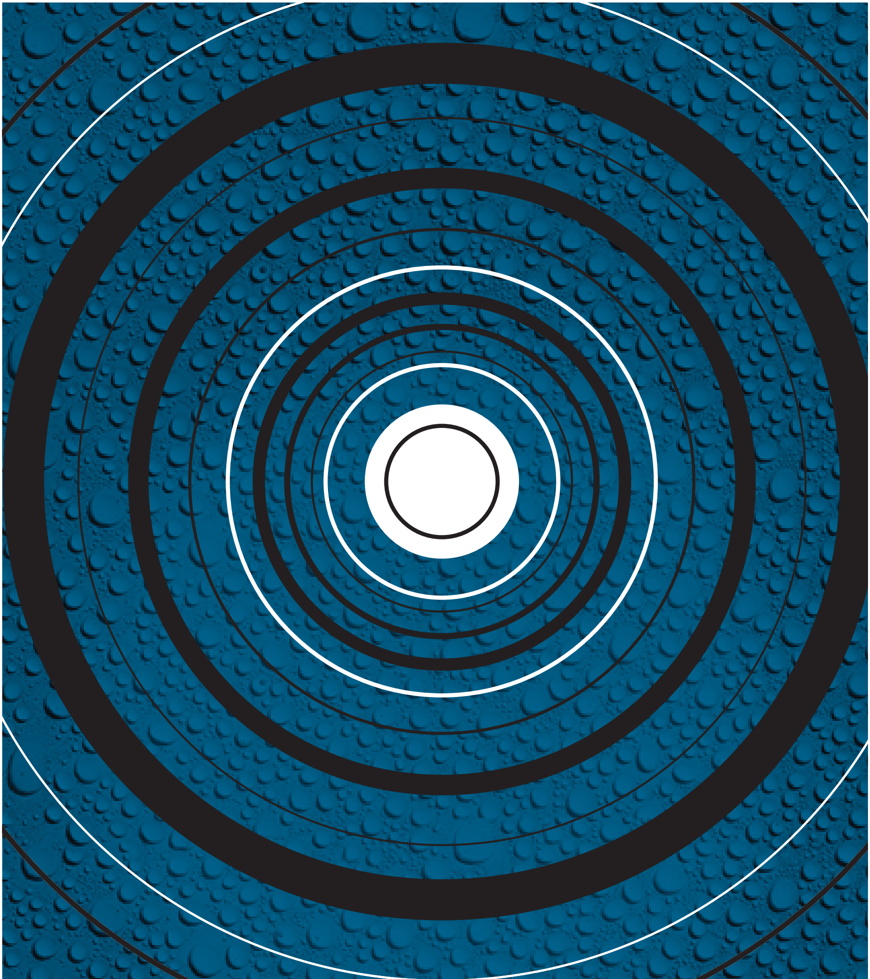
Pressure Technical Manual

For PVC and polyethylene pipe systems



Utilities Solutions

MARLEY

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1. PLASTIC PIPELINES

- GENERAL

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PLASTICS PIPES FOR PRESSURE APPLICATIONS

This manual has been designed to detail the properties, design and installation requirements for the plastics pipe systems produced by Marley New Zealand Limited. These plastics pipes are made from PVC and MDPE and where comments are made that are relevant to both systems the term “plastics” is used. For specific details relevant to a particular material type the generic term (ie, PVC or MDPE) is.

PVC (POLYVINYL CHLORIDE)

PVC is produced from the polymerisation of VCM (Vinyl Chloride Monomer) which is made from sodium chloride (common salt) and hydrocarbons from natural gas. PVC requires the addition of certain additives including heat stabilisers and lubricants to enable it to be processed into finished products. The addition of plasticisers results in flexible PVC which is commonly used for hoses, shoe soles, flooring and upholstery materials.
Rigid PVC pressure pipes do not contain plasticisers and are commonly referred to as uPVC or PVC-u pipes indicating that they are unplasticised.
PVC can also be made more ductile with the use of impact modifiers and these pipes are referred to as mPVC or PVC-m pipes.
In this manual PVC is used to refer to both PVC-u and PVC-m pipes and where a specific property may differ it is referenced by its full name.

MEDIUM DENSITY PE (MDPE)

MDPE materials are produced by low pressure polymerisation methods and have densities in the range of 0.93 - 0.94 kg/m3.
The current range of materials referred to as MDPE are classified as PE 100, PE 80B materials which are specialised polyethylene polymers.
MDPE materials generally have improved properties in elongation and crack propagation compared to HDPE materials.
Applications include any water reticulation, sewer and waste water ducts, gas pipe, elevated temperature applications such as artesian bore water reticulation, travelling irrigator coils and rural water reticulation due to the nature of the piping.

STRENGTH

The “strength” of a pipe may be considered as its ability to withstand (hoop) stress in the pipe material under internal pressure over a prolonged period of time. The design stress for local authorities is chosen to ensure a life in excess of 50 years.
The strength of plastics pipes is known to be time/temperature dependent. This characteristic is used to assess the future available strength of the pipe material by undertaking a hydrostatic pressure test and generating regression curves from varying stress/life to failure tests at varying temperature. These prolonged tests, in excess of 10,000 hours, are accelerated for quality control purposes by using elevated temperatures (typically 80°C) for MDPE. The method identifies a Minimum Required Strength (MRS) value derived from the 50 year extrapolated 97.5% lower confidence limit (LCL) failure stress.
A safety factor is applied to the MRS to determine the design stress permissable safety factor.
The following safety factors are currently in use:

PVC-u	2.14 - AS/NZ - 1477 • 1999
PVC-m	1.42 - AS/NZ - 4765 • 2000
PE80	1.25 - AS/NZ - 4130 • 1997

SERVICE LIFETIME VARIATIONS

The adoption of a 50 year design life to establish a value for hoop stress is arbitrary and does not relate to the actual lifetime of the pipeline.
Where pipelines are used in installations such as water supply, where economic evaluations such as present value calculations are performed, the lifetimes of PE lines designed and operated within the NZ guidelines may be regarded as 70/100 years for the purpose of the calculations.
Any values beyond these figures are meaningless as the assumptions made in other parts of the economic evaluations outweigh the effect of pipe lifetime.
Where the particular application departs from the AS/NZS4130 design criteria, which is based on 50 years, in that a shorter lifetime is required, then the pressure rating of the pipe may be adjusted.
Such applications may occur in mining installations where the economic lifetime of the ore body may be 5 or 10 years or for dredging operations where the project may only be operational for 6 months.
For situations involving high costs of downtime and repair, a higher factor should be used. For less critical situations, lower factors would be quite in order. Where factors such as transient pressures (eg. water hammer) and other loads are predicted and allowed for, lower factors of safety are appropriate.

THE STRESS REGRESSION LINE FOR HOOP STRESS

The traditional method for portraying the tensile strength of plastics pipe is through a graph of log stress vs log time to failure.
This is known as the stress regression line. This chart is a plot of circumferential stress in the pipe wall against time to failure.
Practical tests are done subjecting pipe samples to different hoop stresses and the results of the times to failure are plotted over a range of times up to 10,000 hours. A linear regression line (log log) is established and extrapolated to the longer term.
An appropriate factor of safety is established on the long term ultimate stress to give a working stress for design purposes.
The confidence of extrapolated data such as this depends on a number of factors:

1. The linearity of the data
2. The scatter of the data (data fit)
3. Data available concerning closely allied materials

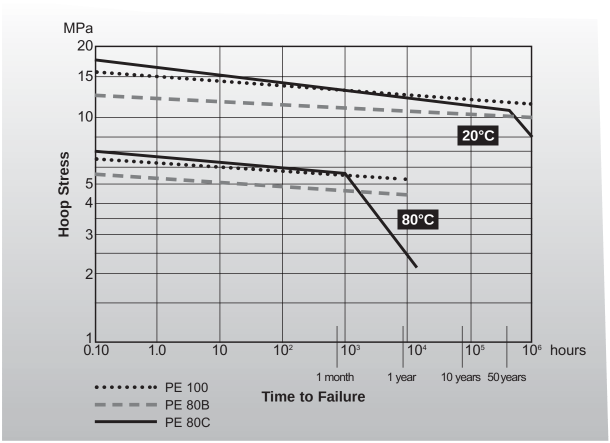
With MDPE which exhibits a knee in the regression line testing is also done at elevated to determine the position of the knee. This stress regression which is used to define the knee is used only as a design basis and does not predict the system life which has been shown to be significantly greater than the conservative predictions.

For specification purposes the design points adopted for PVC-u pipes is the 50 year line with an ultimate stress of 23.6 MPa (26.0 MPa for pipes 175mm and above) giving a safety factor of 2.1. It can be seen that the safety factor at 100 years is only slightly lower. For PVC-m the ultimate stress is 17.5 MPa.
For polyethylene pipes the method of classifying the material is by reference to its Minimum Required Strength (MRS). The MRS is determined by using the value of the predicted hoop stress (97.5% lower confidence limit) at the 50 year point.
The hydrostatic design stress (HDS) is obtained by the application of a factor, not less than 1.25, to the MRS value.
The wall thickness of Marley MDPE manufactured to AS/NZ4130 are established by use of the Barlow formula as follows:

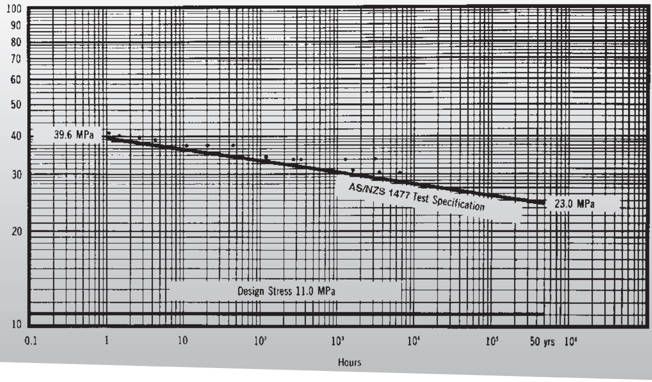
$$T = \frac{PD}{2S + P} \quad \text{and} \quad S = MRS/C$$

T	= minimum wall thickness (mm)
P	= working pressure (MPa)
D	= minimum mean OD (mm)
S	= design hoop stress (MPa)
MRS	= Minimum Required Strength
C	= Safety Factor Typically 1.25 for water

TYPICAL STRESS REGRESSION CURVES FOR MDPE



TYPICAL STRESS REGRESSION CURVES FOR PVC



WEATHERABILITY AND TEMPERATURE CHANGES

Black PE material has generally excellent prolonged weatherability properties and can readily withstand wide variations of weather without degradation. Black PE pipes contain carbon black pigments which act both as a pigment and as an ultra violet radiation stabiliser and these pipes require no additional protection for external storage, or prolonged use in natural conditions.

Blue MDPE pipe is subject to a degree of degradation when exposed to ultra violet light (sunlight) for prolonged periods. UV stabilisers are used to counteract this effect and such material has withstood practical exposures for periods in excess of a year without apparent deleterious effects.
Any surface degradation has a particular impact when using fusion jointing techniques and leads to recommendations for the scraping of the surface of the material prior to jointing.
Blue MDPE is basically intended for use in buried conditions unless protected from prolonged sunlight exposure. This is reflected in the current recommendation to provide protection against UV exposure when used in above ground situations or when stored outside for periods greater than one year.
Black MDPE should be purchased for continuous unshaded above ground use.
Natural PVC is degraded by prolonged exposure to UV unless it is afforded some protection. Marley PVC pipes are stabilised with Ti02 to provide suitable protection for up to 50 years exposure.
UV degradation will result in micro crazing of the surface which results in a reduction of impact strength. Tests have shown however that the hoop stress of the pipe is not compromised when such degradation occurs. Marley recommend that pipes that are to be installed in situations where they are directly exposed to UV should be protected by painting with a light coloured acrylic paint or covered.

ELEVATED TEMPERATURES

Reversion
The term “reversion” refers to dimensional change in plastic products as a consequence of “material memory”. Plastic products “memorise” their original formed shape and if they are subsequently distorted, they will return to their original shape under heat.

Theoretically, reversion proceeds at all temperatures, but with high quality extrusion it is of no practical significance in plain pipe at temperatures below 60°C.

Pressure Ratings at Elevated Temperatures
The mechanical properties of plastic pipes are referenced at 20°C. Thermoplastics generally decrease in strength and increase in ductility as the temperature rises and design stresses must be adjusted accordingly.

