

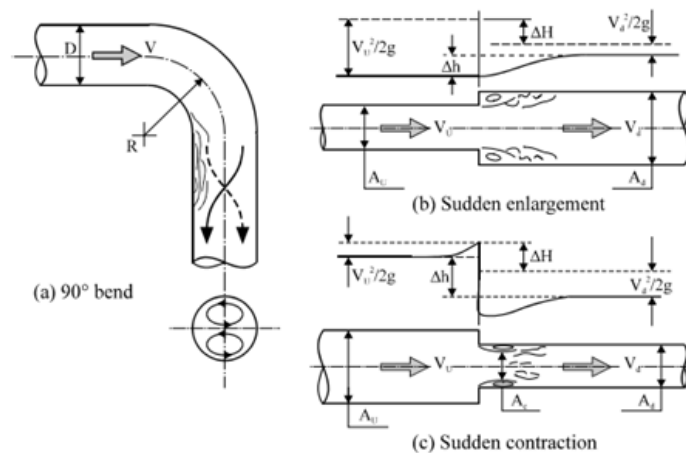
Friction in Pipes

Aim:- To determine the friction factor for the pipes.

Apparatus Required:- Pipe having different diameter connected to a differential manometer, a collecting tank, stopwatch, scale.

Theory

When a gas or a liquid flows through a pipe, the flow of fluid through a pipe is resisted by viscous shear stresses within the fluid and the turbulence that occurs along the internal pipe wall. Due to this there will be a loss of pressure in the fluid, because energy is required to overcome the viscous or frictional forces exerted by the walls of the pipe on the moving fluid. In addition to the energy lost due to frictional forces, there will be a loss in energy when the fluid flows through fittings, such as valves, elbows, contractions and expansions. This loss in pressure is mainly due to the local flow separation as it moves through such fittings. The pressure loss in pipe flows is commonly referred to as head loss. The frictional losses are mainly caused in a straight pipe, friction loss induced in fittings, such as bends, couplings, valves, or transitions in hose or pipe accounts for minor losses. The frictional losses are referred to as major losses (h_f) while losses through fittings, etc, are called minor losses (h_m). Together they make up the total head losses (h) for pipe flows.



In practice, loss in a pipe flow comes into picture in cases like calculation of rate of flow in the pipes connecting two reservoirs at different levels or to calculate the additional head required to double the rate of flow along an existing pipeline. These pipe losses are dependent on number of factors like viscosity of the fluid, the size of the internal pipe diameter, the internal roughness of the inner surface of the pipe, the change in elevation between the ends of the pipe, material of the pipe and the length of the pipe along which the fluid travels.

Friction loss in pipe

The friction loss in a uniform, straight sections of pipe, known as "major loss", is caused by the effects of viscosity, the movement of fluid molecules against each other or against the (possibly rough) wall of the pipe. Here, it is greatly affected by whether the flow is laminar or turbulent.

Laminar Flow: It occurs when the fluid flows in parallel layers without adjacent mixing between the layers. In this type of flow there are neither eddies nor cross currents, with fast flow over the center part of the pipe and no movement near the pipe surface. The roughness of the pipe surface influences neither the fluid flow nor the friction loss. For laminar flow Reynolds's number (Re) < 2100 .

Turbulent Flow: It occurs when the liquid is moving fast with mixing between layers. The speed of the fluid at a point continuously undergoes changes in both magnitude and direction. For turbulent flow Reynolds's number $2100 < Re < 4000$

Transitional flow: is a mixture of laminar and turbulent flow, with turbulence flow in the center of the pipe and laminar flow near the edges of the pipe. Each of these flows behaves in different manners in terms of their frictional energy loss while flowing and have different equations that predict their behaviour. For transitional flow Reynolds's number $Re > 4000$.

It is useful to characterize that roughness as the ratio of the roughness height k to the pipe diameter D , the "relative roughness". Three sub-domains pertain to turbulent flow:

- In the smooth pipe domain, friction loss is relatively insensitive to roughness.
- In the rough pipe domain, friction loss is dominated by the relative roughness and is insensitive to Reynolds number.
- In the transition domain, friction loss is sensitive to both.

The Darcy Equation is a theoretical equation that predicts the frictional energy loss in a pipe based on the velocity of the fluid and the resistance due to friction. It is used almost exclusively to calculate head loss due to friction in turbulent flow.

$$h_f = \frac{fLv^2}{2Dg}$$

Where:

h_f = Friction head loss

f = Darcy resistance factor

L = Length of the pipe

D = Pipe diameter

v = Mean velocity

g = acceleration due to gravity

procedure:-

1. Note down the relevant dimensions as diameter and length of pipe between the pressure tapping, area of collecting tank.
2. Except for the selected diameter pipe, the rest of the pipes are closed.
3. The main inlet valve is opened to allow water to flow through the selected diameter pipe. Open the pipe valve

4. Change the knot of manometer from isolate position to air vent position to remove the air inside the pipe.
5. Change the knot to read position when the steady flow is reached inside the pipe.
6. Turn on the exit valve of the collecting tank to allow water flowing inside the pipe to continuously flow out.
7. Note down the manometer reading.

Observation :-

Length of the pipe (L) =

Diameter of pipe (d) =

Area of collecting tank (A) =

Head loss (H) =

Time taken (t) =

Rise (h) =

Acceleration due to gravity (g)

Calculations:-