Ori-Plast®

SUPERIOR STRENGTH SUPERIOR RESISTANCE

HIGH-DENSITY POLYETHYLENE PIPES TECH FOLIO

ORI-PLAST PIPE SYSTEM

POLYETYLENE PIPE

Introduction

Ori – Plast Polyethylene pipes cater to every conceivable applications – from drinking water supply and tube well system to transportation of pulverized solids and dredging to cable deducation – in a wide variety of pipe sizes. Ori – Plast also provides different types of clamps and coupling for repairing and expanding the line.

Benefits / Advantages:

- Non-corrosive & chemically inert.
- Abrasion resistance.
- Favorable mechanical properties including toughness.
- Greater burst strength due to greater flexibility.
- Improved fluid flow area due to smoother inner surface.
- Greater longevity.
- High Reliability and proven service performance.
- High impact strength.
- Great flexibility,light weight,easy and fast installation.
- Excellent water hammer resistance.
- Ideal in shifting soil condition and in earthquake prone areas.
- UV resistant.
- Excellent weld – ability – leak proof joints.
- Wide variety of installation methods.
- Long service life – overall economy.
- Usage – Potable water supply, Hot water supply, Slurry disposal, Irrigation, Telecom and Bore well application.

Pipes

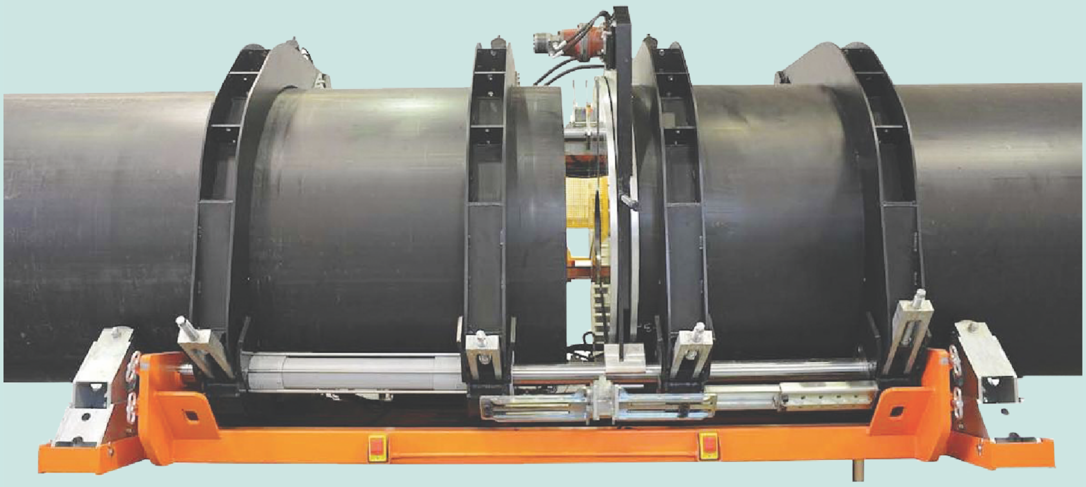
Size Range	-	20mm to 630mm
Pressure Class	-	PN 2 to PN 20
Grades	-	PE63, PE80,PE 100

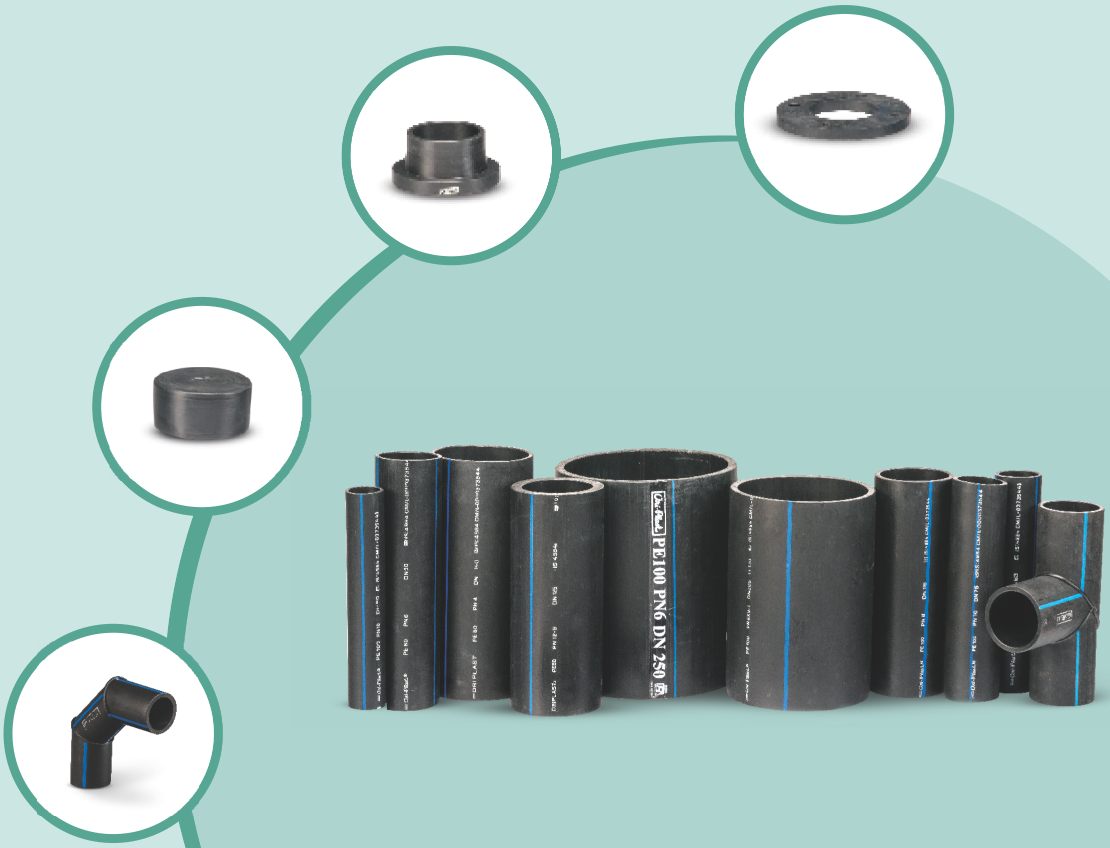
Jointing Techniques

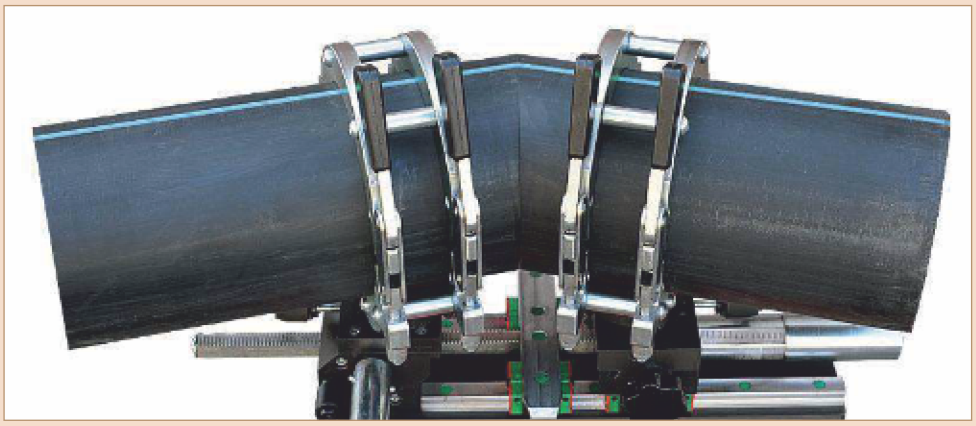
Ori-Plast Polyethylene pipes can be jointed by different means,some of jonting techniques are as given below:

Butt Fusion Welding

During recent years several different methods of welding polyolefins pipes have been developed. In diameter HDPE pipes the most usual is butt welding. The welding procedure involves accurate machine planing of the pipe ends followed by heating to the melting point of the pipe ends, which are then joined together under pressure.The heating time,temperature and pressure are adjusted so that the physical properties of the original material are retained. Both the temperature and the pressure must be carefully checked and adapted to the actual raw material,the pipe diameter and the wall thickness.



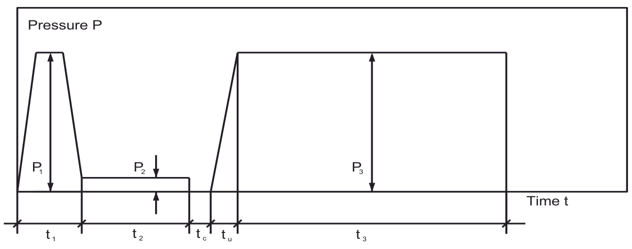




The principle sequences of the welding procedure are graphically illustrated,where the pressure (expressed as compressive stress in the pipe wall) is given as a function of time.The procedure starts when the heating element ("the mirror") has reached its welding temperature,which normally is in the range of 220°C for HDPE, 210°C for MDPE. With the mirror placed between the two pipe ends,first a high pressure (P_1)is applied, the duration of which (t_1) is chosen so that full surface contact is reached between the mirror and the butt-ends of the pipes. Then a very low (almost zero) perssure P_2 is kept constant during the time t_2.This time is a function of the pipe wall thickness and shall be rather long. A common fault is that t_2 is chosen too short,so that the depth of the molten material is insufficient when the welding pressure P_3 is then applied. It is also important that this pressure P_3 is not so high as to force the molten material aside to an extent that cold welding may occur.
The time tc stands for the change-over time during which the pressure is brought to zero,the heating mirror is removed and the pipe ends are pushed together.This time is a very critical one,as then the molten material is freely exposed to the air causing risk of thermal oxidation as well as cooling down of pipe ends. Consequently, it is utmost importance that the time tc is kept as short as possible.

Then starts the build-up time tu of the welding pressure P_3. The pressure build-up shall occur softly and not too abruptly. The welding pressure P_3 is of the same magnitude as P_1 is of the same magnitude as P_1 and shall be kept

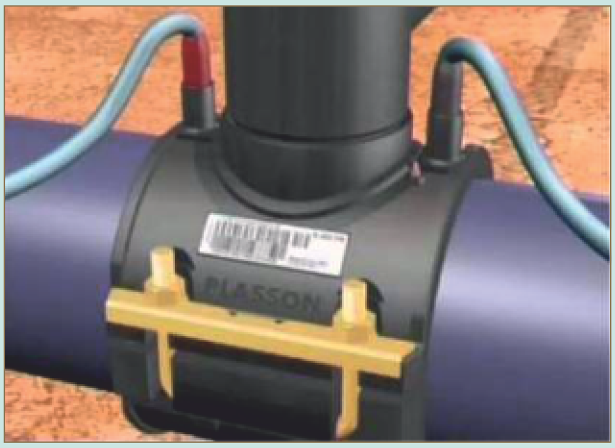
constaant during the cooling tme t_3. It is verified that the duration of cooling time has a significant influence on the quality of the weld. A common mistake is to choose this time too short in the struggle for increasing the pipe joining capacity.

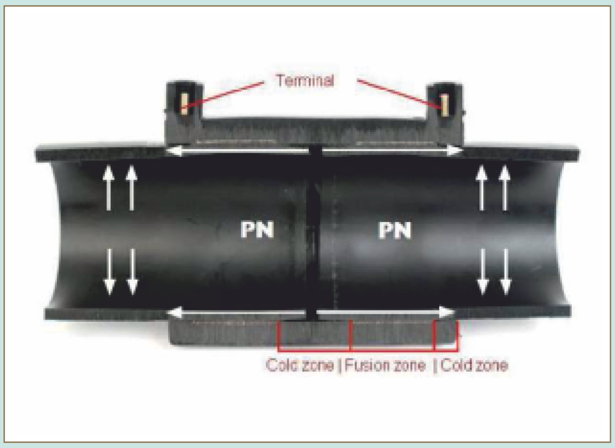


Graphical illustration of the butt welding procedure

Electrofusion Welding

In the 1970 's HDPE and MDPE pipes were widely introduce for low pressure natural gas distribution. The pipes are normally buried in the ground and are recognized as having relatively small diameters from 20 up to 225mm. (Larger electrofusion fittings up to a diameter of 710 mm have recently been developed). In this context faster and safer jointing methods were asked than for those represented by butt welding or common socket fusion.The result was the development of the electrofusion welding technique for jointing pipes and fittings.This technique is today also widely applied for water distribution pipes. Special fittings are used with a heating element (wires) moulded-in close to the surface to be welded.We know principle of the electrofusion coupler jointing.The fitting is basically a double socket coupler with an electrical heating element within the bore.Two connection terminals are externally accessible for application of electrical heating energy to the element.When the two squared and scraped pipes ends are inserted into the coupler and the current is applied via a control box to the terminals the heat generated in the element fuses the two jointing surfaces togather? The fusion time and the power supply are regulated manually or automaticallly at the control box. A wide range of standard fittings,branch saddles,etc.in sizes up to about 250 mm is available within most electrofusion programs.





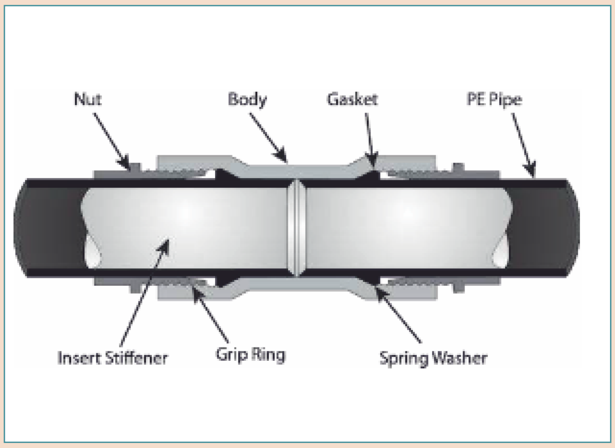
A significant matter which has to be analysed concerns particularly the long-term tensile strength of joint.It should be observed that a regular internal hydrostatic pressure test at 80°C is not sufficient for determining the long term strength of the joint,as such a test will only simulate an axial stress,which is 50% of the actually acting hoop stress. How far the test result is relevent for joints between polyolefins which have different melt flow properties must also be considered.

