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PRESSURE ENERGY LOSES ANALYSIS AT FLOW DIVIDING TOWARD ANGLE VARIATION Y EXTANTION

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Abstract: **This study aims to analyze Pressure Losses in Separating Flow from Variations in Connection Angles Y. This research was conducted at the Laboratory of Fluid Mechanics at the Department of Mechanical Engineering, Hasanuddin University, by first preparing equipment and research materials. In this study the independent variables used are the flow rate (Q) before and after passing the pipe joint Y and the variation of the joint angle Y (α). dependent variables are the Reynolds number (Re), the coefficient of loss (Loss Coefficients) (K3-1, K3-2) and the amount of pressure loss (head loss) (hk). The results of the study concluded that; (1) Changes in Angle in the test section will affect the increase in Loss Coefficients in Each Branch, (2) Changes in Reynolds Numbers (Re) will affect changes in the value of Loss Coefficients (K) in each Branch, (3) Changes in Reynold Numbers (Re) will affect the value of the pressure loss (h) at the connection angle Y, and (4) The difference in experimental results with previous studies sourced from several national and international journals is different because of: the type of test pipe used in the study, the type of test section, technology, measurement that has not been precise due to fluctuations in pressure, diameter of the test specimen, different variations in water discharge, different room temperatures, and variations in different angles.**

Keywords: **Pressure Energy, Flow Separation, Fluid Mechanics, Reynolds Numbers.**

1. INTRODUCTION

The development of fluid mechanics from time to time is growing rapidly. Likewise with the application of fluid mechanics, both in the industrial world, the maritime world and in everyday life. Likewise in industries that use a lot of piping installations that function to drain fluid to the destination. In this installation, many connections are used to turn, divide the flow into branches and join the flow. Separation of fluid flow in branching is unavoidable especially in the installation of pipes for residential settlements even in the installation of pipes on ships such as cargo ships, containers, tankers and other types of ships, this will certainly reduce the performance of the system.

The first internal flow study by a German teacher, Julius Weisbach in 1850, examined the losses in the head of the pipe then continued by Engineer Henry Darcy of France, in 1857 who conducted the pipe flow experiment and first revealed the effects of roughness on pipe barriers known as the Darcy-Weisbach equation. Then Osborne Reynold experimented with his classic pipe in 1883 which showed the importance of Reynolds numbers in fluid flow.

During the fluid flowing through the pipeline there are many pressure losses called Major Head Loss and Minor Head Loss (ME-105, 2010). Major losses are pressure losses that occur due to fluid friction with the wall along the pipe and Minor losses are losses due to fluid passing through the connection. The flow that occurs in the branching pipe causes the flow to be turbulent and separation, so the coefficient of friction is high and causes a pressure drop which will affect the energy needed by the pump. (Salimin, 2009) Flow through separation usually functions to flow distribution in a piping installation at a place. Turbulent flow has a higher coefficient of friction compared to laminar flow, the high coefficient of friction has a direct effect on the amount of pressure drop and the amount of energy needed to drain the fluid (Setyo, 2006).

Research on the effects of angles on flow characteristics in Tee 90^0 connections has basically been carried out. In his research, Costa (2006), variations in pressure, average velocity and turbulent velocity that occur in water flow in the form of sharp angles and round angles at Tee 90^0 connections are measured at 50% flow ratio with Reynolds number 32,000 for sharp angles and 30,000 for the circular angle, of the two geometric shapes the flow branch loss coefficient is higher than the main pipe because the flow combining occurs in the branch pipe. The round corner connection for (r / R = 0.1) causes high turbulence in the branch pipe which results in a shorter, thinner and weaker reverse circulation bubble area so that the coefficient of losses decreases in branch flow, increases in dissipation of the branch flow coefficient and losses energy (KD) is reasonable that the round corner Tee connection is more efficient for all Reynolds numbers.

If the fluid flows through a branching, separation will occur resulting in compressive losses. According to (Dwiyantoro, 2004). The branching of the incompressible fluid flow causes disruption to the flow due to separation which causes loss of total pressure. The collision that occurs in the branching pipe causes the flow to be turbulent, so the coefficient of friction is high and causes a pressure drop which will affect the energy needed by the pump. Which area the pressure drop occurs and how much influence the variation of the angle of connection Y on the coefficient of loss in the flow separation by varying the angle of the Y branch (dividing Y). Based on the thoughts and descriptions above, in order to answer the problem, a study was carried out with the title "Analysis of Pressure Losses - Energy Pressure on Separation of Flow Against Variations in Connection Angles Y".

The aim of this research is :

1. Determine the effect of changes in branch angle on the loss coefficient (K) with a variation of the connection angle Y (α) respectively 45^0, 60^0, 75^0, 90^0.105^0.