ELEVATED TEMPERATURE PRESSURE DE-RATING

uPVC Pipes

Temp °C	PN6	PN9	PN12	PN15
20	0.60	0.90	1.20	1.50
30	0.48	0.72	0.96	1.20
40	0.36	0.54	0.72	0.90
50	0.24	0.36	0.48	0.60
60	0.12	0.18	0.24	0.30

PE80B Material

Maximum Working Pressure (Metres Head)						
Temp °C	**PN4**	**PN6.3**	**PN8**	**PN10**	**PN12.5**	**PN16**
20	40	63	80	100	125	160
25	39	61	78	97	122	156
30	37	59	75	94	112	156
35	35	55	70	87	109	140
40	32	51	65	81	102	130
45	30	47	60	75	94	120
50	26	41	52	65	81	104

PE100 Material

Maximum Working Pressure (Metres Head)						
Temp ºC	**PN4**	**PN6.3**	**PN8**	**PN10**	**PN12.5**	**PN16**
20	40	63	80	100	125	160
25	37	59	75	94	112	156
30	35	55	70	87	109	140
35	32	51	74	80	100	128
40	29	46	58	73	91	117
45	26	42	53	66	83	106
50	24	37	47	59	74	94

The above tables are based on the relationship:

$$P_T = P_{20} \frac{(70 - T)}{50}$$

where:

P_T = maximum working pressure at T°C
P_{20} = maximum working pressure at 20°C
T = material temperature °C

This is equivalent to a reduction in working pressure of 2% per 1°C rise in temperature above 20°C. Pressure ratings for pipes of other classes may be computed from these relationships.
The material temperature in question here is the average temperature of the pipe wall under operational conditions.
Temperature is averaged in two ways:
1. Across the wall of the pipe:
Where a temperature differential exists between the fluid in the pipe and the external environment, the operating temperature may be taken as the mean of the internal and external pipe surface temperatures.
It should be noted that the pressure condition where flow is stopped for prolonged periods should also be checked. In this event, water temperature and outside temperature may equalise.

2. With respect to time:
The average temperature may be considered to be the weighted average of temperatures in accordance with the percentage of time spent at each temperature under operational pressures:

$$T_m = T_1L_1 + T_2L_2 + ... + T_nL_n$$

where L_n = proportion of life spent at temperature T_n

This approximation is reasonable provided the temperature variations from the mean do not exceed ±10°C which is generally the case for pipes

buried below 300 mm.
For most underground water supply systems, the overall mean temperature from meteorological records is appropriate for class selection purposes, since this represents the mean of the annual and diurnal sinusoidal temperature patterns.
For systems subjected to lager variations, the temperature for rating purposes should be taken as the maximum less 10°C. However the peak temperature should not exceed 60°C.

Example

A reticulation system is to be installed in a town with a mean ground temperature at pipe depth 20°C. The December-February average is 25°C. Although diurnal variations occur with air temperatures up to 40°C during heatwave period, water temperatures and ground temperatures at pipe depth do not exceed the mean of 27°C. A 50 year life is required at basic factor of safety 2.145.

Weighted average temperature:

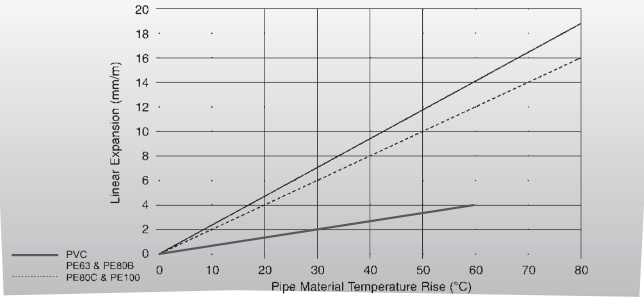
$$T_m = 25(3/12) + 20.5(6/12) + 15(3/12)$$
$$= 6.25 + 10.25 + 3.75 = 20.25°C$$

Therefore use rating for 20°C. This is the same result as taking the mean.

EXPANSION AND CONTRACTION

All materials expand and contract with changes in temperature and uPVC has a relatively high rate of change.
The coefficient of thermal expansion for PVC is 7×10^{-5}/°C.
A handy rule is 7 mm change in length for every 10 metres for every 10°C change in temperature.
The coefficient of thermal expansion for MDPE is 2.0×10^{-4}/°C.
A handy rule is 14mm change in length for every 10 metres for every 10°C change in temperature.
Therefore this characteristic must be considered carefully in the design of the pipeline and during installation. In buried pipelines the main consideration of thermal movement is during installation in high ambient temperatures.
Under these conditions the black PE pipe will be at its maximum surface temperature and when placed into a shaded trench and backfilled, will undergo the maximum temperature change and hence thermal movement.
in these cases the effects of thermal movement can be minimised by some minor snaking of the pipe in the trench for small diameter sizes (up to 110mm).
For large diameter pipe the final connection shouldbe left until the pipe temperature has stabilised to that of the surrounding soil.
Above ground pipes require no expansion/contraction considerations for free ended pipe or where lateral movement is of no concern on site. Alternatively, pipes may be anchored at intervals to allow lateral movement to be spread evenly along the length of the pipeline.
Where rubber ring jointed (Z joint) pipe is used for buried urban water supply, the thermal movement caused by seasonal changes in temperature can be absorbed by the rubber ring rocking in the recess. The joint is not able to absorb the gross movement caused on occasions by the severe temperature drop at the time of laying.
A pipeline should be allowed to expand and contract freely.
Wherever possible, expansion and contraction should be taken up by changes in direction.
Careful positioning of fixed points will enable the direction of expansion and contraction to be controlled.
Expansion bellows and O-ring slip joints should be used only as a last resort; the pipes must then be suitably protected against separation.
Care must be taken in the positioning of loose brackets, as these can sometimes create conditions in which there may be a risk of shearing.
Values and heavy components must be independently supported so that no stresses are imposed on the pipeline.

THERMAL LINEAR EXPANSION OF PLASTICS PIPE



TOUGHNESS

General

In practice it is recognised that plastics is a tough, resilient material capable of withstanding the normal rigours of pipelaying and service conditions. The many years of successful installation and service of PVC and MDPE pipe in the water industry confirms this confidence.

Abrasion

Plastics pipes have high resistance to abrasion by suspended particles being carried in the water, however the external surface can be scratched and gouged by sharp objects. Careful handling is therefore required but provided the depth of any surface notch is no greater than 10% of the wall thickness, there is no significant loss in the stress rupture performance of the pipe.
The properties of plastics pipes including flexibility, ease of handling and robustness have led to their widespread use for abrasive applications such as mine tailings and slurry transportation.
Abrasion occurs as a result of friction between the pipe wall and the transported particles.
The actual amount and rate of abrasion of the pipe wall is determined by a combination of:

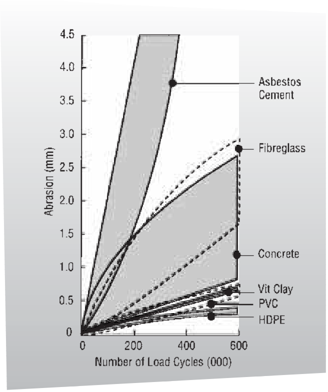
- the specific gravity of the solids
- the solids content in the slurry
- solid particle shape, hardness and size
- fluid velocity
- pipe material

In general terms plastics pipes have superior abrasion resistance to steel, cast and ductile iron, asbestos and fibre reinforced cement pipes and provide a more cost effective solution for abrasive slurry installations.
Laboratory test programs have been performed in the UK, Germany and the USA on standardised slurries to obtain relative wear comparisons for various materials using sliding and rotating pipe surfaces.
The results of test programs using the Darmstadt method of Kirschmer and reported by Meldt (Hoechst AG) for a slurry of quartz sand/gravel water with a solids content 46% by volume and a flow velocity of 0.36 m/s are shown.
These were performed across a range of materials and show the excellent abrasion resistance of MDPE and PVC.

Conductivity

Plastics pipes are poor conductors. At all times PE pipe should be protected against radiant heat that could raise its surface temperature above 60C.
Plastics pipes are also poor conductors of electricity and no attempt should, therefore, be made to use pipework constructed of the material as means of earthing electrical equipment.
Because of their electrical resistivity, caution is required in the handling and use of plastics pipes where the generation of high levels of static electricity may present a hazard.

COMPARATIVE ABRASION RATES OF PIPE MATERIALS



HYDRAULIC PROPERTIES

The smooth bore of plastics pipes enables them to be treated as `hydraulically smooth` when used for the conveyance of potable water.
The smooth surface discourages the formation of scale in hard water areas but certain waters may, at times, give rise to slime and silt deposits, particularly at joints or fittings and this may increase frictional losses.
For the purpose of calculation of flow rates in new plastics pipelines, the Colebrook-White formula may be used in which the value of the hydraulic roughness factor Ks is 0.003 mm for clean water. Further details of hydraulic constants, flow charts and frictional losses are given.

MAXIMUM WORKING PRESSURE

CLASS	METRES HEAD	MPa	PSi
PN6	61	0.6	87
PN9	91	0.9	130
PN12.5	122	1.2	178
PN15	153	1.5	217
PN18	184	1.8	260

There are, however, many factors which must be considered when determining the severity of service and the appropriate class of pipe. In some instances, standard factors of safety may be too conservative, in others too risky. The final choice is up to the designer in the light of his knowledge of his particular situation.

FIRE RATING

PE pipe systems will support combustion and as such are not suitable for use in fire rated zones in buildings without protection.
In multi-storey buildings PE systems penetrating floor cavities must be enclosed in fire rated service ducts.
PVC pipe systems may support combustion but are self-extinguishing when the source of ignition is removed.

CHEMICAL RESISTANCE AND STABILITY

Corrosion Resistance

For all practical purposes, plastics pipes are chemically inert within their normal temperature range of use. They do not rot, rust, pit, corrode or lose wall thickness through chemical or electrical reaction with the surrounding soil. They do not normally support the growth of, nor is it affected by algae, bacteria or fungi.

Chemical Effects

Plastics pipes have a good resistance to a wide range of chemicals. In the water supply context, the main concern is the effect of certain chemicals existing in contaminated ground, some of which can have harmful effect upon the pipe material or may cause taste problems in extreme cases due to permeation through the material wall. In broad terms the most common harmful chemicals are oxidisers, cracking agents and certain solvents as shown in the Chemical Resistance Table.

Where pipelines are to be laid in environments where significant concentrations of such chemicals may prevail (e.g. garage forecourts, within certain processing works, etc) the use of PVC or MDPE is NOT recommended unless suitability sleeved, although it is noted leakage of this nature is not acceptable under the Environment Act.

For the effects of specific chemicals on plastics pipes see chemical resistance table.

Chemical Attack

Chemicals that attack plastics do so at differing rates and in differing ways. There are two general types of chemical attack on plastic:

1. Swelling of the plastic occurs but the plastic returns to its original condition if the chemical is removed. However, if the plastic has a compounding ingredient that is soluble in the chemical, the plastic may be changed because of the removal of this ingredient and the chemical itself will be contaminated.
2. The base resin or polymer molecules are changed by crosslinking, oxidation, substitution reactions or chain scission. In these situations the plastic cannot be restored by the removal of the chemical. Examples of this type of attack on uPVC are aqua regia at 20^{0}C and wet chlorine gas.

FACTORS AFFECTING CHEMICAL RESISTANCE

A number of factors can affect the rate and type of chemical attack that may occur. These are:

Concentration: In general, the rate of attack increases with concentration, but in many cases there are threshold levels below which no significant chemical effect will be noted.

Temperature: As with all processes, rate of attack increases as temperature rises. Again, threshold temperatures may exist.

Period of Contact: In many cases rates of attack are slow and of significance only with sustained contact.

Stress: Some plastics under stress can undergo higher rates of attack. In general uPVC is considered relatively insensitive to “stress corrosion”.

Considerations for Plastics Pipe

For normal water supply work, plastics pipes are totally unaffected by soil and water chemicals. The question of chemical resistance is likely to arise only if they are used in unusual environments or if they are used to convey chemical substances. Table 2 gives guidance in this context.
For applications characterised as food conveyance or storage, health regulations should be observed. Specific advice should be obtained on the use of plastics pipes.

PERMEABILITY

Plastics pipes can be shown to be permeable to certain gases and liquids under extreme conditions, the rate of permeation being mainly dependent upon the thickness of the pipe, the concentration, time and temperature.

Permeation of natural gas into the water supply pipe causing taste problems should be of no concern provided reasonable separation distances are maintained.

Chemicals Potentially Harmful to Plastics Pipes

Group	Generalised Examples	Effect on MDPE	Effect on PVC
Oxidisers	Very strong acids	Degradation.	Generally no degradation
Cracking agents	Concentrated Detergents	No degradation. (Under high temperatures, accelerates cracking under stress in brittle manner).	No degradation
Solvents	Hydrocarbons, such as petrols and oils.	No degradation but may be absorbed into pipe wall causing reduction in hoop strength and possible taste problems.	Can swell and soften PVC causing reduction in hoop strength and possible taste problems.
Alkaline Solutions	Strong Alkalines	No degradation	Generally no degradation but Chloride Solution needs to be given special attention.

Note: For detailed information refer to Chemical Resistance Chart.

2. PVC & PE

- Consideration before Design

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Mainlaying Design and Installation Considerations

Design Considerations

1. PVC pipes are usually joined using the push-fit elastomeric jointing ring or solvent cement techniques. The push-fit technique has advantages as it is less dependent on weather conditions and provides allowances for pipe movement. The solvent cement technique is usually restricted to smaller diameter pipes.

2. The sub surface material to be excavated should be assessed for its suitability as backfill material, i.e. free from large sharp stones, heavy clay, etc. If the material is unsuitable for bedding and surround to the pipe then imported material should be utilised and the surplus spoil removed from site.

3. The properties of PVC make it suitable for areas subject to minor ground movements due to seismic forces, mining subsidence, compaction of filled sites or the disturbance caused by the activities of other utilities in the vicinity. In larger sizes greater than DN 160 special attention to the flexibility of the joints is necessary.

4. Where PVC is to be used in environments with temperatures greater than 20°C for prolonged periods, the allowable operating pressure should be reduced in accordance our recommendations, to maintain the expected life of the pipe.

