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Research Article

Modification and Testing on Major Loss Apparatus by considering various Effecting Parameters

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Abstract

The purpose of carrying out current experimental & analysis is to co-relate the head loss with various affecting parameters. For mathematical analysis and graphical analysis purpose use of MATLAB is considered to find the more accurate equation for head loss. This new formula and study will provide the base for chemical and irrigation department for calculating the accurate head loss by using various materials in various working conditions. Experimental work also helps to calculate the accurate lost power to overcome the friction. In the past review it is shown that head loss is directly proportional to the square of velocity, but in experimental study it observed that the relation is non-linear. Also the linearity varies with discharge rate. It is found minimum for some particular value of discharge. The accuracy of formula validated and verified on head loss measuring apparatus by using known values of discharge rate which are calculated from interpolation of graph & gives expected result regarding head loss.

Keywords: *Discharge, friction, head loss, major loss, minor loss*

1. Introduction

Piping technology is based on the widespread ideology of liquid stream. When a real (viscous) fluid flows during a pipe, some of energy is depleted through maintaining the flow. Owing to internal friction and disorder, this energy is transformed into thermal energy. Such a change leads to the appearance of the energy loss in terms of the fluid depth termed as the head loss and normally classified into two classes. Effectively due to friction, the first category is known as linear or major head loss. It is there all through the length of the channel. The other type known as minor or singular head loss is due to the minor accessories and accessories present in a pipe set-up. The appurtenance encountered by the fluid flow which is a rapid or steady change of the limits results in a change in degree, direction or distribution of the velocity of the flow. This categorization into major and minor head losses is rather comparative. For a pipeline of small length having many slight appurtenances, the total minor head loss can be larger than the frictional head loss. In petroleum and water delivery networks, the pipelines are of substantial length and therefore the terms major head loss and minor head loss can be used with no any mystification. A huge number of studies were approved out in order to get a general and accurate formulation of the diverse types of head losses. It was the first to have come out by means of a relative for the head loss. As brought up by Darcy contributed very much to the application of the derived relation, as a result connecting his name with that of Weisbach.

The relation is consequently most commonly known as the Darcy-Weisbach method. It fundamentally depends on the friction coefficient and the virtual roughness. In the past work it is shown that head loss is directly relative to square of speed, but in experimental study it is observed that the relation is non-linear and the linearity varies with discharge rate. And it is found minimum for some particular value of discharge. Y. Lahiouel and A. Haddad studied energy losses in pipes used for the carrying of fluids (water, petroleum etc) are in effect due to friction, as well as to the varied singularities met (Y.Lahioual, A.Hadad, 2015). These losses are more often than not rehabilitated into head reductions in the way of the flow. The information of facts of such alteration allows the purpose of the essential power needed for the carrying of the fluid among two points. Results are presented in terms of the linear head loss (Hl) versus the Reynolds (Re) number. All flow regimes were found to be turbulent. Darcy approaches appear to be the more able to predicting the head loss. The integration of multifaceted expressions for the friction coefficient with their great spectrum of application seems to ends up with satisfactory results. Increase in the Reynolds number leads to superior errors. This is probably due to the fact that the flow field moves from the laminar or transitional system to the turbulent system.

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Kade Campbell conducted study to measure the effects that conduit diameter have on the friction factor, or major losses and the things that various fittings have on the minor losses in conduits (Kade Campbell, 2015). Calculations were carried to determine structure pressure drop need investigational facts to report for friction losses occurring in valves and fittings. To uncover the major losses during the structure, a Technovate fluid route system was used. The pressure losses transversely into two parts of pipe, by internal diameters of 0.42 and 1.03 inches, and across an orifice were found. By Cd having value of 0.656, the volumetric discharge (Q) can be established using equation 1 below. Six readings at different flow rates were got with the pressure differences across the orifice as employed to find discharge. The pressure losses across the two sections of pipe (head loss) are used to find the Darcy friction factor (f) for the sections of pipe. The smaller diameter pipe produced a higher friction factor across the section which was caused by the higher ratio of the surface area of the inner pipe to the cross sectional area. The frictional factor for the smaller diameter for various flow rates ranged from 0.0302 to 0.0372. The frictional factors for the larger diameters ranged from 0.0240 to 0.0295. The minor losses were found by calculated the pressure drops across various pipe fittings.

