POLYETHYLENE PIPES & FITTINGS

TetraPlast Pipe Industries (Pvt.) Ltd.

INTRODUCTION

Developments in technology have also provided plastics raw materials production with important improvements. Low density polyethylene (PE 32-LDPE), developed in early 1950's, was first used in drinking water pipes. Later on, application of raw material PE 63, being improved, was successfully applied in systems that do not require high pressure. However, because of the technical properties of the material, PE 63 could only be used in natural gas systems that require low pressure (maximum 4 bars). PE producers presented PE 80 raw material for use as 2nd generation after PE 63. Thus, PE 80 raw material had also started being used in drinking water and natural gas systems with high performance. 3rd generation PE 100 raw material, developed in early 1990's, has brought both high performance and economical solution to usage area in water, drinking water and natural gas systems.

The first drinking water applications with HDPE pipes has started in 1960's in USA and Canada, and the projects that had been done then, are still in service without problems.

1 st generation raw materials; PE 32 (LDPE), PE 40 (LDPE), PE63 (HDPE)
2nd generation raw materials; PE80 (MDPE), PE 80 (HDPE)
3rd generation raw materials; PE 100 (HDPE)

Tetraplast manufactures PE 100 pipes between diameters 020 - 400 mm, PE 80 natural gas pipes between diameters 020 - 0315 mm.

The pipes are produced in coils up to 90 mm diameter and the diameters above 90 mm in 12 m length, apart from this, production upon request is available.

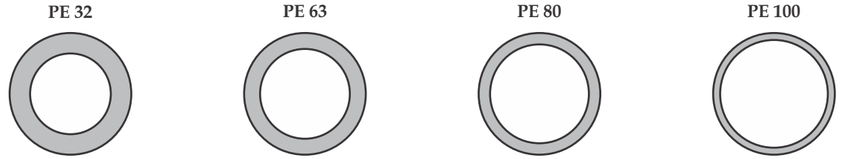
Advantages of Polyethylene Pipes

- Have high flexibility. This facilitates assembly. Breaking extension is minimum 600%.
- They are not affected by underground movements, do not have breaking property.
- Their stroke endurance and rupture crease resistance are high.
- Provide important advantages with planning in diameter selection with their low interior roughness.
- Appropriate for underwater installation, are not affected by sea water and sea movements.
- Do not have assembling loss, for assembling methods.
- Work without problem in nominal operating pressure for minimum 50 years.
- Resistant to UV radiation.
- Are not affected by harmful materials, which are in structure of soil and cause corrosion effect. Therefore there is no need for cathodic protection.
- Resistant against chemical materials.
- Do not change the odour and taste of water, therefore suitable for health...
- It is impossible for plant and tree roots to enter in the pipes.

CLASIFICATION OF POLYETHYLENE MATERIALS

As the density of the PE materials increase, the mechanical resistance values also increase. Because of being produced of different raw materials, the decrease in the wall thickness of a pipe can be seen in the illustration below.

In case a pipe with an external diameter of 110 mm and operating pressure of 10 bar is produced of PE 32, PE 63, PE 80 and PE 100 raw materials, the wall thicknesses and weights are to be due to following data.



s : 18.3 mm
m: 5.09 kg/m

s : 10 mm
m: 3.14 kg/m

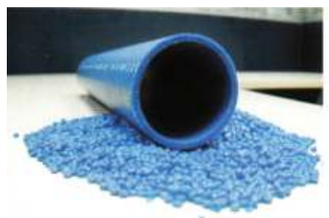
s : 8.1 mm
m: 2.62 kg/m

s : 6.6 mm
m: 2.17 kg/m

s: Wall thickness, m: meter weight

PROPERTIES OF RAW MATERIALS

Polymer Data	Unit	Test Method	PE 32	PE 63	PE 80	PE 80	PE 100
Color			Black/Blue	Black/Blue	Yellow	Black	Black/Blue
Density	g / cm³	ISO 1183	0.910-0.925	>0.940	>0.930	>0.950	>0.950
	g/ 10 dk.	ISO 1133		0.3 - 0.55	0.8 - 1.3	0.4 - 0.7	0.3 - 0.7
Mechanical Properties							
Yield Stress	Mpa	ISO527	>12	>21	>15	>20	>23
Yield Elongation	%	ISO 527	>%350	>%500	>%500	>%500	>%600
Elasticity Module	MPa	ISO 527	500	600	700	700	1000
Other Properties							
Oxidation Start Time	Minute	ISO 10837	>20	>20	>20	>20	>20
Carbon Black Amount	%	ISO 6964	2.5 0.5	2.5 0.5		2.5 0.5	2.5 0.5
Carbon Black Distribution	Note	ISO 11420	max3	max3		max3	max3