Extrusion Welding

When manufacturing large diameter fittings,bends,branches,reducers as well as chambers and containers, butt welding can normally not be used for jointing the various parts togather.Previously hot-gas welding was used with welding rods of the same material as basic one.A cheaper and safer method was developed in the early 1970's, called extrusion welding, The welding rod is here replaced by extruded bead which is directly pressed into the weld groove.The sides of the groove are preheated to the welding temperature by means of hot-air heating.It is important that hot air is dry and free from oil.

Compression Joints

It is also detachable joint.The joint is effected by an internal liner and a compression ring or sleeve which shrinks and therefore compresses the pipe wall on to the liner,thus gripping to the wall of the pipe. The liner and compression sleeve may also be an integral unit.



Screwed Joints(Threaded Joints)

These can be used for HDPE pipes with higher pressure ratings which have thick walls. It should be noted that such threading reduces the factor of safety and hence working pressure in the lower classes will have to be assumed for design purposes.Ordinary metal cutting dies of adjustable and guided variety may be used.As far as possible, a full thread should be cut in one operation.It is advisable to plug the end of the pipe during threading operation to avoid distortion due to flexiblity. When threading the pipe,taper threads should be used and only the exact number of threads re-quired for the joint should be cut so that when the joint is made, all the threaded portion of the pipe is totally enclosed in the fitting.
Galvanised iron fittings can be used where there is no risk of corrosion. In conditions, rigid HDPE or other corrosion-resistant material fittings should be used.
Under no circumstances should steel pipe wrenches be used on HDPE pipes or fittings.

Telescopic Joint

Any joint (Socket and spigot type) that permits sliding the free end (spigot end) inside the socket with a rubber or suitable gasket, without any leakage is called telescopic joint.
The socket could be an integral part of the pipe at one end or two ends or a special coupler into which the free ends (Spigot ends) of the pipes are pushed to achieve a water tight joint.
These joints are normally weak in longitudinal pull and hence head anchoring wherever such a tendency of longitudinal pull is likely in the pipe line.

Service Connections

Off take of service connections from larger bore pipes is achieved by using SERVICE SADDLE along with FERRULE.
The SADDLE is made of two clamps (made from plastic or metal strips) with Bolts and Nuts.When fastened on to the pipe, they completly enclose the pipe tightly.One of the clamps has a round hole at which point a threaded socket is incorporated by moulding or welding.

A round hole is made in the main HDPE pipe line at the place where water is required to be tapped. Conventional equipment for tapping under pressure may be used with these service connections using a special trepanning cutter to pierce the pipe wall.The clamps of the SADDLE are fastened on to the pipe loosely in the first instance.A rubber gasket is slipped in between the inner surface of the clamp and outer surface of the pipe all round. A hole equal in size to the hole in the pipe is made in the rubber gasket also.When the hole of the pipe, the rubber gasket and the socketed hole of the clamp are all aligned the bolts of the SADDLE are tightened.The rubber gasket prevents lekage of water sideways.The water from the main pipe now finds an outlet through the socket of the clamp. The FERRULE is screwed on to the Socket.The outlet end of the FERRULE is having Male Threads to which a Threaded Socket Coupling is fitted, and the small size pipe with male threads is screwed on the free end of the socket, thus enabling off-take of water from the main line-establishing service connection.
Some FERRULES have self contained cutters.Ferrules should not be screwed directly into unreinforced pipes without the introduction of a rainforced SADDLE piece.
Moulded SADDLES with built-in sockets of different inside diameter are available.

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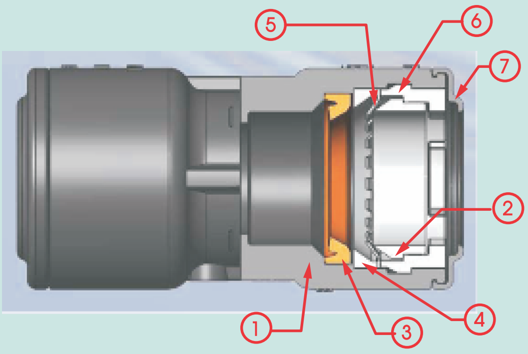
Pushon the pushfit fittings for water pipe

TECHNICAL SPECIFICATION : ISO 14236:2000

Mechanical joint fittings for use with polyethylene pressure pipes in water supply systems, compatible with thermoplastic pipes for water supply application with pipe O.D according to ISO 4427, ISO 161, DIN 8074, DIN 8077

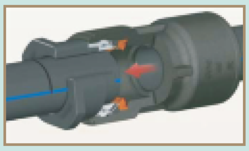
PROPERTIES	TEST METHODS
Maximum Working Pressure	16 Bar (Hydrostatic pressure test)
Resistance to Internal Pressure (25 BAR @ 20°C)	ISO 12092
Leak-tightness under Internal Pressure (18BAR @ 20°C)	ISO 3503
Resistance to Pull-Out	ISO 3501
Leak-tightness under Internal Vacuum	ISO 3459
Long term pressure test for Leak-tightness of assemble joints	ISO 1167



No.	Part Name	Material
1	Fitting Body	PP-R
2	Wedge Ring	POM
3	Lip Seal	EPDM
4	Support Ring	PP
5	Grab Ring	Stainless Steel
6	Backup Sleeve	POM
7	Dust Cover	PP-R

HOW IT WORKS

1. Push the pipe to the end. check the mark on the pipe to ensureit reach to the end stop
2. The grab ring's teeth. grab on the pipe surface firmly. the teeth are in opposite direction of the flow. In case of water hammer or tensile stress the teeth will grip the pipe more firmly to prevent pull out.
3. To uninstall, insert the release key into the hole and press it to fold the teeth and pullout the pipe. In case of large fittings press the key and twist the pipe to pull out
4. Dust cover protects the fitting holes from sediment



JOINTING OF THE PUSHON FITTINGS

DO

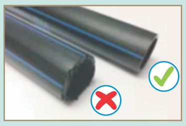
Cut pipe square by the pipe snipper, then chamfer the pipe end with the chamfer tool. A must do

Mark the pipe by measuring at the pipe depth line on the fittings.

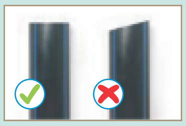
Push the pipe into the fittings until it reaches the mark.

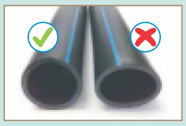
DON'T

Avoid using saws to cut the pipe, pipe snipper is recommended



Deburring,chamfering, sanding to rub out the sharp, bur or scratch is a must





TO UNINSTALL

Take off the Dust Cover.

Snap the release key on the pipe and align the pins with the holes around the backup sleeve.

Cut pipe square

BENEFITS

● Easy connections: PUSHON is heat free without having to solder, crimping, clamps, unions, glues or special tools needed ● Full Flow: PUSHON has compact size without reducing inner bore to allow full flow resulting low working pressure ● Reusable: PUSHON fittings can be easily removed so that they can be used again when required. ● O-ring is made of superior quality synthetic rubber "EPDM" that has high water & weather resistant ● Cost effective: PUSHON save your time, labor and cost ● Outlet thread is patented: The thread of PUSHON have a combination of plastic and bronze to protect leakage (Patent No. US 6186558B1)

IMPORTANT TERMINOLOGY OF HDPE PIPES

- **Long Term Hydrostatic Strength:** It is considered to be the property of the material used for manufacture of pipes which are designed to last a minimum of 50 years or more under stress. It is determined by way of extrapolation (regression analysis) of short term (9000h) behavior of the material obtained by analytical techniques.
- **Minimum Required Strength (MRS):** It is the minimum value for long term hydrostatic strength (LTHS) of the material (for 50 years at 20°c) and is expressed in MPa.

  The value of MRS for different grade of HDPE materials are as follows:

  1. Grade PE 63 - 6.3 MPa
  2. Grade PE 80 - 8.0 MPa
  3. Grade PE 100 - 10.0 MPa

- **Safe Hydrostatic Design Stress (σ):** It is the maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential in nature resulting due to internal hydrostatic water pressure. It is derived by dividing MRS by the coefficient 'C', i.e.

  $$\sigma = MRS / C$$

- **Service Design Coefficient (C):** It is an over all coefficient with a value greater than 1 (one) which takes into consideration of service condition and properties of the components of piping system other than those represented in Lower Confidence Limit.

  Some common reference values for C:

Specification	Purpose	At Temperature	Values
ISO 4427, DIN 8074:1999 etc	For Conveyance of potable water	20° C	1.25
IS 4984 : 1995	For Conveyance of potable water	30° C	1.60
IS 14333 : 1996	For Sewerage disposal	30° C	2.00
IS 14885 : 2001	For Gaseous Fuel conveyance	20° C	2.00

- **Standard Dimension Ratio (SDR):** It is the ratio of outside diameter (D) of the pipe to its minimum wall thickness (t_{min}).
- **Maximum Allowable Operating Pressure (MAOP) or Pressure Ratings (PR):** The highest effective continuous pressure of water in the piping system expressed in "Bar", taking into consideration the physical and mechanical characteristics of the components of the piping system. It is given by the equation

  $$\text{MAOP or PR} = 20 \text{ X } \sigma / (SDR - 1)$$

DETERMINATION OF WALL THICKNESSES FOR BIS SPECIFICATIONS,

(IS 4984 : 2016 AND IS 14333 : 1996)

- **Minimum wall Thickness:** By replacing SDR by D / t_{min} in the above equation, we can calculate the minimum wall thickness of the pipe as follows:

  $$t_{min} = (D \text{ X } PR) / (20 \text{ X } \sigma + PR)$$

  The figures calculated above are to be rounded off to the next higher 0.1mm

- **Maximum wall Thickness:** The maximum wall thickness of HDPE pipes can be determined by the following equation:

  For pipes OD upto 355mm: $t_{max} = 1.1 \text{ x } t_{min} + 0.2\text{mm}$

  For pipes OD above 355mm: $t_{max} = 1.5 \text{ X} t_{min} + 0.2\text{mm}$

  The figures calculated above are to be rounded off to the next higher 0.1m

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PROPERTIES OF HDPE PIPE GRADE RAW MATERIAL (Typical Value)

Properties	Unit	Typical Value	Test Method
Density at 23°C:			
Base Resin Compound	g / cm^3	0.949 0.959	ISO 1183 ISO 1183
Viscosity number	ml/g	380	ISO 1628
Melt Flow Rate At 190 °C/2.16 Kg At 190 °C/5.00 Kg At 190 °C/21.6 Kg	 g/10 min g/10 min g/10 min	 < 0.1 0.25 8	 ISO 1133 ISO 1133 ISO 1133
Carbon black Content	%	2.0 – 2.5	ISO 6964
Carbon black Dispersion	grade	<3	ISO 11420
Tensile:			
Strength Modulus / E-Modulus @ 23°C	Mpa	1100	ASTMD-790
Strength Modulus / E- Modulus @ 43° C	Mpa	704	ASTMD-790
Stress @ Yield	Mpa	25	ISO 527
Strain @ Yield	%	8.5	ISO 527
Strength @ Yield	N/mm^2	25	ISO 527
Elongation @ Yield	%	>350	ISO 527
Strength @ Break	N/mm^2	33	ISO 527
Maximum Elongation	%	>800	ISO 527
Flexural modulus, 2 % Secant	Mpa	1150	ASTMD -790
Tensile Creep Modulus (1 hr)	N/mm^2	850	ISO 899
Tensile Creep Modulus(1000 hr)	N/mm^2	360	ISO 899
Hardness			
Shore D (3 secs)	Shore	60	ISO 868
Shore D (15 secs)	Shore	59	ISO868
Charpy Impact Strength			
UnNotched	KJ/m^2	No Break	ISO 179
Notched			
At 23 °C	KJ/m^2	26	ISO 179
At-30 °C	KJ/m^2	13	ISO 179
At 0°C	KJ/m^2	16	ISO 179
At-20 °C	KJ/m^2	14	ISO 179
Oxidative Induction Time, 200° C	min	>20	ISO 11357
Vicat Softening temperature, VST-A/50	°C	127	ISO 306
MRS	Mpa	10	ISO 9080
Flexural Creep Modulus (4 Point Loading)			
1 Min	Mpa	1100	DIN 19537-2
24 hr	Mpa	560	DIN 19537-2
2000 hr	Mpa	330	DIN 19537-2
Flexural Stress at 3.5 % Deflection	Mpa	20	ISO 178
Heat Deflection Temperature			
At 1.8 Mpa	°C	60	ISO 75
At 0.45 Mpa	°C	85	ISO 75
Resistance to Slow Crack Growth, Notched	Hrs	>2400	ISO 13479
Resistance to Slow Crack Growth, Notched(10% Stabilizer)	Hrs	>10000	ISO 4599

PROPERTIES OF HDPE PIPE GRADE MATERIAL (Typical Value)

Rapid Crack Propagation , S4 @0 °C	Bar	⩾10	ISO 13477
Resistance to Gas Constituents	Hrs	>48	ISO 4437
FNCT,(4.0 Mpa, 2% Arkopal N 100, 80 °C)	Hrs	>1000	ISO 16770
Brittleness Temperature	°C	<-70	
Odour Threshold		<1	BS 6920-1: Clause 4
Resistance to liquid chemicals(Change in mass & tensile properties)[2]	20 °C	60 °C	ISO/TR 10358
Sulfuric Acid Solution	Satisfactory	Satisfactory	
Sodium Hydroxide Solution	Satisfactory	Satisfactory	
Ammonium Hydroxide Solution	Satisfactory	Satisfactory	
Nitric Acid, 25%	Satisfactory	Satisfactory	
Ferric Acid Detergent[3]			
Ferric Chloride, Ferric Nitrate & Ferric Sulphate	Satisfactory	Satisfactory	
Bacteriollogical: Growth of Aquatic Microorganism	@30 °C	Confirm	BS 6920-1:Clause 6
Resistance to internal Pressure with hoop stress			
3.9 Mpa at 80 °C for 165 hrs		Pass	ISO1167
2.8 Mpa at 80 °C for 1000 hrs		Pass	ISO 1167
Long term chemical resistance test for 10000 hrs		Note 4	
Thermal Stability, 210 °C	min	>15	EN728
Thermal Conductivity @ 20 °C	W/m K	0.34	
Linear Expansion Coeff. (20-90)	mm/m °C	<0.2	
Processing Guidelines	°C	200-220	
ESCR	Hrs	>10000	ISO 4599

Notes:

1. These are typical values for HDPE
2. Chemical resistance: This classification is intended to provide general guidelines on the utilization of high density polyethylene, at the mentioned temperatures, in the absence of internal & external mechanical stresses.
3. Ferric Acid is not Known in the free state, but forms definite salts used in detergents.
4. Refer to ISO/TR 10358 for specific chemical resistance.