5. Corrosive ground (e.g. ground with low pH or high sulphate characteristics) has no known effect on PVC but all metal fittings, ancillary equipment, bolts etc should be carefully protected against corrosion in the normal way.

6. Contaminated ground, however, must be considered carefully. PVC is resistant to most chemicals, but is vulnerable to petroleum products and certain solvents. Where concentrations of such contaminants exist, PVC should NOT be used unless suitably protected. Where any doubt exists, soil sampling should be undertaken and specialist advice sought.

7. Where the natural ground water table is high, or the construction trench is liable to flooding, special consideration should be given to the possibility of flotation of the pipe when empty. This particularly applies to the larger diameters where special anchoring or weighting may be necessary prior to backfilling.

8. Direct connection of PVC to sources of high frequency should be avoided and a flexible joint should be used to isolated such vibration.

Laying Considerations

1. Gradual changes of direction of PVC pipelines can be accommodated by pipe deflection but every effort should be made to keep the pipe as central as possible within the trench to enable correct side-fill compaction.

2. PVC should generally be installed in straight runs in order to reduce the stresses induced when the pipe is bent. It is possible in some circumstances however to bend the pipe in a radius no less than 200 times the pipe diameter. Elastomeric ring joints will provide for some deflection of the pipe in the vicinity of 3° but it is unacceptable for the trailing joint to have an angular deflection greater than 1°C.

2. During the pipelaying of continuous fusion joint systems, allowance should be made for the movement likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at the end connections to fixed positions and at branch connections.

3. In cold conditions allowance should be made for expansion with push-fit joints to accommodate subsequent thermal expansion. Once a pipeline is installed the temperature variation is usually very small and is not likely to induce any significant stress or movement in the pipe system.

4. Whenever possible, a minimum distance of 300mm from obstructions should be maintained. This distance is often possible when laying parallel to other services but not always practicable when crossing other services. A separation distance of 75mm may be allowed for a square crossing but suitable protection should be provided from possible joint loading, interference, damage or contamination.

5. PVC is not a conductor of electricity and no attempt should be made to use PVC pipework as a means of earthing electrical equipment. Similarly, because of its high electrical resistivity, caution is required in the use of the material where the avoidance of static electricity may be an important consideration.

6. PVC is a poor conductor of heat but can burn when subjected to a naked flame. Upon removal of the source of ignition burning ceases.

7. The installation of flanged fittings such as sluice valves, hydrant tees, end caps etc. usually requires the use of stub flanges complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balanced torque. Provision should be made where heavy fittings are installed for concrete support both for the weight and to resist the turning moments associated with valves and hydrants.

8. Where there are large diameter fabricated fittings installed in the main, similar concrete support may be necessary to counteract the imbalance of forces under working conditions.

9. PVC pipes and fittings may be partially or completely surrounded by concrete but the pipe should be protected by a heavy duty polyethylene membrane to avoid possible damage during pouring or compaction and to prevent high localised stresses.

10. After completion of an installation, pipework and fittings should be inspected and made ready for testing to ensure the safety of the system. If the system is a large one it should be made ready to be tested in sections of convenient length.

11. The degree to which the trench is backfilled prior to testing will be influenced by:

- The prevailing site and/or traffic conditions.
- The potential risk for flotation.
- The unbalanced forces due to configuration and imposed test pressure.

Where practical it is advisable to consider leaving at least the mechanical joints exposed throughout the testing.

12. As part of the preparation for the hydrostatic pressure test, all anchorages and struts should be checked to ensure they are adequate to withstand the excess pressure and it is advisable to re-tighten all bolted and flanged joints and to check that all intermediate control valves are open.

13. Complete and accurate records should be taken of the installation. It is useful for records to be taken before the pipes are buried whilst memories are fresh and key elements are still visible. Photographic records of important or complex feature should be considered.

14 The marker tape, where used , should be laid along the line of the main and connected at each end to either a sluice valve or hydrant. The recommended position of the tape is 350mm below the surface directly above the crown of the pipe.

Mainlaying Design and Installation Considerations

Design Considerations

1. PE pipes are normally joined using fusion techniques. Butt fusion jointing is usually carried out above ground and after cooling, long lengths of pipe are snaked into the trench. This procedure requires consideration of appropriate storage areas, jointing canopies and working space at the trench side away from the spoil areas. Attention must be given to the additional inconvenience caused to both pedestrian and vehicular traffic. Extra signs and protection barriers will be required.

2. The sub surface material to be excavated should be assessed for its suitability as backfill material, i.e. free from large sharp stones, heavy clay, etc. If the material is unsuitable for bedding and surround to the pipe then imported material should be utilised and the surplus spoil removed from site.

3. The properties of MDPE make such pipelines particularly suitable for areas subject to ground movement due to seismic forces, mining subsidence, compaction of filled sites or the disturbance caused by the activities of other utilities in the vicinity.

4. Where PE is to be used in environments with temperatures greater than 20°C for prolonged periods, the allowable operating pressure should be reduced in accordance our recommendations, to maintain the expected life of the pipe.

5. Corrosive ground (e.g. ground with low pH or high sulphate characteristics) has no known effect upon PE but all metal fittings, ancillary equipment, bolts etc should be carefully protected against corrosion in the normal way.

6. Contaminated ground, however, must be considered carefully. PE is resistant to most chemicals, but is vulnerable to petroleum products and certain solvents. Where concentrations of such contaminants exist, PE should NOT be used unless suitably protected. Where any doubt exists, soil sampling should be undertaken and specialist advice sought.

7. Where the natural ground water table is high, or the construction trench is liable to flooding, special consideration should be given to the possibility of flotation of the pipe. This particularly applies to the larger diameters where special anchoring or weighting may be necessary prior to the backfill being installed.

8. Direct connection of MDPE PE80 and PE100 to sources of high frequency such as pump outlet flanges should be avoided and a flexible joint should be used to isolate such vibration.

Laying Considerations

1. Gradual changes in direction of PE pipelines can be accommodated by pipe deflection but every effort should be made to keep the pipe as central as possible within the trench to enable correct side-fill compaction. Similar care should be taken when any distortion of coiled pipe has occurred.

2. During the pipelaying of continuous fusion joint systems, allowance should be made for the movement likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at the end connections to fixed positions and at branch connections.

3. For summertime installations, with two fixed connection points, a slightly longer length of polyethylene may be required to compensate for contraction of the pipe in the cooler trench bottom. The snaking of the pipe in the trench which naturally occurs with pipe sized 90mm and below, is normally sufficient to compensate for this anticipated thermal contraction.

4. During a winter installation, the exact length of pipe should be used. Pipe which is too short or not aligned must not be drawn up by the bolts of a flanged connection because of potential overstressing of the stub end, flanged adapter and ultimately the valve or fixture to which it is connected.

5. It is advisable to defer the final tie-in connections until thermal stabilisation of the pipeline has occurred. Once a pipeline is installed and in service, the temperature variation is usually small, occurring over an extended period of time and is not likely to induce any significant stress or movement in the pipe system.

6. Whenever possible, a minimum distance of 300mm from obstructions and other services should be maintained. This distance is often possible when laying parallel to other services but not always practicable when crossing other services. A separation distance of 75mm may be allowed for a square crossing but suitable protection should be provided from possible joint loading, interference, damage or contamination.

7. Polyethylene is not a conductor of electricity and no attempt should be made to use PE pipework as a means of earthing electrical equipment. Similarly, because of its high electrical resistivity, caution is required in the use of the material where the avoidance of static electricity may be an important consideration.

... Laying Considerations

8. The bending of polyethylene is permissible and the properties of fusion jointed systems enable changes of direction without recourse to the provision of special bends or anchor blocks. However, the pipe should not normally be cold bent to a radius smaller than 20 times the diameter. For push-fit or mechanical non end-load resistant jointing systems, anchor blocks to withstand the resultant thrusts must be provided in the traditional manner.

9. Although the hot bending of PE pipe is possible under carefully controlled conditions, under no circumstances should hot bending be attempted on site.

10. Polyethylene is a poor conductor of heat but is flammable and should not be exposed to naked flame.

11. The installation of flanged fittings such as sluice valves, hydrant tees, end caps etc usually requires the use of polyethylene stub flanges complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balanced torque. Provision should be made where heavy fittings are installed for concrete support both for the weight and to resist the turning moments associated with valves and hydrants.

12. Where there are large diameter fabricated fittings installed in the main, similar concrete support may be necessary to counteract the inbalance of forces under working conditions. Consideration should be given to introducing a flanged connection on the branch outlet of the tee so that the branch main joint can be made in a separate operation.

13. Polyethylene pipes and fittings may be partially or completely surrounded by concrete but the pipe should be protected by a heavy duty polyethylene membrane to avoid possible damage during pouring or compaction and to prevent high localised stresses.

All concrete bedding should be at least 100mm thick.

14. After completion of an installation, pipework and fittings should be inspected and made ready for testing to ensure the safety and efficiency of the system. If the system is a large one it should be made ready to be tested in sections of convenient length.

15. The degree to which the trench is backfilled prior to testing will be influenced by:

- the prevailing site and/or traffic conditions;
- the potential risk of flotation;
- the unbalanced forces due to configuration and imposed test pressure.

Where practical it is advisable to consider leaving at least the mechanical joints exposed throughout the test.

16. As part of the preparation for the hydrostatic pressure test, all anchorages and struts should be checked to ensure they are adequate to withstand the excess pressure and it is advisable to retighten all bolted flanged joints and to check that all intermediate control valves are open.

17. Complete and accurate records should be taken of the installation. It is useful for records to be taken before the pipes are buried whilst memories are fresh and key elements are still visible. Photographic records of important or complex features should be considered.

18. The marker tape should be laid along the line of the main and connected at each end to either a sluice valve or hydrant. The recommended position of the tape is 350mm below the surface directly above the crown of the pipe.

3. PVC

RETURN TO
CONTENTS

- Material Properties
- Pipe Dimensions
- Assembly & Socket Construction Dimensions
- Flow Charts
  - -Series 1 (PN 6, PN 9, PN 12, PN 15, PN 18)
  - -Series 2 (PN 4.5 to 20)
- Fitting Dimensions

MATERIAL PROPERTIES

PROPERTIES OF uPVC

PROPERTY	VALUE	CONDITIONS AND REMARKS
PHYSICAL PROPERTIES		
Molecular weight	14,000	
Relative density	1.42	cf: 1.48
Water absorption	0.12%	23˚C, 24 hours
Hardness	80	Shore D Durometer, Brinell 15, Rockwell R 114
Impact strength: 20˚C	$20kJ/m^2$	Charpy 250 µm notch tip radius
Impact strength: 0˚C	$8kJ/m^2$	Charpy 250 µm notch tip radius
Coefficient of friction	0.4	uPVC to uPVC cf: PE 0.25
MECHANICAL PROPERTIES		
Ultimate tensile strength	52 MPa	AS 1175 Tensometer at constant strain rate
Elongation at break	50 - 80%	AS 1175 Tensometer at constant strain rate
Short term creep rupture	44 MPa	Constant load 1 hour value cf: PE 10 - 16
Long term creep rupture	28 MPa	Constant load extrapolated 50 year value
Elastic tensile modulus	3.0 - 3.3 GPa	1% strain at 100 seconds cf: PE 0.6 - 0.8
Elastic flexural modulus	2.7 - 3.0 GPa	1% strain at 100 seconds cf: PE 0.6 - 0.8
Long term creep modulus	0.9 - 1.2 GPa	Constant load extrapolated 50 year secant value
Shear modulus	1.0 GPa	1% strain at 100 seconds
Bulk modulus	4.7 GPa	1% strain at 100 seconds
Poissons ratio	0.4	Increases marginally with time under load
ELECTRICAL PROPERTIES		
Dielectric strength (breakdown)	14 - 20 kV/mm	Short term, 3mm specimen
Volume resistivity	$2 \times 10^{14}\,\Omega m$	AS 1255.1
Surface resistivity	$10^{13} - 10^{14}\,\Omega$	AS 1255.1
Dielectric constant (permittivity)	3.9 (3.3)	50 Hz (10^6Hz) AS 1255.4
Dissipation factor (power factor)	0.01 (0.02)	50 Hz (10^6Hz) AS 1255.4
THERMAL PROPERTIES		
Softening point	80 - 84°C	Vicat method 120B BS 2782
Max. continuous service temp.	60°C	
Coefficient of thermal expansion	7×10^{-5}/K	7mm per 10m per 10°C cf: PE 18-20 x 10^{-5}
Thermal conductivity	0.16 W/[m.K]	0-50°C
Specific heat	1,000 J/[kg.K]	0-50°C
Thermal diffusivity	$1.1 \times 10^{-7}\ m^2/s$	0-50°C
FIRE PERFORMANCE		
Flammability	45%	ASTM D2683 Fennimore Martin test, cf: PE 17.5
Ignitability test	10 - 12 (/20)	cf: 9 - 10 when tested as pipe)
Smoke produced test	6 - 8 (/10)	cf: 4 - 6 when tested as pipe) AS 1530
Heat evolved test	0	) Early Fire
Spread of flame index	0	Will not support combustion) Hazard Test

General properties of uPVC compounds used in pipe manufacture are given. Properties of thermoplastics are subject to significant changes with temperature, and the applicable range is noted where appropriate. Mechanical properties are subject to duration of stress application, and are more properly defined by creep functions. More detailed data pertinent to pipe applications are given in the design section of this manual. For data outside of the range of conditions listed, users are advised to contact our Technical Department.

