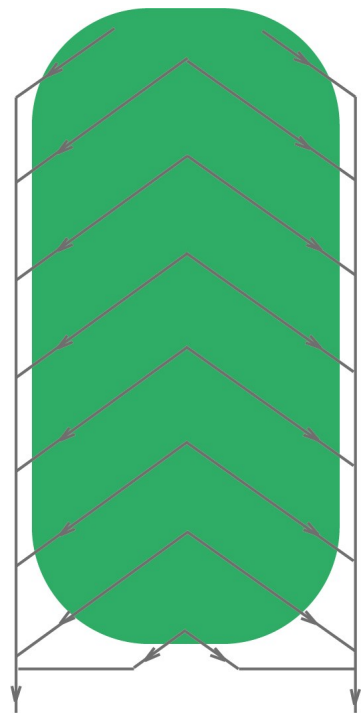
EPS geosynthetic particles have a particular design to achieve high water flow and void space . Cell size structure suitable for a high compressive strength. It is not brittle at subzero temperatures.

Observing the golf course during a heavy rain event can help identify problem areas and provide valuable insight into how water moves across. The presence of puddling in low areas of a green following irrigation or natural precipitation is a sign of poor surface drainage. This phenomenon can be caused by poor design and/or construction, or by settling over time.

drenotube® is suitable for the drainage of golf courses, football fields, and other outdoor events where natural, artificial or hybrid grass is present.



Example of a heringbone pattern drainage through the fairway and also in the bunkers. A grid design is also typically used to drain large flat areas. Outlets are diverted to a lower terrain. Cover the upper end of the pipe with an end-cap to prevent soil or sand from getting into the drainage line.



Another pattern used in sport fields and golf courses areas. Water is collected by carrier pipes at the sides of the field to the outlets. Inspection boxes are generally located every 30 meters along the drain. **drenotube®** drainage should have a minimum cover of 40 cm backfill.

ADVANTAGES

PERFORMANCE

- Superior water flow rate and higher storage capacity compared with gravel.
- Test and certificates for the finished product and all components (Compressive strength, creep in compression, ageing, flow capacity, etc.)
- Product has been monitored and evaluated on-site and approved through most US States since 1991 with thousands of installations in use.
- **CE** approval ETA number 15/0201
- Avis technique (CSTB France) NF P 16-351 Drainage Norm Reference 17.2 / 19-346_V1
- FDES LCA (Life Cycle Assestment) NF EN 15804 + A1 and its national supplement NF EN 15804 / CN Verification No: 7-418: 2019

COST EFFECTIVE

- Saves time, money and avoids trouble-shooting
- Easier and cheaper transport
- Easily hand-carried into position reducing time and labor
- Reduces the volume of excavation
- No gravel is needed. Easier cleanup at job site

INSTALLATION

- Quick and easy installation without skilled labour
- No trucks or heavy equipment are needed to bring the product to the construction site
- Secure handling. Its lightness entails no labour risk
- It is clean and fines free.
- Ability to contour along sloped sites and around trees, corners or other obstacles
- Faster installation. Placement rate 10 meters per minute. Joined with a rapid click fit connection
- Pre-assembled modules provides entire on-site implementation. Central pipe is surrounded by uniform thickness of aggregate throughout the way. The geotextile filter is perfectly centered.
- Lightweight system is perfect for repairs in tight job sites. About 100 times lighter than gravel. It can be installed quickly with limited site disruption
- No need of shoring when working in deep trenches. Segments can be joined in the surface and pulled down without entering

SUSTAINABITILY

- Manufactured from post-industrial recycled environmentally friendly materials.
- All components are recyclable
- Avoids environmental impact of aggregate quarrying, preserving the landscape
- Durable. Expected life span of all components is over 50 years

The object of subsurface drainage is to keep fluctuations of moisture as minimum as possible. Variations in moisture content are mainly caused due to:

- Fluctuations in movement of capillary water
- Rising of ground water table
- Seepage water from adjacent area
- Percolation of rain water

Healthier grass and sod

Good drainage promotes deeper root growth stabilizing the playing surface and reducing soil compaction caused by heavy traffic.