2. Determine the effect of the Reynolds number (Re) on the value of the loss coefficient (K) for each corner of the Y branch connection (α) with varying angles of 45^0, 60^0, 75^0, 90^0.105^0 respectively.

3. Determine the effect of changing the Reynolds number (Re) to the total loss coefficient (Ktot) with angular variations of 45^0, 60^0, 75^0, 90^0.105^0 respectively.

4. Determine the effect of changes in Reynold's number (Re) to the value of pressure loss (h) with h as a function of Re and the connection angle Y (α) 45^0, 60^0, 75^0, 90^0.105^0.

2. LITERATURE REVIEW

Basic Theory of Fluid Flow

Based on the form of the flow, the fluid can be classified as follows: perfect fluid, real fluid, compressible and incompressible. A perfect fluid has no viscosity and cannot be compressed. The concept of perfect fluid makes it possible to solve simpler mathematical formulations.

Loss Coefficient Analysis on Dividing

Flow through branching (dividing) usually serves to divide or combine from several fluid flows. In the branching pipe industry it is also used as a filter for impurities or a separator between water and steam. The coefficient of loss at branching depends on (source, Miller 1970):

1. Comparison of the area of the channel (Leg)

2. Angles between branches

3. Chamfer or branching radius

The energy equation in general (James W, Donald RF Harleman, 1966) is:

$$\frac{\delta Q}{dt} - \frac{\delta W_{shaf}}{dt} - \frac{\delta W_{shear}}{dt} = \int \left(\frac{p}{\rho} + e \right) \rho V dA + \frac{\partial}{\partial t} \int e \rho dV$$

Measurement and Location of Separation

To match the existing theory with experiments, visualization will be made by making a branching model of a pipe with a transparent pipe, then fluid flow with the same discharge variation. To detect the occurrence of separation is to measure the pressure before and after the flow passes through the bend, as for the separation is marked by a decrease in pressure as shown in Figure 1 In the area of separation there will be a reverse flow direction which will result in a sharp pressure drop.

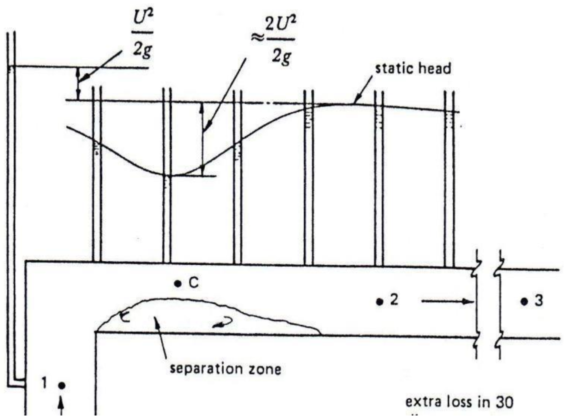

Figure 1. The separation zone (separation zone) is shown by the reduction in static pressure (Miller) For separations that occur in dividing and combining will occur as shown in Figure 2 shown by P. notation

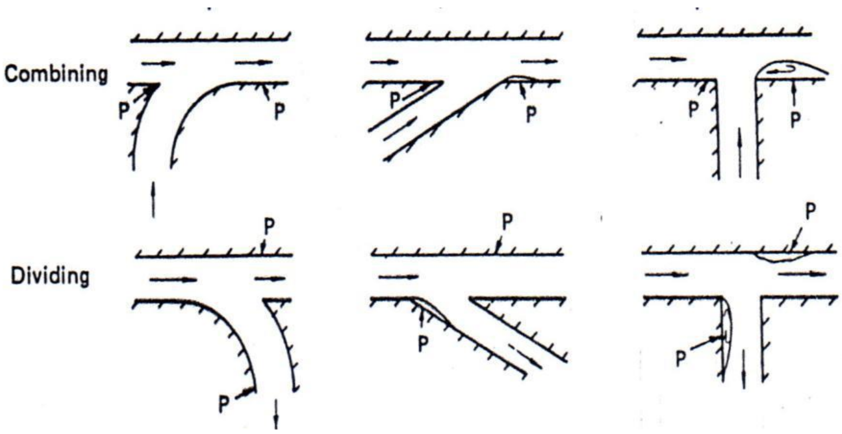

Figure 2: Location of gradients of loss at branching (Miller)

3. RESEARCH METHOD

The research was carried out at the Fluid Mechanics Laboratory of the Department of Mechanical Engineering, Hasanuddin University, by first preparing the research tools and materials.

a. Planning and assembling tools

The design and manufacture of tools intended to facilitate the smooth research. Collection of comparative data and literature for one of the objects of planning and procurement of the required equipment and materials is ready, so a research installation is made as shown in the picture above.

b. Prior to conducting research, inspection must be carried out on the equipment to be tested as follows:

• Fill both reservoirs (1) and (2) with enough water and ensure the centrifugal pump runs properly.