FIELDS OF APPLICATION

	PE 32 LDPE	PE 63 HDPE	PE 80 MDPE	PE 80 HDPE	PE 100 HDPE
Drinking Water Pipelines		✓	✓	✓	✓
Pressurized Irrigation Pipelines	✓	✓	✓	✓	✓
Main System Connection Applications		✓	✓	✓	✓
Gas Lines			✓	✓	✓
Refinery Establishment Pipeline			✓	✓	✓
Drinking Water Purification Installation			✓	✓	✓
Swimming Pool Pipeline			✓	✓	✓
Pressurized Air Lines			✓	✓	✓
Hard Material Transportation Lines	✓	✓	✓	✓	✓
Pipeline For Chemical Substances		✓	✓	✓	✓
Coated Geothermal Heating Pipes			✓	✓	✓
Cable Protection Pipe			✓		
Sewerage Pipelines			✓	✓	✓
Solid Waste Methane Gas Evacuation Line			✓	✓	✓
Solid Waste Drainage Line			✓	✓	✓
Sea Discharge Application			✓	✓	✓
Fish Breeding Site Application			✓	✓	✓







LIFE SPAN

PE 100 Pipes

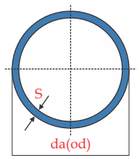
TEMPERATURE (°C)	OPERATING TIME (Year)	SDR								
		41	33	21	17	13.6	11	9	7.4	6
		PIPES SERIES								
		20	16	10	8	6.3	5	4	3.2	2.5
		PN								
		4	5	8	10	12.5	16	20	25	32
		OPERATING PRESSURE								
10	5	5.0	6.3	10.1	12.6	15.7	20.2	25.2	31.5	40.4
	10	4.9	6.5	9.9	12.4	15.5	19.8	24.8	31	39.7
	25	4.8	6.0	9.6	12.1	15.1	19.3	24.2	30.2	38.7
	50	4.7	5.9	9.5	11.9	14.8	19.0	23.8	29.7	38.0
	100	4.6	5.8	9.3	11.6	14.6	18.7	23.3	29.2	37.4
20	5	4.2	5.3	8.4	10.6	13.2	16.9	21.2	26.5	33.9
	10	4.1	5.2	8.3	10.4	13.0	16.6	20.8	26.0	33.3
	25	4.0	5.0	8.1	10.1	12.7	16.2	20.3	25.4	32.5
	50	4.0	5.0	8.0	10.0	12.5	16.0	20.0	25.0	32.0
	100	3.9	4.9	7.8	9.8	12.2	15.7	19.6	24.5	31.4
30	5	3.6	4.5	7.2	9.0	11.2	14.4	18.0	22.5	28.8
	10	3.5	4.4	7.0	8.8	11.0	14.1	17.7	22.1	28.3
	25	3.5	4.3	6.9	8.6	10.8	13.8	17.2	21.6	27.6
	50	3.3	4.2	6.7	8.4	10.6	13.5	16.9	21.2	27.1
40	5	3.0	3.8	6.1	7.7	9.6	12.3	15.4	19.3	24.7
	10	3.0	3.8	6.0	7.6	9.5	12.1	15.2	19.0	24.3
	25	2.9	3.7	5.9	7.4	9.2	11.8	14.8	18.5	23.7
	50	2.9	3.6	5.8	7.2	9.1	11.6	14.5	18.2	23.3
50	5	2.6	3.3	5.3	6.7	8.3	10.7	13.4	16.7	21.4
	10	2.6	3.2	5.2	6.5	8.1	10.4	13.0	16.2	20.3
	15	2.3	2.9	4.7	5.9	7.4	9.5	11.8	14.8	19.0
60	5	1.9	2.4	3.8	4.8	6.0	7.7	9.7	21.1	15.5
70	2	1.5	1.5	3.1	3.9	4.9	6.2	7.8	9.8	12.5

1. The figures in the table are prepared in assumption that water flows in the pipes, and current for water. In compliance with the DIN 8074 standard, the security factor is assumed to be C = 1.25.