Maximum playability

Provides firm, consistent playing surfaces. Allows to resume play faster in heavy rain episodes.

Reduced risk of disease

Turf that does not continuously sit in damp soils will be more resistant to fungus and disease.

Removal of soluble salts

Improves turf quality in a more arid areas through the leaching of soluble salts.

drenotube® Installation Guide must be carefully read before starting the works. Units are printed longitudinally with a line displaying the words "This side up". Segments must be installed positioning this line upwards. Cover the upper end of the pipe with the end cap to prevent soil or sand from getting into the pipe. The bottom of the trench needs to be leveled at a slope of 0,5 to 2,5 per cent.

PERFORMANCE STATEMENT DR -2404-EN

CE

BASIC FEATURES	PERFORMANCE			TECHNICAL SPECIFICATIONS
Drainage capacity under pressure for SN4 version (4kN/m^2 ring stiffness) Above 60 KPa would be convenient to use a higher ring stiffness SN8 (8kN/m^2)		**DR300SN04ST6/3**	**DR370SN04ST6/3**	ETA 15/0201 22/04/2015
	kPa	dm^3/s/m		
	0	5,80	12,50	
	10	5,65	12,25	
	20	5,50	12,00	
	30	5,35	11,75	
	40	5,25	11,50	
	50	5,15	11,25	
	60	5,00	11,00	
		DR300SN08ST6/3	**DR370SN08ST6/3**	
	80	4,70	9,90	
	100	4,30	8,00	
	120	4,00	7,50	
b) Deformation under pressure (dry conditions)		**DR300SN04ST6/3**	**DR370SN04ST6/3**	ETA 15/0201 22/04/2015
	kPa	mm		
	10	40	40	
	20	50	65	
	40	72	90	
	60	100	110	
Dedormation under pressure and ageing due to oxidation	Same values as b)			ETA 15/0201 22/04/2015
Dedormation under pressure and ageing due to hydrolysis	Same values as b)			ETA 15/0201 22/04/2015
Deformation under pressure microbiologically aged	Same values as b)			ETA 15/0201 22/04/2015
Dangerous materials content	None, all components are inert			ETA 15/0201 22/04/2015

European Assessment Document EAD 280001-00-0704 ETA 15/0201

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PREASSEMBLED DRAINAGE AND INFILTRATION

Sand based backfill may be mixed with silt (1 to 13 per cent) and organic matter (up to 4 per cent) The object is to obtain a mix with the desired infiltration rate. Drain lines may become visible if the backfill dries out considerably faster than surrounding soils.

Backfilling drainage trenches with a sand mix provides an excellent medium for turfgrass establishment while allowing excess water to rapidly move into the underlying sub-surface drain lines.

The best solution for side-hill seepage is to install an interceptor or curtain drain just above the wet area near the base of the slope. The bottom of the trench should be positioned just into the less permeable subsoil, placing **drenotube®** drainage pipes and then backfilling with a highly permeable sand mixture.