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STABILITY REQUIREMENTS OF PIPES FOR INTERNAL PRESSURE CREEP RUPTURE TEST

Date evaluated from extensive tests performed in Germany and India show that High Density Polyethylene pipes can stand an internal pressure of 11.0 kg/cm2 over 48 hours at a temperature of 176°F or 80°C. This feature is relevant and pertinent to the characteristics in extreme conditions.

Stability Requirements of Pipes for Internal Creep Rupture Test

(Clause 8.1, 9.1.2 & B - 4.3 of IS 4984 : 1995)

Stability Test Specification	Test Temperature	Duration (Minimum Holding Time)	Induced Stress in MPa		
	° C	Hrs.	PE 63	PE 80	PE 100
Acceptance Test	80	48	3.8	4.9	5.7
Type Test	80	165	3.5	4.6	5.5

In India ambient temperature rarely exceed 115° F or 48°C for a very short period and that too when a metallic pipe is exposed to the sun. When HDPE can stand 11.0kg/cm2 at 176° F or 80°C for 48 hours without showing any leakage, swelling or bursting, it can easily withstand working pressure of 10.5 kgf/cm2 at a temperature of 115° F or 48° C. This factor of safety margin is to be carefully borne in mind when considering the use of HDPE pipes in hot climates.

Even a temperature of 115° F or 48° C will never be reached on the surface of HDPE pipes since these pipes are always supposed to be kept charged with water.

CHEMICAL RESISTANCE OF HIGH DENSITY POLYETHYLENE PIPES AND FITTINGS	
Explanation of Symbols and Abbreviations (for detailed conditions to refer IS 14333 : 1996)	
Symbols	**Explanations**
Description of Fluids/Nature of Chemicals (within bracket in column no. 1)	
KSCA	Known Stress-Crack Agent
SSCA	Suspected Stress-Crack Agent
P	Plasticizer
O	Oxidizers
Subl.	Sublimes
dec.	Decomposes
Characteristics of Chemicals (in column no. 2)	
Diluted Solutions	Dilute aqueous solution at a concentration equal to or less than 10%
Solution	Aqueous solution at concentration higher than 10% but not saturated
Saturated Solution	Saturated aqueous solution prepared at 20° C
Conc.	Concentrated fluid
All conc.	Behaviour of fluid over entire range of concentration
tg	At least technical - grade quality
tg-s	Technical - grade solid
tg-l	Technical grade, liquid
tg - g	Technical grade, gas
Work. Solution	Working Solution of concentration usually used in industry concerned
Susp.	Suspension of solid in a saturated solution at 20° C
The concentration are expressed as a percentage by mass at 20°C, unless otherwise stated	
Classifications at Service Temperatures of (in column no. 3 & 4)	
S	Satisfactory resistance, No indication that the serviceability would be impaired
L	Limited resistance, depending on condition of use
NS	Resistance Not satisfactory, not recommended for service applications under any condition.

CHEMICAL RESISTANCE OF HIGH DENSITY POLYETHYLENE PIPES AND FITTINGS

(References from IS 14333 : 1996, Annex D)			
Chemical	Concentration in %	Classification at Temperature	
		20°C	60°C
Acetaldehyde (KSCA)	40	L	NS
	tg-l	S	L
Acetic Acid (KSCA)	Upto 10	S	S
	10 to 40	S	
	50	S	
	40 to 60	S	L
	80	S	L
Acetic Acid, glacial	>96	S	L
Acetic Anhydride (SSCA)	tg - l	NS	NS
Acetone	tg - l	L	L
Acrylic Emulsion	Working Solution	S	S
Adipic Acid	Sat. Solution	S	S
Air	tg - g	S	S
Allyl Alcohol	tg - l	S	S
Aluminium Chloride	All concentration	S	S
Aluminium Fluoride	Suspension	S	S
Aluminium Hydroxide	Suspension	S	S
Aluminium Nitrate	Saturated Solution	S	S
Aluminium Oxychloride	Suspension	S	S
Aluminium Potassium Sulphate (Alum - all types)	Saturated Solution	S	S
Aluminium Sulphate	All concentration	S	S
Ammonia aqueous	Saturated Solution	S	S
Ammonia, dry gas	tg - g	S	S
Ammonia liquid	tg - g	S	S
Ammonium Carbonate (dec at 58° C)	Saturated Solution	S	S
Ammonium Chloride	Saturated Solution	S	S
Ammonium Fluoride	Up to 20	S	S
	Saturated Solution	S	S
Ammonium Hydrogen Carbonate	Saturated Solution	S	S
Ammonium Hydroxide	10	S	S
	28	S	S
Ammonium Metaphosphate	Saturated Solution	S	S
Ammonium Nitrate	Saturated Solution	S	S
Ammonium Persulphate	Saturated Solution	S	S
Ammonium Sulphate	Saturated Solution	S	S
Ammonium Sulphide	Saturated Solution	S	S
Ammonium Thiocyanate	Saturated Solution	S	S
Amyl Acetate (SSCA/P)	tg - l	NS	NS
Amyl Alcohol (KSCA/P)	tg - l	S	L
Amyl Chloride (P)	tg - l	NS	NS
Aniline (KSCA/P)	tg - l	NS	NS

Antimony (III) Chloride	Sat. Solution	S	S
Apple Juice	Working Solution	S	
Aqua Regia (O)	HCL/HNO3 (3:1)	NS	NS
Aromatic Hydrocarbons (SSCA/P)		NS	NS
Arsenic Acid	All concentration	S	S
Ascorbic Acid	10	S	S
Barium Bromide	Saturated Solution	S	S
Barium Carbonate	Suspension	S	S
Barium Chloride	Saturated Solution	S	S
Barium Hydroxide	Saturated Solution	S	S
Barium Sulphate	Suspension	S	S
Barium Sulphide	Saturated Solution	S	S
Beer	Working Solution	S	S
Benzaldehyde	tg - l	S	L
Benzene (SSCA/P)	tg - l	NS	NS
Benzene Sulfonic acid	Solution	S	S
Benzoic acid	All concentration	S	S
Bismuth Carbonate	Saturated Solution	S	S
Bleach lye	10	S	S
Borax	Sat. Solution	S	S
Boric Acid	All concentration	S	S
Boron Trifluoride	Saturated Solution	S	S
Brine	All concentration	S	S
Bromine, gas	tg - g	NS	NS
Bromine, liquid (O)	tg - l	NS	NS
Butandiol (KSCA)	All concentration	S	S
Butane, gas	tg - g	S	S
Butter (SSCA)		S	S
n-Butyl Acetate (SSCA/P)	tg - l	L	NS
n-Butyl Alcohol (KSCA)	tg - l	S	S
Butyric Acid (P)	tg - l	NS	NS
Calcium Bisulphide	Solution	S	S
Calcium Carbonate	Suspension	S	S
Calcium Chlorate	Saturated Solution	S	S
Calcium Chloride	Saturated Solution	S	S
Calcium Hydroxide	Saturated Solution	S	S
Calcium Hypochlorite (dec. at 10% chlorine)	Solution	S	S
Calcium Nitrate	Saturated Solution	S	S
Calcium Oxide	Suspension	S	S
Calcium Sulphate	Suspension	S	S
Calcium Sulphide	Diluted Solution	L	L
Camphor oil (SSCA/P)	Working Solution		L
Cabon Dioxide, dry gas	tg - g	S	S
Cabon Dioxide, wet gas	tg - g	S	S
Carbon Disulphide	tg - l	NS	NS
Cabon Monoxide, gas	tg - g	S	S

Carbon Tetrachloride	tg - l	L	NS
Carbonic Acid	Working Solution	S	S
Castor Oil (KSCA)	Conc.	S	S
Chlorine, dry gas (O)	tg - g	L	NS
Chlorine, Liquid (O)	tg - g	NS	NS
Chlorine water	Saturated Solution (2%)	S	S
Chloroacetic Acid	Solution	S	S
Chlorobenzene (SSCA/P)	tg - l	NS	NS
Chloroform (SSCA/P)	tg - l	NS	NS
Chloromethane, gas	tg - g		L
Chlorosulphonic Acid	tg - s	NS	NS
Chrome Alum (chromium potassium sulphate)	Solution	S	S
Chromic Acid	20	S	L
	50	S	L
Cider (KSCA)	Working Solution	S	S
Citric Acid (KSCA)	Sat. Solution	S	S
Coconut Oil alcohols (KSCA)	Working Solution	S	S
Coffee	Working Solution	S	S
Cola concentrates (KSCA)	Working Solution	S	S
Copper (II) Chloride	Saturated Solution	S	S
Copper (II) Cyanide	Saturated Solution	S	S
Copper (II) Fluoride	2	S	S
Copper (II) Nitrate	Saturated Solution	S	S
Copper (II) Sulphate	Saturated Solution	S	S
Corn Oil (SSCA)	tg - l	S	S
Cotton Seed Oil (KSCA)	tg - l	S	S
Cresylic Acid	Saturated Solution		L
Cyclohexanol	tg - l	S	S
Cyclohexanone	tg - l	NS	NS
Decalin	tg - l	S	L
Detergent, Synthetic (KSCA)	Working Solution	S	S
Developers (Photographic)	Working Solution	S	S
Dextrin	Solution	S	S
Dextrose (dec. at 200°C)	Solution	S	S
Diazo Salts	Solution	S	S
Dibutylphthalate (SSCA)	tg - l	L	L
Dichlorobenzene(o- & p-) (SSCA/P)	tg - l	NS	NS
Diethylketone (SSCA/P)	tg - l	L	NS
Diethylene Glycol (KSCA)	tg - l	S	S
Diglycolic Acid (KSCA)	Solution	S	S
Dimethylamine	Solution	NS	NS
Dioctyphthalate	tg - l	S	L
Dioxane	tg - l	S	S
Disodium Phosphate		S	S
Emulsions, Photographic (KSCA)		S	S
Ethyl Acetate (SSCA/P)	tg - l	L	NS

Ethyl Alcohol (KSCA)	40	S	L
	100	S	L
Ethyl Benzene (SSCA/P)	tg - l	NS	NS
Ethyl Chloride (P)	Solution	NS	NS
Ethylene Gycol (KSCA)	tg - l	S	S
Ethyl Ether (P)	tg - l	NS	NS
Ferric Chloride	Saturated Solution	S	S
Ferric Nitrate	Saturated Solution	S	S
Ferric Sulphate	Saturated Solution	S	S
Ferrous Chloride	Saturated Solution	S	S
Ferrous Sulphate	Saturated Solution	S	S
Fluoboric Acid	Solution	S	S
Fluorine gas, dry	tg - g	NS	NS
Fluorine gas, wet	tg - g	NS	NS
Fluosilicic Acid	40	S	S
	Concentrated	S	S
Formaldehyde	30 to 40	S	S
Formic Acid	All concentration	S	S
Fructose	Saturated Solution	S	S
Fruit Pulp (SSCA)		S	S
Fuel Oil		L	NS
Furfural (P)	tg - l	NS	NS
Furfuryl Alcohol (SSCA/P)	tg - l	S	L
Gallic Acid	Saturated Solution	S	S
Gas, manufactured	tg - g		S
Gas, Natural Dry	tg - g	S	S
Gas, Natural Wet	tg - g		S
Gasoline (Fuel) (SSCA/P)	Working Solution	L	NS
Gelatine	Solution	S	S
Glucose (dec>200° C)	Solution	S	S
Glycerine (KSCA)	tg - l	S	S
Glycol (KSCA)	tg - l	S	S
Glycolic Acid (KSCA)	30	S	S
Grape Fruit Juice	Working Solution		S
Heptane (SSCA/P)	tg - l	L	NS
Hexachlorobenzene	Solution	S	S
Hexanol (KSCA)	tg - l	S	S
Honey	Working Solution	S	S
Horseradish	Working Solution	S	S
Hydrobromic Acid	All concentration	S	S
Hydrochloric Acid	All concentration	S	S
Hydrocyanic Acid	10	S	S
	Saturated Solution	S	S
Hydrofluoric Acid	upto 10	S	S
	60	S	L
Hydrogen	tg - g	S	S

