Simulation of air flow loss in triangle pipe construction

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Abstract. The purposes of this research are to find out how the simulation of flow velocity, mass flow rate and pressure that occur in each variation of Reynold numbers on the triangle pipe arrangement of solid work software. By using test and simulation analysis methods, using a number of tools and materials so that they can be simulated and simultaneously analyze the resulting design. The tools and materials used in the simulation and analysis process in this design are (1) computers with specifications of the Intel (R) Xeon (R) CPU E3-1246 v3 @ 3.50Ghz 3.50 GHz (2) a solid work keel device for analyzing pressure. This fluid mass flow rate is influenced by the velocity of fluid flow and the temperature at this fluid can influence fluid density and specific gravity. This fluid speed can affect the pressure that hits the pipe. In the simulation results, there is a significant pressure change due to the speed that changes over the sidelines of the same pipeline. This change raises the loss of friction in the arrangement of the pipe pipeline due to the pressure factor that hit the pipe. The pressure that occurs is influenced by the velocity of fluid flow, fluid mass flow rate and cross-sectional area on the triangle pipe arrangement.

1. Introduction

People are always faced with fluid every day without being struck by it. This fluid flow causes many natural symptoms such as hills, canyons that are in the aftermath of the forces that are caused by months of fluid flow. But in the utilization of many losses that arise one of them is the disadvantage in the installation of heat exchanger equipment. The instrument of the heat exchanger has been very often met in daily life. One of them is on the power plant. Tubes compiled in triangular form as a zigzag arrangement will result in gaps in the installation of the Calor Exchanger. The longitudinal direction of stacking arranged with adjacent distances aims to make the pipe arrangement have a higher flow of turbulence so that the heat transfer occurs more and more. Doing modelling is a way to study the system and the model itself and also the various differences in behaviour [1].

But the consequence of the density of the tube file is the occurrence of a larger pressure drop, resulting in large friction as well. This will result in a loss of flow to the triangular pipe arrangement [2]. The more complex an installation arrangement of the heat exchanger is used, the more loss of flow can be found. The fluid that hits the pipe arrangement on the installation of the Calor Exchanger can weaken the current pipeline. Unless the thickness on the pipe wall is operating enough to maintain the pressure working on the pipe installation.

Knowing the loss of flow on a system that utilizes fluid flows as a medium, determines the level of efficiency. If you want to know the losses that occur on the pipeline then it should be done laboratory research. The amount of flow loss on the pipe arrangement is influenced by several factors, such as
pressure hitting the pipe, broad cross-section, fluid temperature, viscosity, and pipe roughness, fluid type weight, and pipe length. Then based on the background, this research is done using SolidWorks software to facilitate the design and calculation process. To understand the fluid flow, you must know some basic properties of the fluid. The basic properties of the fluid are density, specific gravity, pressure, a viscosity [3]. Adjustment of the volume flow rate in the fluid can cause a decrease in the quality of the broadcast that is in the pipe, for that some models are needed when simulating the fluid flow in the program [4]. The deformation of a pipe construction can cause an imbalance between pressure and gravity and will cause a small disturbance in the visual waves of the pipe flow [5]. Several studies have been carried out using a double gamma densitometer to measure fluid retention in a three-phase slug flow and pressure reduction measurements used using a transducer mounted at the end of the pipe, obtained superficial fluid flow velocity of 0.24 m/s for air, 0.05 for oil and water [6]. Much earlier in the year, a slug flow experiment with low viscosity oils of 10 MPa to 5 MPa was drained on a transparent acrylic pipe in a horizontal position with a pipe length of 29.7 m and an internal diameter of 38.1 mm at 2 bar pressure. The lowest speed in the experiment was 1.5-4.3 m/s for air 0.26-1.36 m/s for oil and 0.19-2.08 for water [7]. From some experiments that have been done by researchers, there was actually interest that was carried out related to the flow model of each fluid that moved in a pipe to be able to engineer with simulation methods. The approach using simulation is not new in analyzing, using solidwork the writer will start testing the flow rate of fluid in the pipe and compare the results of experimental testing with the results of the simulation conducted.

2. Research purposes
This research was conducted to find out how the simulation form of flow speed, mass flow rate, and pressure occurred on each variation of the number Reynold on the triangular pipe arrangement of solid work Software.

3. Theory
Simulation is a technique of imitating operations or processes that occur in a system with the help of computer devices and based on certain assumptions so that the system can be learned. Simulation is also a great tool to use if required to experiment in order to find the best comments of the components used in the system.

The simulation approach begins with building the system model. The model should be able to demonstrate how the various components in the system interact with each other so that it really describes the behavior of the system. Once the model is created then the model will be informed to the computer making it possible to be simulated.

