INSTRUCTIONS

FOR

MEAR'S

GAS FLOW CALCULATOR

FOR

HIGH AND LOW PRESSURE FLOW

in Steel Pipes

MODEL No. 3

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GAS FLOW CALCULATOR

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This calculator solves the rational formula for the flow of gases in steel pipes under either high or low pressure conditions, this formula being:.

$$P_1^2 - P_2^2 = \frac{Q^2 f S L}{33{,}100 \ d^5}.$$

where

P_1 = initial pressure in lbs/sq. in. abs
P_2 = terminal pressure. „ „
d = diameter of pipe in inches.
Q = flow in cu. ft./hr. measured at 60°F & 30″ Hg.
L = length of pipe in ft.
S = specific gravity relative to air.
f = coefficient of friction.

The values incorporated for the coefficient of friction are as given by the Colebrook-White formula, using an absolute roughness of .0018″ for clean commercial steel or wrought iron pipes as given by Moody, plus an allowance of 2% for pipe joints and a contingency of 3% as it is accepted that the roughness factors for individual pipes cannot be known with complete accuracy.

Some authorities (e.g. the U.S. Bureau of Mines Monograph No. 9 on the flow of Natural Gas) indicate a lower value for the absolute roughness of steel pipes (down to .0007) but also indicate that these cannot be maintained in service unless all dust and foreign particles are removed from the gas before entering the line or unless the line is regularly cleaned.

The coefficient of friction varies with the mass flow and the pipe bore and this variation is built into the calculator.

FLOW AT HIGH OR LOW PRESSURES

As gas is compressible, its volume is reduced at higher pressures and the pressure loss in pipes is lower roughly in inverse proportion to the absolute pressure.

In calculations where the terminal pressure is substantially atmospheric i.e. 15 lbs./sq. inch absolute, this is allowed for automatically by the calculator and the pressure loss is read off directly against the outer arrow.

In calculations where the terminal pressure is higher than this, then the pressure loss must be read off opposite the average of the inlet and terminal pressures. (lbs./sq. inch gauge).

Often only one of these is known initially but the average pressure in the pipe line is then found either from:—

average pressure = inlet press. — $\frac{1}{2}$ press. loss
or „ „ = outlet „ + „

Whilst the exact pressure loss is not known initially it is readily obtained by successive approximation as shown in the second part of the following example.

EXAMPLE. Required to deliver 100,000 c.f.h. of gas specific gravity 0.5 through an 8″ dia. pipe from 'A' to 'C', 40,000 c.f.h. being taken off at an intermediate point 'B'.

Distance from A to B = 10,000 ft. Distance from B to C = 20,000 ft.
Terminal pressure at C to be 0.3 lbs. sq. in. gauge.

PRESSURE LOSS FROM B TO C

1. Set 8″ dia. to 60,000 c.f.h.
2. Set .5 sp.gr. to 20,000 ft.
3. Read opposite outer arrow :- **Pressure Drop = 4.7 lbs /sq.in.**

Terminal Pressure at C = 0.3 ,,
∴ Pressure at B = 5.0 lbs /sq.in. gauge

PRESSURE LOSS FROM A TO B

1. Set 8″ dia. to 100,000 c.f.h.
2. Set .5 sp. gr. to 10,000 ft.
3. As a fiirst approximation read opposite outer arrow:.
   Pressure Drop if terminal pressure were 15 lbs./sq.in. abs. = 5.9

∴ Average line pressure = 5.0 + (5.9 ÷ 2) = 7.95
Read pressure loss opposite 7.95 average line pressure = 4.6

∴ Average line pressure is now 5.0 + (4.6 ÷ 2) = 7.3
Read Pressure Loss opposite 7.3 average line pressure = **4.7 lbs./sq.in.**

This is sufficiently accurate as any further approximation gives no change in the answer obtained.

∴ Pressure at A = 5.0 + 4.7 = 9.7 lbs./sq.in. gauge

Note that no movement of the dials is necessary during this procedure and once the method is understood exact answers are rapidly obtained.

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 (inches)	Length to Add (feet)			
	Welded Elbow	Long Radius Bend	Globe Valve	Gate Valve
½	1	.5	18	.5
1	2	.75	30	.8
2	3	1.5	54	1.3
4	6	3	107	2.5
8	10	5	214	5
12	15	7		7
20	25	12		12
40	48	22		24
60	72	33		36

Screwed elbows and bends are double the above figures.

ALLOWANCE FOR TEMPERATURE

The calculator assumes that the gas is flowing at 60°F. If the actual temperature is higher than this the pressure loss will increase in direct proportion to the increase in absolute temperature. This neglects any increase in viscosity with temperature which may cause a further slight increase in loss at temperatures of 150°F or more.

SUPER COMPRESSIBILITY

For manufactured towns gas and air the deviations from the perfect gas laws are negligible below 1000 p.s.i. For methane there is a small deviation according to temperature and pressure which is allowed for approximately by the calculator. The higher hydrocarbons such as ethane etc. have greater deviations but as these reduce the pressure loss the error is on the side of safety. CO_2 deviates considerably above 500 p.s.i. according to temperature.

COMPRESSED AIR AND GASES

The calculator deals equally well with compressed air, manufactured towns gas and natural gases, the Specific Gravity scale being designed to allow for variations in the kinematic viscosity as well as the specific gravity.

MODEL No. 3

This improved model replaces the earlier model which was based on Lacey's coefficients of friction obtained from a large number of tests on cast iron mains carrying manufactured towns gas. Since Lacey's tests the Colebrook-White formula for the coefficient of friction has been practically universally adopted as the most logical and accurate for all pipe flow problems. This new model has therefore been based upon Colebrook-White and also on Steel pipes which are coming into increasing use and a suggested addition to the pressure loss of 15% is indicated for cast iron pipes.