Class :2nd stage

Subject: Fluid Flow

Ministry of Higher Education and Scientific Research
Al-Mustaqbal University College

Chemical engineering and petroleum industries

(Fluid Flow Lab)

Experiment No. 10
ENERGY LOSS IN PIPE FITTINGS

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Number of Experiment: 10

Name of Experiment: ENERGY LOSS IN PIPE FITTINGS

Purpose of Experiment:

The objective of this experiment is to determine the loss coefficient (K) for a range of pipe fittings, including several bends, a contraction, and an enlargement.

Introduction:

Two types of energy loss predominate in fluid flow through a pipe network; major losses, and minor losses. Major losses are associated with frictional energy loss that is caused by the viscous effects of the medium and roughness of the pipe wall. Minor losses, on the other hand, are due to pipe fittings, changes in the flow direction, and changes in the flow area. Due to the complexity of the piping system and the number of fittings that are used, the head loss coefficient (K) is empirically derived as a quick means of calculating the minor head losses.

METHOD

The head loss coefficients are determined by measuring the pressure head differences across a number of fittings that are connected in series, over a range of steady flows, and applying the energy equation between the sections before and after each fitting.

EQUIPMENT:-

The following equipment is required to perform the energy loss in pipe fittings experiment:

- Energy losses in bends apparatus,
- Stopwatch for timing the flow measurement,

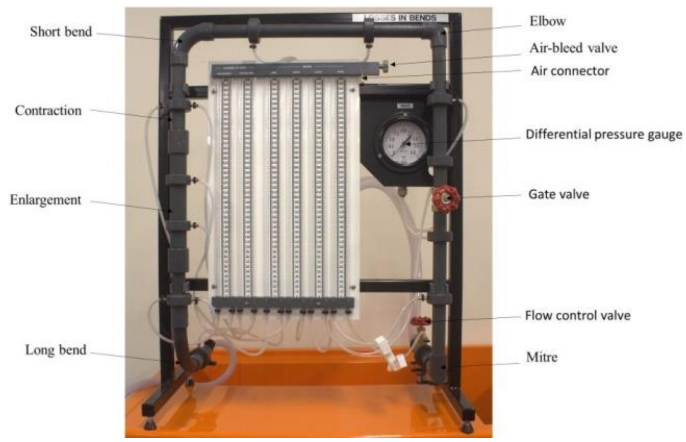

Fig 10.1 Energy Losses in Pipe Fittings Apparatus

EQUIPMENT DESCRIPTION

The energy loss in fittings apparatus consists of a series of fittings, a flow control valve, twelve manometers, a differential pressure gauge, and an air-bleed valve (Figure 10.1). The fittings listed below, connected in a series configuration, will be examined for their head loss coefficient (K):

- Large radius bend (LRB),
- area enlargement,
- area contraction,
- elbow,
- and mitre.

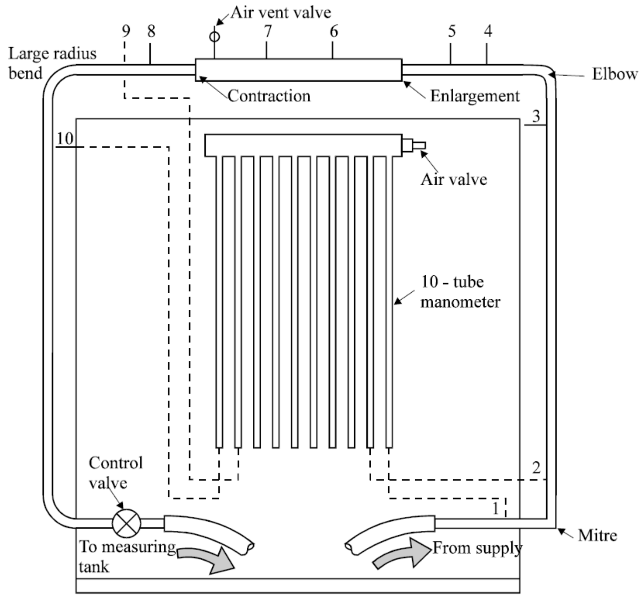

Fig 10.2 *Arrangement of apparatus for measuring losses in pipe fittings.*

Theory:

Bernoulli's equation can be used to evaluate the energy loss in a pipe system:

$$[\frac{P}{\gamma} + \frac{v^2}{2g} + z]_{in} = [\frac{P}{\gamma} + \frac{v^2}{2g} + z]_{out} + h_L \qquad (1)$$

1- Losses in bends :

- **For mitre bends :**

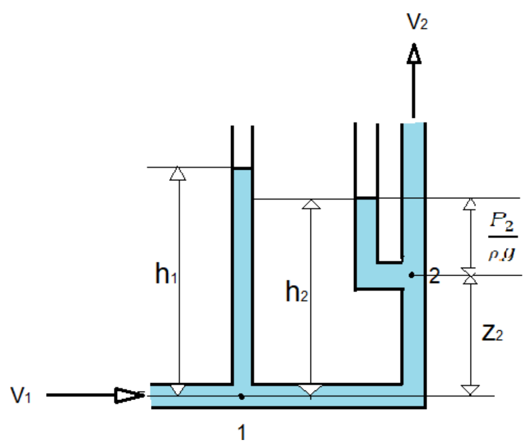

Fig 10.3 1- Losses in mitre bends.

