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AN EXPERIMENTAL INVESTIGATION OF HEAD LOSS THROUGH LOCALLY MADE STRAINERS FOR HAND TUBE-WELLS OF BANGLADESH

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ABSTRACT

In this paper, an experimental investigation has been carried out for flow through locally made polyvinyl chloride (PVC) strainers of hand tube-wells used in Bangladesh. The head loss associated with this strainer has also been obtained. Minor loss coefficient for the strainer has been calculated based on Reynolds number. It is found that the average value of minor loss coefficient is equal to 0.27 and it decreases with the increase of Reynolds number.

Keywords : Strainers, Hand Tube-well, Minor Loss Coefficient

1. INTRODUCTION

Different materials have been widely adopted for hand tube-well strainers in Bangladesh. These are brass strainers, fiber glass strainers and stainless steel strainers. Recently, some attention has been given to the use of PVC strainers for hand tube-wells of Bangladesh, because of cheapness. Minor loss coefficient for metallic strainers varies from 0.3 to 1.2 [1] depending on the diameters. Hussain [2] mentioned that head loss in a fiber glass strainer is 1.5 ft. more than that of a stainless steel strainer. In Bangladesh, polyvinyl chloride (PVC) strainers are used in No. 6 hand tube-well, Tara pump and Rower pump which are all manually driven hand pumps. These pumps can be used for supplying sweet water, as well as for irrigation purposes. A schematic diagram of these pumps fitted with strainer has been shown in Figure 1. Although these strainers are available in the local market but their relevant data for calculating energy losses through these strainers are not available.

In the present experimental investigation, the flow through the radial slots of the strainer is assumed to be uniformly distributed over the horizontal pipe surface. The most suitable parameter on which non-dimensional minor loss coefficient of the straine depends is the Reynolds number. Throughout the experimental investigation the flow is considered to be turbulent. The range of Reynolds number based on internal diameter of the strainer covered in the experiment is between 4×10^4 and 8×10^4. Whereas in practice, the range of Reynolds number for flow through the three types of hand tube-wells is within 5.1×10^4 to 6.3×10^4.

2. METHODOLOGY

For conducting experiments three samples of the strainer are taken arbitrarily. Each sample strainer is about 2m long, having an average outside diameter of 48mm. There is a plain section of about 37mm length at each end of the strainer. The average slot width is 0.2mm and slot pitch is 1.5mm. In total there are eight ribs around the periphery, which are symmetrically distributed. The detail dimensions of the samples are given in Table 1.

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A sectional diagram of the strainer is shown in Figure 2. The relationship between the head loss and minor loss coefficient is given by the equation [3,4,5],