MARLEY UPVC PRESSURE PIPE

Standard: AS/NZS 1477:1999 series 1

		PN6				PN9				PN12				PN15				PN18			
Nominal Size	Mean OD	T Min	T Max	Mean Bore	Mass kg/m	T Min	T Max	Mean Bore	Mass kg/m	T Min	T Max	Mean Bore	Mass kg/m	T Min	T Max	Mean Bore	Mass kg/m	T Min	T Max	Mean Bore	Mass kg/m
15	21.4	-	-	-	-	-	-	-	-	-	-	-	-	1.4	1.7	18.3	0.138	1.6	2.0	17.8	0.158
20	26.8	-	-	-	-	-	-	-	-	1.4	1.7	23.7	0.175	1.7	2.1	23.0	0.212	2.0	2.4	22.4	0.243
25	33.6	-	-	-	-	1.4	1.7	30.5	0.223	1.7	2.1	29.8	0.270	2.1	2.5	29.0	0.323	2.5	3.0	28.1	0.381
32	42.3	-	-	-	-	1.7	2.1	38.5	0.344	2.2	2.6	37.5	0.430	2.7	3.2	36.4	0.521	3.2	3.7	35.4	0.601
40	48.3	1.4	1.7	45.2	0.325	1.9	2.3	44.1	0.435	2.5	3.0	42.8	0.562	3.1	3.6	41.6	0.676	3.6	4.2	40.5	0.777
50	60.4	1.6	2.0	56.8	0.473	2.4	2.8	55.2	0.675	3.1	3.6	53.7	0.858	3.8	4.4	52.2	1.036	4.6	5.3	50.5	1.232
65	75.4	2.0	2.4	71.0	0.723	3.0	3.5	68.9	1.053	3.9	4.5	67.0	1.342	4.8	5.5	65.1	1.624	5.7	6.5	63.2	1.898
80	88.9	2.4	2.8	83.7	1.008	3.5	4.1	81.3	1.453	4.6	5.3	79.0	1.867	5.7	6.5	76.7	2.269	6.7	7.6	74.6	2.626
100	114.3	3.0	3.5	107.8	1.621	4.5	5.2	104.6	2.385	5.9	6.7	101.7	3.057	7.3	8.2	98.8	3.732	8.6	9.7	96.0	4.322
125	140.2	3.7	4.3	132.2	2.448	5.5	6.3	128.4	3.560	7.2	8.1	124.9	4.555	8.9	10.0	121.3	5.551	10.6	11.9	117.7	6.517
150	160.3	4.2	4.8	151.3	3.149	6.3	7.1	146.9	4.622	8.3	9.3	142.7	5.987	10.2	11.4	138.7	7.251	12.1	13.5	134.7	7.531
200	225.3	5.4	6.1	213.8	5.719	7.9	8.9	208.5	8.138	10.5	11.7	203.1	10.68	12.9	14.4	198.0	12.98	15.3	17.1	192.9	15.22
225	250.4	6.0	6.7	237.7	6.961	8.8	9.9	231.7	10.12	11.6	13.0	225.8	13.15	14.4	16.0	220.0	16.06	17.0	19.0	214.4	18.79
250	280.4	6.7	7.5	266.2	8.717	9.9	11.1	259.4	12.73	13.0	14.5	252.9	16.47	16.1	17.9	246.4	20.12	19.1	21.2	240.1	23.56
300	315.5	7.5	8.5	299.5	11.05	11.1	12.4	292.0	16.03	14.7	16.3	284.5	20.89	18.1	20.1	277.3	25.43	21.5	23.8	270.2	29.79
375	400.5	9.5	10.7	380.3	17.71	14.1	15.7	370.7	25.81	18.6	20.7	361.2	33.62	23.0	25.5	352.0	40.99	27.3	30.2	343.0	48.02

MARLEY UPVC SUPER BLUE

Standard: AS/NZS 1477:1999 series 2

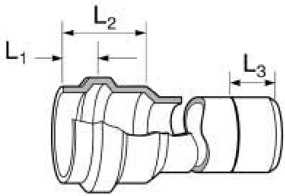
		PN12				PN18			
Nominal Size	Mean OD mm	T Min mm	T Max mm	Mean Bore mm	Mass kg/m	T Min mm	T Max mm	Mean Bore mm	Mass kg/m
100	121.9	6.3	7.1	108.5	3.467	9.2	10.3	9.8	4.912
150	177.4	9.2	10.3	157.9	7.341	13.4	14.9	14.2	10.374
200	232.3	10.8	12.1	209.4	11.358	15.9	17.7	16.8	16.261

MARLEY UPVC PRESSURE PIPE

Assembly and Socket Construction Dimensions (RRJ)

Standard: AS/NZS 1477:1999 series 1

nom size	S	L1	L2	L3
50	80.7	25-30	120	91
65	97.1	30-37	130	103
80	115.0	33-40	135	110
100	147	40-45	130	100
125		47-55	135	110
150	204	55-63	160	130
175	242		173	145
200	272	65-75	190	160
225	294	65-75	185	160
250	331	65-80	225	195
300	382	85-95	230	170
375	476	95-115	250	200

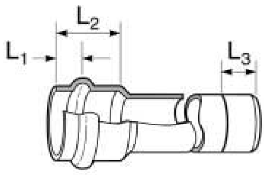


MARLEY UPVC SUPER BLUE

Assembly and Socket Construction Dimensions

Standard: AS/NZS 1477:1999 series 2

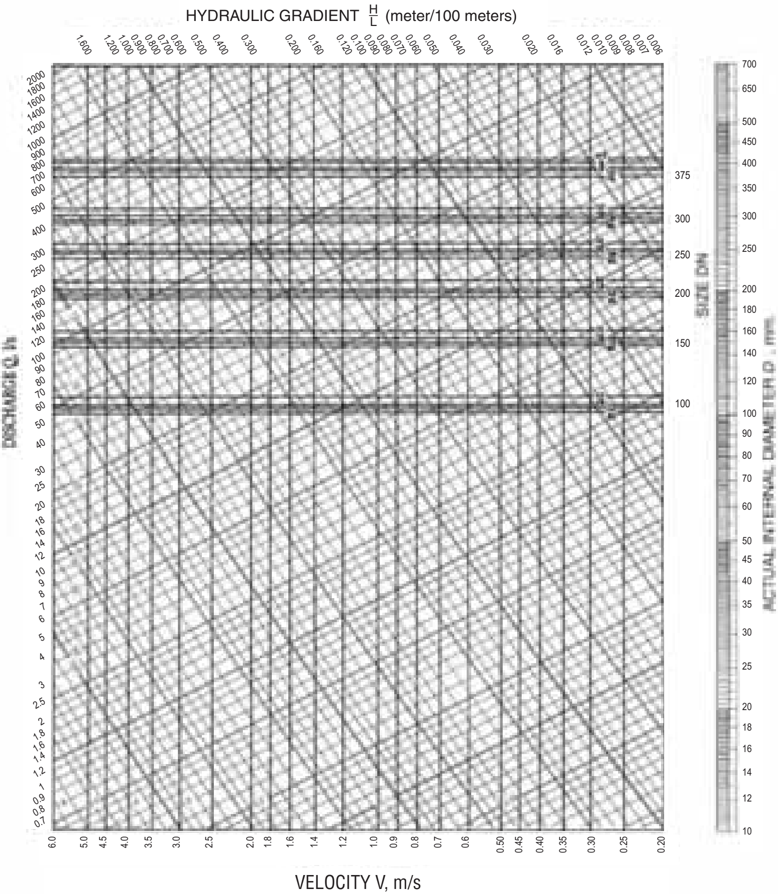
nom size	S	L1	L2	L3
100	157	46-52	134	130
150	221	60-70	172	155
200	288	60-70	183	171



PVC Flow Chart

- PN 4.5 to PN 20

AS1477 PVC (Marley Super Blue)

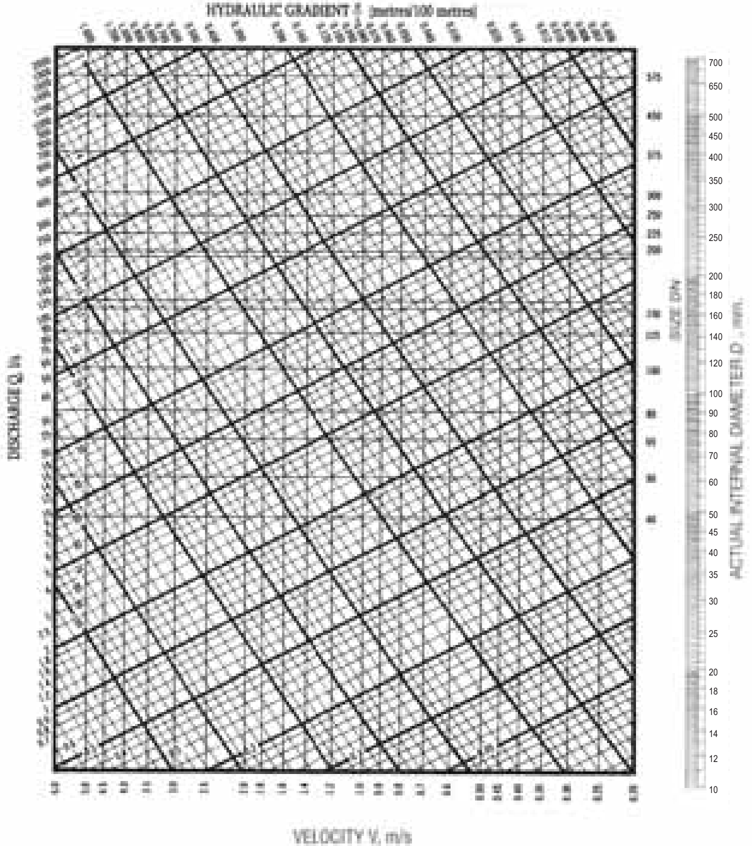


Hydraulic design of pipes k = 0.003mm based on Colebrook-White formula for pipes flowing full with water at 20˚c