Corrugated pipe	Standard	Unit	Value
Outer diameter	UNE EN 61386-1	mm	110
Inner diameter	UNE EN 61386-2-4	mm	SN04 : 93 – SN08 : 91
Ring stiffness	UNE EN ISO 9969	kN/m^2	SN04 : 4 – SN08 : 8
Perforation type		º	360
Slits surface		cm^2/m	50 (±10)
Polymer	UNE 53994 :2011		Polyethylene
Geosynthetic aggregate	**Standard**	**Unit**	**Value**
Bulk density	UNE 92120-2:1998	kg/m^3	10
Specific weight	UNE 83134	kg/m^3	20
Void space		%	50
Specific surface		m^2/m^3	230
Particle number		$units/m^3$	~115.000
Water absorbtion 7 days	UNE EN 12087:1997	%	2,0
Water absorbtion 21 days	UNE EN 12087:1997	%	2,2
Particle size distribution	UNE EN 933-1	% pass	<8 mm: 0 <20 mm: 73 <25 mm: 100
Working temperature	-	ºC	-20 a +65
Color	-	-	Graphite
Geotextile filter	**Standard**	**Unit**	**Value**
Polymer	-	-	Polypropylene
Bonding technique	-	-	Needle punched
Mass per unit area	UNE EN ISO 9864	g/m^2	100
Thickness 2 kPa	UNE EN ISO 9863-1	mm	0,7
Tensile strength MD/CMD	UNE EN ISO 10319	kN/m	8,0/8,0
Elongation at max. load MD/CMD	UNE EN ISO 10319	%	90/80
Static puncture resistance (CBR)	UNE EN ISO 12236	N	1300
Cone drop test	UNE EN ISO 13433	mm	28
Water permeability	UNE EN ISO 11058	$m^3/s/m^2$	0,120
In plane capacity @ 20 kPa	UNE EN ISO 12958	$m^3/s/m$	1x10-6
Opening size O90	UNE EN ISO 12956	µm	80
UV protection			Yes
Net	**Unit**	**Value**	
Polymer	-	Polyethylene	
Weight per unit	g/m	67	
Semiperimeter	cm	51	
Net type	-	Oriented tubular	
Drenotube ®	**Unit**	**Value**	
Length	m	3 or 6	
Weight	g/m	SN04 ~ 1300 SN08 ~ 1592	
Draining surface	cm^2/m	SN04 : 51 SN08 : 50	
Bundle diameter	mm	300	
Maximum installation depth	m	SN04 : 3 SN08 : 5	
Minimum installation depth	m	0,40	

Corrugated pipe	Standard	Unit	Value
Outer diameter	UNE EN 61386-1	mm	160
Inner diameter	UNE EN 61386-2-4	mm	SN04 : 140 – SN08 : 136
Ring stiffness	UNE EN ISO 9969	kN/m^2	SN04 : 4 – SN08 : 8
Perforation type		º	360
Slits surface		cm^2/m	85 (±10)
Polymer	UNE 53994 :2011		Polyethylene
Geosynthetic aggregate	**Standard**	**Unit**	**Value**
Bulk density	UNE 92120-2:1998	kg/m^3	10
Specific weight	UNE 83134	kg/m^3	20
Void space		%	50
Specific surface		m^2/m^3	230
Particle number		$units/m^3$	~115.000
Water absorbtion 7 days	UNE EN 12087:1997	%	2,0
Water absorbtion 21 days	UNE EN 12087:1997	%	2,2
Particle size distribution	UNE EN 933-1	% pass	<8 mm: 0 <20 mm: 73
Working temperature	-	ºC	-20 a +65
Color	-	-	Graphite
Geotextile filter	**Standard**	**Unit**	**Value**
Polymer	-	-	Polypropylene
Bonding technique	-	-	Needle punched
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Thickness 2 kPa	UNE EN ISO 9863-1	mm	0,7
Tensile strength MD/CMD	UNE EN ISO 10319	kN/m	8,0/8,0
Elongation at max. load MD/CMD	UNE EN ISO 10319	%	90/80
Static puncture resistance (CBR)	UNE EN ISO 12236	N	1300
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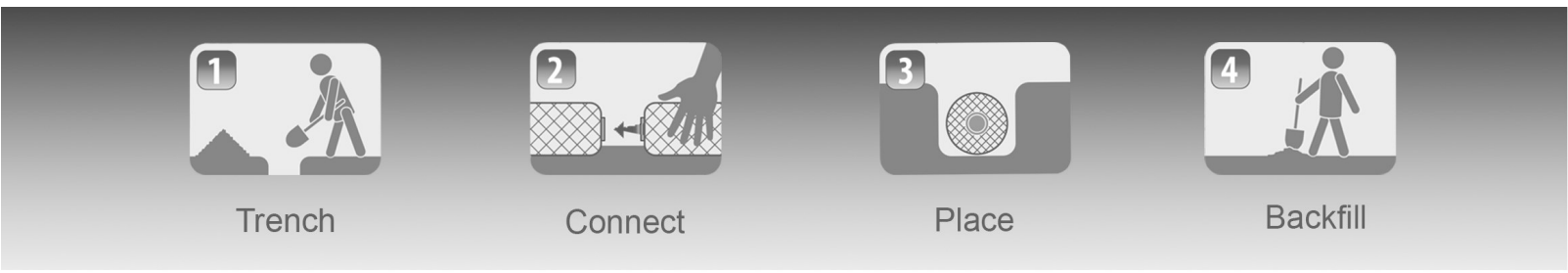
Water permeability	UNE EN ISO 11058	$m^3/s/m^2$	0,120
In plane capacity @ 20 kPa	UNE EN ISO 12958	$m^3/s/m$	1x10-6
Opening size O90	UNE EN ISO 12956	µm	80
UV protection			Yes
Net	**Unit**	**Value**	
Polymer	-	Polyethylene	
Weight per unit	g/m	76	
Semiperimeter	cm	63	
Net type	-	Tubulaire orientée	
Drenotube ®	**Unit**	**Value**	
Length	m	3 or 6	
Weight	g/m	SN04 ~ 2150 SN08 ~ 2482	
Draining surface	cm^2/m	SN04 : 51 SN08 : 50	
Bundle diameter	mm	370	
Maximum installation depth	m	SN04 : 3 SN08 : 5	
Minimum installation depth	m	0,40	