$$h_L = K\frac{V^2}{2g} \qquad (1)$$

where, V is average velocity of fluid through the strainer

K is minor loss coefficient

h_L is the head loss

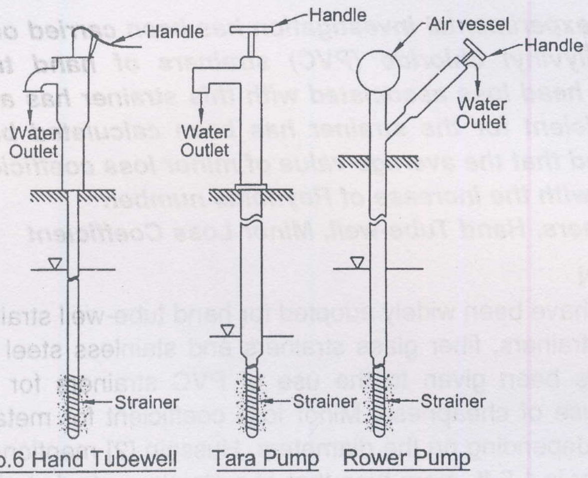

Figure 1 : Different Hand Tube-wells Used in Bangladesh

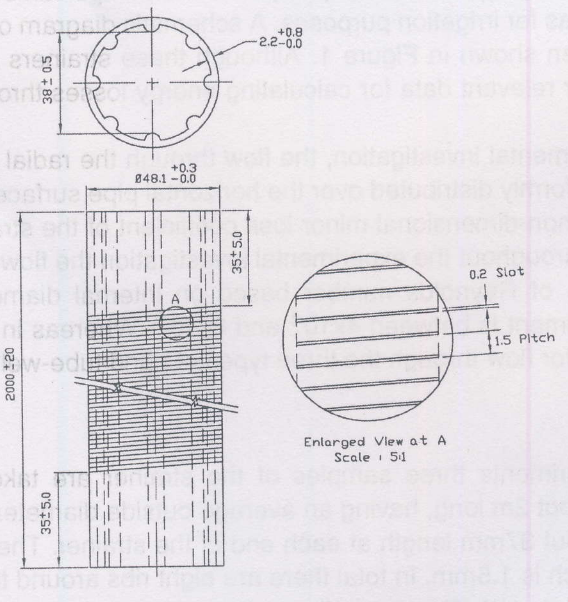

Figure 2: Sectional View of the Strainer

The experiments are carried out by all the strainers separately. The experimental set-up consists of an orifice-meter along with an inclined manometer, axial flow fan unit and a flow controller gate valve. The schematic diagram of the experimental set-up is shown in Figure 3. The orifice-meter is placed in the suction side in order to measure the air-flow rate. The static suction pressure at suitable location of suction side is measured by an inclined manometer for different flow rates. All the fittings and pressure tapings are located with sufficient clearance of straight portion to avoid disturbances in the flow [6]. The flow rate of air is varied by controlling the opening of gate valve. At first, one set of static pressures is measured without placing the strainer. Then by placing the strainers one by one, three sets of static pressures are measured. For each strainer head loss versus Reynolds number is plotted taking data of static pressures with and without strainers. Next for a particular Reynolds number, the difference of static pressures indicates the head loss for that particular Reynolds number in terms of mm of water. From the equation (1), the minor loss coefficient K can be determined. By following the same procedure three samples have been tested. For each sample five readings are taken at different Reynolds numbers.

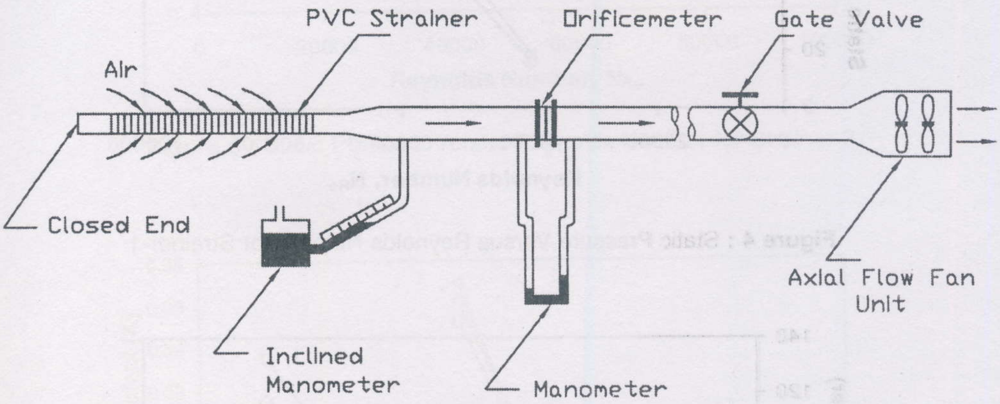

Figure 3 : Schematic Diagram of the Experimental Set-up

3. RESULTS AND DISCUSSION

Figures 4 to 6 show the variation of static pressures with Reynolds number for the three sample strainers. From these figures it is found that the static pressure increases linearly with the increase of Reynolds number. The difference of static pressures between the two curves at a particular Reynolds number shows the head loss at that particular Reynolds number. In Figure 7 comparison of minor loss coefficient for the three samples of strainers is presented. In Table 2 numerical results of them are given. It is observed that the head loss also increases with increase of Reynolds number for all the three samples. From Figure 7 it is evident that the minor loss coefficient also depends on the variation of Reynolds number. However, the average value of minor loss coefficient is found to be equal to 0.27. The average value of minor loss coefficient for the strainer may be used for the calculation of head loss through the strainer.

