



Fabrication, Design and Analysis of Minor Losses in Pipe

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ABSTRACT

This project needed to investigate the effects of fluid flow due to sudden contractions and sudden expansions of the pipe network. The purpose of this project is to demonstrate that Bernoulli's equation cannot correspond to, and by comparing the results of experiments involving sudden contraction and sudden expansion of with each other and with theoretical data, these Predict how the liquid will behave in a situation. The experiments were conducted in two different modes, one causing a sudden contraction of water through the tube and the other causing a sudden swelling through the tube. This project needed to investigate the effects of fluid flow due to sudden contractions and sudden expansions of the pipe network. The purpose of this project is to demonstrate that Bernoulli's equation cannot correspond to, and by comparing the results of experiments involving sudden contraction and sudden expansion of with each other and with theoretical data, these predict how the liquid will behave in a situation. The experiments were conducted in two different modes, one causing a sudden contraction of water through the tube and the other causing a sudden swelling through the tube.

KEYWORDS: *Computtitive fluid dynamics, Vertual analysis,Gambit software, Computational fluid dynamics, fluent software, expansion, contraction, bend in pipe, obstracle.*

1. INTRODUCTION

Two-phase flow is used in a number of industries, such as power generation, refrigeration, distillation, steelmaking, papermaking, and food processing. Since it is still not possible to describe the detailed physics of the flow mechanism for biphasic flow, the pressure drop and the horizontal contraction and expansion are usually best approximated from the relationships experiment. Therefore, reliable estimates of the hydrodynamic properties associated with this type of flow are considered essential for the safe, economical design and efficient operation of two-phase flows. In recent years, several papers have been published on the flow of two-phase gas/liquid.

Freon 12 could be used in a variety of situations. Based on momentum and mass balance as well as their experimental results, they developed a model is used to determine the two-phase pressure drop considering the generally considered acceptable flow characteristics. Based on the solution of one-dimensional conservation equations downstream of the enlargement, Attou et al. developed a semi-analytical model for two-phase pressure drop in rapid enlargements. They evaluated the predictions of three models, including relatively homogenous flow, frozen flow, and bubbly flow, to experimental data and determined that the bubbly flow model had the best consistency [1].

In addition to experimental and computational methods, there has been a considerable trend in Computational Fluid Dynamics (CFD) for both the solution and evaluation of fluid flow issues throughout the last few decades. Industry requires numerous commercial CFD software packages (Fluent, Star-CD, and CFX) to develop and critically evaluate various types of flow circumstances. In addition, CFD is widely used in engineering education [2].

CFD methods have traditionally been taught at the graduate level in academia. In today's curriculum and instruction, there are two approaches to introducing CFD. The first one is the traditional approach, which demonstrates mathematical methodologies while paying little or no consideration to commercial software. The second technique is to offer CFD software to the class without placing any emphasis on learning it. Those software and services encourage learners to get started with the project, though if they lack basic geometrical and mesh-creation skills [3].

After setting the problem parameters, students can generate the results with a simple push of a button.

By using this software, we happened to test the sudden convergence and divergence of the pipe so that it will be able to let us know the results which are nearly similar to the values that will be obtained in the real word experiments. This method will reduce the material cost and the time taken to do the experiment and calculations and also be reducing the man power used to build and calculate.

The software that used to develop a virtual model and conduct a virtual simulation is a well know analysis software ANSYS. In ANSYS there is a built in module specifically for simulation of the fluid and its dynamics and it is known as fluid flow fluent [4].

The pipe section which is required is developed and will be analysed by discretising and analyzing using Fluid Flow (Fluent).

2. RELATED WORK

The head loss sustained by a fluid as it passes via a pipeline is frequently used in hydraulic engineering application. For instance, it may be necessary to determine the additional head required to double the rate of flow along an existing pipeline or to anticipate the rate

of flow along a proposed pipe connecting two reservoirs at different levels.

Pipes are an appropriate means for transporting fluids (liquids or gases) under pressure from one location to another. It is fundamental to optimize performance by eliminating fluid flow losses. Elbows, T-junctions, bends, contractions, expansions, and a variety of other components make up pipes [6]. When a fluid rushes through a pipe, friction between the walls and between the fluid layers transforms the energy into thermal energy. As a consequence, energy dissipation is evaluated in terms of fluid height, which have been referred as the head losses. Major losses, or linear head, occur anywhere along the overall piping system, whereas minor losses, as well as singular head, occur attributable of moderate household consumption or accessories included in a pipe network. For a network of pipes with short pipes and many bends and valves, overall major loss can be smaller than the minor loss.

