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Experimental Investigation on Impact of Jet on Vanes Pipe System to Determine the Minor Losses

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ABSTRACT

The water coming out from the nozzle is called as a jet and when the impacted on the different surfaces and the change in momentum can be determined and the experiment is performed with the nozzle, different type of plates such as flat, Circular and semi circular and a spring scale connected to the balanced beam and different weights are used as counter weights, flow meter and pipes. In this paper during the experimentation of determining the coefficient of impact on the vanes(plates) some of the minor Losses occurred due to the presence of bend in the suction pipe and nozzle pipe line connectivity and the extra fitting such as valve to control the flow on the pipe are present, due to this the flow of water, velocity in the pipe are varied, an attempt is done with this experiment to determine some important minor losses ,major losses are neglected as length of pipe is short. The readings from the experiment on three different plates are conducted and readings are tabulated and compared.

KEYWORDS: *Jet, Flat Plate, Momentum, Minor Losses, Bend, Major losses, Velocity*

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INTRODUCTION

Moving fluids, in natural or artificial systems, may exert different forces on objects in contact with it. To determine the fluid motion, for a finite region of the fluid is usually selected, and the gross effects of the flow, such as its force on an object, is determined by calculating the net mass rate that flows into and out of the control volume. These forces can be determined, as in solid mechanics, by the use of the momentum equation. The force exerted by a jet of fluid on a flat or curve surface can be resolved by applying the momentum equation. The study of these forces is essential to the study of fluid mechanics and hydraulic machinery. When the water coming from the nozzle called as a jet and the jet strikes on the obstruction like a flat plate or vane in the path, the jet exerts the force on the plate is known as Impact of jet. Newton second law of motion states that "the applied force is equal to rate of change in momentum." In momentum equation the algebraic sum of external forces are applied to control volume of fluid in any direction equal to the rate of change of momentum in that direction, in equation form, F = mv, where F is momentum, m is mass in kg and v is velocity of jet in m/s. momentum equation is vector quantity, this means it has both magnitude and direction.The jet apparatus consists a nozzle, and a flow deflector as shown in the figure 1.The Water enters vertically through a nozzle striking a target, mounted on a stem, and leaves through the outlet holes in the cylinder base. The air vent at the top of the cylinder maintains the atmospheric pressure inside the cylinder. A weight pan is mounted on the top of the stem to allow the force of the striking water to be counterbalanced by applied masses.

The velocity of the water (v) leaving the nozzle with the cross-sectional area (A) can be calculated by:

$$v = \frac{Q}{A} \qquad (1)$$

in which Q is the flow rate in m^3/sec

Applying the energy equation between the nozzle exit point and the surface of the deflector Applying the momentum equation to a control volume encompassing the deflected flow results

$$F_y = \rho Q v(cos\theta + 1) \qquad (2)$$

where: F: Force exerted by the deflector on the fluid, ρ: fluid density, θ: 180-α, where α is the flow deflection angle

From equilibrium of forces in a vertical direction, F is balanced by the applied weight on the weight pan, W (W = mg, where m is the applied mass), i.e., F = W. Therefore:

$$W = \rho Q v(cos\theta + 1) \qquad (3)$$

Since Q = VA, this equation can be written as:

$$W = \rho A v^2 (cos\theta + 1) \qquad (4)$$

LITERATURE REVIEW

Farzad Hossain, Afshana Morshed, Rifat Sultana, Md. Quamrul Islam[1]: In this paper the investigation into the reaction force generated by the impact of a jet of water onto various target vanes and to compare between experimental and theoretical forces which are exerted by the jet. The procedure for this experiment is to bring the weight cup in the initial position by applying weight when the flow rate is varied. It can be possible to repeat the same experiment by changing different target vanes. Moreover, the effect of different target vanes can be seen at a constant flow rate by changing the type of target vanes and applying different amounts of weights to bring the weight cup in the initial position. The vanes used in this experiment can be categorized into four geometries. Flat, inclined, spherical and conical vanes are used for this experiment. Experimental and theoretical forces and the percentage of error can be calculated in this experiment. Here, the theoretical forces are depended upon weights applied on the weight cup and the experimental forces are depended on flow rate, nozzle exit velocity, impact velocity and shape of the vanes.