2. In calculation of operating pressure for pipelines, it is advised that the pressure values included in the table are multiplied with fs = 0.8 reduction factor (The reduction factor is for losses that may occur in installation, during welding or flanging and in case of bending of the pipes).

3. In case of transportation of liquids other than water in the pipes, the operating pressure must be reduced by a proper reduction factor.

PE 100 PIPES MEASUREMENT TABLE



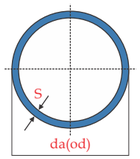
DIN 8074

DIN 8075

ISO 4427

da mm	SDR 41 -PN4			SDR 27.6 - PN6			SDR 21 - PN8			SDR 17 - PN10		
	Code	Smm.	Kg/m	Code	Smm.	Kg/m	Code	Smm.	Kg/m	Code	Smm.	Kg/m
20												
25												
32										7.500.180.032	2.0	0.187
40							7.500.184.040	2.0	0.239	7.500.180.040	2.4	0.295
50							7.500.184.050	2.4.	0.374	7.500.180.050	3.0	0.453
63				7.500.186.063	2.3	0.444	7.500.184.063	3.0	0.580	7.500.180.063	3.8	0.721
75				7.500.186.075	2.7	0.625	7.500.184.075	3.6	0.828	7.500.180.075	4.5	1.020
90	7.500.187.090	2.3	0.645	7.500.186.090	3.3	0.906	7.500.184.090	4.3	1.180	7.500.180.090	5.4	1.460
110	7.500.187.110	2.7	0.943	7.500.186.110	4.0	1.360	7.500.184.110	5.3	1.770	7.500.180.110	6.6	2.170
125	7.500.187.125	3.1	1.230	7.500.186.125	4.6	1.780	7.500.184.125	6.0	2.270	7.500.180.125	7.4	2.760
140	7.500.187.140	3.5	1.540	7.500.186.140	5.1	2.210	7.500.184.140	6.7	2.830	7.500.180.140	8.3	3.460
160	7.500.187.160	4.0	2.000	7.500.186.160	5.8	2.860	7.500.184.160	7.7	3.720	7.500.180.160	9.5	4.520
180	7.500.187.180	4.4	2.490	7.500.186.180	6.6	3.660	7.500.184.180	8.6	4.670	7.500.180.180	10.7	5.710
200	7.500.187.200	4.9	3.050	7.500.186.200	7.3	4.500	7.500.184.200	9.6	5.780	7.500.180.200	11.9	7.050
225	7.500.187.225	5.9	3.860	7.500.186.225	8.2	5.680	7.500.184.225	10.8	7.300	7.500.180.225	13.4	8.930
250	7.500.187.250	6.2	4.830	7.500.186.250	9.1	6.990	7.500.184.250	11.9	8.930	7.500.180.250	14.8	11.000
280	7.500.187.280	6.9	5.980	7.500.186.280	10.2	8.770	7.500.184.280	13.4	11.300	7.500.180.280	16.6	13.700
315	7.500.187.315	7.7	7.520	7.500.186.315	11.4	11.020	7.500.184.315	15.0	14.200	7.500.180.315	18.7	17.400
355	7.500.187.355	8.7	9.550	7.500.186.355	12.9	14.040	7.500.184.355	16.9	18.000	7.500.180.355	21.1	22.100
400	7.500.187.400	9.8	12.100	7.500.186.400	14.5	17.770	7.500.184.400	19.1	22.900	7.500.180.400	23.7	28.000
450	7.500.187.450	11.0	15.300	7.500.186.450	16.3	22.460	7.500.184.450	21.5	28.900	7.500.180.450	26.7	35.400
500	7.500.187.500	12.3	19.000	7.500.186.500	18.1	27.690	7.500.184.500	23.9	35.700	7.500.180.500	29.7	43.800
560	7.500.187.560	13.7	23.600	7.500.186.560	20.3	34.770	7.500.184.560	26.7	44.700	7.500.180.560	33.2	54.800
630	7.500.187.630	15.4	29.900	7.500.186.630	22.8	43.910	7.500.184.630	30.0	56.400	7.500.180.630	37.4	69.400
710	7.500.187.710	17.4	38.000	7.500.186.710	25.7	55.750	7.500.184.710	33.9	71.800	7.500.180.710	42.1	88.100
800	7.500.187.800	19.6	48.100	7.500.186.800	29.0	70.860	7.500.184.800	38.1	91.100	7.500.180.800	47.4	112.000
900	7.500.187.900	22.0	60.900	7.500.186.809	32.6	89.580	7.500.184.900	42.9	115.000	7.500.180.900	53.3	141.000
1000	7.500.187.910	24.5	75.200	7.500.186.810	36.2	110.500	7.500.184.910	47.7	142.000	7.500.180.910	59.3	175.000
1200	7.500.187.920	29.4	108.000	7.500.186.812	43.5	157.000	7.500.184.912	57.2	205.000	7.500.180.912	70.6	255.000
1400	7.500.187.940	34.4	147.000	7.500.186.940	50.7	214.000	7.500.184.914	66.7	278.000			
1600	7.500.187.960	39.2	192.000	7.500.186.960	58.0	280.000	7.500.184.916	76.2	382.000			