3. PROPOSED WORK

3.1 Sudden Expansion

This is a form of minor loss that occurs somewhere at pipe's end or even when smaller diameter pipes meet larger diameter pipes due to a sudden increase in flow area.

Although vortices develop at the entrance of a big diameter pipe, it is greater than that of the loss due to sudden contraction.

Consider a fluid movement in a pipe with a smaller diameter at the entrance and a larger diameter at the exit, as indicated in the diagram below.

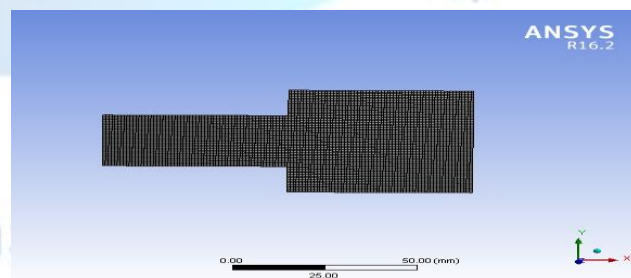


Figure 1: Sudden Contraction

3.2 Sudden Contraction

It is just a type of minor loss which takes place at the end of a pipe or when a greater diameter pipe meets a smaller diameter pipe at the tube's end due to such a sudden compression with in flow area. That's less than the loss caused by the rapid expansion.

Consider a liquid flow through a pipe with a bigger diameter at the entrance and a compressed diameter at the exit, as illustrated in the diagram below.

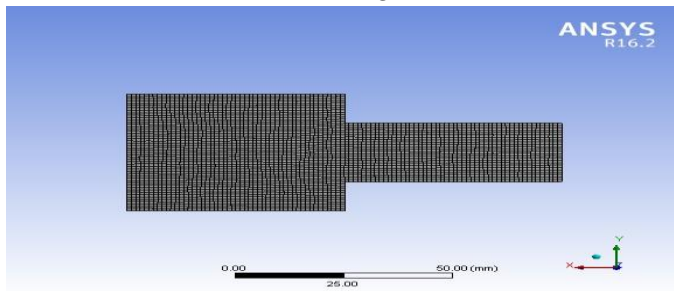


Figure 2: Sudden contraction

3.2 Obstacle in the pipe (Like a Valve)

This is a type of a major loss that can be considered in a pipe which will help to adjust the flow and will oppose the flow significantly.

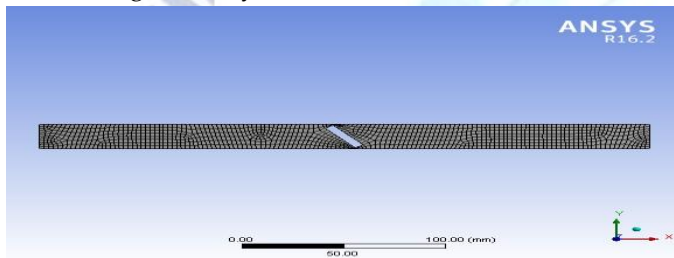


Figure 3: Obstruction in pipe

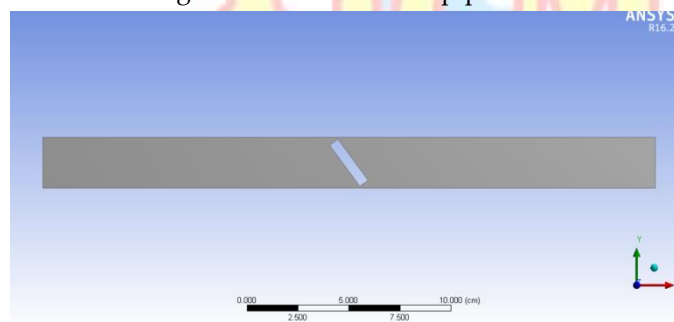


Figure 4: Valve

3.3 Pipe Transition.

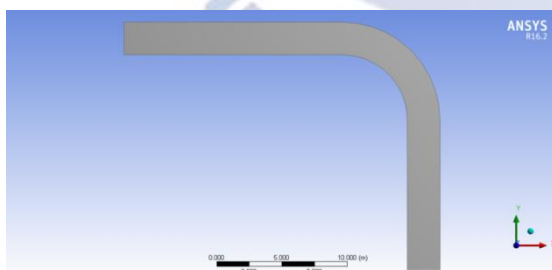


Figure 5: Bent Pipe

The presented sections are developed in ANSYS 2D Fluid Flow Fluent and will be obtained results for major losses, then compared and summed up with the actual experimental results.