St. Johansen, P. Skalle, J. Sveen proposed a model characterized as quasi two-dimensional as it cracks the joined axial and tangential velocity profiles (St. Johansen *et al*., 2012). An opening version of the model is put into practice in the simulator computes velocity profiles and pressure drops with no experiential correlations as of flow-loop experiments. Their simulator is capable of solving stationary situations and takes into account the most important parameters. Dynamic situations, such as change of mud and start-up, time dependent rheology, drill-string eccentricity, cavings, barite sagging, and gas cut mud are all important parameters in critical situations. The model framework presented allows for the inclusion of several of these effects in a fundamental manner. However, we are limited to axi-symmetric geometries. Still, the simulator can be designed in a user-friendly manner.

2. System development

2.1 Loss of head in pipes

When the water is flowing in a channel it experiences some conflict to its motion, whose effect is to reduce the velocity & eventually the head of water existing. While there are many kinds of losses, yet the major loss is due to frictional opposition of the pipe only. The frictional resistance of the pipe depends upon the roughness of the inside pipe. It has been experimentally set up that added roughness of the inside plane of the pipe, greater will be the opposition. This is friction is known as fluid friction & the resistance is known as frictional resistance. The losses are primarily of two types

2.1.1 Major losses

These losses are due to friction. In the case of pipes longer than 1000 times the diameter.

2.1.2 Minor losses

Loss due to entry, loss due to changes in cross - section of the pipe such as sudden contraction, sudden expansion including loss due to change of direction elbows, bends, loss due to obstruction (valve, diaphragm) loss due to exit. In a long pipe the major loss of head is due to friction in the pipe only. The minor losses are so small, as compared to friction loss, that they may be neglected. But in the case of a short pipe, the minor losses, as compared to the friction loss, are of appreciable amount & thus cannot be neglected. The earlier experiments, on the fluid friction were conducted by Froude who concluded that, the frictional resistance varies approximately with the square of the velocity of the liquid, & the frictional resistance varies with the nature of the surface.

2.1.3Darcy's Formula for Loss of Head in Pipes

Consider a uniform long pipe through which the water is flowing at uniform rate.

L- Pipe Length
d – Pipe diameter
v- Water velocity inside the pipe.
f- Resistance due to friction per unit area (of wetted surface) per unit velocity.
h_f -Loss of head due to friction.
Considering sections (1 -1) & (2 - 2) of the pipe and
P_1- Pressure intensity at section at 1-1 &
P_2 - Pressure intensity at section 2-2.

A slight thought will show that P1& P2 would have been equal, if there would have been no frictional resistance.
Considering horizontal forces on water between section (1-1) & (2 - 2) and equating the same,
P_1+ P_2= Frictional resistance.
Or frictional resistance $=P_1A - P_2A$,
Dividing both the side by w

$$\frac{frictionalresistance}{w} = \frac{P_1A-P_2A}{w}$$

Force due to frictional resistance = Product of coefficient of frictional resistance, wetted area and square of velocity.

$$\frac{f'\times\pi DL\times v^2}{w} = \frac{P_1A-P_2A}{w}$$

But $\frac{P_1A-P_2A}{w} = h_f = lossofpressureheadduetofriction$

$$\frac{f'\times\pi DL\times v^2}{\frac{\pi}{4}\times d^2\times w} = h_f$$

$$\frac{4f\prime \times \pi DL\times v^2}{w\times d} = h_f$$

But $f' = \frac{f\times w}{2g} f = Darcy's factor$

$$\frac{4f\times w\times L\times v^2}{2gw\times d} = h_f$$

$$\frac{4f\times L\times v^2}{2gd} = h_f \qquad (1)$$

The discharge, (Q)

$$v = \frac{Q}{A}$$

$$\frac{4f\times L\times (\frac{Q}{A})^2}{2gd} = h_f$$

Put $A = \pi /4\, d^2$

$$\frac{4f\times L\times Q^2}{2gdA^2} = h_f \qquad (2)$$

The equations above give the value of loss of head in pipes due to friction. The subsequent points should be taken into concern at the time of using above equations. The equation (1) should be used when velocity of water in the pipe is known. The equation (2) should be used when discharge in the pipe is known. In actual practice, the minor losses are neglected, until and unless required. If pressure heads (i.e. p/w) of a liquid flowing in a conduit, be plotted as vertical ordinates on the centre line of the pipe, then the line combining the ends of such ordinates is known as hydraulic gradient line

3. Readings and discussion

The setup that is used for experimentation is shown in fig.1 below.

