EN

RENOVATION VRC®+ GAS

PE100-RC WITH ENHANCED STRESS CRACKING RESISTANCE

Raised crack resistant polyethylene PE100-RC (MRS 10) piping systems, with multilayer structure (inner black layer and outer orange layer), intended for the distribution of gaseous fuels (for example, natural gas, methane, propane, butane, LPG and hydrogen) and compliant with the requirements of EN 1555-2 and ISO 4437-2 and with technical specification PAS 1075 (Type 2) for alternative installations.

DISTRIBUTION OF GASEOUS FUELS

IDROTHERM 2000

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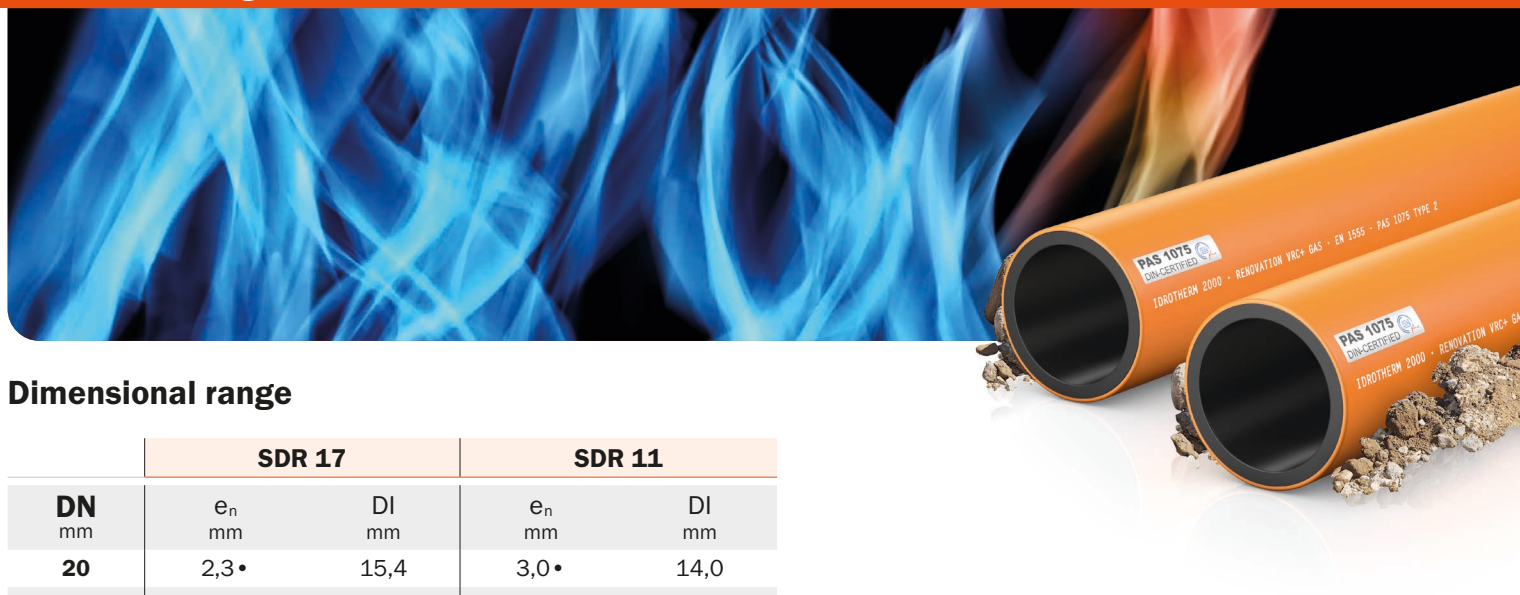

