IMPACT OF PHYSICOCHEMICAL CHARACTERISTICS OF WATER ON COEFFICIENT OF PIPE FRICTION

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Abstract

Frictions are of two type i.e. internal friction and external friction, internal friction as well as external friction of water mainly depends upon Physico-chemical characteristic of water (liquids). It is due to turbidity, hardness, conductivity, temperature and dissolved oxygen of water. External friction can be reduced by different techniques such as by internal coating of pipes in which liquid flow and by increasing or decreasing diameter of pipes. Still it has some internal and external frictional losses. Those frictional losses can also be reduced by the addition quantitative and qualitative amount of surfactant and other chemicals in the water samples. Co-efficient of Friction 'F' of pipe play very important role in fluid mechanics. Co-efficient of Friction initially decreases by the addition of sodium hydroxide and surfactant at diameter two but at diameter one F value initially decreases then increases.

Keywords: *Analysis of water, Friction, Co-efficient of Friction, hardness, surfactant*

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1. INTRODUCTION

The friction factor 'f' depends on the velocity of flow, the pipe diameter, the fluid density and viscosity and the roughness of the pipe, Physico-chemical quality of water. The resistance of flowing fluid is known as frictional resistance produced due to directional flow which depends upon the type of flow of liquid in a pipe line. It may be laminar. Following laws which obey the frictional resistance are 1.Directly proportional to velocity of flowing fluid. 2. Independent of pressure 3.Proportional to area of constant surface 4. Affected by a variation of flowing fluid, The occurrence of laminar or turbulent flow as generated by realistic magnitude of inertia of viscous fluid show that velocity of flow even true liquid having very small velocity frictional resistance in direction of fluid flow and different flow reduced the pressure intensity and difference of pressure reading between any two section is equal to loss of head due to friction. In the formula, hf is coefficient of friction, f is frictional resistance, L is the distance between two manometer readings, v is velocity of fluid, g is acceleration due to gravity, d is diameter of pipe. Reynolds number of flow of fluid to the aperture is generated by means of a regulating valve provided at the end of each pipe as shown in figure, a common inlet valve is provided in main supply line. For the whole apparatus pipe may be 2 or 3 centimeter apart. Sufficient length of pipe line is provided between various fittings.

2. MATERIALS AND METHOD

2.1 Investigation of Co-efficient of Pipe Friction

The manometer rubber tubing is connected to guage points of one of the pipe line. The inlet value is open by keeping the outlet valve close. Now the outlet valve is opened partially keeping the inlet valve fully open. The flow is allowed to get established and then manometer readings are taken. The actual discharge by collecting the water into the tank is measured. Above steps are repeated for four different discharges by taking different samples, and also repeated for other pipes having different diameters.

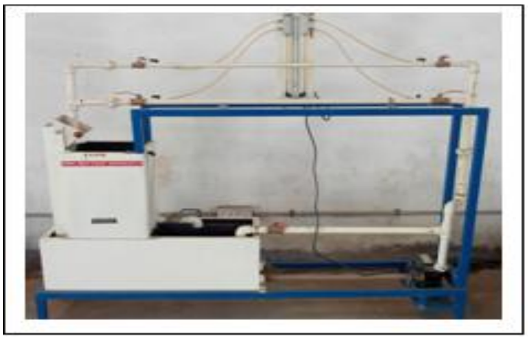

Fig-1 Pipe Friction Apparatus to measure co-efficient of Friction

2.2 Investigation of pH

The pH of water is investigated with the help of Digital pH meter after calibration of instrument at room temperature.

2.3 Investigation of TDS

The TDS of water bodies investigated with the help of Digital TDS meter at 35 0c.

2.4 Investigation of Conductivity

The conductivity of water bodies are investigated with the help of Digital conductivity meter after calibration of instrument using 0.01 molar KCl solutions.

2.5 Investigation of Hardness

The hardness of water sample is investigated by using EDTA complex metric titration method.

2.6 Investigation of Dissolved Oxygen

The oxygen of water sample is investigated by using chemical method. Important parameters of water bodies are given in the Table No1.

Table-1 Co-efficient of Pipe Friction with Bore well Water sample

Sr. No.	Diameter of Pipe 'd' (m)	Area of Tank (m^2)	Height of Water Collected (m)	Time 't' (sec)	Actual Discharge Q=V/t	Piezometer Reading		Head loss due to friction $h_f = h_1 \sim h_2$	$F = \frac{2h_f gd}{4Lv^2}$	Mean F
						h_1 (m)	h_2 (m)			
1	2×10^{-2}	900×10^{-4}	15×10^{-2}	103	1.31×10^{-4}	8×10^{-2}	6.7×10^{-2}	1.3×10^{-2}	6.62×10^{-3}	5.77×10^{-3}
2	2×10^{-2}	900×10^{-4}	15×10^{-2}	84	1.60×10^{-4}	8.7×10^{-2}	7×10^{-2}	1.7×10^{-2}	5.6×10^{-3}	
3	2×10^{-2}	900×10^{-4}	15×10^{-2}	62	2.17×10^{-4}	9.4×10^{-2}	6.6×10^{-2}	2.8×10^{-2}	5.10×10^{-3}	
4	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	169	7.9×10^{-4}	8.7×10^{-2}	8.3×10^{-2}	0.4×10^{-2}	4.15×10^{-3}	2.524×10^{-3}
5	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	63	2.14×10^{-4}	9.6×10^{-2}	7.8×10^{-2}	1.8×10^{-2}	2.54×10^{-3}	
6	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	33	4.09×10^{-4}	9.7×10^{-2}	7.6×10^{-2}	2.27×10^{-2}	8.82×10^{-4}	