Niranjan Aatkare, Akshay Kodlangare[2]:In this paper the Water is used to generate the force and this forced water is impacted on the surface which is measured and compared to change in momentum of the jet. In the experiment water nozzle, a set of target plates, a spring scale connected to the balance beam, flow meter and pipes for re circulation of water have been used. This paper focuses on determination of experimental, theoretical force and percentage of error

Yusuf koc[4]:In this paper the Investigation was carried out on the cleaning process to the impingement of jet, the main parameter that influence the cleaning performance are water temperature, chemicals, cleaning time and impact on the surfaces. Cleaning is the process of using water to remove soil, rust stains or other deposits from the surface.

N. M. Mali, Vijay [5]: In this paper the investigation about how to determine force on flat and inclined plate by using digital weighting pan in test rig of impact of jet. They concluded in this paper that as the discharge increase the value of force exerted also increase.

EXPERIMENTATION

The apparatus is first leveled and the lever brought to the balanced position (as indicated by the tally), with the weight at its zero setting. Note the reading of weight and the following dimensions: diameter of the nozzle, height of the vane above the tip of the nozzle when the lever is balanced, and distance from the pivot of the lever to the centre of the vane. Water is then passed tthrough the supply valve, and the flow rate increased to the maximum. The force on the vane displaces the lever, which is then restored to its balanced position by sliding the weight along the lever. The mass flow rate is established by collection of water over a timed interval. Further observations are then made at a number reducing flow rates.

About three readings are taken. The best way to set the conditions for reduced flow rate is to place the weight exactly at the desired position, and then to adjust the flow control valve to bring the lever to the balanced position. The condition of balance is thereby found without touching the lever, which is much easier than finding the point of balance by sliding the weight. Moreover, the range of settings of the position may be divided neatly into equal steps. The experiment should be run tthrice, first with the flat plate and then with the circular plat and semi circular plate.

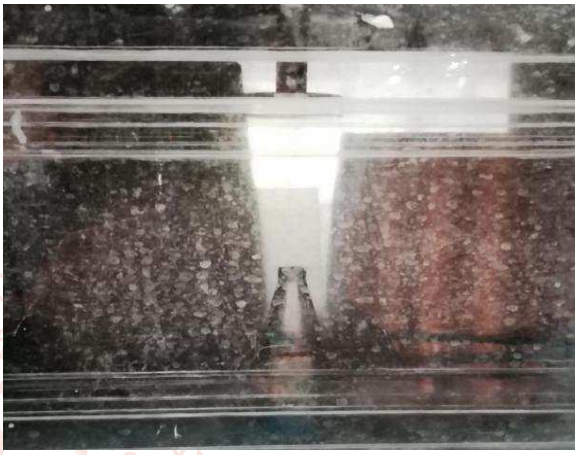

Fig.2 Nozzle With flat plate

Fig.3 Spring Weight System

Fig.4 Impact of Jet Experiment Set up

RESULTS & DISCUSSIONS

Area of the collecting tank = $0.25m^2$
Diameter of the Pipe = 0.030m
Diameter of the Nozzle = 0.010m
Area of the Pipe $=7.06\times10^{-4}m^2$
Area of the Nozzle $=7.85\times10^{-5}m^2$

For flat plate

$F_{The} = \rho\times Q\times V_1(1+\cos\theta)$, Where $\theta=90^0$

$F_{The} = 1000\times5\times10^{-4}\times6.3(1+\cos90^0)=3.18N$,

Similarly all readings are calculated tabulated

Table 1: Experimental values of Circular Plate

S. no	Actual Force	Time taken for 5cm rise
1	4	33
2	10	17
3	12	15

Table 2: Experimental values of Circular Plate

S. no	Discharge	Velocity	Theoretical force	Actual Force
1	3.79×10^{-4}	4.83	4.12	4
2	7.35×10^{-4}	9.36	11.74	10
3	8.37×10^{-4}	10.61	15.08	12