Hydrogen Peroxide	upto 10	S	S
	30	S	S
	90	S	NS
Hydrogen Sulphide, dry gas	tg - g	S	S
Hydroquinone	Saturated Solution	S	S
Hypochlorous Acid	Conc.	S	S
Inks (KSCA)		S	S
Iodine (O) (in potassium iodide)	Saturated Solution	NS	NS
Iodine, (in alcohol)	Working Solution	NS	NS
Lactic Acid	All concentration	S	S
Lead Acetate	Saturated Solution	S	S
Lead Nitrate		S	S
Magnesium Carbonate	Suspension	S	S
Magnesium Chloride	Saturated Solution	S	S
Magnesium Hydroxide	Saturated Solution	S	S
Magnesium Nitrate	Saturated Solution	S	S
Magnesium Sulphate	Saturated Solution	S	S
Maleic Acid (dec 160° C)	Saturated Solution	S	S
Maleic Acid (Subl.)	Solution	S	S
	Saturated Solution	S	S
Mayonnaise	Working Solution		S
Mercuric Chloride	Saturated Solution	S	S
Mercuric Cyanide	Saturated Solution	S	S
Mercurous Nitrate	Saturated Solution	S	S
Mercury	tg - l	S	S
Methyl Alcohol (KSCA)	tg - l	S	S
Methyl Bromide (SSCA)	tg - l	L	NS
Methylene Chloride (SSCA/P)	tg - l	NS	NS
Methyl Ethyl Ketone	tg - l	NS	NS
Milk	Working Solution	S	S
Mineral Oils	Working Solution	S	NS
Molasses	Working Solution	S	S
Mustard, aqueous	Working Solution		S
Naptha (KSCA/P)		L	NS
Naphthalene (SSCA/P)		NS	NS
Nickel Chloride	Saturated Solution	S	S
Nickel Nitrate	Saturated Solution	S	S
Nickel Sulphate	Saturated Solution	S	S
Nicotinic Acid (KSCA)	Suspension		S
Nitric Acid (O)	5	S	S
	10	S	S
	20	S	S
	25	S	S
	50	L	NS
	>50	NS	NS
Nitric Acid, fuming (with Nitrogen Dioxide)		NS	NS

Nitrobenzene (SSCA/P)	tg - l	NS	NS
n-Octane	tg - l	S	S
Oils & Fats	tg - l	S	l
Oleic acid	tg - l	S	S
Oleum	Conc.	NS	NS
Oxalic Acid (KSCA) (Subl.)	Saturated Solution	S	S
Oxygen, gas	tg - g	S	L
Ozone, gas	tg - g	L	NS
Perchloroethylene (P)	tg - l	NS	NS
Petroleum Ether (SSCR)		NS	NS
Phenol	Solution	S	S
Phosphine	tg - g	S	S
Phosphoric Acid	Up to 50	S	S
Phosphorus (III) Chloride	tg - l	S	S
Photographic Solutions		S	S
Pickling baths			
Sulphuric Acid		S	S
Hydrochloric Acid		S	S
Sulphuric - Nitic		S	NS
Picric Acid (Subl.)	Saturated Solution	S	
Plating Solutions (KSCA)			
Brass		S	S
Cadmium		S	S
Chromium		S	S
Copper		S	S
Gold		S	S
Indium		S	S
Lead		S	S
Nickel		S	S
Rhodium		S	S
Silver		S	S
Tin		S	S
Zinc		S	S
Potassium Bicarbonate	Saturated Solution	S	S
Potassium Bisulphate	Saturated Solution	S	S
Potassium Borate	Saturated Solution	S	S
Potassium Bromate	Saturated Solution	S	S
	Up to 10	S	S
Potassium Bromide	Saturated Solution	S	S
Potassium Carbonate	Saturated Solution	S	S
Potassium Chlorate	Saturated Solution	S	S
Potassium Chloride	Saturated Solution	S	S

Potassium Chromate	Saturated Solution	S	S
	40	S	S
Potassium Cyanide	Solution	S	S
	Saturated Solution	S	S
Potassium Dichromate	Saturated Solution	S	S
Potassium Ferricyanide / Ferrocyanide	40	S	S
	Saturated Solution	S	S
Potassium Fluoride	Saturated Solution	S	S
Potassium Hexacyanoferrate (II) (Potassium Pherocyanide)	Saturated Solution	S	S
Potassium Hydrogen Sulphite	Solution	S	S
Potassium Hydroxide	Conc. Solution	S	S
	10-20	S	S
Potassium Hypochlorite	Solution	S	L
Potassium Nitrate	Saturated Solution	S	S
Potassium Orthophosphote	Saturated Solution	S	S
Potassium Perborate	Saturated Solution	S	S
Potassium Perchlorate	Saturated Solution	S	S
Potassium Permanganate	20	S	S
Potassium Persulphate	Saturated Solution	S	S
Potassium Sulphate	Saturated Solution	S	S
Potassium Sulphide	Saturated Solution	S	S
Potassium Sulphite	Saturated Solution	S	S
Potassium Thiosulphate	Saturated Solution	S	S
Propargyl Alcohol (KSCA)		S	S
Propipnic Acid	50	S	S
	tg - l	S	L
Iso Propyl Alcohol (KSCA)	tg - l	S	S
n-Propyl Alcohol (KSCA)	tg - l	S	S
Propylene Dichloride (SSCA/P)	tg - l	NS	NS
Propylene Gycol (KSCA)	tg - l	NS	NS
Pyridine (SSCA)	tg - l	S	L
Resorcinol	Saturated Solution	S	S
Salicylic Acid (Subl.)	Saturated Solution	S	S
Sea Water		S	S
Selenic Acid	Solution	S	S
Shortening (KSCA)		S	S
Silicic Acid	Solution	S	S
Silver Acetate	Saturated Solution	S	S
Silver Cyanide	Saturated Solution	S	S
Silver nitrate	Saturated Solution	S	S
Soap Solution (KSCA)	All concentration	S	S
Sodium Acetate	Saturated Solution	S	S
Sodium Antimonate	Saturated Solution	S	S
Sodium Arsenite	Saturated Solution	S	S
Sodium Benzoate	Saturated Solution	S	S
Sodium Bicarbonate	Saturated Solution	S	S
Sodium Bisulphate	Saturated Solution	S	S

Sodium Bisulphite	Saturated Solution	S	S
Sodium Borate	Solution	S	S
Sodium Bromide	Saturated Solution	S	S
Sodium Carbonate	Saturated Solution	S	S
	25	S	S
	Up to 50	S	S
Sodium Chlorate	Saturated Solution	S	S
Sodium Chloride	All concentration	S	S
Sodium Chlorite	2		S
Sodium Chromate	Diluted Solution	S	S
Sodium Cyanide	Saturated Solution	S	S
Sodium Dichromate	Saturated Solution	S	S
Sodium Ferricyanide	Saturated Solution	S	S
Sodium Ferrocyanide	Saturated Solution	S	S
Sodium Fluoride	Saturated Solution	S	S
Sodium Hydrogensulphite	Saturated Solution	S	S
Sodium Hydroxide	All concentration	S	S
Sodium Hypochlorite	10 to 15	S	S
Sodium Nitrate	Saturated Solution	S	S
Sodium Nitrite	Saturated Solution	S	S
Sodium Phosphate, acid	Saturated Solution	S	S
Sodium Phosphate, neutral	Saturated Solution	S	S
Sodium Silicate	Solution	S	S
Sodium Sulphate	Sat. Solution	S	S
	0.1	S	S
Sodium Sulphide	Saturated Solution	S	S
Sodium Sulphite	Saturated Solution	S	S
	40	S	S
Stannic Chloride	Saturated Solution	S	S
Stannous Chloride	Saturated Solution	S	S
Starch Solution (KSCA)	Saturated Solution	S	S
Stearic Acid (KSCA)		S	S
Sulphur Dioxide, dry gas		S	S
Sulphur Trioxide	tg - l	NS	NS
Sulphuric Acid (O)	Up to 10	S	S
	10 to 50	S	S
	50 to 75	S	L
	80	S	NS
	98	L	NS
	Fuming	NS	NS
Sulphurous Acid	Up to 30	S	S
Tallow (P)			S
Tannic Acid (KSCA)	Saturated Solution	S	S
Tertaric Acid (dec.)	Solution	S	S
	Saturated Solution	S	S
Tetrahydrofuran (SSCA/P)	tg - l	NS	NS
Thionyl Chloride	tg - l	NS	NS

Tin (II) Chloride	Saturated Solution	S	S
Tin (IV) Chloride	Solution	S	S
Titanium Tetrachloride (SSCA)	tg - l	NS	
Toluene (SSCA/P)	tg - l	NS	NS
Transformer Oil		S	L
Trichloroethylene (SSCA/P)	tg - l	NS	NS
Triethanolamine	Solution	S	L
Triethylene Glycol (SSCA)	tg - l	S	S
Trisodium Phosphate	Saturated Solution	S	S
Turpentine (P)	tg - l	L	L
Urea	0 to 30	S	S
Urine		S	S
Vanilla Extract (KSCA)		S	S
Vinegar	Working Solution	S	S
Water		S	S
Water, brackish		S	S
Water, distilled		S	S
Water, fresh		S	S
Water, mineral	Working Solution	S	S
Water, Potable	Working Solution		S
Water, Sea		S	S
Wetting agents (KSCA)	Working solution	S	S
Whiskey (KSCA)	Working Solution	S	S
Wines (SSCA)	Working Solution	S	S
Wines and Spirits	Working Solution	S	S
Xylenes (P)	tg - l	NS	NS
Yeast	Suspension	S	S
Zinc Bromide	Saturated Solution	S	S
Zinc Carbonate	Suspension	S	S
Zinc Chloride	Saturated Solution	S	S
	58	S	S
Zinc Nitrate	Saturated Solution	S	S
Zinc Oxide	Suspension	S	S
Zinc Stearate	Solution	S	S
Zinc Sulphate	Saturated Solution	S	S

Note: In case of any discripencies, information given in IS 14333:1996 should always be considered auithentic and correct.

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FORMULAS FOR CALCULATION OF HEAD LOSSES IN A WATER PIPELINE

{Reference from "Manual on Water Supply and Treatment (Third Edition - Revised & Updated, May 1999)" by Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, New Delhi}

There are different formulas to calculate the Head Losses in pipeline for conveyance of water and the most commonly used ones are the following:

a) Hazen - Williams's formula

$Q = 1.292 \times 10^{-5} \times C \times d^{2.63} \times S^{0.54}$

Where,

Q = Discharge in m^3/ hour

d = Internal diameter of pipe in mm

s = Slope of hydraulic grade line or Head loss due to friction in m/m

c = Hazen - Williams coefficient (design value for DI/CI/MS pipes is 100, where as same for HDPE/uPVC pipes is 145

b) Modified Hazen - Williams's formula:

$h = (L \times Q^{1.81}) / (994.62 \times D^{4.81} \times C_R^{1.81})$

Where,

L = Length of pipeline in m

Q = Discharge in m^3/ sec

d = Internal diameter of pipe in m

h = Head loss due to frictional in m

C_R = Pipe roughness coefficient, (1 for Smooth pipes, <1 for rough pipes)

Comparison of Frictional losses in flow of water through two pipes of different materials of construction

When the discharges in two pipelines of different material of construction are identical, a comparison of Head Loss due to friction can be made as follows :

$$1.292 \times 10^{-5} \times C_1 \times d_1^{\,2.63} \times S_1^{\,0.54} = 1.292 \times 10^{-5} \times C_2 \times d_2^{\,2.63} \times S_2^{0.54}$$

$$\text{Therefore, } S_1 / S_2 = (C_2/C_1)^{1.852} \times (d_2/d_1)^{4.870}$$

Now for sake of further comparison, if the inside diameters of the two pipes happen to be same i.e.$d_1 = d_2$, then the above formula can be further modified as below:

$$S_1/S_2 = (C_2/C_1)^{1.852}$$

Important formulas for calculation of Head loss for turbulent flow in smooth pipes due to frictional resistance

(Reference IS 2951 (Part-I) - 1965, reaffirmed in 1997)

Reynold's Number (R_e): A dimension less number which determines the type of flow i.e. laminar or turbulent, given by $R_e = Vd / v$, where V is the velocity, D is the diameter and v is the kinematic viscosity at any given temperature

Friction factor (f) for Smooth Pipes in Turbulent Flow: For Reynold's number between 3,000 and 1,00,000 $f = 0.316/R_e^{0.25}$, Where as for values higher than 1,00,000 $1/f^{0.5} = 2.0\log_{10} R_e f^{0.5} - 0.8$

Formula for Calculating Frictional Resistance: $h_f = f\,(L/D) \times (V^2/ 2g)$

Where,

h_f = head loss due to friction in 'm' of liquid

f = friction factor

L = length of pipe in 'm'

D = average internal diameter of the pipe in 'm'

V = average velocity in 'm/s' and

G = acceleration due to gravity in m/sec^2

CASE STUDIES OF COMPARISON OF HEAD LOSSES BETWEEN HDPE AND DUCTILE IRON PIPES (CETRIFUGALLY CEMENT MORTAR LINED)

Refering to equation given in previous page i.e $S_1 / S_2 = (C_2 / C_1)^{1.852} \times (D_2 / D_1)^{5.241}$

HDPE pipes, as per BIS as well as various international standards e.g. ISO, DIN etc, are manufactured on outer diameter basis. Hence selecting pipes on the basis of nominal size will not be correct. HDPE pipes having inside diameter close to that of DI pipes should be selected for the purpose. In terms of nominal size it will be either one or two size higher. The Head Loss due to Friction will reduce drastically. It is imperative to mention that the advantages of HDPE pipes over DI and other metallic pipes are always to be considered in totality and not on the cost of pipes alone.