• The pump is run to fill the top tank and open the valve (Q3) and test the leak, after the flow conditions are stable then an experiment is started.

• Check the pressure gauge Manometer is working properly.

• Re-check all systems and ensure there are no leaks.

The research variables consist of independent variables and dependent variables, each of which is as follows:

- The independent variable is the variable whose magnitude is determined before the study. The size of the independent variable is changed to get the relationship between the independent variable and the dependent variable, so that the research objectives can be achieved. In this study the independent variables used are the flow rate (Q) before and after passing the pipe joint Y and the variation of the joint angle Y (α).

- The dependent variable is a variable whose magnitude cannot be determined before the study, but the magnitude depends on the independent variable. In this study the independent variables are Reynolds number (Re), loss coefficient (K3-1, K3-2) and the amount of pressure loss (head loss) (hk).

Connection section research section Y.

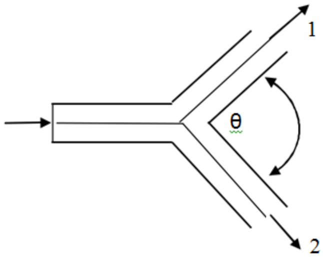

Figure 3: Section of the connection angle research Y

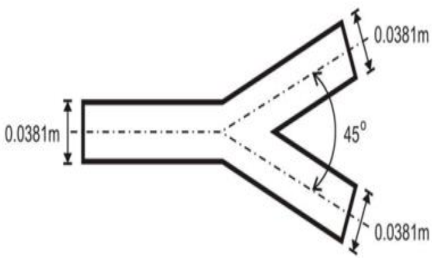

Figure 4: Y Pipe Connection Test Section for 45^0 Angle

4. RESEARCH RESULT

1. Change of Angle as a Function of Loss Coefficient in Each Branch

From this study, the results obtained stated that the greater the branching angle (α) in the test section, the greater the loss coefficient k3 - 1, k3 - 2, and ktot. and this is evidenced in the calculation results, then from the value of the loss coefficient graph. Based on a book written by Donald S. Miller with the title "Internal Flow System" states that each branch that changes near straight then the coefficient of loss is getting smaller and vice versa if the angle changes getting bigger and approaching the T-shaped branching (T Junction), the loss coefficient is getting large, the branch in question is the branching that forms symmetric Y (Y Junction)

The following is a graph of the relationship between the change in angle and the loss coefficient (K) in (K3-1) of the study.

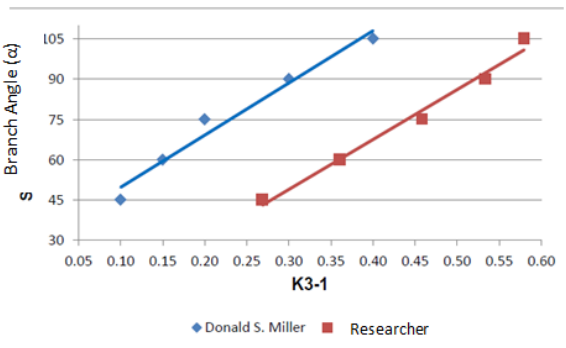

Figure 5: Branch Angle Graph (α) Against the loss coefficient (K3-1) on (K3-1) Donald S. Miller and Researchers

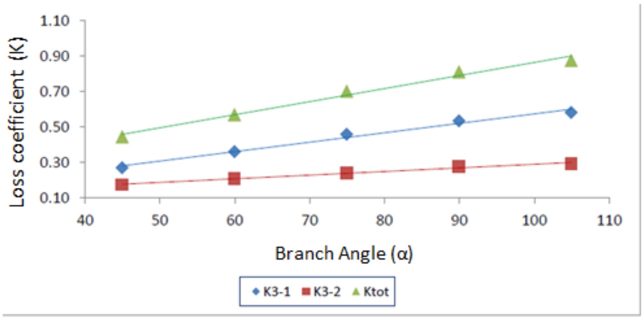

Figure 6: Graph of loss coefficient (K) to Branch Angle (α)

2. Changes in Reynolds Numbers (Re) as a Function of Loss Coefficient (K) values for each branch.

From the results of this study it was found that the greater the Renolds numbers, the k3-1 and k3-2 are getting bigger. This means that in the Y-shaped branching (dividing Y junction) the Reynolds number (Renolds Number) will increase directly to the change in the coefficient of loss at the branch, both k3-1 and k3-2.