$Q_{Act}=\frac{AR}{T}=\frac{0.25\times0.05}{33}=3.79\times10^{-4}m^3/sec$,

$F_{the}=\rho\times Q\times V_1(1+\cos\theta)=4.12N$

Losses In pipes during flat plate:

Loss of head due to bend in pipe

$h_b=\frac{KV^2}{2g}$, K=0.75, When the bend of pipe is 90^0

Extra valve fitting $=\frac{KV^2}{2g}$, K=2.30, Coefficient of pipe fitting

The velocity in pipe is determined from the continuity equation $\rho A_1V_1=\rho A_1V_2$

Table 3: Experimental values bend pipe losses when circular plate is used

S. no	Discharge	Head Loss due to bend in pipe
1	3.79×10^{-4}	0.0107m
2	7.35×10^{-4}	0.0413m
3	8.37×10^{-4}	0.0523m

Table 4: Head Loss due Extra valve fitting when Circular Plate is used

S. no	Discharge	Head Loss due Extra valve fitting
1	3.79×10^{-4}	0.0329m
2	7.35×10^{-4}	0.126m
3	8.37×10^{-4}	0.1604m

Table 5: Experimental values of Flat Plate

S. no	Discharge	Velocity	Theoretical force	Actual Force
1	5.00×10^{-4}	6.3	3.18	2
2	6.25×10^{-4}	7.9	4.9	4
3	8.33×10^{-4}	10.6	8.8	6

Table 6: Experimental values bend pipe losses when Flat plate is used

S. no	Discharge	Head Loss due to bend in pipe
1	5.00×10^{-4}	0.0187m
2	6.25×10^{-4}	0.0296m
3	8.33×10^{-4}	0.0523m

Table 7: Head Loss due Extra valve fitting when Flat plate is used

S. no	Discharge	Head Loss due Extra valve fitting
1	5.00×10^{-4}	0.057m
2	6.25×10^{-4}	0.0907m
3	8.33×10^{-4}	0.1604m

Table 8: Experimental values of Semi Circular Plate

S. no	Discharge	Velocity	Theoretical force	Actual Force
1	4.12×10^{-4}	5.31	4.12	4
2	6.56×10^{-4}	8.38	11.74	10
3	9.25×10^{-4}	11.31	20.08	18

Table 9: Experimental values bend pipe losses for semicircular Plate

S. no	Discharge	Head Loss due to bend in pipe
1	4.12×10^{-4}	0.0088m
2	6.56×10^{-4}	0.0568m
3	9.25×10^{-4}	0.1468m

Table10: Experimental values valve fitting losses semicircular Plate

S. no	Discharge	Head Loss due Extra valve fitting
1	4.12×10^{-4}	0.0270m
2	6.56×10^{-4}	0.174m
3	9.25×10^{-4}	0.450m

Graphs:

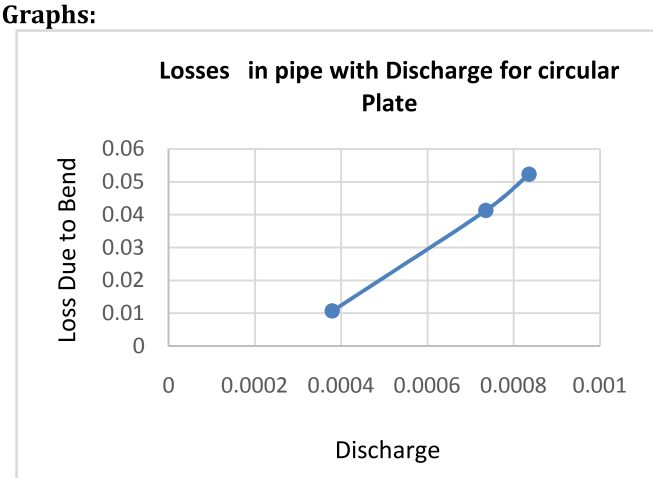

Fig.5 Losses due to bend in the pipe varied with Discharge for circular plate

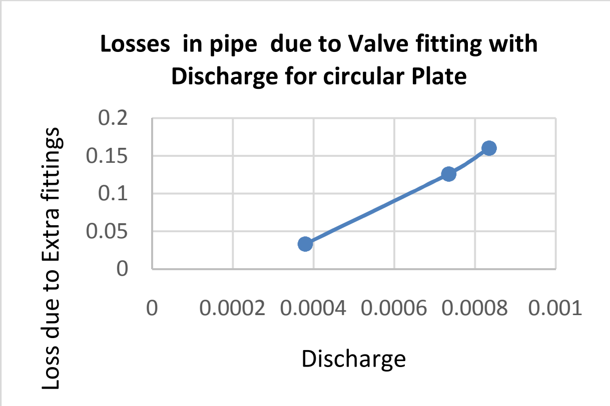

Fig.6 Losses due to valve fittings in the pipe varied with discharge for circular plate

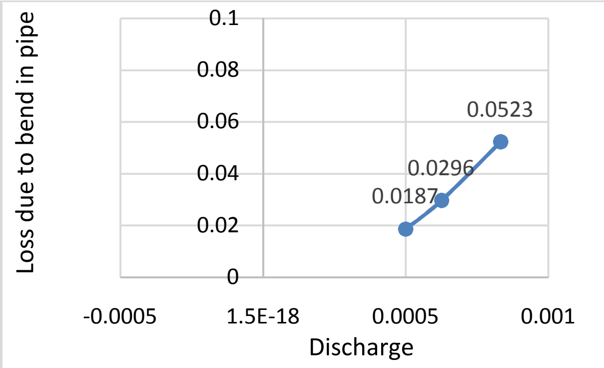

Fig.7 Losses due to bend in the pipe varied with discharge for flat plate

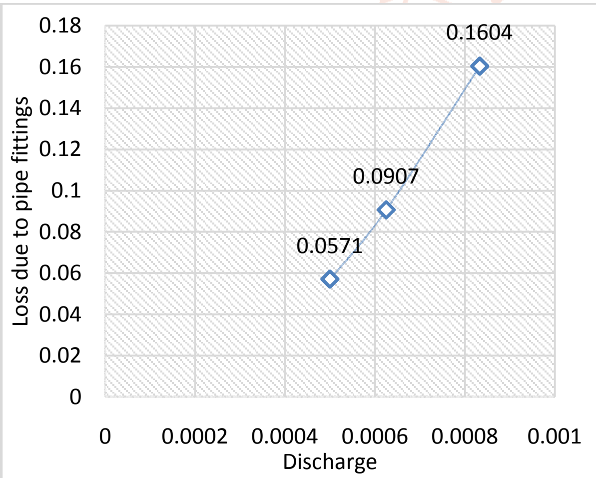

Fig.8 Losses due to valve fittings in the pipe varied with discharge for Flat plate

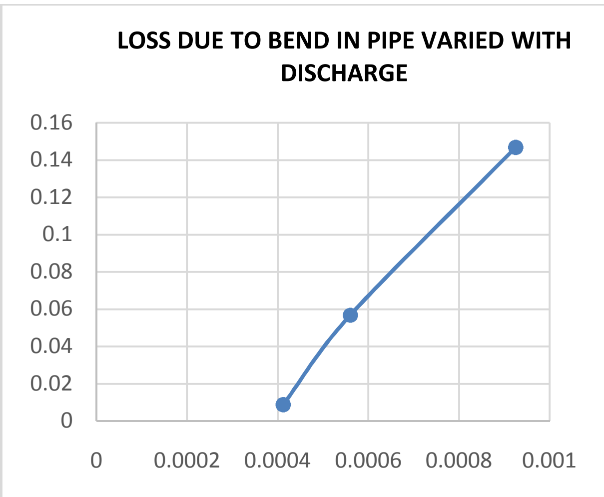

Fig.9 Losses due to bend in the pipe varied with discharge for Semi Circular plate

