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# Experimental Study on Influence of Nature of Fluids on Darcy's Friction Coefficient

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***Abstract***

*All over the world fluids are carried in different ways such as open channels, pipe line, concrete pipes etc. Naturally the fluids are flowing through open channels like rivers, streams and others, but artificially we use pipe line system to carry fluids from one point to other point. When a fluid flows from one point to another inside a pipe there will be a head loss. This head loss is caused by the friction of the fluid with the inner surface of the pipe wall and turbulence of the fluid flow. This head loss and friction coefficient affected by a number of factors which include the size of the pipe, the internal roughness of the surface of the pipe, length of the pipe and also affected by nature of fluids. Present work is to know the variation of friction coefficient for Galvanized Iron (GI) and Un-plasticized Poly Vinyl Chloride (UPVC) pipe materials for different quality of fluids using Darcy Weisbach equation.*

**Keywords:** *Friction coefficient, Head loss, Fluid flow*

## 1. Introduction

A fundamental understanding of fluid-flow is essential in every industry. In the chemical and manufacturing industries, large flow networks are necessary to achieve continuous transport of products and raw materials from different processing units. This requires a detailed understanding of fluid flow in pipes. The fluid which is flowing through these pipes experiences some resistance known as friction. The viscous effects are due to result of the shear stresses that exist at interaction between the pipe wall and the fluid flow. The pressure drop through these systems dependent on the many parameters such as velocity of flow, characteristics of fluids, roughness of the pipe, diameter and length of the pipe.

Swaffield J.A and Bridge S(1983) investigated on Colebrook–white equation with roughness coefficient (k) using 2 set of pipes such as glass and cast iron. They observed that coefficient of roughness for glass pipe is less or approximately equal to zero as compared to cast iron pipe. Gabriel Echavez (1997) studied an increase in losses coefficient with age between 15 and 50 years for small diameter pipes. Nageswara Rao V.V and Viswanadh G.K (2004) reported the variation of hydraulic loss coefficient in PVC pipes. The various dissolved particles like salts, present in water, generally tend to deposit on the walls of the pipes. Such salt deposits may strengthen over a period of time, thus hindering the flow as well as the friction factor. In the case of PVC pipes, it is observed that as the usage increases, the diameter of the pipe is getting reduced because of the deposits that are taking place along the inner walls of the pipes. Diniz V.E.M.G and Souza P.A (2009) investigated the friction factor in pipe flow by using four explicit formula. They compared the results obtained by these formula with the hydraulic programme and observed that the equations which were used to measure head loss and discharge are working satisfactory. Gaddamwar A G & et.al.,(2014) investigated the impact of physico-chemical characteristics of water on coefficient of pipe friction. In this study, four different samples and two different diameter pipe were used for analysis to know the friction. John Sodiki I and Emmanuel AdigioM(2014) reviewed the Hazen William and Darcy-Weisbach equations for determination of friction loss through conduit fittings and valves and concluded that Hazen William and Darcy Weisbach equations are applicable to analyze the frictional loss through pipe fittings in water distribution system. Ntengwe F.W, Chikwa M,Witika L.K (2015) examined the impact of flow rate on the head loss in pipes and fittings for four different diameters of pipes fitted with gate valve, 45° and 90° bends using water as process fluid. They used Darcy-Weisbach, Hazen-Williams and Poisselli's methods to evaluate friction losses and concluded that the head loss decreases with the increase in diameter of pipes but increases with the increase in velocity or discharge regardless of size of pipe.

Hydraulics engineering practice needs the estimate of the head loss incurred by a fluid as it flows along a pipeline. Also loss of head is incurred by fluid mixing which occurs at fittings such as bends or valves, and by frictional resistance at the pipe wall. In Fluid-dynamics the Darcy Weisbach Equation is a phenomenological equation, which relates the head loss or pressure loss due to friction along a given length of pipe to the average velocity of the fluid flow for an in-compressible fluid. Present work is to study the variation of friction coefficient by the influence of material properties of pipe and the nature of fluid using Darcy Weisbach equation.

## 2. Materials and Methodology

Figure-1 shows the flow chart of methodology adopted for estimating Darcy friction coefficient. To study the influence of material properties and physico-chemical quality of the fluid on the friction coefficient, a prototype model was prepared. Two pipes were used for the development of the model which includes a galvanized iron pipe and a Unplasticized Poly Vinyl Chloride (UPVC) pipe of 1.2m length and 25 mm diameter. A cylindrical fibre drum of 205 litres capacity was mainly used to store and supply the fluids through the pipe line system. Inverted U-tube manometer was fitted to measure the head loss through the pipe line. Collecting tank was used to collect fluids after passing through the pipe. The various fittings like T-joints, nipple, collar, coupling and 90° bends were used to connect all above mentioned parts from the overhead tank to the collecting tank.

After setting the prototype model, four kinds of fluids having variable characteristics viz. Mud water, Lime water, Normal water and Soap water were selected. Physical laboratory tests were conducted for fluids to know the characteristic properties for each samples. Selected fluids were made to pass through the Galvanized Iron and Un-plasticized Poly Vinyl Chloride pipe. Inverted Manometer directly gives the values of the head loss through the pipes and time was recorded for 30cm rise of the collecting tank. Using all these data friction co-efficient through each pipe for all fluids were calculated using Darcy-Wiesbach equation.