Dimensional range

	SDR 17		SDR 11	
DN mm	e_n mm	DI mm	e_n mm	DI mm
20	2,3 •	15,4	3,0 •	14,0
25	2,3 •	20,4	3,0 •	19,0
32	2,3 •	27,4	3,0	26,0
40	2,4	35,2	3,7	32,6
50	3,0	44,0	4,6	40,8
63	3,8	55,4	5,8	51,4
75	4,5	66,0	6,8	61,4
90	5,4	79,2	8,2	73,6
110	6,6	96,8	10,0	90,0
125	7,4	110,2	11,4	102,2
140	8,3	123,4	12,7	114,6
160	9,5	141,0	14,6	130,8
180	10,7	158,6	16,4	147,2
200	11,9	176,2	18,2	163,6
225	13,4	198,2	20,5	184,0
250	14,8	220,4	22,7	204,6
280	16,6	246,8	25,4	229,2
315	18,7	277,6	28,6	257,8
355	21,1	312,8	32,2	290,6
400	23,7	352,6	36,3	327,4
450	26,7	396,6	40,9	368,2
500	29,7	440,6	45,4	409,2
560	33,2	493,6	50,8	458,4
630	37,4	555,2	57,2	515,6

DN = nominal diameter DI = inner diameter e_n = nominal thickness

• The calculated values have been rounded up to 2,3 mm for SDR 17 and 3,0 mm for SDR 11 respectively.

Reference standards

EN 1555-2	*"Plastics piping systems for the supply of gaseous fuels – Polyethylene (PE) – Part 2: Pipes"*
ISO 4437-2	*"Plastics piping systems for the supply of gaseous fuels – Polyethylene (PE) – Part 2: Pipes"*
PAS 1075	*Rohre aus Polyethylen für alternative Verlegetechniken – Abmessungen, technische Anforderungen und Prüfung – Pipes made from polyethylene for alternative installation techniques – Dimensions, technical requirements and testing*

The designer of a pipeline shall consider and carefully evaluate the implications of the parameters of each specific project with technical requirements and national regulations.

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Characteristics

The physical and mechanical characteristics of RENOVATION VRC+ GAS pipes are compliant with the technical requirements specified in EN 1555-2 ed ISO 4437-2 standards, as given in the following table.

Characteristic	Test method	Parameters	Requirement
Melt mass-flow rate	EN ISO 1133-1	190 °C - 5 kg	Maximum deviation of ± 20% after processing
Oxdidation induction time	EN ISO 11357-6	200 °C	> 20 min
Longitudinal reversion	EN ISO 2505	110 °C - 1 h	≤ 3%
Elongation at break	EN ISO 6259-1 EN ISO 6259-3	100 mm/min (e ≤ 5mm) 50 mm/min (5 mm < e ≤ 12 mm) 10 mm/min (e > 12 mm)	≥ 350%
Hydrostatic strength	EN ISO 1167-1 EN ISO 1167-2	20 °C - σ 12,0 MPa	> 100 h (no faliure)
		80 °C - σ 5,4 MPa	> 165 h (no faliure)
		80 °C - σ 5,0 MPa	> 1000 h (no faliure)
Resistance to slow crack growth SHT - Strain Hardening Test [1]	ISO 18488	80 °C – 300 µm	< Gp > ≥50 MPa
Resistance to slow crack growth ANPT - Accelerated Noteched Pipe Test [1]	EN ISO 13479	80 °C - 9,2 bar (SDR 11) Water in Nonylphenol ethoxylate	> 300 h (no faliure)
Resistance to slow crack growth CRB - Cracked Round Bar Test [1]	ISO 18489	23 °C – 12,5 MPa - 10 Hz	≥ 1,5 x 10^6 cycles
Resistance to rapid crack propagation - RCP	EN ISO 13477	0 °C	P_C ≥ 1,5 MOP [2]

[1] Tests required in EN 1555-2 and ISO 4437-2 specifically for PE100-RC pipes: Strain Hardening Test (SHT) group size 1 (DN 20-63), Accelerated Notch Pipe Test (ANPT) for group size 2 (DN 75-225) and Cracked Round Bar Test (CRB) for group size 3 (DN 250-630) or 4 (DN 710-800).

[2] P_C = critical RCP pressure MOP = maximum operative pressure

RENOVATION VRC+ GAS pipes are also compliant with the technical specification PAS 1075 (Type 2) which defines additional requirements for the resistance to slow crack growth as described in the table below.

