EXAMPLE

Find the flow in a 3 m square rough concrete channel with a slope of 1 in 1000 running half full.

Area = 3 x 1.5 = $4.5m^2$
Wetted Perimeter = 1.5+3+1.5= 6m

1. Set $4.5m^2$ Area to 6m Wetted Perimeter
2. Set "Rough Concrete" arrow to 1000
3. Read: **Flow = $7.36m^3/s$**

From Velocity Scales: Set green arrow to 7.36 m^3/s and read opposite 4.5 m^2area.
.... **Velocity = 1.64 m/s.**

ALLOWANCE FOR BENDS AND ELBOWS

If the pipe has a number of bends or elbows the following additions to the length should be made for each:-

Pipe Diameter (mm)	Length to Add (metres)			
	Welded Elbow	Long Radius Bend	Globe Valve	Gate Valve
13	.3	.15	5.5	.15
25	.6	.25	9	.25
50	.9	.5	16	.4
100	2	.9	32	.75
200	3	1.5	64	1.5
300	4.5	2		2
500	7.5	3.5		3.6
1000	15	6.5		7

Screwed elbow and bends are double the above figures.

HOT WATER

The volume flow of water at 65°C in steel pipes is approximately 3% greater than at 10°C for the same pressure loss.

MEAR CALCULATORS

Instructions

WATER FLOW CALCULATOR

METRIC MODEL

M. H. MEAR & CO. LTD.,
56 Nettleton Road, Dalton,
HUDDERSFIELD, Yorks.
England,
HD5 9TB.
Telephone Huddersfield 28589

CALCULATOR DESIGNERS

WATER FLOW CALCULATOR

METRIC MODEL

Firstly it should be noted that this calculator is a double-sided instrument, the two sides being entirely independent.

One side determines the flow of water through pipes and ducts of circular cross section and constructed in a variety of materials, *i.e.*, metal pipes, concrete ducts, coated pipes etc. The other side deals with the flow in large open channels of any cross section, rectangular, round, etc.

DESIGN BASIS – PIPES & DUCTS

This side of the calculator solves the rational formula for the flow of fluids in pipes, incorporating coefficients of friction in accordance with the Colebrook-White equation and pipe roughness factors.

The rational formula as applied to water flow is :-

$$P = \frac{3.25 \times 10^7 Q^2 f L}{D^5}$$

where:-
- P = pressure loss bar
- Q = flow, litre/s
- L = length of pipe, m.
- D = bore of pipe, mm.
- f = coefficient of friction

The Colebrook-White equation is :-

$$\frac{1}{\sqrt{f}} = -4 \log_{10} \left(\frac{K_s}{3.7d} + \frac{1.255}{R\sqrt{f}} \right)$$

where:-
- K_s = absolute roughness of pipe in mm.
- R = Reynolds Number

The variable coefficient of friction is built into the calculator and needs no separate determination and a Pipe Material scale makes appropriate allowances for roughness.

The Rational formula combined with the Colebrook-White equation for the coefficient of friction on which this model is based takes account of pipe roughness, viscosity, and Reynolds Number and has been practically universally adopted as the most logical and accurate for problems of fluid flow in pipelines.

The answers have been checked against over 100 well authenticated practical tests on actual pipelines from small metal tubes to long concrete tunnels up to 6 m dia., and give an accuracy appreciably better than the usual Hazen-Williams formula. The pressure loss obtained is for pipes in new condition and allowance should be made for deterioration with age due to corrosion or incrustation according to experience with the type of water being handled. This will result in an increased pressure loss or a reduction in the flow.

Scales are provided, coloured green, for determination of velocity.

Flow in Ducts Running Partly Full

The flow through any pipe, duct or open channel running only partly full can be read off directly against the Proportional Depth scale on the top quadrant. Thus if the depth of water in the pipe is only one quarter of the diameter, the flow is read off immediately opposite .25 on this scale.

It will be seen that paradoxically there is a slight increase in the flow with a pipe only say 95% full, this being due to the appreciable reduction in the length of the wetted perimeter causing a corresponding reduction in the frictional losses as the water leaves the top of the pipe.

With partly full pipes the flow is determined by the slope. Thus if the slope is 1 in 600 it will be appreciated that there is a loss of pressure head of 1m in every 600m of length. To determine the flow therefore the pressure loss is set at 1m and the length at 600m.

EXAMPLE

Find the flow of water through a smooth concrete pipe 500mm bore, 100m long with a pressure loss of 100 millibars (1.02 metres head).

1. Set 500mm bore to 100m long.
2. Set "Smooth Concrete" to 100 millibar Pressure Loss.
3. Read opposite outer arrow:

Flow = 507 litre/s

or alternatively if the pipe is only running 30% full read off against .30 on the Proportional Depth scale:

Flow = 102 litre/s

From Velocity Scales: Set green arrow to 507 litre/s and read opposite 500 mm bore of pipe . . . . **Velocity = 2.55 m/s**

DESIGN BASIS - OPEN CHANNELS

To deal with open channels of non-circular section the other side of the calculator is arranged to solve the Manning Formula which is:

$$Q = \frac{A^{1.66} S^{.5}}{n P^{.66}}$$

where
- Q = flow in m^3/s
- n = Kutters 'n'
- S = slope of channel
- A = area of channel in m^2
- P = wetted perimeter of channel in metres.

It is necessary to obtain the area of the channel occupied by the water and also the corresponding length of the wetted perimeter and to use these values in the calculation.

The Manning Formula will also deal with the flow in circular channels running partly full but it will give low values for the smaller pipes and steeper slopes and it is preferable to use the other side of the calculator.