IRONTITE® DUCTILE IRON PIPE

HYDRAULIC DESIGN

HYDRAULIC PERFORMANCE

To assist the designer in selecting the appropriate diameter, pipe flow charts based on the Colebrook White Transition Equation have been prepared for the designer to determine the relationship between friction loss, discharge and velocity for all available diameters of the Irontite® ductile iron pipe range.

The Irontite® ductile iron flow resistance charts have been limited to the following predetermined parameters,

1. Temperature @ 20°C, which is considered to be a suitable mean value for Australian conditions.
2. Kinematic viscosity of water, u = 1.01 x 10^{-6} m^2/s and
3. Equivalent wall roughness coefficients k = 0.01 mm, 0.03mm and 0.06mm for cement mortar lined pipes with or without seal coats.

ROUGHNESS COEFFICIENTS

The equivalent roughness coefficients value "k" assumes the Irontite® ductile iron pipeline is straight, clean and concentrically jointed without fillings. Possible values ranging between 0.01 to 0.06mm for cement-lined pipes are given in AS 2200 "Design charts for water supply and sewerage".

The lower value in the range represents the expected value for clean, new pipes laid straight. The higher value in the range represents the typical maximum expected for ductile iron pipes. Il cannot be an absolute maximum, as the factors detailed below can lead to even higher roughness values in some circumstances.

Factors that will influence the roughness coefficients are listed as follows:

- Roughening, due to wear by abrasive solids
- Siltation or settlement of suspended particulate matter
- Joint imperfections and filling types and configurations
- Growth of slime which will vary with the age of the pipeline and available nutrient in the water
- Deterioration of unlined ferrous surfaces.

Please note, it is important to ensure an appropriate roughness coefficient is selected for the given circumstances. Designers may assume a higher value is better and provides a high factor of safety. In fact, when dealing with hydraulic systems this is not necessarily the case. Choosing a value that is too high is equally detrimental to the design as choosing a value that is too low.

Where, for instance the system is a pumped main the choice of pumps will be compromised by choosing an inappropriate value for the roughness coefficient. A value that is too high will result in pumps being oversized meaning they will not run at their best efficiency point (B.E.P) and will likely cause issues such as cavitations and possibly premature failure of the pumps. A value that is too low will result in pumps being undersized meaning they will not run at their B.E.P and will result in flow starvation.

WATER TEMPERATURE

The kinematic viscosities for water at various temperatures are given in AS 2200 "Design charts for water supply and sewerage". An approximate allowance for the effect of variation in water temperature can be made by increasing the chart value of the head loss by 1% for each 3°C below 20°C and by decreasing it by 1% for each 3°C in excess of 20°C.

IRONTITE® DUCTILE IRON PIPE

Iplex Pipelines

HYDRAULIC DESIGN

DESIGN

The flow charts provide a convenient graphical mean and are sufficiently accurate for most practical purpose. The roughness coefficient 'k' shown in 'Hydraulic performance' is for raw and potable water. Calculations are based on the Colebrook White Transition Equation and it is assumed pipes are flowing full.

$$v = 2\sqrt{2gDS}\,\log\left[\frac{k}{3.7D} + \frac{2.5/v}{d\sqrt{2gDS}\,\log}\right]$$

Where
k = Colebrook White roughness coefficient, in (m)
v = Velocity, in (m/s)
D = Circular cross-section of pipe, inside diameter, in (m)
S = Slope, in (m/m)
g = gravitational acceleration, in (m/s^2)

This equation takes into account, liquid viscosity and pipe roughness and is commonly used for pipeline design in Australia. It is also regarded throughout the world as the most accurate basis for hydraulic design.

RESISTANCE LOSSES IN FITTINGS

The flow resistance losses in fillings can be related to the equivalent losses in metres of straight pipe. These losses can then be added to the length of the main pipe in order to determine the total friction loss of the system.

Resistance losses at fillings are calculated as follows:

$$H_L = \frac{kv^2}{2g}$$

Where
HL = approximate head loss in meters of water
k = Value of coefficient
v = Velocity in m/s
g = acceleration due to gravity in m/s^2
Resistance coefficients of valves and fillings can be obtained from AS 2200 "Design charts for water supply and sewerage"

DESIGN FLOW VELOCITIES

The Water Services Association of Australia Code WSA 03 design recommendations can be applied to ductile iron pipe installations. In pumped transmission mains where capital cost and discounted running costs are taken into account the Code suggests that the most economic design will have velocities in the range 1 to 2m/s. However there may be circumstances where 2.0m/s is acceptable or 4m/s for short periods. The water agency's advice shall be sought when velocities in excess of 3m/s are being considered on cement-lined pipes.

To facilitate economic designs, the head losses should not exceed 5m/km $\leq$ DN150 and 3m/km for pipes $\leq$ DN2000. Where the pipeline is carry clean water the design velocity should not exceed 4m/s.