PE 100 PIPES MEASUREMENT TABLE



DIN 8074

DIN 8075

ISO 4427

da mm	SDR 13.6 -PN 12.5			SDR 11 - PN 16			SDR 9 - PN 20								
	Code	S mm.	Kg/m	Code	S mm.	Kg/m	Code	S mm.	Kg/m	Code	S mm.	Kg/m	Code	S mm.	Kg/m
20				7.500.176.020	2.0	0.115	7.500.172.020	2.3	0.133	7.500.171.020	2.8	0.154	7.500.169.020	3.4	0.180
25	7.500.175.025	1.9	0.144	7.500.176.025	2.3	0.171	7.500.172.025	2.8	0.200	7.500.171.025	3.5	0.240	7.500.169.025	4.2	0.278
32	7.500.175.032	2.4	0.232	7.500.176.032	2.9	0.272	7.500.172.032	3.6	0.327	7.500.171.032	.4.4	0.386	7.500.169.032	5.4	0.454
40	7.500.175.040	3.0	0.356	7.500.176.040	3.7	0.430	7.500.172.040	4.5	0.509	7.500.171.040	5.5	0.600	7.500.169.040	6.7	0.701
50	7.500.175.050	3.7	0.549	7.500.176.050	4.6	0.666	7.500.172.050	5.6	0.788	7.500.171.050	6.9	0.936	7.500.169.050	8.3	1.090
63	7.500.175.063	4.7	0.873	7.500.176.063	5.8	1.050	7.500.172.063	7.1	1.260	7.500.171.063	8.6	1.470	7.500.169.063	10.5	1.730
75	7.500.175.075	5.6	1.240	7.500.176.075	6.8	1.470	7.500.172.075	8.4	1.760	7.500.171.075	10.3	2.090	7.500.169.075	12.5	2.440
90	7.500.175.090	6.7	1.770	7.500.176.090	8.2	2.120	7.500.172.090	10.1	2.540	7.500.171.090	12.3	3.000	7.500.169.090	15.0	3.510
110	7.500.175.110	8.1	2.620	7.500.176.110	10.0	3.140	7.500.172.110	12.3	3.780	7.500.171.110	15.1	4.490	7.500.169.110	18.3	5.240
125	7.500.175.125	9.2	3.370	7.500.176.125	11.4	4.080	7.500.172.125	14.0	4.870	7.500.171.125	17.1	5.770	7.500.169.125	20.8	6.750
140	7.500.175.140	10.3	4.220	7.500.176.140	12.7	5.080	7.500.172.140	15.7	6.110	7.500.171.140	19.2	7.250	7.500.169.140	23.3	8.470
160	7.500.175.160	11.8	5.500	7.500.176.160	14.6	6.670	7.500.172.160	17.9	7.960	7.500.171.160	21.9	9.440	7.500.169.169	26.6	11.000
180	7.500.175.180	13.3	6.980	7.500.176.180	16.4	8.420	7.500.172.180	20.1	10.100	7.500.171.180	24.6	11.900	7.500.169.180	29.9	14.000
200	7.500.175.200	14.7	8.560	7.500.176.200	18.2	10.400	7.500.172.200	22.4	12.400	7.500.171.200	27.4	14.800	7.500.169.200	33.2	17.200
225	7.500.175.225	16.6	10.900	7.500.176.225	20.5	13.100	7.500.172.225	25.2	15.800	7.500.171.225	30.8	18.600	7.500.169.225	37.4	21.800
250	7.500.175.250	18.4	13.400	7.500.176.250	22.7	16.200	7.500.172.250	27.9	19.400	7.500.171.250	34.2	23.000	7.500.169.250	41.6	27.000
280	7.500.175.280	20.6	16.800	7.500.176.280	25.4	20.300	7.500.172.280	31.3	24.300	7.500.171.280	38.3	28.900	7.500.169.280	46.5	33.800
315	7.500.175.315	23.2	21.200	7.500.176.315	28.6	25.600	7.500.172.315	35.2	30.800	7.500.171.315	43.1	36.500	7.500.169.315	52.3	42.700
355	7.500.175.355	26.1	26.900	7.500.176.355	32.2	32.500	7.500.172.355	39.7	39.100	7.500.171.355	48.5	46.300	7.500.169.355	59.0	54.300
400	7.500.175.400	29.4	34.100	7.500.176.400	36.3	41.300	7.500.172.400	44.7	49.600	7.500.171.400	54.7	58.800	7.500.169.400	66.5	68.900
450	7.500.175.450	33.1	43.200	7.500.176.450	40.9	52.300	7.500.172.450	50.3	62.700	7.500.171.450	61.5	74.400	7.500.169.450	75.0	90.000
500	7.500.175.500	36.8	53.300	7.500.176.500	45.4	64.500	7.500.172.500	55.8	77.300	7.500.171.500	68.3	91.800			
560	7.500.175.560	41.2	66.900	7.500.176.560	50.8	80.800	7.500.172.560	62.5	97.000	7.500.171.560	75.7	117.000			
630	7.500.175.630	46.3	84.600	7.500.176.630	57.2	102.000	7.500.172.630	70.0	125.000						
710	7.500.175.710	52.2	107.000	7.500.176.710	64.5	130.000									
800	7.500.175.800	58.8	136.000	7.500.176.800	72.8	169.000									
900	7.500.175.900	66.1	172.000												
1000	7.500.175.910	73.6	218.000												
1200															
1400															
1600															