CASE 1	**BETWEEN 200mm X K7 DI PIPES vs 225mm X PE 100 X PN 6 HDPE PIPES**	
C_1	Design Value of Hazen - Williams coefficient for HDPE Pipe*	145
C_2	Design Value of Hazen - Williams coefficient for DI Pipe *	140
D_1	Inside Diameter of 225mm X PE 100 X PN 6 HDPE Pipe in mm	203
D_2	Inside Diameter of 200mm x K7 DI pipe in mm	200
S_1	Head Loss due to Friction in HDPE Pipes	
S_2	Head Loss due to Friction in DI Pipes	
	Therefore, S_1/S_2	0.87
	or $S_1 = 0.87 \times S_2$	
CASE 2	**BETWEEN 200mm X K7 DI PIPES vs 250mm X PE 100 X PN 8 HDPE PIPES**	
C_1	Design Value of Hazen - Williams coefficient for HDPE Pipe*	145
C_2	Design Value of Hazen - Williams coefficient for DI Pipe*	140
D_1	Inside Diameter of 250mm X PE 100 X PN 8 HDPE Pipe in mm	218.2
D_2	Inside Diameter of 200mm X K7 DI Pipe in mm	200
S_1	Head Loss due to Friction in HDPE Pipes	
S_2	Head Loss due to Friction in DI Pipes	
	Therefore, S_1/ S_2	0.59
	or $S_1 = 0.59 \times S_2$	
CASE 3	**BETWEEN 200mm X K7 DI PIPES vs 250mm X PE 100 X PN 10 HDPE PIPES**	
C_1	Design Value of Hazen - Williams coefficient for HDPE Pipe*	145
C_2	Design Value of Hazen - Williams coefficient for DI Pipe*	140
D_1	Inside Diameter of 225mm X PE 100 X PN 10 HDPE Pipe in mm	211
D_2	Inside Diameter of 200mm X K7 DI Pipe in mm	200
S_1	Head Loss due to Friction in HDPE Pipes	
S_2	Head Loss due to Friction in DI Pipes	
	Therefore, S_1/S_2	0.71
	Or $S_1 = 0.71 \times S_2$	

*Reference Manual on Water Supply and Treatment (3rd. Edition, May 1999) of Central Public Health and Environmental Engineering Organisation, MOUD, Govt. of India, New Delhi

SURGE PRESSURE OR WATER HAMMER IN HDPE PIPELINE

When a fluid flowing through a pipeline is suddenly brought to rest by closing off the valve or due to failure of electric supply in case of motor driven pump set, there is an abrupt rise in pressure due to the dissipation of Kinetic Energy of the fluid. This energy is transmitted as a wave along the length of the pipeline. The pressure wave and the accompanying pulsations create noise known as knocking. The sudden rise in pressure has the effect of a hammering action on the pipe wall. Hence this phenomenon is known as Water Hammer.

The excess pressure due to water hammer is in addition to the normal hydrostatic pressure in the pipeline and the actual magnitude of the rise in pressure depends upon the speed at which the valve is closed, the length of the pipeline and the elasticity of the pipe material. Thus while designing a pipeline it must be ensured that the sum of the maximum operating pressure and the calculated surge pressure should not exceed the maximum test pressure which in the case of HDPE and other thermoplastic pipe material is 1.5 times their Pressure Ratings or Maximum Allowable Working Pressure.

FORMULAS FOR CALCULATION OF SURGE (MAXIMUM WATER HAMMER) PRESSURE AND WAVE VELOCITY IN PIPELINE

$$H_{max} = (C \times D)_v / g$$

Where,

H_{max}	= Surge or Maximum Pressure due to Water Hammer in 'm'
C	= Pressure Wave Velocity in m / sec
g	= Acceleration due to Gravity in m / sec /sec
D_v	= Change of Velocity or Normal Velocity in Pipeline, before sudden change in m / sec

$$C = 1425 / \{1 + (k/E) \times (SDR - 2)\}^{0.5}$$

Where,

		Pipe Material	Unit	Values
k	Bulk Modulus of Water		kg / m^2	2.07×10^8
E	Modulus of Elasticity of pipe material	HDPE	kg / m^2	9.0×10^7
SDR	= Standard Dimension Ratio or Dimension Ratio (DR)			

WAVE VELOCITY AND SURGE PRESSURE FOR PIPES FOR CHANGE OF VELOCITY OF 1.0M / SEC

For HDPE pipes as per SDR Series (e.g. ISO 4427 / DIN 8074) & Dimension Ratio Matching as per Indian standards

Standard Dimension Ratio (SDR)	51	41	33	26	22	21	17.6	17	13.6	11	9	7.4	6	5
Wave Velocity in m/sec	133.6	149.6	167.6	190.1	207.9	213.1	234.6	239.2	270.9	305.9	344.6	389.0	446.2	507.0
Surge Pressure $H_{max\ 1.0m/sec}$ for a change of velocity of 1.0m / sec	13.6	15.3	17.1	19.4	21.2	21.7	23.9	24.4	27.6	31.2	35.1	39.7	45.5	51.7

DETERMINING OF SURGE PRESSURE FOR ANY OTHER CHANGE OF VELOCITY

H_{max} for any other change velocity = Actual Change of Velocity X $H_{max\ 1.0m/sec}$

For example, for a change of velocity of 1.5m / sec in case of a flow through HDPE pipes of SDR 21, the H_{max} will be equal to 1.5 X 21.7 m or 32.6m

SOME IMPORTANT PARAMETERS FOR TRANSPORTATION OF SLURRY THROUGH HDPE PIPES

Turbulent Flow: One of the most important parameters of flow of slurry through HDPE pipes is Turbulent Flow, having a Reynold's number greater than 4000. In case of turbulent flow, particles which remain in suspension in the slurry mixture, bounce off the inside surface of the HDPE pipe due to its elastic properties. This phenomenon along with the toughness of the material due to high molecular weight provides a service life that significantly exceeds the life of many metal piping materials. In case the flow is not turbulent i.e. the flow velocity is too low, the particles will drift towards the bottom of the pipe and slide along the surface resulting in direct abrasion and HDPE being a softer material will corrode significantly.

Particle Size: Liquid slurry is essentially a mixture of solid particles which are commonly granular materials e.g. sand, fly ash, coal dust etc in a carrier liquid, mainly water. Hence the size of the particle plays an important role while designing a pipeline for slurry transportation. When the particle size is around 15 microns or less the slurry viscosity increases above that of the carrying liquid. Where as, in case of larger particles, the viscosity of the slurry mixture will be approximately that of the carrier liquid itself. Hence it is important to calculate the specific gravity, the viscosity and ultimately the kinetic viscosity of the slurry prior to design of the pipeline.

Critical / Critical Settlement Velocity (Vc): It is the minimum velocity to be maintained for turbulent flow of the slurry and is expressed by the formula

- $V_c = F_L \{0.002gd (S_s - 1)\}$, where symbols other than the one explained above
- V_c = Critical Settlement Velocity in m/sec
- F_L = Velocity Coefficient (values of which depends on percentage of solid concentration and can be provided on request)
- g = acceleration due to gravity in m/sec^2
- d = Inside diameter of the pipe, in mm
- S_s = Specific Gravity of the solid

However, maintaining the flow velocity of the slurry at about 30% above the critical settlement velocity is preferred. This will ensure that the particle will remain in suspension and avoid excessive pipeline wear. An approximate minimum velocity for fine particle (below 50 microns / 0.05mm in diameter) slurry is 1.22m/sec (4.0ft/sec) to 2.14m/sec (7.0ft/sec), provided turbulent flow is maintained.

The minimum velocity (Vmin) in m/sec for larger particle (over 150 microns/0.15 mm in diameter) slurry may be calculated by $V_{min} = 0.245 (d)^{0.5}$.

Elevation Head (H_E): In case the pipeline is laid against gravity, the elevation head loss is increased by the specific gravity of the slurry mixture i.e. $H_E = S_M$ X actual head difference between pumping point and discharge point.

Calculation of Life Expectancy: The Creep Strength (i.e. the circumferential stress) of HDPE pipes at 30° C and 20,000 hrs level, which is generally considered as the designed life period, is 8.5 N/mm^2 or 8.5 mpa or 85.0 kg/cm^2.

When a pipe is subjected to an internal pressure (P), the Circumferential Stress (σ) developed in the pipe wall is given by the following formula

- $\sigma = P \times (d-s) / 2s$, where,
- d = Outside Diameter, in mm
- s = Average Wall Thickness, in mm

While carrying slurry through HDPE pipes, it has been experimentally (by stimulated wear test) established that the average abrasion that takes place per hour amount is 0.5 μm (micro millimeter) or 5.0×10^{-4}mm With the increasing abrasion i.e. decreasing wall thickness, the circumferential stress increases. Thus, if s' or (s-0.5μm xT) is the wall thickness after running the system for 'T' hours, the increased circumferential stress (σ)can beobtainedby σ' = P (d-s') / 2s'

The Factor of Safety, when the Creep Strength at 30 °C and at 20,000hrs level is divided by the increased circumferential stress (σ'), it should not be less than 1.3 which is the minimum acceptable value.

COMPARISON OFDURABILITY UNDER ABRASIVE CONDITION OF M.S & HDPE PIPES

7% V/V Sand & Water				14% V/V Sand & Water			
Bend Radius in cm	M.S (Hours)	HDPE (Hours)	HDPE to M.S Life Ratio	Bend Radius in cm	M.S (Hours)	HDPE (Hours)	HDPE to M.S Life Ratio
100	1,600	6,700	4.19	100	1,000	4,150	4.15
200	2,100	7,800	3.17	200	1,400	4,900	3.50
400	3,600	15,000	4.33	400	2,600	10,350	3.98

Standards and Application PE Pipe

Application	Applicable Standard
Gaseous Fuels	IS:14885, ISO: 4437
Hot & cold water supply	ISO 22391 (Part-1)
Potable water, house connections	IS:4984, ISO : 4427 and DIN 8074/75
Rural and agricultural	IS : 14151 (Part - 1)
Water supply	IS 4984
Irrigation	IS : 14151 (Part - 1 & 2)
Drip irrigation	IS 13488
Coal handling in Mines	IS 4984
Industrial applications	IS 4984
PLB Ducts	TEC specification G/CDS-08/02, Nov. 2004.

Fields of Application

In view of the various advantages mentioned earlier and because 'ORI-PLAST' High Density Polyethylene pipes are inert to chemicals,non-toxic and does not impart any taste or smell,its applications are innumerable.

1. Water Supply System

(a) Water mains
(b) Distribution
(c) Service pipes
(d) Slurry Disposal

2. Drainage Pipe System

(a) Surface and rain water
(b) Waste water mains
(c) Sub-soil water

3. Sewage Pipe System
(a) Domestic
(b) Sanitary
(c) Industrial corrosive effluents disposal
(d) Internal sewers
(e) Main sewers

4. Irrigation Pipe System
(a) Fields
(b) Tea plantations
(sprinkler irrigation system)
(c) Liquid fertilizers

5. Sprinkler System-as replacement for Aluminium pipes :
(a) Lawns
(b) Golf Course
(c) Gardens
(d) Orchards
(e) Nurseries