Test	Test method	Parameters	Requirement for raw material	Requirement for pipe
Notch Pipe Test (NPT) [3]	ISO 13479	80 °C - 9,2 bar (SDR 11)	> 8760 h	-
Point Loading Test (PLT) [4]	-	80 °C - sol. 2% Arkopal N-100 - 4 MPa	> 8760 h [3]	> 8760 h [3]
Full Notch Creep Test - FNCT [5]	ISO 16770	80 °C - sol. 2% Arkopal N-100 - 4 MPa	> 8760 h [4]	> 3300 h [5]

[3] Accelerated procedure (PLT+) at 90 °C in 2% NM5 solution with requirement >450 h.
[4] Accelerated procedure (ACT) at 90 °C in 2% NM5 solution with requirement >400 h.
[5] Accelerated procedure (ACT) at 90 °C in 2% NM5 solution with requirement >195 h.

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Design considerations

Gas supply systems are designed to provide a safe and continuous distribution of gas, therefore the design of the pipeline must include both technical aspects and procedures with environmental and safety aspects.

The design of a piping network based on RENOVATION VRC+ GAS should include but not be limited to basic data for the gas supply system to be installed, such as the family of the gas, the anticipated gas flow, the design pressure which is required to be maintained within values that permit correct functioning of pressure regulators and specific user appliances, the layout of the existing gas supply system, the gas velocity in the pipes which should be sufficiently low to limit excessive movement of any impurity and the dynamic variations in gas flow due to special industrial applications.

Maximum operating pressure

The maximum operating pressure (MOP) of a pipeline based on RENOVATION VRC+ GAS shall be selected by the network operator, mainly on the basis of the gas supply system requirements, the pipe SDR series and service conditions, and the overall design coefficient (which also takes into account the national or local regulations), provided it does not exceed 10 bar.

The MOP shall be calculated using the following equation, where:

$$C = \frac{20 \times MRS}{MOP \times (SDR - 1) \times D_F}$$

MRS = minimum required strength = 10 for PE100-RC
C = Service (design) coefficient as specified in ISO 12162, greater than or equal to 2 for pipeline systems for natural gas (higher values for other gases)
D_F = temperature de-rating coefficient

Average operating temperature (°C)	De-rating coefficient (D_F)
20	1,0
30	1,1
40	1,3

The ratio of the critical RCP pressure, P_c, to MOP shall be ≥1,5 at the minimum operating temperature. If case this parameter decreases below 0 °C, the ratio shall be recalculated using a P_c value determined from the minimum expected operating temperature of the pipe.

Laying

Care shall be taken to prevent damage of a piping system based on RENOVATION VRC+ GAS during the whole process of installation. Changes of direction of a pipeline shall be achieved by means of preformed bends or elbow fittings or by the natural flexibility of the pipe (natural flexing can be used for bend radii greater than or equal to 25 x DN).

The minimum clearance between the pipe and obstacles (e.g. utilities, structures or immovable rocks) shall be 200 mm from the pipe surface (a protection barrier shall be installed, if this cannot be observed). Furthermore, special precautions shall be taken in case the gas pipeline is laid alongside or crosses other buried services (e.g. a hot water pipeline, a petrol station or a high-voltage cable).

Excavating and backfilling of the trench shall be in compliance with the procedures authorized by the pipeline operator and the width of the bottom shall be large enough to allow correct installation. Pipes may be laid in the trench without preparation of the bottom, if relatively soft and fine-grained soils free of large and sharp edged stones are present (national and local regulations may be applicable).

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Pipes shall not be overstressed by tensile forces during laying. According to ISO/TS 10839, if RENOVATION VRC+ GAS pipes are laid by drag, care shall be taken that the force is not greater than the values given by the following formulas.

$$F = \frac{\sigma \times \pi \times d_e^2}{SF \times SDR}$$

$$\sigma = \frac{\sigma_y}{1,25}$$

Where:

F = maximum drag force (N)
SDR = standard dimension ratio
d_e = outside pipe diameter (mm)
σ = maximum tensile stress (MPa)
SF = safety factor (a value of 2,0 is normally used)
σ_y = tensile stress at yield (MPa)

The drag force obtained is related on an environmental temperature of 20 °C and can be applied for a relative short time. For higher temperatures derating factors should be applied.