CONNECTION METHODS

Butt Welding

Polyethylene pipes may Pe produced to be connected by butt welding method depending on the project. But, there *are* limitations for connection with this welding method in respect of both diameter and wall thickness. Connection with this welding method can be applied to diameters between 50 mm and 1600 mm; and relative to the diameters, to wall thicknesses from 5 mm to 100 mm. Butt welding process is

carried in accordance with DVS 2207 standard.

Matters to be paid attention in connection of PE pipes with butt welding method are:

- Heat of the welding environment should not be below 5°C.
- Wall thicknesses of the pipes to be connected must be equal, if there is any difference. Then the difference must not exceed 10%.
- Butt welding machine to be used in welding must be certified.
- Prior to welding process, welding surfaces must be scrapped, oxidation removed and complete contact of welding surfaces must be provided.
- After scrapping of the welding surface, it must be preserved from dirt. If there is any re-dirtying, the scrapping process must be repeated.
- Prior to being heated with iron, the surface to be welded must be cleaned with pure alcohol.
- Although the weld iron heat is between 200°C - 220°C, it must be designated regarding the raw material of the pipe and application standard.
- After the welding process has started, during weld cooling period, the connection pressure values of the pipes must be kept equal.
- Since, the air circulation formed in the pipes accelerates the cooling process of weld, during welding one end of the pipes must be closed.
- Before starting welding process the heat values of the machine must be checked and welding must be started 5 minutes after reaching desired heat value.
- Iron part of the machine and the welding part of the pipe must be cleaned prior to welding.
- Welding pressure test for pressurized drinking water pipes are applied in accordance with DIN 4270 standard.

PIPE INSTALLATION RULES

Rules for pipe installation are stated in DIN 19630, DIN 4033, DIN 18300 and EN 1610 standards. Pipes may be lowered to the canal after being welded outside the canal. Keeping canal excavation narrow is the important matter in here.

- Pipes must not be crushed in no matter.
- Usage of pipes damaged during stocking or transportation (damaged by sharp tools or material like stone) must be strictly avoided.

- There must not be any accumulation of subterranean water or rain water in the canal (In case of presence of water in canal, it must be discharged by pumps).

- Non-sticking sand, pebble, mixed sand with mixed grain and pebble are suitable for use as filling material.(DIN 19630 standard).

- Canal depth must be of minimum 70-80 cm.

- If the excavation soil is suitable for filling, pipe may be laid on bottom of canal without need for bedding. If the excavation soil is not suitable (stony, moist, etc) for filling, canal depth must be increased and bedding with dry filling material (e.g. sand) must be applied.