6. Transportation of products in milk and food processsing industries.

7. Oil and Petroleum

(a) Oil main

(b) Crude oil flow pipes

(c) Petroleum gas pipes

(d) Refinery process pipes

8. PLB Ducting :

(a) Telecommunication

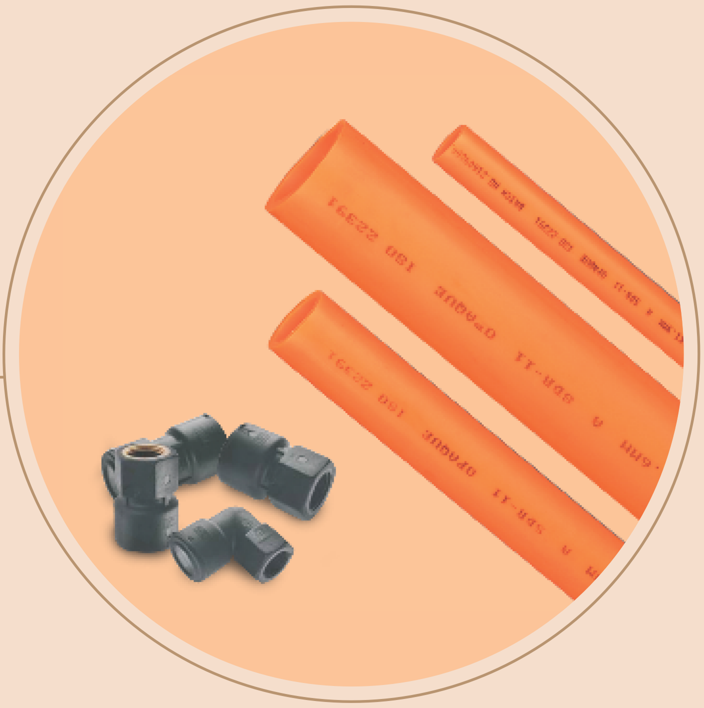
9. PE-RT Piping

(a) Plumber hot water application

(b) Solar heater piping systems

(c) Industrial hot water application

(d) Air Conditioning systems



Ori-Plast®

DIMENSIONS OF HDPE PIPES AS PER IS : 4984 : 2016

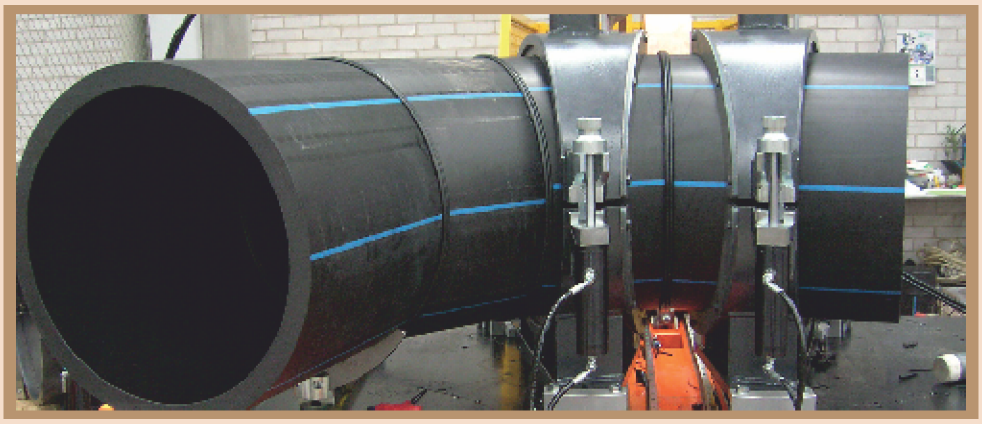
				Pipe Series																			
Grade Of Material				SDR 41		SDR 33		SDR 26		SDR 21		SDR 17		SDR 13.6		SDR 11		SDR 9		SDR 7.4		SDR 6	
				NOMINAL PRESSURE (PN) Bar																			
PE 63				PN 2		PN 2.5		PN 3.2		PN 4		PN 5		PN 6		PN 8		-		-		-	
PE 80				PN 2.5		PN 3.2		PN 4		PN 5		PN 6		PN 8		PN 10		PN 12.5		PN 16		PN 20	
PE 100				PN 3		PN 4		PN 5		PN 6		PN 8		PN 10		PN 12.5		PN 16		PN 20		-	
Size	OD (mm)		Ovality	W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)	
	MIN	MAX	MIN	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
16	16.0	16.3	1.2															1.8	2.1	2.2	2.5	2.7	3.1
20	20.0	20.3	1.2													1.9	2.2	2.3	2.6	2.7	3.1	3.4	3.8
25	25.0	25.3	1.2											1.9	2.2	2.3	2.6	2.8	3.2	3.4	3.8	4.2	4.7
32	32.0	32.3	1.3									1.9	2.2	2.4	2.7	2.9	3.3	3.6	4.1	4.4	4.9	5.4	6.0
40	40.0	40.4	1.4							1.9	2.2	2.4	2.7	3.0	3.4	3.7	4.2	4.5	5.1	5.4	6.0	6.7	7.5
50	50.0	50.4	1.4					2.0	2.3	2.4	2.7	3.0	3.4	3.7	4.2	4.6	5.2	5.6	6.3	6.8	7.6	8.4	9.3
63	63.0	63.4	1.5					2.5	2.9	3.0	3.4	3.7	4.2	4.7	5.3	5.8	6.5	7.0	7.8	8.6	9.6	10.5	11.7
75	75.0	75.5	1.6	1.9	2.2	2.3	2.6	2.9	3.3	3.6	4.1	4.5	5.1	5.6	6.3	6.9	7.7	8.4	9.3	10.2	11.3	12.5	13.9
90	90.0	90.6	1.8	2.2	2.5	2.8	3.2	3.5	4.0	4.3	4.8	5.3	5.9	6.7	7.5	8.2	9.1	10.0	11.1	12.2	13.5	15.0	16.6
110	110.0	110.7	2.2	2.7	3.1	3.4	3.8	4.3	4.8	5.3	6.0	6.5	7.3	8.1	9.0	10.0	11.1	12.3	13.6	14.9	16.5	18.4	20.3
125	125.0	125.8	2.5	3.1	3.5	3.8	4.3	4.8	5.4	6.0	6.7	7.4	8.2	9.2	10.2	11.4	12.7	13.9	15.4	16.9	18.7	20.9	23.1
140	140.0	140.9	2.8	3.5	4.0	4.3	4.8	5.4	6.0	6.7	7.5	8.3	9.2	10.3	11.4	12.8	14.2	15.6	17.3	19.0	21.0	23.4	25.8
160	160.0	161.0	3.2	3.9	4.4	4.9	5.5	6.2	6.9	7.7	8.6	9.5	10.6	11.8	13.1	14.6	16.2	17.8	19.7	21.7	24.0	26.7	29.5
180	180.0	181.1	3.6	4.4	4.9	5.5	6.2	7.0	7.8	8.6	9.6	10.6	11.8	13.3	14.7	16.4	18.1	20.0	22.1	24.4	26.9	30.0	33.1
200	200.0	201.2	4.0	4.9	5.5	6.1	6.8	7.7	8.6	9.6	10.7	11.8	13.1	14.7	16.3	18.2	20.1	22.3	24.6	27.1	29.9	33.4	36.8
225	225.0	226.4	4.5	5.5	6.2	6.9	7.7	8.7	9.7	10.8	12.0	13.3	14.7	16.6	18.4	20.5	22.7	25.0	27.6	30.5	33.7	37.5	41.4
250	250.0	251.5	5.0	6.1	6.8	7.6	8.5	9.7	10.8	12.0	13.3	14.7	16.3	18.4	20.3	22.8	25.2	27.8	30.7	33.8	37.3	41.7	46.0
280	280.0	281.7	9.8	6.9	7.7	8.5	9.5	10.8	12.0	13.4	14.8	16.5	18.3	20.6	22.8	25.5	28.2	31.2	34.4	37.9	41.8	46.7	51.5
315	315.0	316.9	11.1	7.7	8.6	9.6	10.7	12.2	13.5	15.0	16.6	18.6	20.6	23.2	25.6	28.7	31.7	35.0	38.6	42.6	47.0	52.5	57.9
355	355.0	357.2	12.5	8.7	9.7	10.8	12.0	13.7	15.2	16.9	18.7	20.9	23.1	26.1	28.8	32.3	35.6	39.5	43.6	48.0	52.9	59.2	65.2
400	400.0	402.4	14.0	9.8	10.9	12.2	13.5	15.4	17.0	19.1	21.1	23.6	26.1	29.5	32.6	36.4	40.1	44.5	49.1	54.1	59.6	66.7	73.5
450	450.0	452.7	15.6	11.0	12.2	13.7	15.2	17.3	19.1	21.5	23.8	26.5	29.3	33.1	36.5	40.9	45.1	50.0	55.1	60.9	67.1	75.0	82.6
500	500.0	503.0	17.5	12.2	13.5	15.2	16.8	19.3	21.3	23.9	26.4	29.5	32.6	36.8	40.6	45.5	50.2	55.6	61.3	67.6	74.5	83.4	91.8
560	560.0	563.4	19.6	13.7	15.2	17.0	18.8	21.6	23.9	26.7	29.5	33.0	36.4	41.2	45.4	50.9	56.1	62.3	68.6	75.7	83.4	93.4	102.8
630	630.0	633.8	22.1	15.4	17.0	19.1	21.1	24.3	26.8	30.0	33.1	37.1	40.9	46.4	51.1	57.3	63.1	70.0	77.1	85.2	93.8	105.0	115.6
710	710.0	716.4	...	17.3	19.1	21.6	23.9	27.3	30.1	33.9	37.4	41.8	46.1	52.2	57.5	64.6	71.2	78.9	86.9	96.0	105.7	118.4	130.3
800	800.0	807.2	...	19.5	21.6	24.3	26.8	30.8	34.0	38.1	42.0	47.1	51.9	58.9	64.9	72.8	80.2	88.9	97.9	108.2	119.1		
900	900.0	908.1	...	22.0	24.3	27.3	30.1	34.7	38.3	42.9	47.3	53.0	58.4	66.2	72.9	81.9	90.2	100.0	110.1	121.7	134.0		
1000	1000.0	1009.0	...	24.4	26.9	30.3	33.4	38.5	42.5	47.7	52.6	58.9	64.9	73.6	81.1	90.9	100.1	111.2	122.4				
1200	1200.0	1210.8		29.3	32.3	36.4	40.1	46.2	50.9	57.2	63.0	70.6	77.8	88.3	97.2	109.1	120.1						
1400	1400.0	1412.6		34.1	37.6	42.5	46.9	53.9	59.4	66.7	73.5	82.4	90.7	103.0	113.4								
1600	1600.0	1614.4		39.0	43.0	48.5	53.5	61.6	67.9	76.2	83.9	94.2	103.7	117.7	129.6								
1800	1800.0	1816.2		43.9	48.4	54.6	60.2	69.3	76.3	85.8	94.5	105.9	116.6										
2000	2000.0	2018.0		48.8	53.8	60.6	66.8	77.0	84.8	95.3	104.9	117.7	129.6										

Ori-Plast®

DIMENSIONS OF HDPE PIPES AS PER IS 14333:1996
FOR PE 63 GRADE OF MATERIAL

All Dimensions Are in "mm"

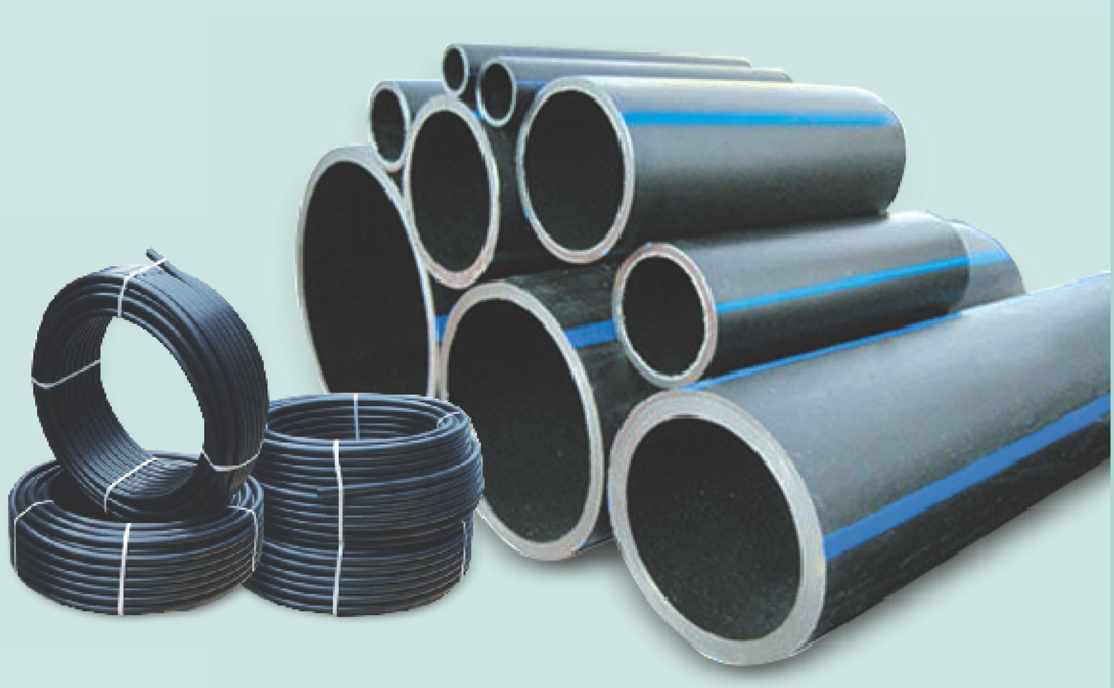
Naminal Diameter	Outside Diameter		WALL THICKNESS														
			PN 2.5		PN 4		PN 6		PN 8		PN 10		PN 12.5		PN 16	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
63	63.0	63.6			4.0	4.6	5.8	6.6	7.5	8.5	9.0	10.1	10.9	12.2	13.3	14.9
75	75.0	75.7	3.0	3.5	4.7	5.4	6.9	7.8	8.9	10.0	10.8	12.1	13.0	14.5	15.8	17.6
90	90.0	90.9	3.6	4.2	5.7	6.5	8.2	9.3	10.6	11.9	12.9	14.4	15.6	17.4	19.0	21.1
110	110.0	111.0	4.4	5.1	6.9	7.8	10.0	11.2	13.0	14.5	15.8	17.6	19.0	21.1	23.2	25.8
125	125.0	126.2	5.0	5.7	7.9	8.9	11.4	12.8	14.8	16.5	17.9	19.9	21.6	24.0	26.4	29.3
140	140.0	141.3	5.6	6.4	8.8	9.9	12.8	14.3	16.5	18.4	20.0	22.2	24.2	26.9	29.5	32.7
160	160.0	161.5	6.4	7.3	10.0	11.2	14.6	16.3	18.9	21.0	22.9	25.4	27.6	30.6	33.7	37.3
180	180.0	181.7	7.2	8.2	11.3	12.7	16.4	18.3	21.2	23.6	25.8	28.6	31.1	34.5	37.9	41.9
200	200.0	201.8	8.0	9.0	12.5	14.0	18.2	20.3	23.6	26.2	28.6	31.7	34.5	38.2	42.2	46.7
225	225.0	227.1	9.0	10.1	14.1	15.8	20.5	22.8	26.5	29.4	32.2	35.7	38.8	42.9	47.4	52.4
250	250.0	252.3	10.0	11.2	15.7	17.5	22.8	25.3	29.5	32.7	35.8	39.6	43.2	47.8	52.7	58.2
280	280.0	282.6	11.2	12.6	17.5	19.5	25.5	28.3	33.0	36.5	40.0	44.2	48.3	53.4		
315	315.0	317.9	12.6	14.1	19.7	21.9	28.7	31.8	37.1	41.1	45.0	49.7	54.4	60.1		
355	355.0	358.2	14.2	15.9	22.2	24.7	32.3	35.8	41.8	46.2	50.8	56.1				
400	400.0	403.6	16.0	18.6	25.0	29.0	36.4	42.1	47.1	54.4	57.0	66.0				
450	450.0	454.1	18.0	20.9	28.2	32.7	41.0	47.4	53.0	61.2						
500	500.0	504.5	20.0	23.2	31.3	36.2	45.5	52.6								
560	560.0	565.0	22.4	26.0	35.0	40.5	51.0	58.9								
630	630.0	635.7	25.2	29.2	39.4	45.6	57.3	66.1								