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + H_L$$

Where : $Z_1=0$, $V_1=V_2$

$H_1 = h_2 + H_L$ → $H_L = h_1 - h_2$

- **For elbow fitting**:

$H_L = h_3 - h_4$

- **For LRB**:

$H_L = h_9 - h_{10}$

2- Losses in fitting :

- For enlargement fitting:

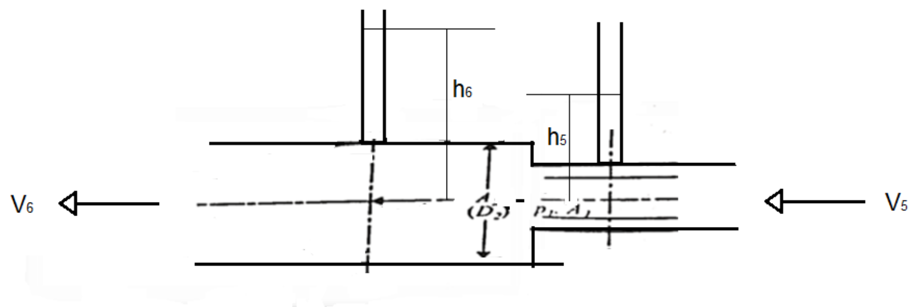

Fig 10.4 Losses in enlargement fitting.

$$\frac{P_5}{\rho g}+\frac{V_5^2}{2g}+Z_5=\frac{P_6}{\rho g}+\frac{V_6^2}{2g}+Z_6+H_L$$

$$h_5+\frac{V_5^2}{2g}=h_6+\frac{V_6^2}{2g}+H_L$$

$$H_L=(h_5-h_6)+(\frac{V_5^2}{2g}-\frac{V_6^2}{2g})$$

Here $V_5 = V_{D1}$ and $V_6 = V_{D2}$, so :

$$H_L=(h_5-h_6)+(\frac{V_5^2}{2g}-\frac{V_6^2}{2g})$$

- **For contraction fitting**:

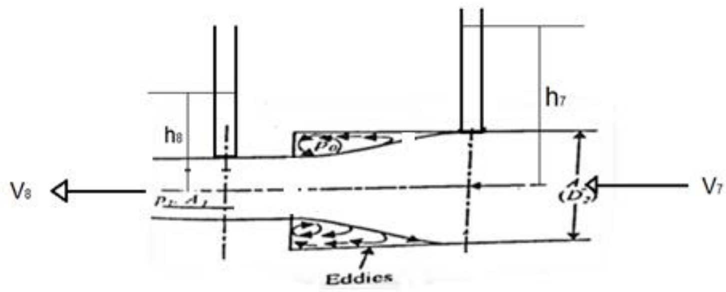

Fig 10.5 Losses in contraction fitting.

$$H_L = (h_7 - h_8) + (\frac{V_7^2}{2g} - \frac{V_8^2}{2g})$$

in which h_1 and h_2 are manometer readings before and after the fitting.

The energy loss that occurs in a pipe fitting can also be expressed as a fraction (K)

$$\Delta h = K\frac{v^2}{2g} \qquad (3)$$

of the velocity head through the fitting:

where:

K: loss coefficient, and

v: mean flow velocity into the fitting.

Because of the complexity of the flow in many fittings, K is usually determined by experiment. The head loss coefficient (K) is calculated as the ratio of the manometric head difference between the input and output of the fitting to the velocity head.

$$K = \frac{\Delta h}{\frac{v^2}{2g}} \qquad (4)$$

The pressure difference (Δh) between before and after the gate valve is measured directly using the pressure gauge. This can then be converted to an equivalent head loss by using the conversion ratio:

1 bar= 10.2 m water

To identify the flow regime through the fitting, the Reynolds number is calculated as:

$$Re = \frac{vD}{\nu} \qquad (6)$$

Procedure:-

Adjust the flow from the bench control valve, and at a given flow rate, take the readings from all of the manometers after the levels are fixed. In order to determine the volume flowrate, you should carry out a timed volume collection using the volumetric tank. This is achieved by closing the ball valve and measuring (with a stopwatch) time taken to accumulate a known volume of fluid in the tank, which is read from the sight glass. You should collect fluid for at least one minute to minimize timing errors. Repeat this procedure to give a total of at least three sets of measurements.

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Discussion:

1. Explain minor losses in a pipe?
2. Give an expression for loss of head due to sudden enlargement of the pipe?
3. Give an expression for loss of head due to mitre bends?