Table-2 Co-efficient of Pipe Friction with Bore well Watersample+0.05M NaOH solution:

Sr. No.	Diameter of Pipe 'd' (m)	Area of Tank (m^2)	Height of Water Collected (m)	Time 't' (sec)	Actual Discharge Q=V/t	Piezometer Reading		Head loss due to friction $h_f= h_1\sim h_2$	$F = \frac{2h_f gd}{4Lv^2}$	Mean F
						h_1 (m)	h_2 (m)			
1	2×10^{-2}	900×10^{-4}	15×10^{-2}	77	1.75×10^{-4}	7.7×10^{-2}	9.5×10^{-2}	1.8×10^{-2}	5.06×10^{-3}	3.76×10^{-3}
2	2×10^{-2}	900×10^{-4}	15×10^{-2}	57	2.36×10^{-4}	7.6×10^{-2}	9.2×10^{-2}	1.6×10^{-2}	2.46×10^{-3}	
3	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	128	1.05×10^{-4}	8.7×10^{-2}	8.3×10^{-2}	0.5×10^{-2}	2.91×10^{-3}	2.02×10^{-3}
4	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	46	2.93×10^{-4}	9.2×10^{-2}	7.7×10^{-2}	1.5×10^{-2}	1.13×10^{-3}	

Table-3 Co-efficient of Pipe Friction with bore well Water sample + 0.05M NaOH solution + surfactant 13 gm

Sr. No.	Diameter of Pipe 'd' (m)	Area of Tank (m^2)	Height of Water Collected (m)	Time 't' (sec)	Actual Discharge Q=V/t	Piezometer Reading		Head loss due to friction $h_f= h_1\sim h_2$	$F = \frac{2h_f gd}{4Lv^2}$	Mean F
						h_1 (m)	h_2 (m)			
1	2×10^{-2}	900×10^{-4}	15×10^{-2}	80	1.68×10^{-4}	7.9×10^{-2}	9.1×10^{-2}	1.2×10^{-2}	3.64×10^{-3}	2.45×10^{-3}
2	2×10^{-2}	900×10^{-4}	15×10^{-2}	57	2.36×10^{-4}	7.8×10^{-2}	9.0×10^{-2}	1.2×10^{-2}	1.84×10^{-3}	
3	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	129	1.046×10^{-4}	8.1×10^{-2}	8.7×10^{-2}	0.6×10^{-2}	3.55×10^{-3}	2.40×10^{-3}
4	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	77	1.75×10^{-4}	8.2×10^{-2}	8.8×10^{-2}	0.6×10^{-2}	1.26×10^{-3}	

Table-4 Co-efficient of Pipe Friction with bore well Water sample + 0.05M NaOH solution + surfactant 39 gm:

Sr. No.	Particulars of Sample	Co-efficient of Friction 'F' (diameter of pipe = 2 cm)	Co-efficient of Friction 'F' (diameter of pipe = 1.5 cm)
1	Sample No. 1(Bore well Water)	5.77×10^{-3}	2.524×10^{-3}
2	Sample No. 2 (Bore well Water + 0.05M NaOH)	2.45×10^{-3}	2.40×10^{-3}
3	Sample No. 3 (Bore well Water + 0.05M NaOH solution + surfactant 13 gm)	3.76×10^{-3}	2.02×10^{-3}
4	Sample No. 4 (Bore well Water sample + 0.05M NaOH solution + surfactant 39 gm)	3.1×10^{-3}	5.61×10^{-3}
5	Remark	F value decreases from top to bottom	F value initially decreases then increases

Table-5 Comparison of Co-efficient of Friction of different samples

Sr. No.	Diameter of Pipe 'd' (m)	Area of Tank (m^2)	Height of Water Collected (m)	Time 't' (sec)	Actual Discharge Q=V/t	Piezometer Reading		Head loss due to friction $h_f = h_1 \sim h_2$	F = $\frac{2h_f gd}{4Lv^2}$	Mean F
						h_1 (m)	h_2 (m)			
1	2×10^{-2}	900×10^{-4}	15×10^{-2}	58	2.32×10^{-4}	8.0×10^{-2}	8.9×10^{-2}	0.9×10^{-2}	1.43×10^{-3}	3.1×10^{-3}
2	2×10^{-2}	900×10^{-4}	15×10^{-2}	105	1.28×10^{-4}	7.8×10^{-2}	9.0×10^{-2}	1.2×10^{-2}	4.77×10^{-3}	
3	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	140	9.64×10^{-5}	7.8×10^{-2}	9.1×10^{-2}	1.3×10^{-2}	9.06×10^{-3}	5.61×10^{-3}
4	1.5×10^{-2}	900×10^{-4}	15×10^{-2}	78	1.7×10^{-4}	7.9×10^{-2}	8.9×10^{-2}	1.0×10^{-2}	2.16×10^{-3}	