drenotube®

P R E A S S E M B L E D D R A I N A G E A N D I N F I L T R A T I O N



EASY TO INSTALL

EFFICIENCY

COST EFFECTIVE

ECO-FRIENDLY

FUMOSO INDUSTRIAL S.A. LIMITED WARRANTY

drenotube® when installed and operated in a drainage system in accordance with Fumoso Industrial S.A. instructions, is warranted to the original purchaser "Holder" against defective materials and workmanship. Fumoso liability specifically excludes the cost of removal and/or installation of the drenotube® "Units"

The limited warranty is exclusive. There are no other warranties with respect to the Units.

This Limited Warranty shall be void if any part of the drenotube® system is manipulated by anyone other than Fumoso. The Limited Warranty does not extend to incidental, consequential, special or indirect damages. Fumoso shall not be liable for penalties or liquidated damages, including loss of production and profits, labor and materials, overhead costs, or other losses or expenses incurred by the Holder or any third party. Specifically excluded from Limited Warranty coverage are damage to the Units due to ordinary wear and tear, alteration, accident, misuse, abuse or neglect of the Units; the Units being subjected to vehicle traffic or other conditions which are not permitted by the installation instructions; failure to maintain the minimum ground covers set forth in the installation instructions; the placement of improper materials into the system containing the Units; failure of the Units due to improper siting or improper sizing or improper operation; or any other event not caused by Fumoso. This Limited Warranty shall be void if the Holder fails to comply with all of the terms set forth in this Limited Warranty. Further, in no event shall Fumoso be responsible for any loss or damage to the Holder, the Units, or any third party resulting from installation or shipment, or from any product liability claims of Holder or any third party. For this Limited Warranty to apply, the Units must be installed in accordance with all site conditions required by the local authorities and normatives and all other applicable laws and Fumoso Industrial S.A. installation instructions.

No representative of Fumoso Industrial S.A. has the authority to change or extend this Limited Warranty. No warranty applies to any party other than the original Holder.

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FDES VÉRIFIÉE inies

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