PVC Flow Chart

- PN 6

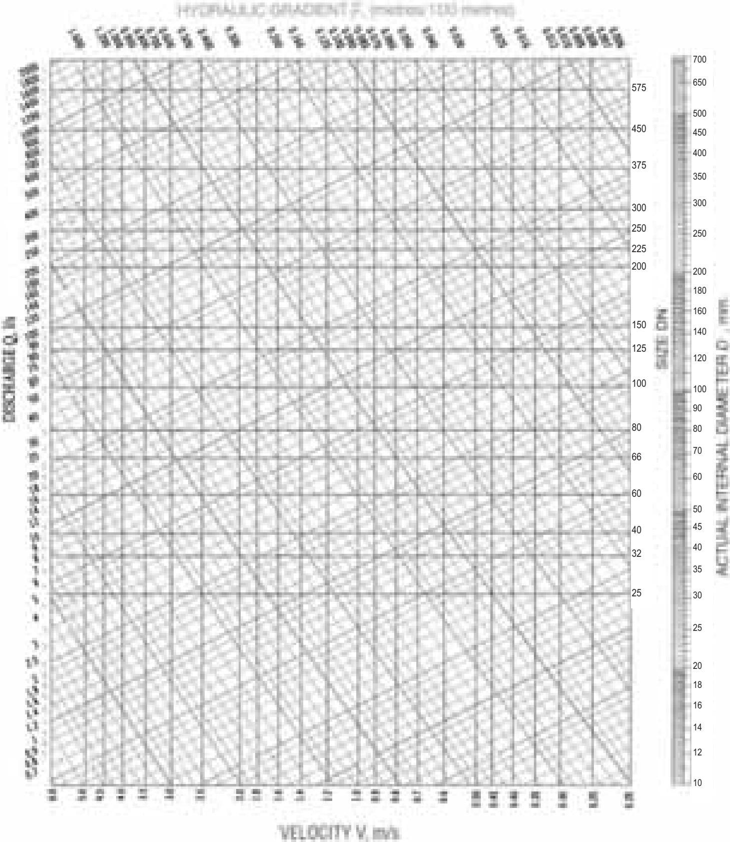
AS1477 Series 1



PVC Flow Chart

- PN 9

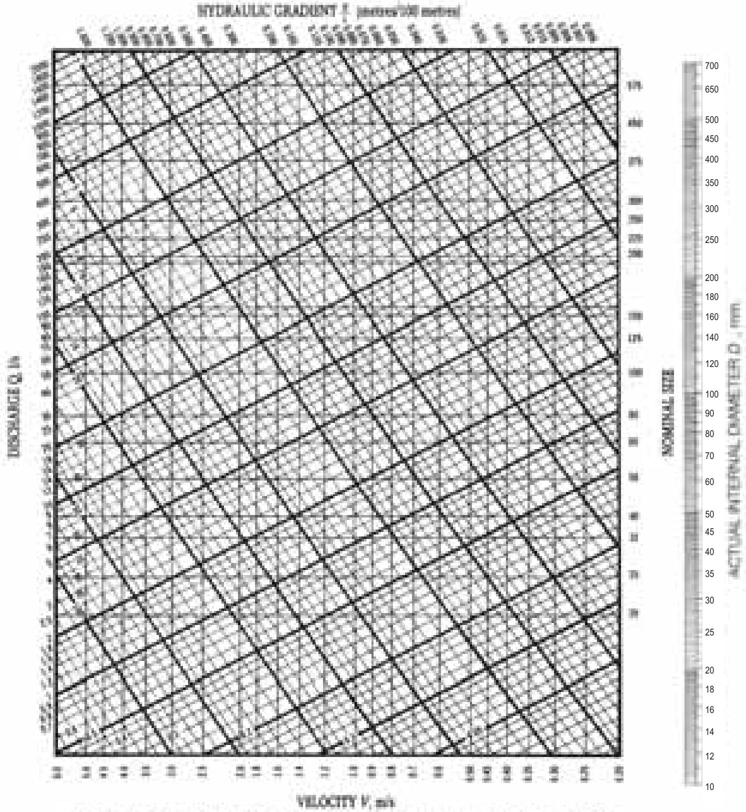
AS1477 Series 1



PVC Flow Chart

- PN 12

AS1477 Series 1

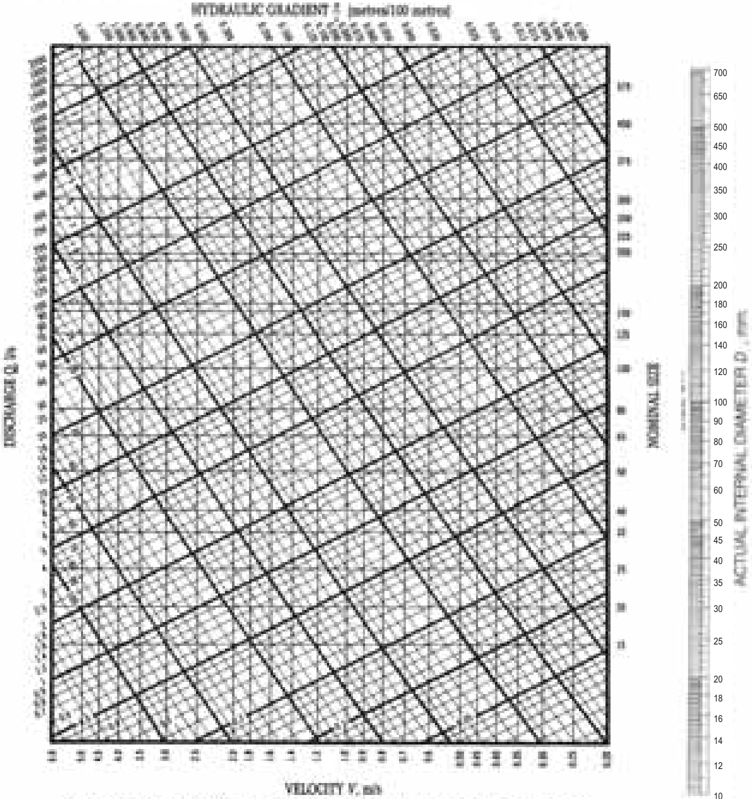


Hydraulic design of pipes k = 0.003mm based on Colebrook-White formula for pipes flowing full with water at 20°C

PVC Flow Chart

- PN 15

AS1477 Series 1

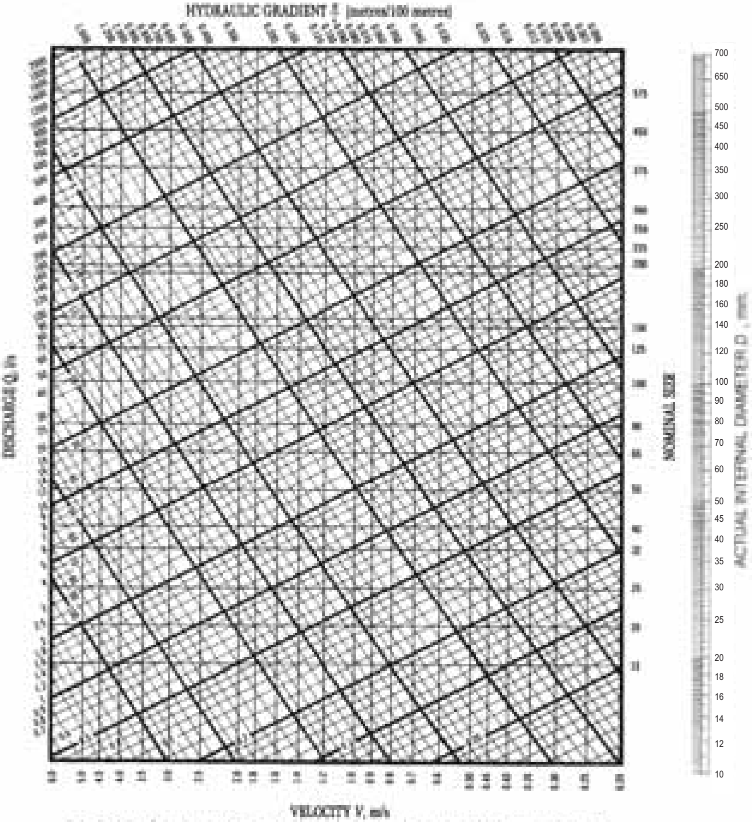


Hydraulic design of pipes k = 0.003mm based on Colebrook-White formula for pipes flowing full with water at 20°C

PVC Flow Chart

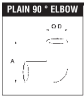
- PN 18

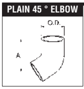
AS1477 Series 1

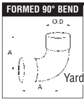


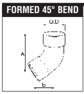
Hydraulic design of pipes k = 0.003mm based on Colebrook-White formula for pipes flowing full with water at 20°C

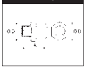
Fitting Dimensions

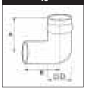
DESCRIPTION		CODE	NOMINAL SIZE	A	O.D.
PLAIN 90 ° ELBOW 		801-15-90	15	49	28
		801-20-90	20	59	32
		801-25-90	25	65	41
		801-32-90	32	94	51
		801-40-90	40	112	57
		801-50-90	50	101	69
		801-65-90	65	135	84
		801-80-90	80	145	102
		801-100-90	100	202	135
	G1361	801-125-90	125	234	163
		801-150-90	150	271	178
	G106	801-175-90	175		
		801-200-90	200	357	248
	Not on list	801-225-90	225		
	Not on list	801-300-90	300		

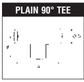
DESCRIPTION		CODE	NOMINAL SIZE	A	O.D.
PLAIN 45 ° ELBOW 		801-15-45	15	57	25
		801-20-45	20	52	33
		801-25-45	25	49	41
		801-32-45	32	78	50
		801-40-45	40	77	51
		801-50-45	50	83	69
		801-65-45	65	117	88
		801-80-45	80	145	104
		801-100-45	100	165	135
	G0082	801-125-45	125		
	G0102	801-150-45	150	231	179
		801-175-45	175	287	230
		801-200-45	200	300	260
	Not on list	801-225-45	225		
	Not on list	801-300-45	300		

DESCRIPTION		CODE	NOMINAL SIZE	A	O.D.
FORMED 90° BEND 		803-15D-90	15	63	25
		803-20D-90	20	148	31
		803-25D-90	25	166	38
		803-32D-90	32	199	48
		803-40D-90	40	135	55
		803-50D-90	50	309	69
	Yard	803-65D-90	65		
		803-80D-90	80	374	100
		803-100D-90	100	471	131
	Yard	803-125D-90	125	578	162
	Not on list	803-150D-90	150		
	Yard	803-175D-90	175		
		803-200D-90	200		
	Not on list	803-225C-90	225		
	Not on list	803-300C-90	300		

DESCRIPTION		CODE	NOMINAL SIZE	A	B	O.D.
FORMED 45° BEND 		803-15D-45	15	180	71	25
		803-20D-45	20	177	76	31
		803-25D-45	25	203	78	38
		803-32D-45	32	215	78	48
		803-40D-45	40	250	113	55
		803-50D-45	50	246	115	68
	Yard	803-65D-45	65			
		803-80D-45	80	326	182	99
		803-100D-45	100	648	333	125
	Yard	803-125D-45	125			
	Yard	803-150D-45	150			
	Not on list	803-175D-45	175			
	Yard	803-200D-45	200			
	Not on list	803-225D-45	225			
	Not on list	803-300D-45	300			

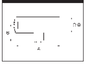
DESCRIPTION	CODE	NOMINAL SIZE	A	O.D.
REDUCING VALVE ADAPTOR 	817-20-15	20x15	45	31
	817-25-20	25x20	49	37
	817-32-15	32x15	54	42
	817-32-25	32x25	58	47
	817-40-32	40x32	63	57
	817-50-32	50x32	69	60

DESCRIPTION	CODE	NOMINAL SIZE	A	B	O.D.@ socket
M & F RRJ FORMED BEND 90° 	Z803-50D-90	50			
	Z803-65D-90	65	440	400	75
	Z803-80D-90	80	523	476	89
	Z803-100D-90	100	475		
	Z803-125D-90	125			
	Z803-150D-90	150			
	Z803-175D-90	175	989	985	246
	Z803-200D-90	200	1013	976	282
	Z803-225C-90	225			
	Z803-300C-90	300			
45° 	803-50D-45	50			
	803-65D-45	65	565	281	102
	803-80D-45	80			
	803-100D-45	100			
	803-125D-45	125			
	803-150D-45	150			
	803-175D-45	175			
	803-200D-45	200			
	803-225D-45	225			
	803-300D-45	300			

DESCRIPTION		CODE	NOMINAL SIZE	A	B	O.D.
PLAIN 90° TEE 		804-15	15	89	45	26
		804-20	20	65	33	33
		804-25	25	125	62	40
		804-32	32	138	69	52
		804-40	40	166	83	57
		804-50	50	192	97	70
		804-65	65	185	93	84
		804-80	80	214	107	106
		804-100	100	233	118	131
		804-125	125	308	154	173
		804-150	150	347	166	179
		804-175	175	415	209	229
		804-200	200	464	230	249
	Yard	804-225	225			
		804-300	300	1020	670	335

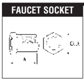
Fitting Dimensions

PLAIN 90° REDUCING TEE



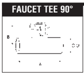
CODE	NOMINAL SIZE	A	B	O.D.
805-20-15	20x15	86	43	31
805-25-15	25x15	60	35	41
805-25-20	25x20	93	47	39
805-32-20	32x20	96	46	53
805-32-25	32x25	96	46	53
805-40-15	40x15	118	50	58
805-40-25	40x25	102	49	60
805-40-32	40x32	111	57	58
805-50-15	50x15	98	52	71
805-50-20	50x20	114	55	75
805-50-25	50x25	111	60	71
805-50-32	50x32	119	64	71
805-50-40	50x40	125	65	71
805-80-25	80x25	134	68	103
805-80-32	80x53	161	72	102
805-80-40	80x40	199	81	104
805-80-50	80x50	200	88	104
805-100-50	100x50	189	99	132
805-100-80	100x80	222	127	132

FAUCET SOCKET



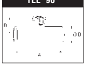
CODE	NOMINAL SIZE	A	O.D.
806.15	15	98	39
806-20	20	57	43
806-25	25	57	49
806-32	32	62	60
806-40	40	69	66
806-50	50	71	81
806-65	65	84	96
806-80	80	94	113
806-100	100	112	144

FAUCET TEE 90°



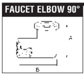
CODE	NOMINAL SIZE	A	B	O.D.
807-15-90	15	89	32	26
807-20-90	20	86	44	31
807-25-90	25	92	46	39

FAUCET REDUCING TEE 90°



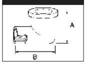
CODE	NOMINAL SIZE	A	B	O.D.
807-20-15-90	20x15	54	32	33
807-25-15-90	25x15	60	40	31
807-25-20-90	25x20	92	46	39

FAUCET ELBOW 90°



CODE	NOMINAL SIZE	A	B	O.D.
808-15-90	15	44	58	27
808-20-90	20	54	54	34
808-25-90	25	66	47	39
808-32-90	32	80	55	51

FAUCET REDUCING ELBOW 90°

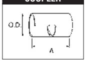


CODE	NOMINAL SIZE	A	B	O.D.
808-25-15-90	25X15	66	47	39
808-25-20-90	25X20	66	46	39

EXPANSION COUPLER

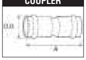
CODE	NOMINAL SIZE	A	O.D.
809-15	15	126	47
809-20	20	138	153
809-25	25	141	61
809-32	32	149	73
809-40	40	175	80
809-50	50	185	93
809-100	100	313	162

PLAIN SOCKET COUPLER



CODE	NOMINAL SIZE	A	O.D.
810-15	15	54	27
810-20	20	66	34
810-25	25	53	39
810-32	32	58	49
810-40	40	65	56
810-50	50	77	70
810-65	65	110	66
810-80	80	105	103
810-100	100	126	133
810-125	125	184	165
810-150	150	184	190
810-175	175		
810-200	200	239	248
810-225	225		
810-300	300	570	347

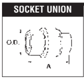
RRJ SOCKET COUPLER



CODE	NOMINAL SIZE	A	O.D.
Z810-50	50		
Z810-65	65		
Z810-80	80		
Z810-100	100		
Z810-125	125	402	180
Z810-150	150	448	202
Z810-175	175	450	146
Yard Z810-200	200		
Z810-225	225	490	272
Yard Z810-300	300		

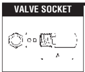
Fitting Dimensions

SOCKET UNION



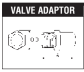
CODE	NOMINAL SIZE	A	O.D.
811-15	15	67	56
811-20	20	67	63
811-25	25	74	70
811-32	32	81	83
811-40	40	91	96
811-50	50	98	111