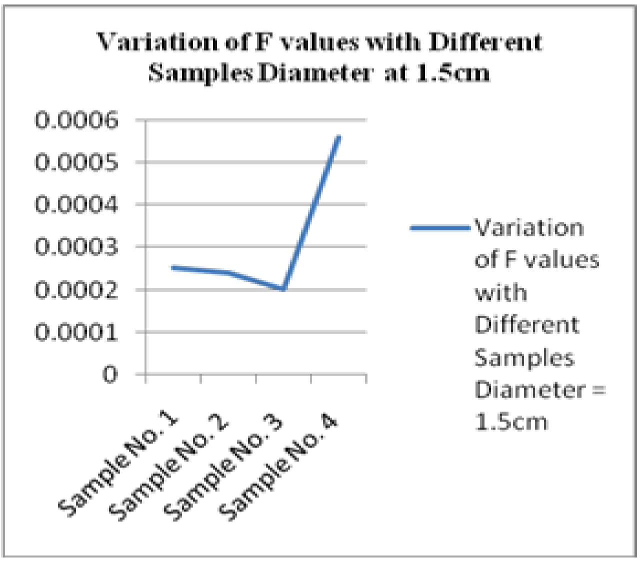

Fig-2 Graph between Samples vs. F values at 2cm diameter

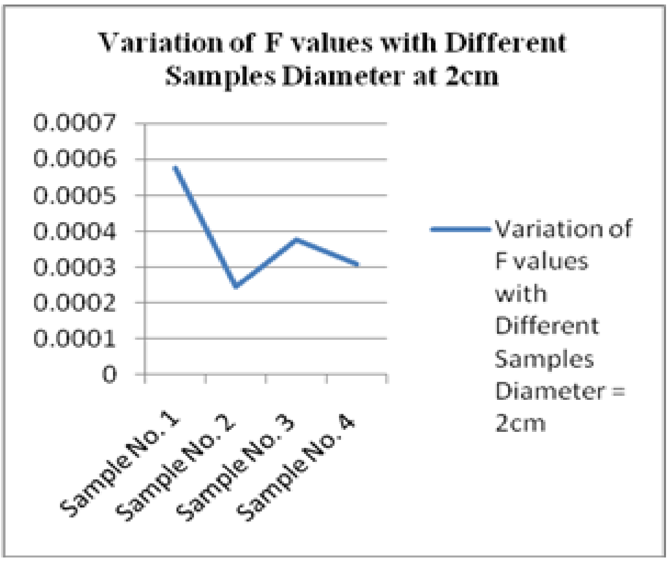

Fig-3 Graph between Samples vs. F values at 1.5 cm diameter

Table-6: Physicochemical characteristic of bore well water sample

Sr. No.	Parameters	Result	Remark
1	TDS(ppm)	101 ppm	Due to turbidity
2	pH	7.42	Slightly Basic
3	Conductivity	0.91 Ms	Conductivity due to ions
4	Total Hardness (ppm)	500 ppm	Hard water
5	Temporary Hardness (ppm)	150 ppm	$CaCO_3$
6	Permanent Hardness (ppm)	350 ppm	Dissolved Salts
7	Dissolves oxygen (ppm)	7.1 ppm	High
8	Temperature	$26.1\ 0^{C}$	Moderate
9	Humidity	Min.37%, Max. 39%	High
10	Colour	Colourless	---
11	Odour	Odourless	----

3. CONCLUSIONS

Coefficient of pipe friction mostly depends upon the Physico-chemical quality of water which flow through the pipe. From table and graph it is clear that Coefficient of pipe friction initially decreases with the water sample containing 0.5 molar sodium hydroxide solution at 2 diameter pipe but when water containing 0.5 molar sodium hydroxide with 13 gram surfactant it is decreases at same diameter were as water sample containing 0.5 molar sodium hydroxide with 39 gram surfactant it initially decreases then increases in the case of 1.5 diameter pipe.

Coefficient of pipe friction varies with the Physico-chemical feature of water sample. It is lowest with water sample containing 0.5 molar sodium hydroxide.

4. RESULTS

Coefficient of pipe friction depends upon the Physico-chemical characteristics of water sample and diameter of pipe in which water flow. Addition of suitable quantity of NaOH and surfactant reduces the coefficient of pipe friction from 5.77 × 10-3 to 3.1 × 10-3 at diameter 2 and 2.524 × 10-3 to 2.02 × 10-3 at diameter 1.5 but use of excess quantity of surfactant further sudden increases the coefficient of pipe friction from 2.02 × 10-3 to 5.61 × 10-3. This concept is used in the artificial hydro power generation.

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