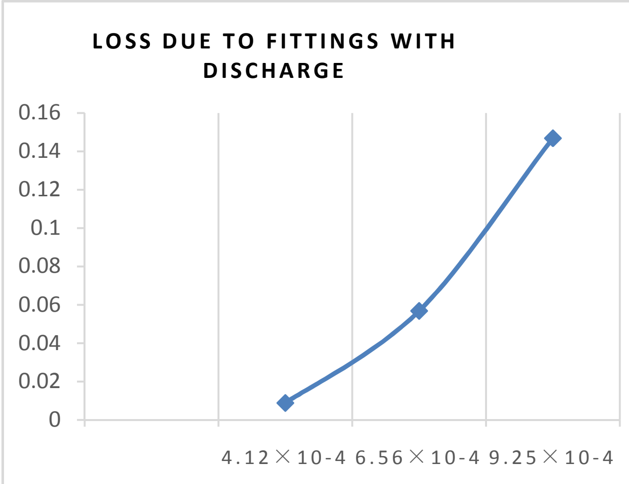

Fig.10 Losses due to valve fittings in the pipe varied with discharge for Semi Circular plate

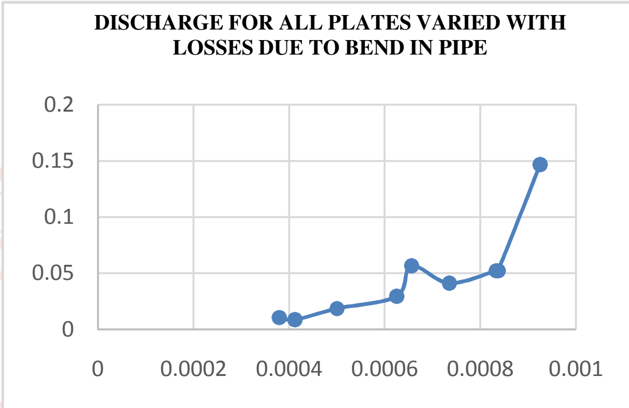

Fig.11 Discharge for all plates varied with losses due to bend in pipe

Fig.12 Discharge for all plates varied with losses due to extra fittings on pipe

CONCLUSION

The Results obtained are compared for different type of plates such as flat plate ,Circular plate and Semi circular Plate ,the nozzle is connected with a pipe line with a 90^0 bend shaped connectivity and water regulating valve is placed on the pipe as result during the experimentation some of the minor losses occurred which shows impact on the flow of water which strikes on the plate and due to this there will be small reduction in efficiency value of different plates as this is an attempt made to determine the impact of minor losses and the major losses are neglected as length of pipe is very Small when the discharge increases for different plates the looses value also increased and the looses from the exit of the nozzle can also be determined.

REFERENCES

[1] Farzad Hossain, Afshana Morshed, Rifat Sultana, Md. Quamrul Islam "Measurement of Flow Rate and Impact Force on Different Vanes through Impact of Jet,"International Journal of Modern Research in Engineering & Management (IJMREM),Volume1,Issue7,July2018 ISSN: 2581-4540

[2] Niranjan Aatkare, Akshay Kodlangare,"Design and analysis of impact of jet on vanes" Proceedings of Conference on Advances on Trends in Engineering Projects (NCTEP-2019),In Association with Novateur Publications IJIERT-ISSN No: 2394-3696 ISBN. No.978-93-87901-03-2 February, 15th and 16th, 2019

[3] Ankush kumar Jain,Amit Singh Kudal,"To verify the momentum equation by Impact of jet apparatus on flat plate", International Journal of Innovative and Emerging Research in Engineering,Volume 4, Issue 4, 2017

[4] Yusuf koc,"An experimental study of mechanical effect in cleaning process", Sigma Journal Engineering and Natural Sciences

[5] N. M. Mali, Vijay, "Determination of force on flat and inclined plates using weighting pan in test rig of impact of jet", International Journal of Innovative and Emerging Research in Engineering, volume 5

[6] Aishwarya Singh Rathore,"Role of vane angle and its shape on jet mixing of a subsonic coaxial jet", International journal of Engineering research in Mechanical and civil Engineering, volume 3

[7] Dr. P. N. Modi "Hydraulics and fluid mechanics including hydraulics machines", Raj sons publications Pvt. Ltd. (PP 978,986)