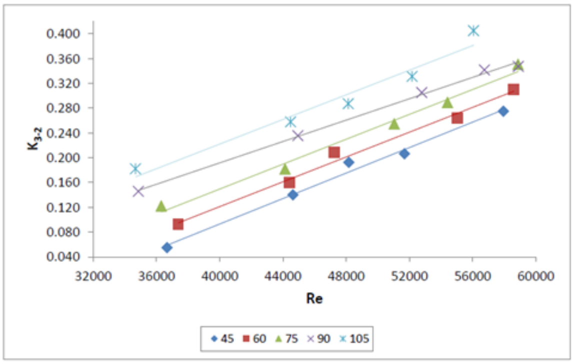

Figure 7: Graph of Loss Coefficient (K3-2) Against Reynolds (Re)

3. Changes in Reynolds Numbers to the Total Loss Coefficient (Ktotal)

The coefficient on total loss is the sum between the coefficients of losses per branch. the results of the study show the value of the coefficient of loss in each branch tends to increase this is due to the greater angle at the branching, the greater the resistance. In the branching Y (dividing Y "conical junction") the results are obtained that the greater the branching angle, the greater the total coefficient value. This is also stated in the results of previous studies using the branching "Lateral Dividing Branch" also showed the same conclusion.

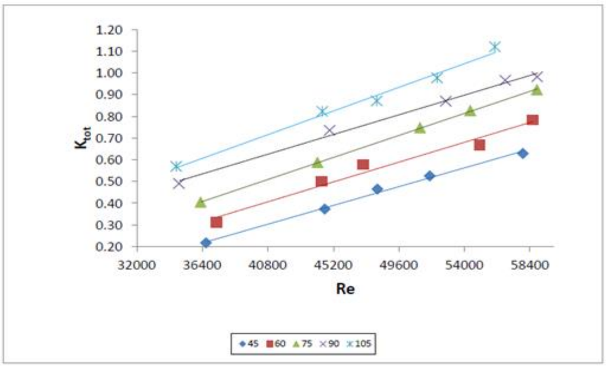

Figure 8: Graph of Loss Coefficient (Ktot) Against Reynolds Numbers (Re)

4. Change in Reynold's number (Re) to the value of pressure loss (h) at the connection angle Y (α)

In fluid mechanics we know that there are two types of head losses, major losses and minor head losses in this study. The test section used is smooth pipe and small to large dividing lines. .

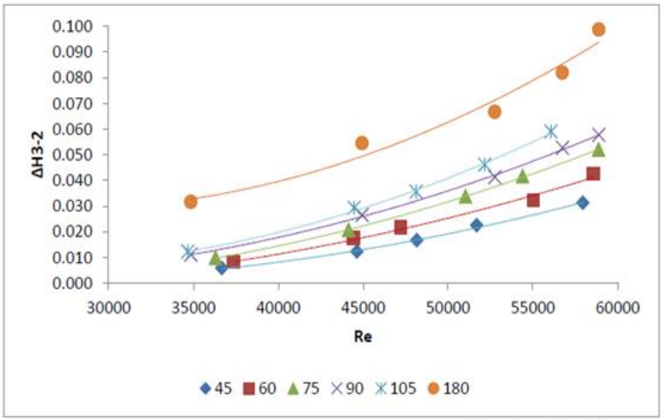

Figure 9: Changes in Reynold Numbers (Re) to the value of pressure loss (h) at the connection angle Y (α)

From some comparative graphs that have been shown in the discussion above such as Donalds S. Miller, Blevins, Donalds S. Miller and Rahmat Subagyo, there are slight differences and this is caused by several factors, namely:

- The type of test pipe used in research
- Type of test section
- Technology
- Measurement that has not been precise due to pressure fluctuation
- Diameter of the test object
- Different variations in water discharge
- Different room temperatures
- Different angular variations

5. CONCLUSION

Based on the results of research and calculations - calculations that have been carried out on the separation of the flow in the variation of the branching angle of the pipe (dividing Y), then several conclusions can be drawn, namely:

1. Angle changes in the test section will affect the increase in the Loss Coefficient in Each Branch
2. Changes in Reynolds Numbers (Re) will affect changes in the value of the Loss Coefficient (K) at each branch.
3. Changes in Reynold Numbers (Re) will affect the pressure loss value (h) at the connection angle Y
4. Differences in the results of experiments with previous studies sourced from several national and international journals, there are differences caused by:
   - Types of test pipes used in research
   - Type of test section
   - Technology
   - Inaccurate measurement due to pressure fluctuation
   - Test object diameter
   - Different variations in water discharge
   - Different room temperatures
   - Different angular variations

6. SUGGESTION

1. In the piping installation and distribution of water it should be avoided flow separation by using a Y dividing with a large branching angle because it will cause losses due to separation.

2. For further research can be done by varying the diameter in leg 1 to determine the change in the coefficient of loss that occurs in the branch.

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