DIMENSIONS OF HDPE PIPES AS PER IS 14333:1996 FOR PE 80 GRADE OF MATERIAL

All Dimensions Are in "mm"

Naminal Diameter	Outside Diameter		WALL THICKNESS													
			PN 2.5		PN 4		PN 6		PN 8		PN 10		PN 12.5		PN 16	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
63	63.0	63.6			3.0	3.5	4.4	5.1	5.8	6.6	7.0	7.9	8.6	9.7	10.5	11.8
75	75.0	75.7	2.3	2.8	3.6	4.2	5.3	6.1	6.9	7.8	8.4	9.5	10.2	11.5	12.5	14.0
90	90.0	90.9	2.8	3.3	4.3	5.0	6.3	7.2	8.2	9.3	10.0	11.2	12.2	13.7	15.0	16.7
110	110.0	111.0	3.4	4.0	5.3	6.1	7.7	8.7	10.0	11.2	12.3	13.8	14.9	16.6	18.4	20.5
125	125.0	126.2	3.8	4.4	6.0	6.8	8.8	9.9	11.4	12.8	13.9	15.5	16.9	18.8	20.9	23.2
140	140.0	141.3	4.3	5.0	6.7	7.6	9.8	11.0	12.8	14.3	15.6	17.4	19.0	21.1	23.4	26.0
160	160.0	161.5	4.9	5.6	7.7	8.7	11.2	12.6	14.6	16.3	17.8	19.8	21.7	24.1	26.7	29.6
180	180.0	181.7	5.5	6.3	8.6	9.7	12.6	14.1	16.4	18.3	20.0	22.2	24.4	27.1	30.0	33.2
200	200.0	201.8	6.1	7.0	9.6	10.8	14.0	15.6	18.2	20.3	22.3	24.8	27.1	30.1	33.4	37.0
225	225.0	227.1	6.9	7.8	10.8	12.1	15.7	17.5	20.5	22.8	25.0	27.7	30.5	33.8	37.5	41.5
250	250.0	252.3	7.6	8.6	12.0	13.4	17.5	19.5	22.8	25.3	27.8	30.8	33.8	37.4	41.7	46.1
280	280.0	282.6	8.5	9.6	13.4	15.0	19.6	21.8	25.5	28.3	31.2	34.6	37.9	41.9	46.7	51.6
315	315.0	317.9	9.6	10.8	15.0	16.7	22.0	24.4	28.7	31.8	35.0	38.7	42.9	47.1	52.5	58.0
355	355.0	358.2	10.8	12.1	17.0	18.9	24.8	27.5	32.3	35.8	39.5	43.7	48.0	53.0	59.2	65.4
400	400.0	403.6	12.2	14.3	19.1	22.2	28.0	32.4	36.4	42.1	44.5	51.4	54.1	62.5		
450	450.0	454.1	13.7	16.0	21.5	25.0	31.4	36.4	41.0	47.4	50.0	57.7				
500	500.0	504.5	15.2	17.7	23.9	27.7	34.9	40.4	45.5	52.6	55.6	64.2				
560	560.0	565.0	17.0	19.8	26.7	31.0	39.1	45.2	51.0	58.9						
630	630.0	635.7	19.1	22.2	30.0	34.7	44.0	50.8	57.3	66.1						

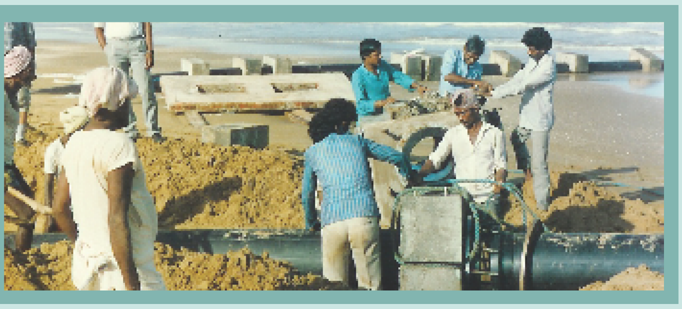


DIMENSIONS OF HDPE PIPES AS PER IS 14333:1996 FOR PE 100 GRADE OF MATERIAL

All Dimensions Are in "mm"												
Naminal Diameter	Outside Diameter		WALL THICKNESS									
			PN 6		PN 8		PN 10		PN 12.5		PN 16	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
63	63.0	63.6	3.6	4.2	4.7	5.4	5.8	6.6	7.0	7.9	8.7	9.8
75	75.0	75.7	4.3	5.0	5.6	6.4	6.9	7.8	8.4	9.5	10.4	11.7
90	90.0	90.9	5.1	5.9	6.7	7.6	8.2	9.3	10.0	11.2	12.5	14.0
110	110.0	111.0	6.3	7.2	8.2	9.3	10.0	11.2	12.3	13.8	15.2	17.0
125	125.0	126.2	7.1	8.1	9.3	10.5	11.4	12.8	13.9	15.5	17.3	19.3
140	140.0	141.3	8.0	9.0	10.4	11.7	12.8	14.3	15.6	17.4	19.4	21.6
160	160.0	161.5	9.1	10.3	11.9	13.3	14.6	16.3	17.8	19.8	22.1	24.6
180	180.0	181.7	10.2	11.5	13.4	15.0	16.4	18.3	20.0	22.2	24.9	27.6
200	200.0	201.8	11.4	12.8	14.9	16.6	18.2	20.3	22.3	24.8	27.6	30.6
225	225.0	227.1	12.8	14.3	16.7	18.6	20.5	22.8	25.0	27.7	31.1	34.5
250	250.0	252.3	14.2	15.9	18.6	20.7	22.8	25.3	27.8	30.8	34.5	38.2
280	280.0	282.6	15.9	17.7	20.8	23.1	25.2	28.3	31.2	34.6	38.7	42.8
315	315.0	317.9	17.9	19.9	23.4	26.0	28.7	31.8	35.0	38.7	43.5	48.1
355	355.0	358.2	20.1	22.4	26.3	29.2	32.3	35.8	39.5	43.7	49.0	54.1
400	400.0	403.6	22.7	26.4	29.7	34.4	36.4	42.1	44.5	51.4	55.2	63.7
450	450.0	454.1	25.5	29.6	33.4	38.7	41.0	47.4	50.0	57.7		
500	500.0	504.5	28.4	32.9	37.1	42.9	45.5	52.6	55.6	64.2		
560	560.0	565.0	31.7	36.7	41.5	48.0	51.0	58.9				
630	630.0	635.7	35.7	41.3	46.7	54.0	57.3	66.1				

DIMENSIONS OF POLYETHYLENENE PIPES FOR GASEOUS FUELS AS PER IS 14885:2001

All Dimensions Are in "mm"											
Naminal Outside Diameter	Mean Outside Diameter		WALL THICKNESS								
			SDR 17.6		SDR 13.6		SDR 11.0		SDR 9.0		
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
16	16.0	16.3	2.3	2.7	2.3	2.7	3.0	3.4	3.0	3.4
20	20.0	20.3	2.3	2.7	2.3	2.7	3.0	3.4	3.0	3.4
25	25.0	25.3	2.3	2.7	2.3	2.7	3.0	3.4	3.0	3.4
32	32.0	32.3	2.3	2.7	2.3	2.7	3.0	3.4	3.6	4.1
40	40.0	40.4	2.3	2.7	3.0	3.4	3.7	4.2	4.5	5.1
50	50.0	50.5	2.9	3.3	3.7	4.2	4.6	5.2	5.6	6.3
63	63.0	63.6	3.6	4.1	4.7	5.3	5.8	6.5	7.1	8.0
75	75.0	75.7	4.3	4.9	5.5	6.2	6.8	7.6	8.4	9.4
90	90.0	90.8	5.2	5.9	6.6	7.4	8.2	9.2	10.1	11.3
110	110.0	111.0	6.3	7.1	8.1	9.1	10.0	11.1	12.3	13.7
125	125.0	126.1	7.1	8.0	9.2	10.3	11.4	12.7	14.0	15.5
140	140.0	141.3	8.0	8.9	10.3	11.5	12.7	14.1	15.7	17.4
160	160.0	161.4	9.1	10.2	11.8	13.1	14.6	16.2	17.9	19.8
180	180.0	181.6	10.3	11.5	13.3	14.8	16.4	18.2	20.1	22.3
200	200.0	201.8	11.4	12.7	14.7	16.3	18.2	20.2	22.4	24.8
225	225.0	227.0	12.8	14.2	16.6	18.4	20.5	22.7	25.1	27.8
250	250.0	252.3	14.2	15.8	18.4	20.4	22.7	25.1	27.9	30.8
280	280.0	282.5	16.0	17.7	20.6	22.8	25.4	28.1	31.3	34.6
315	315.0	317.8	17.9	19.8	23.2	25.7	28.6	31.6	35.2	38.9
355	355.0	358.2	20.2	22.4	26.1	28.9	32.3	35.7	39.7	43.8
400	400.0	403.6	22.8	25.2	29.4	32.5	36.4	40.2	44.7	49.3
450	450.0	454.1	25.6	28.3	33.1	36.6	41.0	45.2	50.3	55.5
500	500.0	504.5	28.5	31.5	36.8	40.6	45.5	50.2	55.8	61.5
560	560.0	565.0	31.9	35.2	41.2	45.5	51.0	56.2		
630	630.0	635.7	35.8	39.5	46.3	51.1	57.3	63.2		



DIMENSIONS OF HDPE PIPES AS PER IS 14151 (Part-1) : 1994

All Dimensions Are in "mm"

Naminal Diameter	Outside Diameter		WALL THICKNESS							
			Class 1 0.25 MPa		Class 2 0.32 MPa		Class 3 0.40 MPa		Class 4 0.60 MPa	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
40	40.0	40.4							2.3	2.8
50	50.0	50.5					2.0	2.4	2.9	3.4
63	63.0	63.6			2.0	2.4	2.5	2.9	3.8	4.4
75	75.0	75.7	2.0	2.4	2.5	2.9	3.0	3.4	4.5	5.2
90	90.0	90.8	2.2	2.6	2.9	3.4	3.5	4.1	5.3	6.1
110	110.0	111.0	2.7	3.2	3.4	3.9	4.2	4.8	6.5	7.4
125	125.0	126.2	3.1	3.6	3.8	4.5	4.8	5.5	7.4	8.3
140	140.0	141.3	3.5	4.1	4.3	5.0	5.4	6.1	8.3	9.3
160	160.0	161.5	3.9	4.5	4.9	5.6	6.2	7.0	9.4	10.6
180	180.0	181.7	4.4	5.0	5.5	6.3	6.9	7.8	10.6	11.9
200	200.0	201.8	4.9	5.6	6.1	7.0	7.7	8.7	11.8	13.2

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DIMENSIONS OF HDPE PIPES AS PER ISO: 4427:2007

Grade of Material				Pipe Series																			
				SDR 6		SDR 7.4		SDR 9		SDR 11		SDR 13.6		SDR 17		SDR 21		SDR 26		SDR 33		SDR 41	
				S 2.5		S 3.2		S 4		S 5		S 6.3		S 8		S 10		S 12.5		S 16		S 20	
				NOMINAL PRESSURE (PN) bar																			
PE 40				-		PN 10		PN 8		-		PN 5		PN 4		PN 3.2		PN 2.5		-		-	
PE 63				-		-		-		PN 10		PN 8		-		PN 5		PN 4		PN 3.2		PN 2.5	
PE 80				PN 25		PN 20		PN 16		PN 12.5		PN 10		PN 8		PN 6 d		PN 5		PN 4		PN 3.2	
PE 100				-		PN 25		PN 20		PN 16		PN 12.5		PN 10		PN 8		PN 6 c		PN 5		PN 4	
Size	OD (mm)		Ovality	W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)	
	MIN	MAX	MM	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
16	16.0	16.3	1.2	3.0	3.4	2.3	2.7	2.0	2.3	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20	20.0	20.3	1.2	3.4	3.9	3.0	3.4	2.3	2.7	2.0	2.3	...	...	...	...	...	...	...	...	...	...	...	...
25	25.0	25.3	1.2	4.2	4.8	3.5	4.0	3.0	3.4	2.3	2.7	2.0	2.3	...	...	...	...	...	...	...	...	...	...
32	32.0	32.3	1.3	5.4	6.1	4.4	5.0	3.6	4.1	3.0	3.4	2.4	2.8	2.0	2.3	...	...	...	...	...	...	...	...
40	40.0	40.4	1.4	6.7	7.5	5.5	6.2	4.5	5.1	3.7	4.2	3.0	3.5	2.4	2.8	2.0	2.3	...	...	...	...	...	...
50	50.0	50.4	1.4	8.3	9.3	6.9	7.7	5.6	6.3	4.6	5.2	3.7	4.2	3.0	3.4	2.4	2.8	2.0	2.3	...	...	...	...
63	63.0	63.4	1.5	10.5	11.7	8.6	9.6	7.1	8.0	5.8	6.5	4.7	5.3	3.8	4.3	3.0	3.4	2.5	2.9	...	...	...	...
75	75.0	75.5	1.6	12.5	13.9	10.3	11.5	8.4	9.4	6.8	7.6	5.6	6.3	4.5	5.1	3.6	4.1	2.9	3.3	...	...	...	...
90	90.0	90.6	1.8	15.0	16.7	12.3	13.7	10.1	11.3	8.2	9.2	6.7	7.5	5.4	6.1	4.3	4.9	3.5	4.0	...	...	...	...
110	110.0	110.7	2.2	18.3	20.3	15.1	16.8	12.3	13.7	10.0	11.1	8.1	9.1	6.6	7.4	5.3	6.0	4.2	4.8	...	...	...	...
125	125.0	125.8	2.5	20.8	23.0	17.1	19.0	14.0	15.6	11.4	12.7	9.2	10.3	7.4	8.3	6.0	6.7	4.8	5.4	...	...	...	...
140	140.0	140.9	2.8	23.3	25.8	19.2	21.3	15.7	17.4	12.7	14.1	10.3	11.5	8.3	9.3	6.7	7.5	5.4	6.1	...	...	...	...
160	160.0	161.0	3.2	26.6	29.4	21.9	24.2	17.9	19.8	14.6	16.2	11.8	13.1	9.5	10.6	7.7	8.6	6.2	7.0	...	...	...	...
180	180.0	181.1	3.6	29.9	33.0	24.6	27.2	20.1	22.3	16.4	18.2	13.3	14.8	10.7	11.9	8.6	9.6	6.9	7.7	...	...	...	...
200	200.0	201.2	4.0	33.2	36.7	27.4	30.3	22.4	24.8	18.2	20.2	14.7	16.3	11.9	13.2	9.6	10.7	7.7	8.6	...	...	...	...