Fig.1 Experimental setup

The readings are taken for the pipes made up of MS, aluminium & PVC material. The diameters of pipes used for experimentation are 12.5 & 22 mm. Sample readings for MS pipe of 12.5 mm diameter are shown in below table.1

Table 1 Sample readings for M.S. Pipe of 12.5mm dia.

S. No	Discharge	Friction factor
1	3.692	0.00796
2	2.584	0.0112
3	1.273	0.02296
4	1.1245	0.01716
5	1.1189	0.00495

The readings are used to find the values of head loss for all given materials & diameters as mentioned above. The results obtained are plotted in graphs as below.

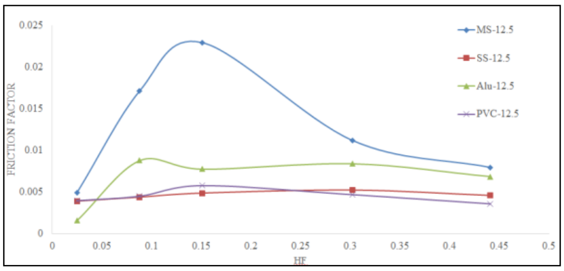

Fig.2 Head Loss Vs. Friction factor for 12.5 mm diameter pipe

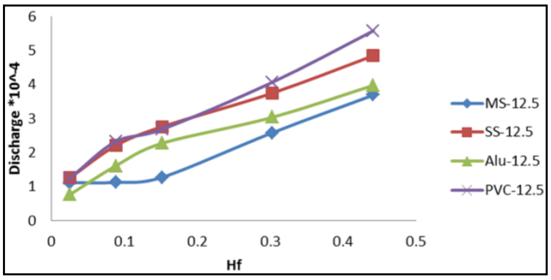

Fig.3 Head Loss Vs. Discharge for 12.5 mm diameter pipe

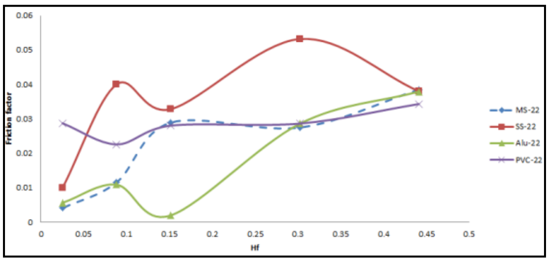

Fig.4 Head Loss Vs. friction factor for 22 mm diameter pipe

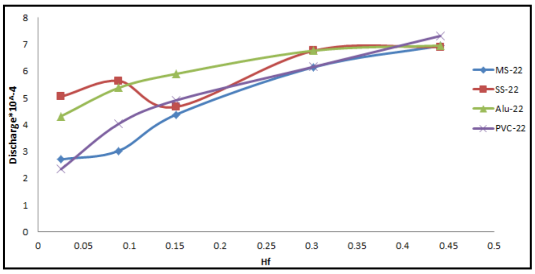

Fig.5 Head Loss Vs. discharge for 22 mm diameter pipe

The readings are also plotted on graphs using MATLAB & using equation generation tool following governing equations are generated for each of the above pipes.

For MS pipe,

$h_f = (2.5e^{-0.13}*ff^4)-(7e^{0.09}ff^3)+(7.1e^{-0.005}*ff^2)^{-0.3}$

$h_f = (2.02e^{-0.23}*Q^5)-(5.4e^{0.001}Q^4)+(9.4e^{-0.005}*Q^3)+(4.032e^{-0.001})^{-0.41}$

Above equations shows relation between head loss & friction factor as well as head loss & discharge.

Conclusions

Following conclusions can be drawn from the present experimentation;

1) For 12.5mm diameter friction factor for MS is highest of all while least for PVC pipe.
2) For 12.5mm diameter discharge is more for PVC and least for MS.
3) For 22mm diameter, stainless steel has more friction factor and less for Al.
4) For 22mm diameter Al have high discharge value and MS have lesser.
5) Use of MATLAB software can be done for plotting relations between the parameters.

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