As the minor loss coefficient of the locally made hand tube-well strainers is not available, the results would serve a useful purpose to find the energy loss for flow through these strainers. It is expected that the present results would complete the lack of the information available on the loss coefficients of locally made PVC hand tube-well strainers. In the present analysis, the experimental work is done using air as a fluid. Since minor loss coefficient and Reynolds number are both dimensionless, final results can be applied to water or any other fluid.

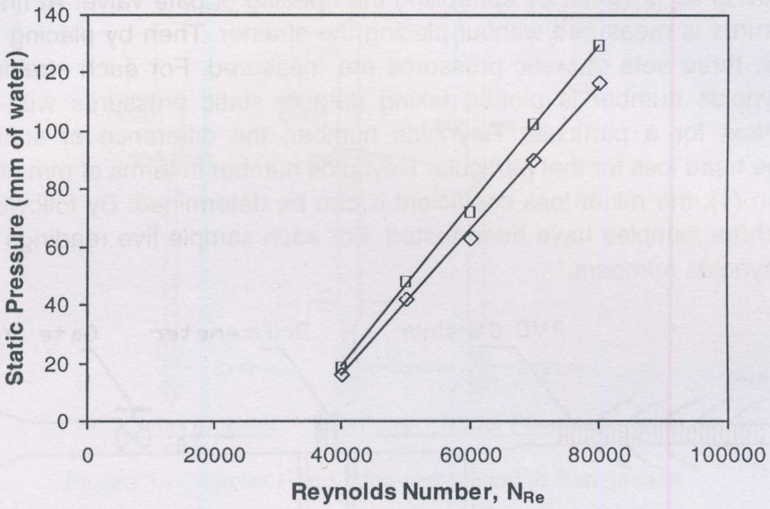

Figure 4 : Static Pressure Versus Reynolds Number for Strainer-1

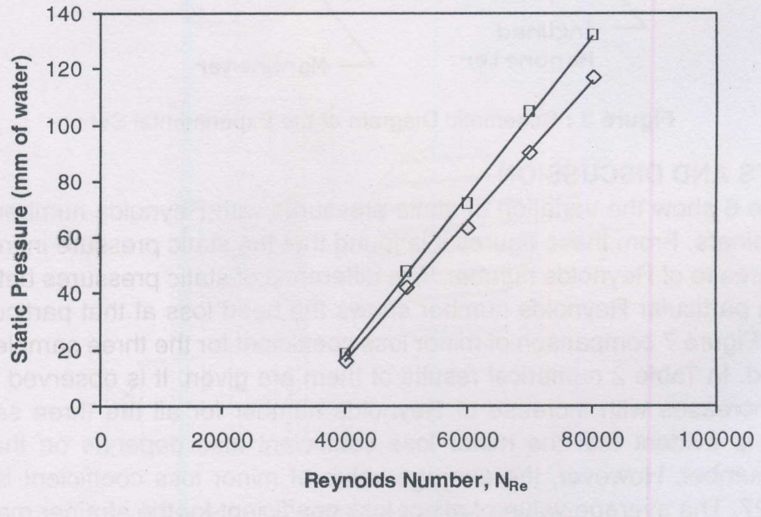

Figure 5 : Static Pressure Versus Reynolds Number for Strainer-2

However, further works will be necessary to understand the mechanism of losses taking place in the slots of strainer. Velocity profiles may be found out at the strainer to look into the nature of secondary flow taking place in the transverse direction. Flow in the laminar regions may also be investigated.