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Size	OD (mm)		Ovality	W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)		W/T(MM)	
	MIN	MAX	MM	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
225.0	226.4	4.5	37.4	41.3	30.8	34.0	25.2	27.9	20.5	22.7	16.6	18.4	13.4	14.9	10.8	12	8.6	9.6	...	...	...	...	225
250.0	251.5	5.0	41.5	45.8	34.2	37.8	27.9	30.8	22.7	25.1	18.4	20.4	14.8	16.4	11.9	13.2	9.6	10.7	...	...	...	...	250
280.0	281.7	9.8	46.5	51.3	38.3	42.3	31.3	34.6	25.4	28.1	20.6	22.8	16.6	18.4	13.4	14.9	10.7	11.9	...	...	...	...	280
315.0	316.9	11.1	52.3	57.7	43.1	47.6	35.2	38.9	28.6	31.6	23.2	25.7	18.7	20.7	15	16.6	12.1	13.5	9.7	10.8	7.7	8.6	315
355.0	357.2	12.5	59.0	65.0	48.5	53.5	39.7	43.8	32.2	35.6	26.1	28.9	21.1	23.4	16.9	18.7	13.6	15.1	10.9	12.1	8.7	9.7	355
400.0	402.4	14.0	...		54.7	60.3	44.7	49.3	36.3	40.1	29.4	32.5	23.7	26.2	19.1	21.2	15.3	17.0	12.3	13.7	9.8	10.9	400
450.0	452.7	15.6	...		61.5	67.8	50.3	55.5	40.9	45.1	33.1	36.6	26.7	29.5	21.5	23.8	17.2	19.1	13.8	15.3	11.0	12.2	450
500.0	503.0	17.5	...				55.8	61.5	45.4	50.1	36.8	40.6	29.7	32.8	23.9	26.4	19.1	21.2	15.3	17	12.3	13.7	500
560.0	563.4	19.6	...				62.5	68.9	50.8	56.0	41.2	45.5	33.2	36.7	26.7	29.5	21.4	23.7	17.2	19.1	13.7	15.2	560
630.0	633.8	22.1	...				70.3	77.5	57.2	63.1	46.3	51.1	37.4	41.3	30	33.1	24.1	26.7	19.3	21.4	15.4	17.1	630
710.0	716.4	...	...				79.3	87.4	64.5	71.1	52.2	57.6	42.1	46.5	33.9	37.4	27.2	30.1	21.8	24.1	17.4	19.3	710
800.0	807.2	...	...				89.3	98.4	72.6	80.0	58.8	64.8	47.4	52.3	38.1	42.1	30.6	33.8	24.5	27.1	19.6	21.7	800
900.0	908.1	...	...				...	...	81.7	90.0	66.2	73	53.3	58.8	42.9	47.3	34.4	38.3	27.6	30.5	22.0	24.3	900
1000.0	1009.0	...	...				...	...	90.2	99.4	72.5	79.9	59.3	65.4	47.7	52.6	38.2	42.2	30.6	33.5	24.5	27.1	1000
1200.0	1210.8	...	...				...	...	...	...	88.2	97.2	67.9	74.8	57.2	63.1	45.9	50.6	36.7	40.5	29.4	32.5	1200
1400.0	1412.6	...	...				...	...	...	...	102.9	113.3	82.4	90.8	66.7	73.5	53.5	59.0	42.9	47.3	34.3	37.9	1400
1600.0	1614.4	...	...				...	...	...	...	117.6	129.5	94.1	103.7	76.2	84.0	61.5	67.5	49.0	54.0	39.2	43.3	1600
1800.0	1816.2	...	...				...	...	...	...	...	...	105.9	116.6	85.7	94.4	69.1	76.2	54.5	60.1	43.8	48.3	1800
2000.0	2018.0	...	...				...	...	...	...	...	...	117.6	129.5	95.2	104.9	76.9	84.7	60.6	66.8	48.8	53.8	2000

DIMENSIONAL CHART OF POLYETHYLENE PIPES AS PER DIN 8074:1999

All Dimensions Are in "mm"																														
Naminal Diameter	Outside Diameter		Wall Thickness of Pipes for Pipe Series / Standard Dimension Ratio of																											
			PIPE SERIES																											
			25		20		16		12.5		10.5		10		8.3		8		6.3		5		4		3.2		2.5		2	
			STANDARD DIMENSION RATIO (SDR)																											
			51		41		33		26		22		21		17.6		17		13.6		11		9		7.4		6		5	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
10	10.0	10.3																									1.8	2.2	2.0	2.4
12	12.0	12.3																							1.8	2.2	2.0	2.4	2.4	2.9
16	16.0	16.3																					1.8	2.2	2.2	2.7	2.7	3.2	3.3	3.9
20	20.0	20.3																	1.8	2.2	1.9	2.3	2.3	2.8	2.8	3.3	3.4	4.0	4.1	4.8
25	25.0	25.3															1.8	2.2	1.9	2.3	2.3	2.8	2.8	3.3	3.5	4.1	4.2	4.9	5.1	5.9
32	32.0	32.3													1.8	2.2	1.9	2.3	2.4	2.9	2.9	3.4	3.6	4.2	4.4	5.1	5.4	6.2	6.5	7.7
40	40.0	40.4							1.8	2.2	1.9	2.3	1.9	2.3	2.3	2.8	2.4	2.9	3.0	3.5	3.7	4.3	4.5	5.2	5.5	6.3	6.7	7.6	8.1	9.2
50	50.0	50.5					1.8	2.2	2.0	2.4	2.3	2.8	2.4	2.9	2.9	3.4	3.0	3.5	3.7	4.3	4.6	5.3	5.6	6.4	6.9	7.8	8.3	9.4	10.1	11.4
63	63.0	63.6			1.8	2.2	2.0	2.4	2.5	3.0	2.9	3.4	3.0	3.5	3.6	4.2	3.8	4.4	4.7	5.4	5.8	6.6	7.1	8.1	8.6	9.7	10.5	11.8	12.7	14.2
75	75.0	75.7	1.8	2.2	1.9	2.3	2.3	2.8	2.9	3.4	3.5	4.1	3.6	4.2	4.3	5.0	4.5	5.2	5.6	6.4	6.8	7.7	8.4	9.5	10.3	11.6	12.5	14.0	15.1	16.9
90	90.0	90.9	1.8	2.2	2.2	2.7	2.8	3.3	3.5	4.1	4.1	4.8	4.3	5.0	5.1	5.9	5.4	6.2	6.7	7.6	8.2	9.3	10.1	11.4	12.3	13.8	15.0	16.7	18.1	20.2
110	110.0	111.0	2.2	2.7	2.7	3.2	3.4	4.0	4.2	4.9	5.0	5.7	5.3	6.1	6.3	7.2	6.6	7.5	8.1	9.2	10.0	11.2	12.3	13.8	15.1	16.9	18.3	20.4	22.1	24.6

Ori-Plast®

125	125.0	126.2	2.5	3.0	3.1	3.7	3.9	4.5	4.8	5.5	5.7	6.5	6.0	6.8	7.1	8.1	7.4	8.4	9.2	10.4	11.4	12.8	14.0	15.6	17.1	19.1	20.8	23.1	25.1	27.9
140	140.0	141.3	2.8	3.3	3.5	4.1	4.3	5.0	5.4	6.2	6.4	7.3	6.7	7.6	8.0	9.0	8.3	9.4	10.3	11.6	12.7	14.2	15.7	17.5	19.2	21.4	23.3	25.9	28.1	31.2
160	160.0	161.5	3.2	3.8	4.0	4.6	4.9	5.6	6.2	7.1	7.3	8.3	7.7	8.7	9.1	10.3	9.5	10.7	11.8	13.2	14.6	16.3	17.9	19.9	21.9	24.3	26.6	29.5	32.1	35.6
180	180.0	181.7	3.6	4.2	4.4	5.1	5.5	6.3	6.9	7.8	8.2	9.3	8.6	9.7	10.2	11.5	10.7	12.0	13.3	14.9	16.4	18.3	20.1	22.4	24.6	27.3	29.9	33.1	36.1	40.0
200	200.0	201.8	3.9	4.5	4.9	5.6	6.2	7.1	7.7	8.7	9.1	10.3	9.6	10.8	11.4	12.8	11.9	13.3	14.7	16.4	18.2	20.3	22.4	24.9	27.4	30.4	33.2	36.8	40.1	44.4
225	225.0	227.1	4.4	5.1	5.5	6.3	6.9	7.8	8.6	9.7	10.3	11.6	10.8	12.1	12.8	14.3	13.4	15.0	16.6	18.5	20.5	22.8	25.2	28.0	30.8	34.1	37.4	41.4	45.1	49.9
250	250.0	252.3	4.9	5.6	6.2	7.1	7.7	8.7	9.6	10.8	11.4	12.8	11.9	13.3	14.2	15.9	14.8	16.5	18.4	20.5	22.7	25.2	27.9	30.9	34.2	37.9	41.6	46.0	50.1	55.4
280	280.0	282.6	5.5	6.3	6.9	7.8	8.6	9.7	10.7	12.0	12.8	14.3	13.4	15.0	15.9	17.7	16.6	18.5	20.6	22.9	25.4	28.2	31.3	34.7	38.3	42.4	46.5	51.4	56.2	62.1
315	315.0	317.9	6.2	7.1	7.7	8.7	9.7	10.9	12.1	13.6	14.4	16.1	15.0	16.7	17.9	19.9	18.7	20.8	23.2	25.8	28.6	31.7	35.2	39.0	43.1	47.7	52.3	57.8	63.2	69.8
355	355.0	358.2	7.0	7.9	8.7	9.8	10.9	12.2	13.6	15.2	16.2	18.1	16.9	18.8	20.1	22.4	21.1	23.5	26.1	29.0	32.2	35.7	39.7	43.9	48.5	53.6	59.0	65.1		
400	400.0	403.6	7.9	8.9	9.8	11.0	12.3	13.8	15.3	17.1	18.2	20.3	19.1	21.3	22.7	25.2	23.7	26.3	29.4	32.6	36.3	40.2	44.7	49.4	54.7	60.4	66.5	73.4		
450	450.0	453.8	8.8	9.9	11.0	12.3	13.8	15.4	17.2	19.2	20.5	22.8	21.5	23.9	25.5	28.3	26.7	29.6	33.1	36.7	40.9	45.2	50.3	55.6	61.5	67.9				
500	500.0	504.0	9.8	11.0	12.3	13.8	15.3	17.1	19.1	21.3	22.8	25.3	23.9	26.5	26.4	31.5	29.7	32.9	36.8	40.7	45.4	50.2	55.8	61.6	68.3	75.4				
560	560.0	564.3	11.0	12.3	13.7	15.3	17.2	19.2	21.4	23.8	25.5	28.3	26.7	29.6	31.7	35.1	33.2	36.8	41.2	45.6	50.8	56.2	62.5	69.0						
630	630.0	634.6	12.3	13.8	15.4	17.2	19.3	21.5	24.1	26.8	28.7	31.8	30.0	33.2	35.7	39.5	37.4	41.4	46.3	51.2	57.2	63.0								
710	710.0	714.9	13.9	15.5	17.4	19.4	21.8	24.2	27.2	30.2	32.3	35.8	33.9	37.5	40.2	44.5	42.1	46.6	52.2	57.7	71.2									
800	800.0	805.0	15.7	17.5	19.6	21.8	24.5	27.2	30.6	33.9	36.4	40.3	38.1	42.2	45.3	50.1	47.4	52.4	58.8	64.9										
900	900.0	905.0	17.6	19.6	22.0	24.4	27.6	30.6	34.4	38.1	41.0	45.3	42.9	47.4	51.0	56.4	53.3	58.9	66.1	73.0										
1000	1000.0	1005.0	19.6	21.8	24.5	27.2	30.6	33.9	38.2	42.3	45.5	50.3	47.7	52.7	56.7	62.6	59.3	65.5												
1200	1200.0	1206.0	23.5	26.1	29.4	32.6	36.7	40.6	45.9	50.7	54.6	60.3	57.2	63.2	68.0	75.0														
1400	1400.0	1406.0	27.4	30.4	34.4	38.1	42.9	47.4	53.5	59.1	63.7	70.3	66.7	73.6																
1600	1600.0	1606.0	31.3	34.7	39.2	43.4	49.0	54.1	61.2	67.6																				

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