- Thickness of bedding to be done must be minimum Al = 100 mm +1/10 DN. Bedding material must be compressed with a lightly working compactor until a 95 % endurance is obtained.

- Pipe side fillings A2, must be poured at 30 cm width and must be compressed with a compactor at a rate of 92-95 %. This process must be continued in every 30 cm until exceeds pipe for 30 cm.

- After pipe is passed for A3 = 30 cm, filling process must be completed by compressing with a mid power compactor.

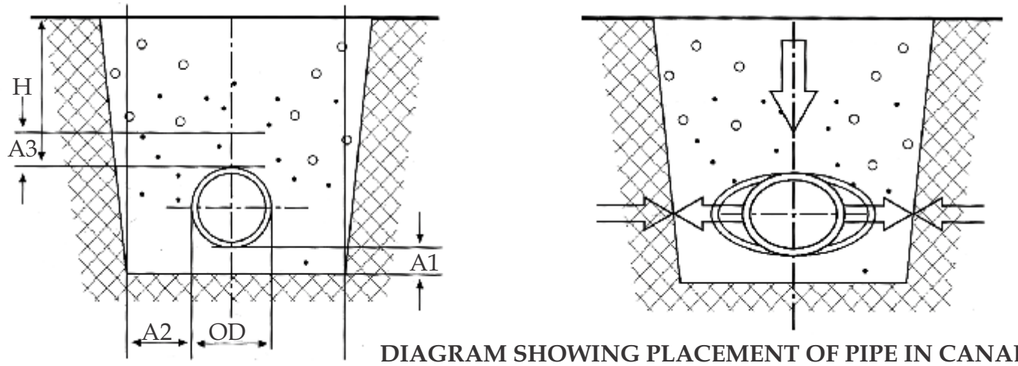


DIAGRAM SHOWING PLACEMENT OF PIPE IN CANAL

RULES FOR CARRIAGE AND STORAGE

There must be no nails, hard substances, stone, etcin the dump of the transportation vehicle.

Pipes must not be placed in the vehicle in disorder.

Pipes must never be thrown during load, unload. Ground of storage area must also be cleaned from In stacking of coils, the height of coils stacked upwards must not exceed 1.5 m. Straight pipes may be stored in ways.

Pyramid Storage
5X10 woods are paved on the ground with 1 m intervals. Pipes are stored as pyramid, decreasing by one in each row, not exceeding 1.5 m of height. Side supports must be used to prevent pipes from sliding.

Grid Storage
As in pyramid storage, ground is paved with wood. Pipes are stored in a maximum height of 1.5 m, to form a 90° angle to the bottom pipe in each row. A square of 12 X 12 X 1.5 m dimensions is formed.

In stocks made in summer months, storage height must be limited to 1 m in order to prevent hot weather deform pipes.

Blue pipes must be covered with canvas until use, to be protected from UV radiation.

QUALITY CONTROL TESTING METHODS

In production and quality control of PE pipes, all tests in accordance with following standards are applied. PI are shipped only after tests and controls are completed and have taken TETRAPLAST QUALITY APPROVAL.

Designation of Density (ISO 1183)
Done for the purpose of establishing the weight of material in unit volume. Material is firstly weighed in air **a** then in liquid of which the density is known and density is calculated according to the determined calculate method.

Designation of MFI (Meit Flow Index) (ISO 1133)
Done for the purpose of examination of behaviour of material before processed, against heat. Samples take from test with MFI apparatus are weighed by analytical scale and values received are loaded to the apparatus and result in gr / 10 min unit is determined.

Breaking Resistance (ISO 527)
This is the test where the behaviour of material against power is observed, breaking resistance and elasticity module are determined.

QUALITY CONTROL TESTING METHODS

Breaking Extension (ISO 527)
This is the test where the extension amount of material at the moment of breaking is determined in percentage (%).

Hydrostatic Pressure Test (ISO 9080 EN 921)
This is the test where the behaviour of pipes against pressure in time is observed in shortened environmental conditions. Changes in pipes in a 50 years period are observed applying high pressure conditions.

Homogeneity Test (ISO 13 949)
This test is done for the purpose of observation of homogeneous pigment distribution and probable cavities, licrotome cross section taken at 10-15 urn is observed under microscope.

Carbon Black Amount Analysis (ISO 6964)
This test is done for the purpose of observing the percentage (%) of carbon black amount reinforced in material in refinery environment in order to acquire resistance to UV rays.