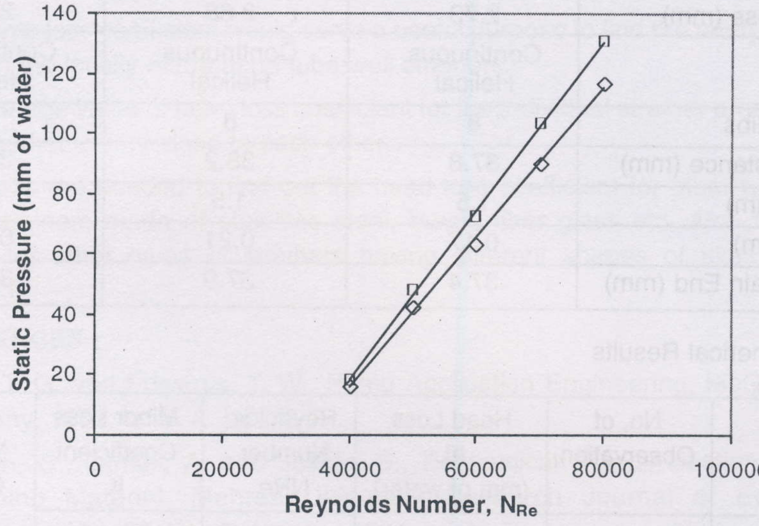

Figure 6 : Static Pressure Versus Reynolds Number for Strainer-3

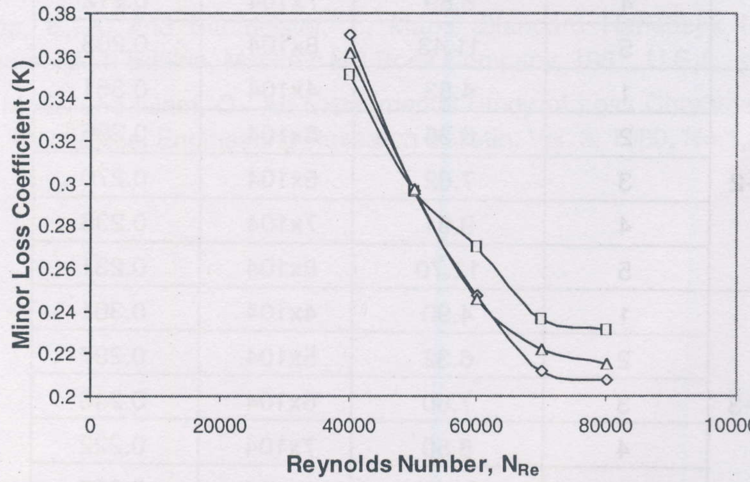

Figure 7 : Minor Loss Coefficient Versus Reynolds Number for Three Strainers

Table 1: Detail Dimensions of the Strainer Samples

Parameters	Strainer-1	Strainer-2	Strainer-3
Outside Diameter (mm)	48.25	48.24	48.22
Wall Thickness (mm)	2.73	2.68	2.60
Slotting	Continuous Helical	Continuous Helical	Continuous Helical
Number of Ribs	8	8	8
Rib to rib Distance (mm)	37.8	38.2	37.9
Slot Pitch (mm)	1.5	1.5	1.5
Slot Size (mm)	0.17	0.21	0.18
Length of Plain End (mm)	37.4	37.9	38.6

Table 2: Numerical Results

Condition	No. of Observation	Head Loss hL (mm of water)	Reynolds Number NRe	Minor Loss Coefficient K	Average Minor Loss Coefficient
For Strainer-1	1	5.08	4x104	0.370	
	2	6.35	5x104	0.296	
	3	7.62	6x104	0.247	
	4	8.89	7x104	0.212	
	5	11.43	8x104	0.208	
For Strainer-2	1	4.83	4x104	0.351	
	2	6.35	5x104	0.296	
	3	7.62	6x104	0.270	0.27
	4	9.91	7x104	0.236	
	5	12.70	8x104	0.231	
For Strainer-3	1	4.90	4x104	0.361	
	2	6.32	5x104	0.297	
	3	7.60	6x104	0.246	
	4	8.50	7x104	0.222	
	5	11.90	8x104	0.215	

4. CONCLUSION

- Static pressure and minor loss coefficient depend on Reynolds number significantly.
- There is some variation of the minor loss coefficient at the higher Reynolds number and for lower Reynolds number this variation is small for the three strainers.
- The minor loss coefficient would serve a useful purpose to find the energy loss for flow through the locally made hand tube-well strainers.
- The average value of head loss coefficient for the individual strainer procured from the local market is very close to each other.

Further works are needed to find out the head loss coefficient for other types of locally available strainers made of stainless steel, brass, fiber glass etc. Also the head loss coefficient for other types of strainers having different shapes of slots can also be investigated.

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