Material around the pipes shall be compacted so as to avoid excessive pipe ovality and shall be done layer by layer. Backfill materials around the pipe shall be selected to prevent damage to the pipe from contact with sharp edges during and after compaction.

Unless otherwise specified, buried pipelines shall have a minimum soil cover of 0,6 m (not necessary for small diameter service pipes). Exceptions may be applied for pipes entering metering or regulating boxes, but such pipes shall be protected against external interference. Higher soil cover shall be provided in case of roads with heavy traffic and with railways or waterway crossings.

Excavated materials may be used as backfill provided they are free from stones and sharp objects likely to damage the pipes (backfill materials may be regulated by national or local regulations).

The base material (PE100-RC) for RENOVATION VRC+ GAS pipes is able to withstand the severe stresses coming from the ground more effectively than established PE100. This range is therefore specifically suitable for alternative installations (sandless bedding or no dig) both for replacement and new laying of pipelines, in compliance with international guidelines.

The enhanced resistance to stress crack increases the reliability and lifetime expectancy of the underground pipes, which might be otherwise affected from scratches, notches and point loadings due to the subsoil.

RENOVATION VRC+ GAS pipes can therefore be used especially for installation without sand embedding and a re-use of the excavated soil in open trenches, for installation using trenchless techniques (e.g. Horizontal Directional Drilling, micro-tunnelling, ploughing, etc.) and for rehabilitation of pipeline systems.

Jointing

Jointing procedures for RENOVATION VRC+ GAS pipes shall be carefully followed to obtain reliable and good quality joints:

A. BUTT FUSION

This technique consists of heating the planed ends of the mating surfaces of two pipes by holding them against a flat heating plate until molten, removing the heating plate, pushing the two softened ends against one another, holding under pressure for a given time and allowing the joint to cool.

Butt fusion joints shall be made under defined conditions of pressure, time and temperature, following the general procedure provided by ISO 21307.

Extreme ambient temperature (e.g. rain fall and wind and significant solar heating of the pipe surface) can adversely affect the fusion process, therefore special precautions shall be taken.

The butt fusion equipment used shall be compliant with ISO 12176-1. Maintenance and calibration shall be carried out on a regular basis and a precise temperature measurement device may be used to check the surface temperature of the heating tools (it is preferable to use a fully-automated butt fusion equipment with retrievable jointing records).

The pressure shall be selected so that the required force is produced at the interface, irrespective of frictional and pressure losses in the butt fusion equipment and drag resistance from the pipe system. The butt fusion temperature is generally between 210 and 230 °C and is defined in technical specifications, e.g. ISO 21307.

B. ELECTROFUSION

The basic principle of this technique consists of heating an electrical coil incorporated in the internal surfaces of the fittings (e.g. couplers, reducers, tees, elbows and saddles) causing the material adjacent to the coil to melt and making the pipe and fitting surfaces fuse.

Care shall be taken to use only electrofusion fittings with design MOP and SDR compatible with the pipes to be joined. The fittings shall be kept in their protective packaging until they are ready to be joined to the pipe and the surfaces to be fused shall be dry and clean before beginning the jointing procedure. With a suitable mechanical tool the outer fusion surface of the pipe shall be scraped for greater than the length of the fusion depth or the contact area of saddles, in order to remove the oxidized material.

Re-rounding and alignment clamps shall be used, if required to minimize pipe ovality and misalignment.

Maintenance and calibration of the control units and generator shall be carried out on a regular basis to achieve high quality fusion joints.

B. MECHANICAL

All mechanical joints (e.g. compression-type couplings, steel-to polyethylene transition fittings, steel stub flanges) shall be resistant to end load as defined in ISO 17885 and the metallic parts of fittings shall be resistant to or protected against corrosion. The joints shall be assembled according to the design pressure of the network and be free of stress.

Testing

Pressure testing (hydraulic or pneumatic methods) shall be performed in compliance with EN 12327, taking into considerations all precautions to protect persons and the environment if air or inert gas is used as the test medium.

Pressurized polyethylene pipes at ambient temperature are subject to expansion by creep which might affect the result of the pressure testing (at higher test pressure, this effect can be substantial).