VALVE SOCKET



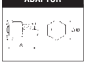
CODE	NOMINAL SIZE	A	O.D.
813-15	15	51	30
813-20	20	68	33
813-25	25	72	42
813-32	32	78	55
813-40	40	91	62
813-50	50	107	75
813-65	65	93	92
813-80	80	93	113
813-100	100	112	144

VALVE ADAPTOR



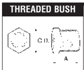
CODE	NOMINAL SIZE	A	O.D.
817-15	15	43	31
817-20	20	47	37
817-25	25	53	47
817-32	32	60	57
817-40	40	64	63
817-50	50	79	80
817-80	165	113	152
817-100	186	144	154

REDUCED FAUCET ADAPTOR



CODE	NOMINAL SIZE	A	O.D.
819-15-15	15x15	42	34
819-25-15	25x15	45	36
819-25-20	25x20	49	40
819-32-25	32x25	55	49
819-40-25	40x25	58	54
819-50-15	50x15	56	65
819-50-25	50x25	62	65
819-50-50	50x50	68	81

THREADED BUSH

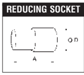


CODE	NOMINAL SIZE	A	O.D.
818-20-15	20X15	26	36
818-25-20	25X20	30	37

PLAIN CROSS (Rated PN9 Only)

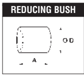
CODE	NOMINAL SIZE	A	O.D.
820-15	15	64	28
820-20	20	84	34
820-25	25	98	41
820-32	32	114	52
820-40	40	124	59
820-50	50	139	71

REDUCING SOCKET



CODE	NOMINAL SIZE	A	O.D.
823-20-15	20X15	46	33
823-25-15	25X15	53	42
823-25-20	25X20	52	39
823-32-25	32X25	66	50
823-40-20	40X20	64	57
823-40-32	40X32	72	57
823-50-40	50X40	75	70
823-65-50	65X50	104	86
823-80-50	80X50	100	103
823-80-65	80X65	120	101
823-100-50	100X50	116	133
823-100-80	100X80	124	133
823-125-100	125X100	78	48
823-150-125	150X125	205	198
823-150-100	150X100	183	187
823-155-150	155X150	218	197

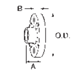
REDUCING BUSH



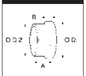
CODE	NOMINAL SIZE	A	O.D.
824-20-15	20x15	21	27
824-25-15	25x15	25	33
824-25-20	25x20	32	38
824-32-25	32x25	35	48
824-40-25	40x25	79	48
824-40-32	40x32	30	48
824-50-25	50x40	37	60
824-50-40	65x50	48	70
824-65-50	80x50	45	75
824-80-50	80x65	53	89
824-80-65	80x65	51	89
824-100-50	100x50	63	115
824-100-80	100x80	61	114
824-125-100	125x100	79	139
824-150-100	150x100	88	161
824-150-125	150x125	86	160
824-175-150	175x150	109	200
824-200-150	200x150	155	225
824-200-175	200x175		
824-300-225	300x225		

Fitting Dimensions

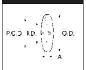
DESCRIPTION	CODE	NOMINAL SIZE	A	B	O.D.
FULL FACE FLANGE	825-15	15	28	13	96
	825-20	20	30	13	102
	825-25	25	33	30	115
	825-32	32	121	13	33
	825-40	40	42	13	132
	825-50	50	46	13	153
	825-65	65	67	13	169
	825-80	80	57	13	184
	825-100	100	68	16	216
	825-125	125	99	19	253
	825-150	150	98	20	280



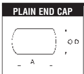
DESCRIPTION	CODE	NOMINAL SIZE	A	B	O.D.	O.D.2
STUB FLANGE	826-50	50	39	14	97	74
	826-65	65	55	10	106	89
	826-80	80	69	12	129	106
	826-100	100	75	13	161	137
	826-125	125	81	14	188	165
	826-150	150	91	17	212	188
	826-200	200	126	26	273	245
G0722	826-225	225				
	826-300	300	178	32	376	346



DESCRIPTION	CODE	NOMINAL SIZE	A	O.D.	P.C.D.	I.D.
METAL BACKING RING	827-50	50	11	163	118	77
	827-65	65	11	165	129	92
	827-80	80	10	189	150	113
	827-100	100	13	215	176	138
	827-125	125	10.5	226	210.5	166.2
	827-150	150	11	284	240	191
	827-175	175	10.5	335	295.4	235.4
	827-200	200	10	342	293	249
	827-225	225	11	372	326	276
	827-300	300	10	462	408	348

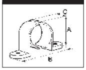


DESCRIPTION	CODE	NOMINAL SIZE	A	O.D.
PLAIN END CAP	830-15	15	26	25
	830-20	20	30	31
	830-25	25	34	39
	830-32	32	40	49
	830-40	40	46	56
	830-50	50	55	70
	830-65	65	72	86
	830-80	80	77	103
	830-100	100	93	133
	830-125	125	135	164
	830-150	150	135	190
	830-200			

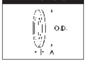


DESCRIPTION	CODE	NOMINAL SIZE	A	B	O.D.
THREADED END PLUG	837-15	15	25.1	7	30
	837-20	20	30	7	36
	837-25	25	30	8	45
	837-32	32	32.2	8	58
	837-40	40	33.2	9	63
	837-50	50	37.3	9	80
	837-80	80	53.4	20	113
	837-100	100	58	20	144

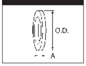
DESCRIPTION	CODE	NOMINAL SIZE	A	B	C
PIPE CLIP	840-15	15	34	59	19
	840-20	20	39	65	19
	840-25	25	52	73	19
	840-32	32	62	82	19
	840-40	40	67	87	19
	840-50	50	81	102	19



DESCRIPTION	CODE	NOMINAL SIZE	A	O.D.
NEOPRENE GASKET FOR FULL FACE FLANGE 825	842-15	15		
	842-20	20	3	56
	842-25	25	3	50
	842-32	32	3	71
	842-40	40	3	78
	842-50	50	3	92
	842-65	65	3	106
	842-80	80	3	126
	842-100	100	3	156
	842-150	150	3	217



DESCRIPTION	CODE	NOMINAL SIZE	A	O.D.
NEOPRENE GASKET FOR STUB FLANGE 826	845-50	50	3	85
	845-65	65	3	100
	845-80	80	3	115
	845-100	100	3	144
	845-125	125	3	182
	845-150	150	3	215
	845-175	175	3	255
	845-200	200	3	282
	845-225	225	10	300
	845-300	300	10	380



4. POLYETHYLENE

RETURN TO CONTENTS

Material Properties

1.1 Mechanical Properties of Polyethylene @ 20.0ºC

	PE80	PE100
Density		
-Blue	>944 kg/m^3	>950 kg/m^3
-Black	>949 kg/m^3	>959 kg/m^3
Water Abrasion		
Hardness	67% (Shore D)	67% (Shore D)
Izod Impact Strength @(-20°C)	90 J/m	90 J/m
Coefficient of Friction		
Ultimate Tensile Strength	39 N/mm^2 (50mm/min)	30 N/mm^2 (50mm/min)
Tensile strength at yield	18 MPa	22 MPa
Elongation at Break	>600%	>600%
Environmental Stress Cracking resistance	>700h	>700h
Minimum Required Strength	8.0 MPa	10.0 MPa
Elastic Flexural Modulus	700 MPa	1000 MPa
Shear Modulus	400-470 N/mm2	600 N/mm2
Charpy Impact strength	22-35 kJ/m2	17-26 kJ/m2

1.2 Electrical Properties

	PE80	PE100
Dielectric Strength	70 kV/mm	22-53 kV/mm
Specific Volume Resistivity	1015 OHM.cm	1015 OHM.cm
Surface Resistivity	>1015 OHM	>1015 OHM
Dissipation Factor	5.5 (50 Hz) 2.5 (106 Hz)	5.5 (50 Hz) 2.5 (106 Hz)

1.3 Thermal Properties

	PE80	PE100
Vicat Softening Point	116 °C	124 °C
Thermal Conductivity	0.423-0.45W/m°K	0.4W/m°K
Specific Heat	2.6 KJ/[kg.K]	2.6 KJ/[kg.K]
Brittleness Temperature	<-70 °C	<-100 °C
Linear Thermal Expansion	$1.4x10^{-4}$/K	$1.3x10^{-4}$/K

.3.0 PE80 Pipe Dimensions

Standard AS/NZS 4130

PE80: SDR 13.6 - SDR 9

		PN10 SDR 13.6				PN12.5 SDR 11				PN16 SDR 9			
Nominal Size	Mean OD	Mean Bore	T Min	T Max	Mass kg/m	Mean Bore	T Min	T Max	Mass kg/m	Mean Bore	T Min	T Max	Mass kg/m
20	20.2	16.7	1.6	1.9	0.096	16.1	1.9	2.2	0.110	15.2	2.3	2.7	0.132
25	25.2	21.1	1.9	2.2	0.142	20.2	2.3	2.7	0.168	19.2	2.8	3.2	0.199
32	32.2	27.0	2.4	2.8	0.230	26.0	2.9	3.3	0.266	24.5	3.6	4.1	0.326
40	40.2	33.8	3.0	3.4	0.353	32.3	3.7	4.2	0.423	30.6	4.5	5.1	0.507
50	50.3	42.4	3.7	4.2	0.546	40.4	4.6	5.2	0.657	38.4	5.6	6.3	0.788
63	63.3	53.3	4.7	5.3	0.870	51.0	5.8	6.5	1.038	48.2	7.1	8.0	1.256
75	75.4	63.7	5.5	6.2	1.214	61.0	6.8	7.6	1.450	57.6	8.4	9.4	1.766
90	90.5	76.5	6.6	7.4	1.744	73.1	8.2	9.2	2.102	69.1	10.1	11.3	2.548
110	110.5	93.3	8.1	9.1	2.615	89.4	10.0	11.1	3.114	84.5	12.3	13.7	3.783
125	125.6	106.1	9.2	10.3	3.371	101.5	11.4	12.7	4.041	96.1	14.0	15.5	4.880
140	140.7	118.9	10.3	11.5	4.223	113.9	12.7	14.1	5.037	107.6	15.7	17.4	6.132
160	160.8	135.9	11.8	13.1	5.512	130.0	14.6	16.2	6.612	123.1	17.9	19.8	7.986
180	180.9	152.8	13.3	14.8	6.996	146.3	16.4	18.2	8.358	138.5	20.1	22.3	10.104
200	200.9	169.9	14.7	16.3	8.577	162.5	18.2	20.2	10.302	153.7	22.4	24.8	12.488
225	226.1	191.1	16.6	18.4	10.895	182.9	20.5	22.7	13.044	173.2	25.1	27.8	15.760
250	251.2	212.4	18.4	20.4	13.421	203.4	22.7	25.1	16.043	192.5	27.9	30.8	19.433
280	281.3	237.9	20.6	22.8	16.813	227.8	25.4	28.1	20.108	215.4	31.3	34.6	24.423
315	316.5	267.6	23.2	25.7	21.311	256.3	28.6	31.6	25.458	242.4	35.2	38.9	30.901
355	356.6	301.6	26.1	28.9	27.011	288.8	32.2	35.6	32.305	273.3	39.6	43.7	39.150
400	401.8	339.9	29.4	32.5	34.256	325.4	36.3	40.1	41.017	307.8	44.7	49.3	49.769
450	452.1	382.4	33.1	36.6	43.398	366.1	40.9	45.1	51.949	346.5	50.2	55.4	62.923
500	502.3	424.9	36.8	40.6	53.546	406.8	45.4	50.1	64.096	385.0	55.8	61.5	77.657
560	562.5	475.9	41.2	45.5	67.167	455.8	50.8	56.0	80.283				
630	632.9	535.5	46.3	51.1	84.911	512.6	57.2	63.1	101.737				
710	713.2	603.4	52.2	57.6	107.862								
800	803.6	680.0	58.8	64.8	136.820								
1000	1004.5												

