Hazen-Williams Formula

Empirical formulae are sometimes used to calculate the approximate head loss in a pipe when water is flowing and the flow is turbulent. Prior to the availability of personal computers the Hazen-Williams formula was very popular with engineers because of the relatively simple calculations required.

Unfortunately the results depend upon the value of the friction factor C_{hw} which must be used with the formula and this can vary from around 80 up to 130 and higher, depending on the pipe type, pipe size and the water velocity.

The imperial form of the Hazen-Williams formula is:

$$h_f = 0.002083\, L\, (100/C)^{1.85} \times (gpm^{1.85}/d^{4.8655})$$

where:
h_f = head loss in feet of water
L = length of pipe in feet
C = friction coefficient
gpm = gallons per minute (USA gallons not imperial gallons)
d = inside diameter of the pipe in inches

The empirical nature of the friction factor C_{hw} makes the 'Hazen-Williams' formula unsuitable for accurate prediction of head loss.

The results are only valid for fluids which have a kinematic viscosity of 1.13 centistokes, where the fluid velocity is less than 10 feet per sec and the pipe size is greater than 2" diameter. Water at 60º F (15.5º C) has a kinematic viscosity of 1.13 centistokes.

Common Friction Factor Values of C_{hw} used for design purposes are:

Asbestos Cement 140
Brass tube 130
Cast-Iron tube 100
Concrete tube110
Copper tube130
Corrugated steel tube 60
Galvanized tubing 120
Glass tube130
Lead piping130
Plastic pipe140
PVC pipe 150
General smooth pipes 140
Steel pipe 120
Steel riveted pipes 100
Tar coated cast iron tube 100
Tin tubing130
Wood Stave 110

These factors include some allowance to provide for the effects of changes to the internal pipe surface due to the build up of deposits or pitting of the pipe wall during long periods of use.