Hydrostatic testing should be carried out with water, taking care to avoid any possible contamination. The test pressure shall be maintained at the highest point of the test section and be checked by using a suitable pressure gauge (no air should remain at high points).

On reaching the specified test pressure, allowing pressure and temperature to stabilize, the first pressure reading shall be taken. Any loss in pressure shall be compensated by providing additional water (the volume of ‘make up’ water shall be recorded).

The pressure shall then be recorded during testing and noted at the beginning and at the end of the test period and the test section shall be visually inspected for any signs of leakage.

Pneumatic testing shall be carried out with air or inert gas and on reaching the specified test pressure the test section shall be isolated from the pressure source.

Once pressure and temperature are stabilized, the first reading shall be taken and the pressure shall be recorded during testing and the test section visually inspected for any sign of leakage.

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The strength test pressure (STP) selected for a pipeline shall be appropriate to its MOP and shall take into account the following guidance derived from EN 12007-2.

$$1,5 \times MOP \leq STP \leq \frac{20 \times MRS}{SDR - 1}$$

$$MIP < STP \leq 0,9 \times P_c$$

Where:

MIP = maximum incidental pressure which a system can experience during a short time limited by the safety devices

MOP = maximum pressure at which a system can be operated continuously under normal operating conditions

MRS = minimum required strength = 10 MPa for PE100-RC

P_c = critical RCP pressure

Storage, handling and trasport

RENOVATION VRC+ GAS pipes are available both in straight lengths and in coils. They should be stored in order to minimize any potential damage by crushing, piercing, scratching, kinking or flattening. The pipes should be stacked on flat surfaces, free from stones and sharp objects which might damage them and any contact with aggressive chemical products (i.e. liquid hydrocarbons) should be avoided.

When loading, unloading or handling, it is preferable to use forklift trucks to move the packages, without dragging or throwing the pipes on the ground.

When transporting pipes, flatbed vehicles shall be used in which the pipes shall rest uniformly on a surface free from any possible object which might damage the pipes and effectively secured in place.

At low temperature, flexibility is reduced and more care should be taken when handling the pipes. Furthermore, particular care is needed during uncoiling operations to protect the operators against the effects of uncontrolled spring back of the pipe, particularly at low temperature.

According to the specific functional requirements of EN 12007-2, RENOVATION VRC+ GAS pipes shall be inspected before installation and those with surface defects deeper than 10% of the nominal wall thickness shall not be used.

Additional information related to the suitability for hydrogen

RENOVATION VRC+ GAS pipes are fully consistent with the distribution of hydrogen at operating temperatures and pressures within the scope of the reference standards and national regulations, as proved by experience, laboratory investigations and practical tests.

H2ready® GEPRÜFT / TESTED

Polyethylene is classified with satisfactory resistance to hydrogen in ISO/TR 10358 and PPI TR-19.

CEN/TR 17797 provides a guide on how the injection of hydrogen into gas infrastructures can impact processes from the input of gas into the on-shore transmission network up to the inlet connection of gas appliances.

This has led to the position papers of TEPPFA (The European Plastic Pipes and Fittings Association), DVGW (Deutscher Verein des Gas- und Wasserfaches - German Technical and Scientific Association for Gas and Water) and KRV (Fachverband der Kunststoffrohr-Industrie – German Plastics Pipes Association) that polyethylene piping systems can be taken in consideration for use with pure hydrogen or with hydrogen-methane based mixtures.

RENOVATION VRC+ GAS pipes have been tested for hydrogen permeability through specific tests and are certified “H2ready” for the distribution of hydrogen in gas networks.

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Product certifications and environmental product declaration (EPD)

RENOVATION VRC+ GAS pipes are certified according to EN 1555-2 by EN/ISO/IEC 17065 accredited certification bodies. For size ranges covered by certification, full details are available on idrotherm2000.com and in the database of the certification bodies.

An environmental product declaration (EPD) is also available for RENOVATION VRC+ GAS pipes, developed on the basis of ISO 14025 and EN 15804 standards, verified and validated by an independent body and available on the EPD International platform (environdec.com).

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