3.0 PE80B Pipe Dimensions

Standard AS/NZS 4130

PE80B: SDR 33 - SDR 17

		PN4 SDR 33				PN5 SDR 26				PN6.3 SDR 21				PN8 SDR17			
Nominal Size	Mean OD	Mean Bore	T Min	T Max	Mass kg/m	Mean Bore	T Min	T Max	Mass kg/m	Mean Bore	T Min	T Max	Mass kg/m	Mean Bore	T Min	T Max	Mass kg/m
20	20.2	16.7	1.6	1.9	0.096	16.7	1.6	1.9	0.096	16.7	1.6	1.9	0.096	16.7	1.6	1.9	0.096
25	25.2	21.7	1.6	1.9	0.122	21.7	1.6	1.9	0.122	21.7	1.6	1.9	0.122	21.7	1.6	1.9	0.122
32	32.2	28.7	1.6	1.9	0.159	28.7	1.6	1.9	0.159	28.7	1.6	1.9	0.159	28.1	1.9	2.2	0.184
40	40.2	36.7	1.6	1.9	0.201	36.7	1.6	1.9	0.201	36.1	1.9	2.2	0.233	35.0	2.4	2.8	0.292
50	50.3	46.8	1.6	1.9	0.254	46.0	2.0	2.3	0.309	45.1	2.4	2.8	0.370	43.9	3.0	3.4	0.450
63	63.3	59.0	2.0	2.3	0.392	58.1	2.4	2.8	0.471	56.9	3.0	3.4	0.574	55.2	3.8	4.3	0.716
75	75.4	70.4	2.3	2.7	0.544	69.2	2.9	3.3	0.669	67.7	3.6	4.1	0.822	65.8	4.5	5.1	1.011
90	90.5	84.5	2.8	3.2	0.783	83.0	3.5	4.0	0.971	81.3	4.3	4.9	1.179	79.0	5.4	6.1	1.454
110	110.5	103.2	3.4	3.9	1.164	101.9	4.3	4.9	1.454	99.2	5.3	6.0	1.768	96.5	6.6	7.4	2.162
125	125.6	117.3	3.9	4.4	1.504	115.4	4.8	5.4	1.834	112.9	6.0	6.7	2.260	109.9	7.4	8.3	2.759
140	140.7	131.5	4.3	4.9	1.868	129.2	5.4	6.1	2.316	126.5	6.7	7.5	2.831	123.1	8.3	9.3	3.464
160	160.8	150.4	4.9	5.5	2.415	147.6	6.2	7.0	3.037	144.5	7.7	8.6	3.713	140.7	9.5	10.6	4.522
180	180.9	169.2	5.5	6.2	3.056	166.3	6.9	7.7	3.782	162.7	8.6	9.6	4.666	158.3	10.7	11.9	5.720
200	200.9	187.7	6.2	7.0	3.827	184.6	7.7	8.6	4.688	180.6	9.6	10.7	5.778	175.8	11.9	13.2	7.055
225	226.1	211.5	6.9	7.7	4.767	207.9	8.6	9.6	5.894	203.3	10.8	12.0	7.305	197.8	13.4	14.9	8.951
250	251.2	234.9	7.7	8.6	5.912	230.9	9.6	10.7	7.302	226.1	11.9	13.2	8.939	220.0	14.8	16.4	10.969
280	281.3	263.1	8.6	9.6	7.393	258.7	10.7	11.9	9.106	253.0	13.4	14.9	11.282	246.3	16.6	18.4	13.778
315	316.5	296.0	9.7	10.8	9.369	290.9	12.1	13.5	11.602	284.9	15.0	16.6	14.180	277.1	18.7	20.7	17.450
355	356.6	333.6	10.9	12.1	11.844	327.9	13.6	15.1	14.658	321.0	16.9	18.7	17.999	311.1	21.1	23.4	22.203
400	401.8	375.8	12.3	13.7	15.085	369.5	15.3	17.0	18.588	361.5	19.1	21.2	22.952	351.9	23.7	26.2	28.062
450	452.1	423.0	13.8	15.3	19.000	415.8	17.2	19.1	23.507	406.8	21.5	23.8	29.030	395.9	26.7	29.5	35.559
500	502.3	470.0	15.3	17.0	23.432	462.0	19.1	21.2	28.996	452.0	23.9	26.4	35.815	440.0	29.6	32.7	43.802
560	562.5	526.3	17.2	19.1	29.487	517.4	21.4	23.7	36.339	506.4	26.7	29.5	44.817	492.7	33.2	36.7	55.028
630	632.9	592.2	19.3	21.4	37.203	582.1	24.1	26.7	46.053	569.8	30.0	33.1	56.624	554.4	37.3	41.2	69.541
710	713.2	667.3	21.8	24.1	47.278	655.9	27.2	30.1	58.533	641.9	33.9	37.4	72.090	624.6	42.1	46.5	88.438
800	803.6	752.0	24.5	27.1	59.891	739.2	30.6	33.8	74.133	723.4	38.1	42.1	91.375	703.9	47.4	52.3	112.141
1000	1004.5	940.1	30.6	33.8	93.439	924.1	38.2	42.2	115.694	904.2	47.7	52.6	142.841	879.8	59.3	65.4	175.319

PE100 Pipe Dimensions

Standard AS/NZS 4130

		PN4 SDR 41				PN6.3 SDR 26				PN8 SDR 21			
Nominal Size	Mean OD	Mean Bore	T Min	T Max	Mass kg/m	Mean Bore	T Min	T Max	Mass kg/m	Mean Bore	T Min	T Max	Mass kg/m
20	20.2	16.7	1.6	1.9	0.096	16.7	1.6	1.9	0.096	16.7	1.6	1.9	0.096
25	25.2	21.7	1.6	1.9	0.122	21.7	1.6	1.9	0.122	21.7	1.6	1.9	0.122
32	32.2	28.7	1.6	1.9	0.159	28.7	1.6	1.9	0.159	28.7	1.6	1.9	0.159
40	40.2	36.7	1.6	1.9	0.201	36.7	1.6	1.9	0.201	36.1	1.9	2.2	0.233
50	50.3	46.8	1.6	1.9	0.254	46.0	2.0	2.3	0.309	45.1	2.4	2.8	0.370
63	63.3	59.0	2.0	2.3	0.392	58.1	2.4	2.8	0.471	56.9	3.0	3.4	0.574
75	75.4	70.4	2.3	2.7	0.544	69.2	2.9	3.3	0.669	67.7	3.6	4.1	0.822
90	90.5	85.5	2.3	2.7	0.783	83.0	3.5	4.0	0.971	81.3	4.3	4.9	1.179
110	110.5	104.7	2.7	3.1	1.164	101.3	4.3	4.9	1.454	99.2	5.3	6.0	1.768
125	125.6	118.9	3.1	3.6	1.504	115.4	4.8	5.4	1.834	112.9	6.0	6.7	2.260
140	140.7	133.2	3.5	4.0	1.868	129.2	5.4	6.1	2.316	126.5	6.7	7.5	2.831
160	160.8	152.3	4.0	4.5	2.415	147.6	6.2	7.0	3.037	144.5	7.7	8.6	3.713
180	180.9	171.5	4.4	5.0	3.056	166.3	6.9	7.7	3.782	162.7	8.6	9.6	4.666
200	200.9	190.5	4.9	5.5	3.827	184.6	7.7	8.6	4.688	180.6	9.6	10.7	5.778
225	226.1	214.4	5.5	6.2	4.767	207.9	8.6	9.6	5.894	203.3	10.8	12.0	7.305
250	251.2	238.0	6.2	7.0	5.912	230.9	9.6	10.7	7.302	226.1	11.9	13.2	8.939
280	281.3	266.7	6.9	7.7	7.393	258.7	10.7	11.9	9.106	253.0	13.4	14.9	11.282
315	316.5	300.2	7.7	8.6	9.369	290.9	12.1	13.5	11.602	284.9	15.0	16.6	14.180
355	356.6	338.2	8.7	9.7	11.844	327.9	13.6	15.1	14.658	321.0	16.9	18.7	17.999
400	401.8	381.1	9.8	10.9	15.085	369.5	15.3	17.0	18.588	361.5	19.1	21.2	22.952
450	452.1	428.9	11.0	12.2	19.000	415.8	17.2	19.1	23.507	406.8	21.5	23.8	29.030
500	502.3	476.3	12.3	13.7	23.432	462.0	19.1	21.2	28.996	452.0	23.9	26.4	35.815
560	562.5	533.6	13.7	15.2	29.487	517.4	21.4	23.7	36.339	506.4	26.7	29.5	44.817
630	632.9	600.4	15.4	17.1	37.203	582.1	24.1	26.7	46.053	569.8	30.0	33.1	56.624
710	713.2	676.5	17.4	19.3	47.278	656.2	27.2	30.1	58.533	641.9	33.9	37.4	72.090
800	803.6	762.3	19.6	21.7	59.891	739.2	30.6	33.8	74.133	723.4	38.1	42.1	91.375
1000	1004.5	952.9	24.5	27.1	93.439	924.1	38.2	42.2	115.694	904.2	47.7	52.6	142.841

PE100: SDR 17 - SDR 11

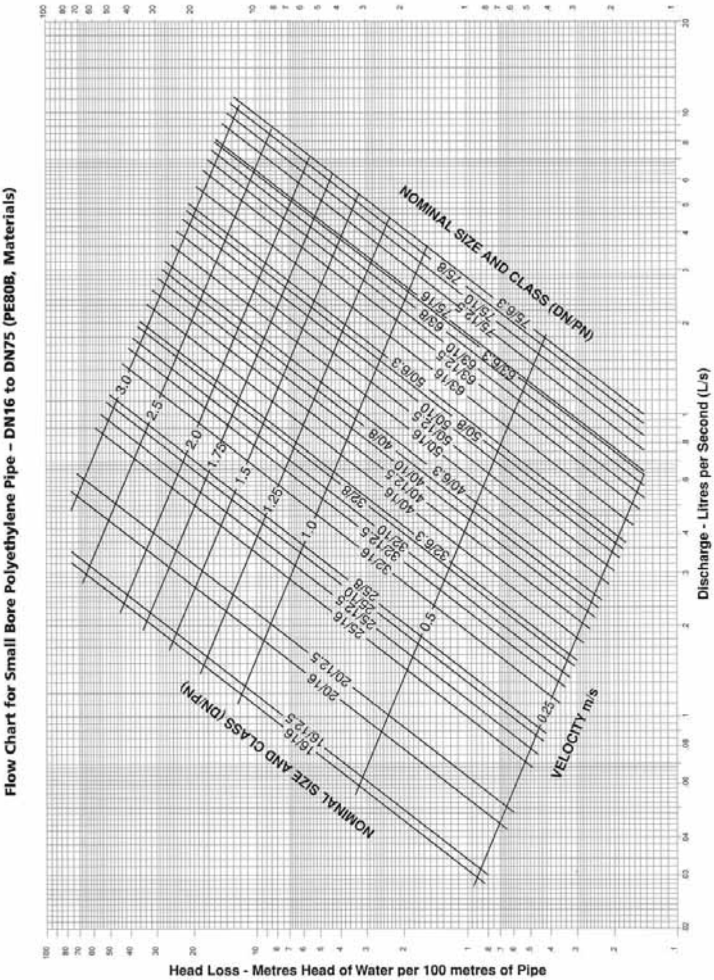
PE100 Pipe Dimensions

Standard AS/NZS 4130

		PN10 SDR 17				PN12.5 SDR 13.6				PN16 SDR 11			
Nominal Size	**Mean OD**	**Mean Bore**	**T Min**	**T Max**	**Mass kg/m**	**Mean Bore**	**T Min**	**T Max**	**Mass kg/m**	**Mean Bore**	**T Min**	**T Max**	**Mass kg/m**
20	20.2	16.7	1.6	1.9	0.096	16.7	1.6	1.9	0.096	16.1	1.9	2.2	0.110
25	25.2	21.7	1.6	1.9	0.122	21.1	1.9	2.2	0.142	20.2	2.3	2.7	0.168
32	32.2	28.1	1.9	2.2	0.184	27.0	2.4	2.8	0.230	26.0	2.9	3.3	0.266
40	40.2	35.0	2.4	2.8	0.292	33.8	3.0	3.4	0.353	32.3	3.7	4.2	0.423
50	50.3	43.9	3.0	3.4	0.450	42.4	3.7	4.2	0.546	40.4	4.6	5.2	0.657
63	63.3	55.2	3.8	4.3	0.716	53.3	4.7	5.3	0.870	51.0	5.8	6.5	1.038
75	75.4	65.8	4.5	5.1	1.011	63.7	5.5	6.2	1.214	61.0	6.8	7.6	1.450
90	90.5	79.0	5.4	6.1	1.454	76.5	6.6	7.4	1.744	73.1	8.2	9.2	2.102
110	110.5	96.5	6.6	7.4	2.162	93.3	8.1	9.1	2.615	89.4	10.0	11.1	3.114
125	125.6	109.9	7.4	8.3	2.759	106.1	9.2	10.3	3.371	101.5	11.4	12.7	4.041
140	140.7	123.1	8.3	9.3	3.464	118.9	10.3	11.5	4.223	113.9	12.7	14.1	5.037
160	160.8	140.7	9.5	10.6	4.522	135.9	11.8	13.1	5.512	130.0	14.6	16.2	6.612
180	180.9	158.3	10.7	11.9	5.720	152.8	13.3	14.8	6.996	146.3	16.4	18.2	8.358
200	200.9	175.8	11.9	13.2	7.055	169.9	14.7	16.3	8.577	162.5	18.2	20.2	10.302
225	226.1	197.8	13.4	14.9	8.951	191.1	16.6	18.4	10.895	182.9	20.5	22.7	13.044
250	251.2	220.0	14.8	16.4	10.969	212.4	18.4	20.4	13.421	203.4	22.7	25.1	16.043
280	281.3	246.3	16.6	18.4	13.778	237.9	20.6	22.8	16.813	227.8	25.4	28.1	20.108
315	316.5	277.1	18.7	20.7	17.450	267.6	23.2	25.7	21.311	256.3	28.6	31.6	25.458
355	356.6	311.1	21.1	23.4	22.203	301.6	26.1	28.9	27.011	288.8	32.2	35.6	32.305
400	401.8	351.9	23.7	26.2	28.062	339.9	29.4	32.5	34.256	325.4	36.3	40.1	41.017
450	452.1	395.9	26.7	29.5	35.559	382.4	33.1	36.6	43.398	366.1	40.9	45.1	51.949
500	502.3	440.0	29.6	32.7	43.802	424.9	36.8	40.6	53.546	406.8	45.4	50.1	64.096
560	562.5	492.7	33.2	36.7	55.028	475.9	41.2	45.5	67.167	455.8	50.8	56.0	80.283
630	632.9	554.4	37.3	41.2	69.541	535.5	46.3	51.1	84.911	512.6	57.2	63.1	101.737
710	713.2	624.6	42.1	46.5	88.438	603.4	52.2	57.6	107.862				
800	803.6	703.9	47.4	52.3	112.141	680.0	58.8	64.8	136.820				
1000	1004.5	879.8	59.3	65.4	175.319								