4. Piping system
The pipe is a medium where the fluid from one unit to the other. In general, the characteristics are determined based on the constituent material. The size of the pipe diameter is based on the "Nominal" diameter of the outer diameter (OD) or inner diameter (ID). Tubing is a pipe with a diameter smaller than the pipe, its usefulness (in general) is for the liaison between the measuring instrument with the process of pipe an instrument to the control system. The standard size for tubing is always the outer diameter (OD) [8].

5. Fluid
Fluid flow or liquid substances (including water and gas vapors) are distinguished from solid objects due to their ability to flow. The fluid is easier to flow because the bonding of molecules in the fluid is much smaller than the molecular bonds in solids, as the fluid has a relatively small barrier to change of shape due to friction.
6. Research and method
This research was conducted on the arrangement of triangular pipes at the technical faculty building of the Universitas Muhammadiyah Sumatera Utara. The implementation time is about 4 months. The research process starts from the process of simulating, designing and analyzing objects using several tools and materials so that they can be simulated and also analyze the resulting design.

The tools and materials used in the simulation process and analysis of this design are (1) computer with specification Intel (R) Xeon (R) CPU E3-1246 v3 @ 3.50 GHz (2) Solid work software to analyze the pressure.

7. Research procedure
This research procedure is made into several steps:
1. Preparing the simulation design of the flow made on the triangular pipe arrangement.
2. Determine the size to be made in the triangular pipe arrangement, pipe length, pipe diameter, fluid type, speed flow and the mass flow rate used in the simulation
3. Designing a simulated flow using a DESIGN solid work that has been made
4. Conducting simulations
5. Observation of the simulation while recording all observations of flow velocity on the triangular pipe arrangement and performing numerical simulation
6. Perform documentation on testing/simulation

8. Result and discussion
The process of evaluation and simulation of the pipe arrangement and using solid work, there are known numbers Reynold that varied up to 10 variations are analyzed and produce the speed value in each experiment and flow rate of the mass. External simulation results are varied based on the Reynold numbers 1000 – 10000 obtained comparisons between the speed and the mass flow rate can be seen in Figure 1.

It is known that the higher speed of incoming fluid hit the pipe then the mass flow rate is getting bigger so that each flow level causes the airflow loss on the triangular pipe arrangement. Further, there is a comparison between speed and pressure can be seen in Figure 2.

![Figure 1. Comparison of graphs of acceleration against mass flow rates](image-url)
The Data on the graph provides information that the higher the speed of incoming fluid hit the pipe, and then the pressure received pipe from the air will be greater. Further to the comparison between speed (V) and fluid friction loss (f) on the above test result data can be seen in the following chart.

Known the higher the speed of incoming fluid hit the pipe, then the friction losses that occur are not always greater. It is influenced by the fluid speed factor and the fluid type of weight. This fluid mass flow rate is influenced by fluid flow velocity and the fluid temperature is capable of affecting the density and weight of fluid types. This fluid velocity is able to affect the pressure hitting the pipes. In simulated results, there is a significant pressure change due to the speed that changes through the sidelines of the triangular pipe arrangement. This change raises the friction loss of the triangular pipe arrangement due to the pressure factor hitting the pipe. The pressure that occurs affected by fluid flow velocity, fluid mass flow rate and cross-section of triangular pipe arrangement. the ratio between the friction losses of the pipe to the fluid will be shown in figure 3.

From the graph above it can be seen the influence of pipe construction, the intersection will affect the velocity of fluid flow. Pipe roughness will reduce the speed of fluid flow, and affect the travel time of the fluid to be delivered. The energy used will also be greater if the losses in the pipe are greater. The highest roughness when testing was obtained up to 8 at a speed of 3,758 m/s and at a speed of 4,277 m/s. while the lowest roughness is obtained at speeds of 0.939 m/s and 3,288 m/s.
9. Summary
This research provides several conclusions. First, the fluid mass flow rate is influenced by fluid flow velocity, the fluid used is air with temperatures 300 °K (26.85 °C). The temperature in the fluid affects the fluid density and weight of the fluid type. Second, fluid velocity affects the pressure that will hit the pipe. In simulated solid work, the color-changing part is a representation of the significant pressure change due to the changing speed when passing a gap-between the triangular pipe arrangement. Third, friction losses occur due to pressure factors that hit the pipe. The magnitude of pressure is influenced by fluid flow velocity, fluid mass flow rate and a broad cross-section of the triangular pipe arrangement.

10. Suggestion
Based on the results of this study, the researcher gives some suggestions, i.e: The process of arranging should pay more attention to the air temperature that hit the pipe correctly. Subsequent research should pay attention to the details of the selection of materials and pipe sizes used to avoid the loss of friction that is not too large.

Acknowledgments
I thank a lot to the university and my students who provide support morally and help me in completing this research so that the purpose of this research can be achieved. I hope I can develop this research with more active student involvement so that it is able to enrich student's and universities’ knowledge.

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