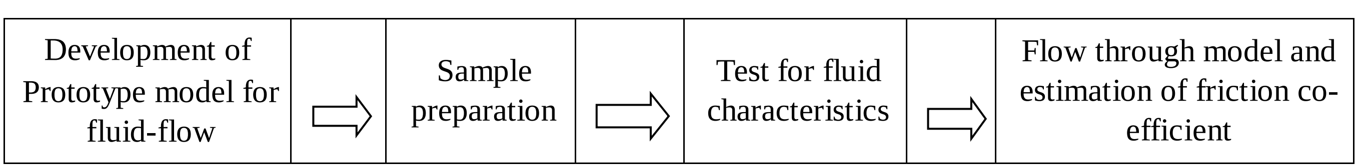


Figure 1: Methodology for estimating Darcy friction coefficient

## 3. Result and Discussion

Table 1: Physical and Chemical characteristics of Fluids

| Sl No. | Samples | Colour | Odour | pH | Turbidity (NTU) | Settleable Solids (ml) | Specific Gravity |
|---|---|---|---|---|---|---|---|
| 1 | Mud water | Brown Red | Earthy | 8.1 | 750 | 60 | 1.02 |
| 2 | Lime water | Milky | Nil | 9.3 | 550 | 37 | 1.01 |
| 3 | Normal water | Colourless | Nil | 7.5 | 14 | 0 | 1 |
| 4 | Soap water | White | Chemical | 11.2 | 200 | 3 | 0.88 |

Table 1 shows list of the fluids used in the experimentation for physical and chemical characteristics. Mud water, Lime water, Normal water and Soap water samples are chosen for the study. The physical properties of fluids such as Colour, Odour, Turbidity, Specific gravity and Chemical properties of fluids such as pH and settleable solids were measured. All the samples were alkaline in nature with little variation of specific gravity. Mud water and Lime water are turbid in nature with more settleable solids.

Table 2: Variation of Darcy's friction co-efficient for mud water, lime water, normal water and soap water both for G.I and UPVC pipe.

| Sl No. | Samples | Average coefficient of friction (f) | |
|---|---|---|---|
| | | GI pipe | UPVC pipe |
| 1 | Mud water | 0.005900 | 0.004403 |
| 2 | Lime water | 0.005677 | 0.003996 |
| 3 | Normal water | 0.004685 | 0.003841 |
| 4 | Soap water | 0.004039 | 0.003437 |

Table. 2 shows the variation of Darcy friction co-efficient for the samples for both G.I and UPVC pipes. It was observed that in all kinds of fluids, friction coefficient for G.I was more than UPVC pipe because the internal roughness of pipe was more for G.I pipe. The internal roughness is due to undulations inside the pipe, which can create local eddy currents within the fluid adding a resistance to flow through the pipe. As fluids in order, for mud water friction coefficient was more because it is highly turbid and denser fluid having high molecule of attraction. Further for lime water friction coefficient value was less compared to mud water but it was more compared to normal water and soap water.

Efficient flow of fluid is essential for every Industry or treatment units. The transporting system must not provide excessive hindrance to the flow of fluid in the pipe. Any fittings, bends and valves placed in the fluids transport system should offer little resistance to flow of material. From the study, it was clear that, type of pipe and type of fluid plays a key role in determination of coefficient of friction in a pipe flow.

## 4. Conclusion

The working model is effective in determining the coefficient of friction for all kinds of fluids. Type of pipe and type of fluid plays a key role in determination of coefficient of friction in a pipe flow. The coefficient of friction for GI pipe is more as compare to UPVC pipe, because GI pipe has more internal roughness. The coefficient of friction is more for mud water than lime water followed by normal water and soap water due to high turbidity. The Mud water has more settle able solids compared to rest of the fluids and the presence of solids causes hindrance to flow behavior.

**References**

1 Diniz, V. E. M. G. & Souza, P. A., Four explicit formulae for friction factor calculations in pipe flow, WIT Transactions on Ecology and the Environment, 2004, pp. 369-380.

2. Gabriel Echavez, Increase in losses coefficient with age for small diameter pipes, Journal of Hydraulic Engineering, Vol. 123, 1997, pp. 157-159.

3. Gaddamwar A.G, Banarse K.R, Yawale S.P, and Rajput, P.R, Impact of Physico-chemical Characteristics of Water On Coefficient of Pipe Friction, International Journal of Research in Engineering and Technology, Vol. 03, 2014, pp.34-438.

4. John Sodiki, I., and Emmanuel Adigio, M., A Review on the Development and Application of Methods for Estimating Head Loss Components in Water Distribution Pipe work, American Journal of Engineering Research, Vol. 03, 2014, pp. 91-96.

5. Nageshwar Rao V. V., and Vishwanath G.K., Variation of Hydraulic loss coefficient in PVC pipes, HYDRO - 2004, organized by Association of Hydraulic Engineers, 2004.

6. Ntengwe, F.W., Chikwa, M., and Witika, L. K., Evaluation Of Friction Losses in Pipes And Fittings of Process Engineering Plants, International Journal of Scientific and Technology Research, Vol.04, 2015, pp. 30-336.

7. Swaffield J.A and Bridge S, Applicability of the Colebrook-White Formula to Represent Frictional Losses in Partially Filled Unsteady Pipe flow, Journal of research of the national bureau of standard, Vol. 88, pp. 389-393.