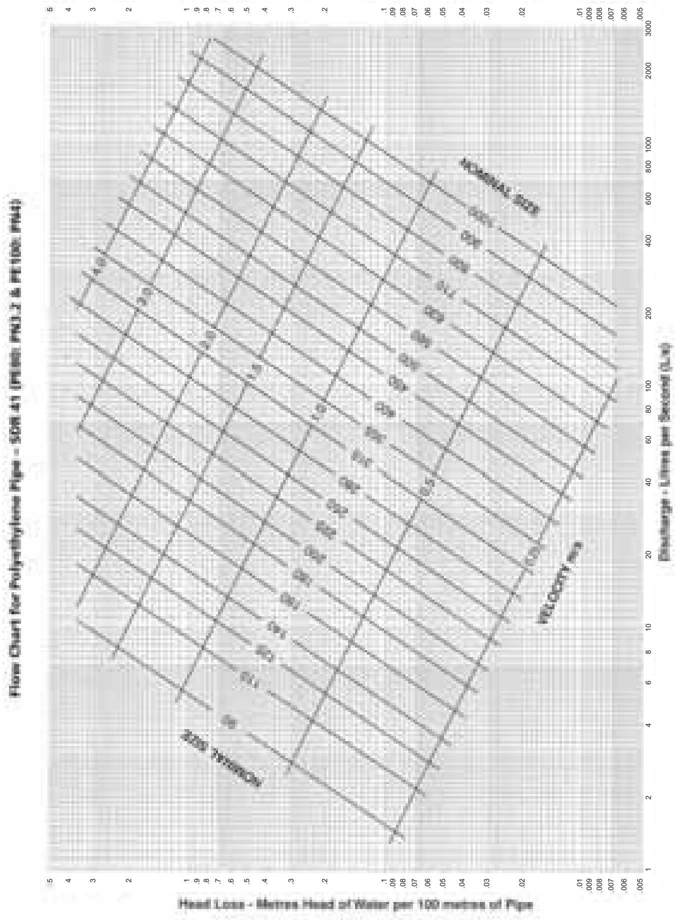
Flow Chart

Small Bore Polyethylene Pipe - DN16 to DN75 (PE80B Materials)



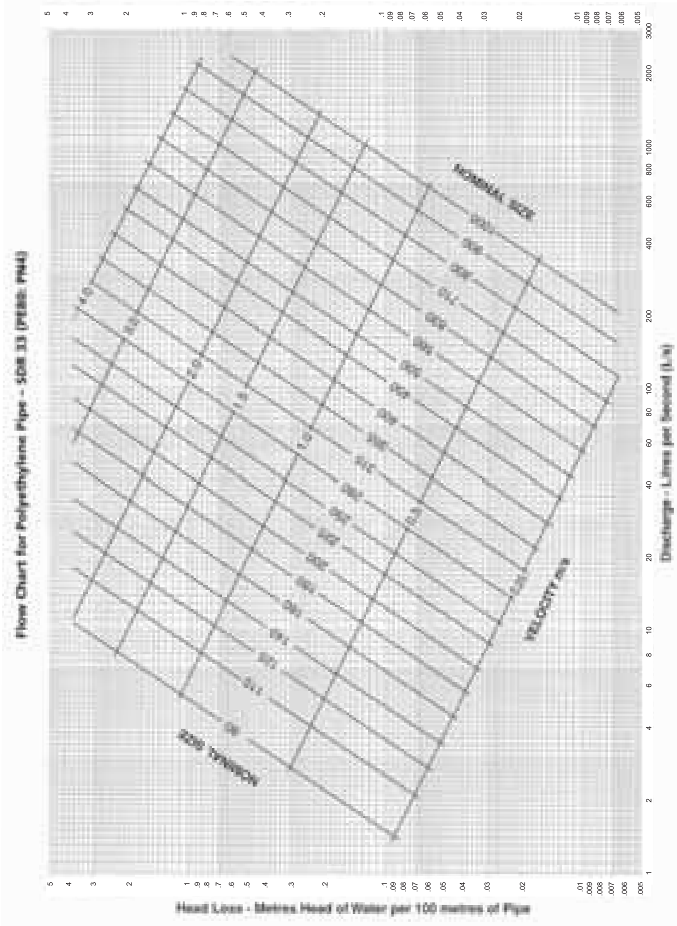
Flow Chart

Polyethylene Pipe - SDR 41
(PE80: PN3.2 & PE100: PN4)



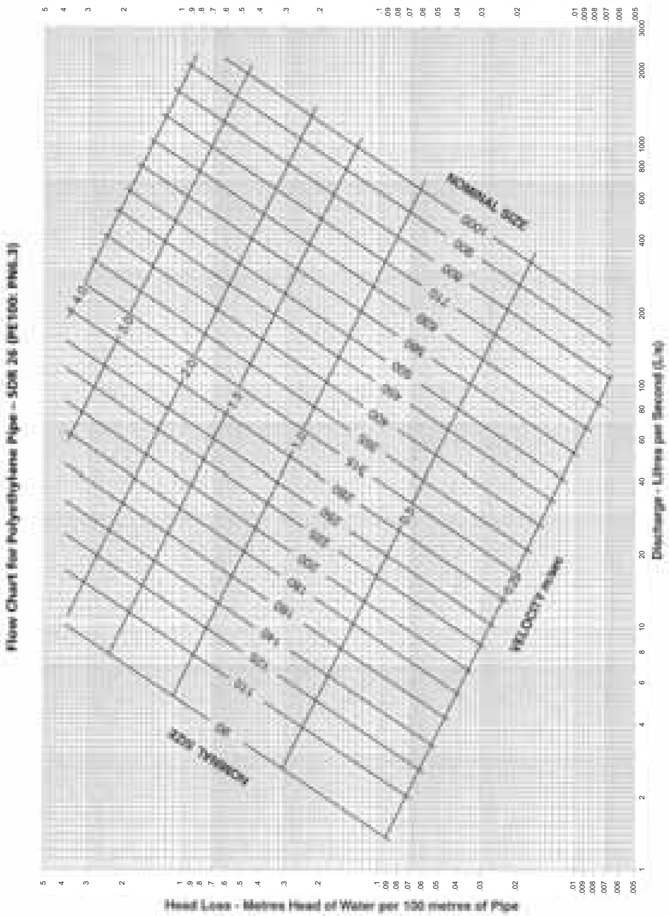
Flow Chart

Polyethylene Pipe - SDR 33
(PE80: PN4)



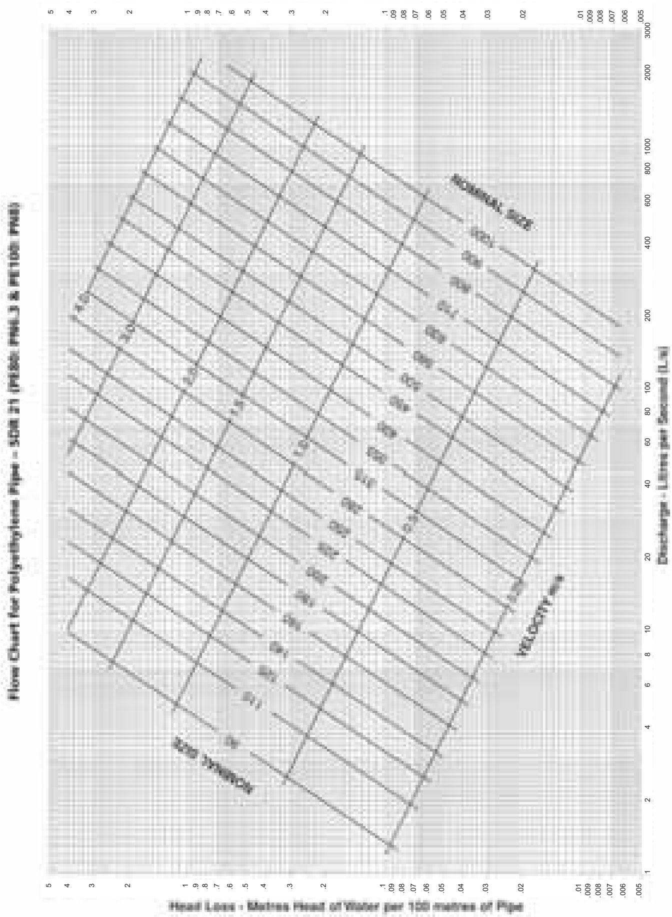
Flow Chart

Polyethylene Pipe - SDR 26
(PE 100: PN6.3)



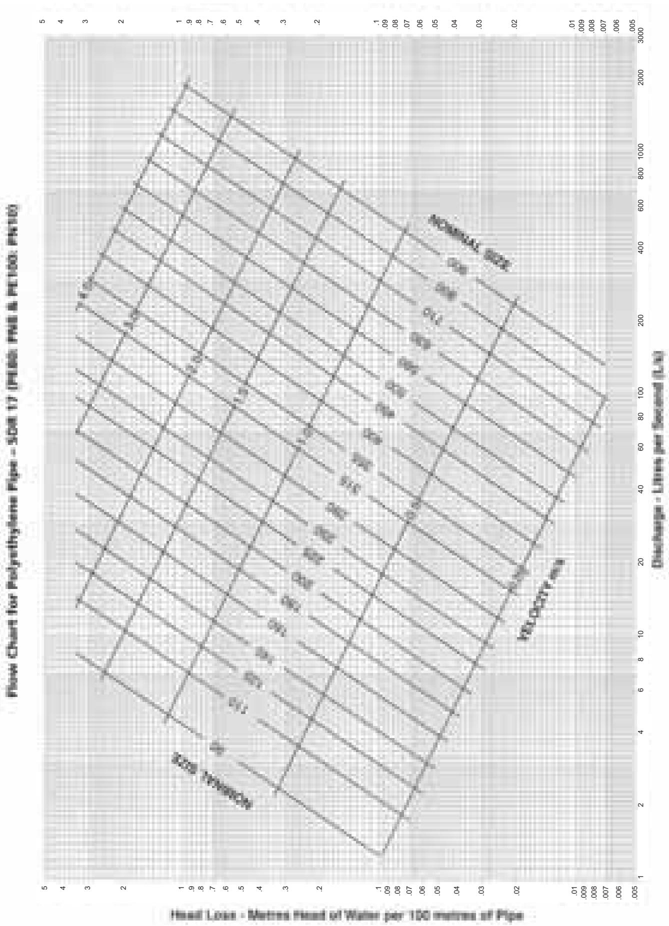
Flow Chart

Polyethylene Pipe - SDR 21
(PE 80: PN6.3 & PE100: PN8)



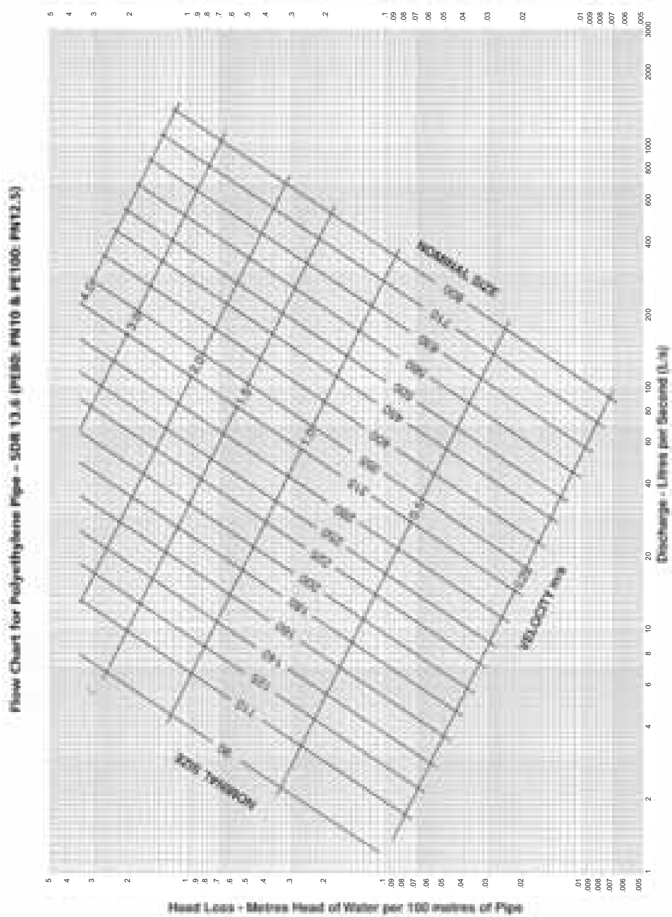
Flow Chart

Polyethylene Pipe - SDR 17
(PE 80: PN8 & PE100: PN10)



Flow Chart

Polyethylene Pipe - SDR 13.6
(PE 80: PN10 & PE100: PN12.5)



Flow Chart

Polyethylene Pipe - SDR 11
(PE80: PN 12.5 & PE100: PN16)