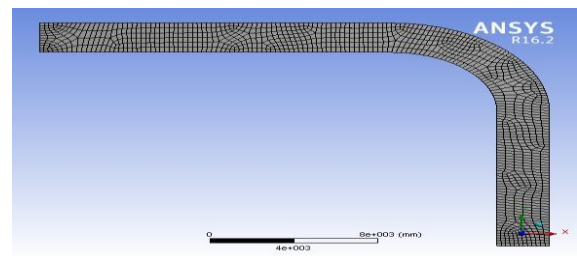


Figure 6: design for bend in pipe

3.4 Experimental requirements



Figure 7: Total Assembly of the Piping

Metal fabrication refers to the methods for making products, components, and structures out of raw metals. Fabrications are the items or products made by these operations. Metal fabrication is done by manufacturing utilising a combination of manual and automated methods. They turn raw metals into metal things called as fabrications using various procedures. Assembling procedures are also part of metal fabrication. The purpose of assembly operations is to attach two or more metal workpieces together. One of the most popular forms of assembly procedures is welding.

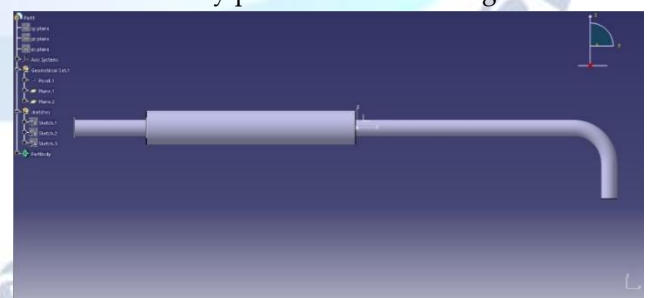


Figure 8: the sudden expansion, contraction, bend in pipe, and obstruction in pipe.

It entails heating the metal workpieces until they melt and fuse together. Rivets are used to join metal parts together. A rivet is a sort of bolt-shaped fastening. Bolts, on the other hand, have a threaded shaft.

3.5 Specifications of fabrications

1. Sump tank size: 0.9 m x 0.45 m x 0.3 m S.S. tank
2. Measuring Tank Size: 0.6 m x 0.25m x 0.25 m S.S. Tank
3. Differential Manometer: 1 m range with 1mm scale of graduation
4. No. of pipes:
4. Galvanized Iron (GI)
5. Piping system sizes: 25 mm, 50mm
6. Pressure taping distance: 0.5 m
7. Pump set: Pump is 25x25mm² sizes, centrifugal, mono block pump with single phase, 2pole, 220V, 1/2HP, 50 Hz, 2800 rpm, AC supply

4. RESULTS

4.1 Experimental Results

Hence, the minor loss & coefficients for sudden expansion and contraction in a circular pipe is to be determined.

Table 1: Exoerimental Results

Types of losses	S. No	Pressure Readings		H_{mean}	Time required for taking 100 mm rise	$Q_{act} = \frac{AXR}{T}$	$v_1 = \frac{Q_{act}}{A_1}$	$v_2 = \frac{Q_{act}}{A_2}$
		H_1 (cm)	H_2 (cm)					
Sudden expansion	1	2	1.5	0.5	50.85	1.22×10^{-4}	0.24	0.06
Sudden contraction	2	1.5	1	0.5	32.29	1.93×10^{-4}	0.39	0.09
Bend in pipe	3	1	0.5	0.5	22.36	2.79×10^{-4}	0.56	0.255
Obstruction in pipe	4	0.5	0.25	0.25	14.12	4.39×10^{-4}	0.89	0.45

- a) Head loss due to Sudden Expansion = $9.305 \times 10^{-3} m$
- b) Head loss due to Sudden Contraction = $5.044 \times 10^{-4} m$
- c) Head loss due the Bend in pipe= $9.59 \times 10^{-3} m$
- d) Head loss due the obstruction in pipe= $0.5119 m$

5. RESULTLS OF ANSYS

The computational and analytical results are developed in ANSYS virtually by providing the

parameters of the pipe (i.e. Diameter, length of the sections Etc...)

Table 2: Results of Thermal Analysis

Parameters	Velocity value		Pressure value	
	Min.	Max.	Min.	Max.
Sudden expansion	1.147e-01	1.147e+00	-5.485+00	1.096e+02
Sudden contraction	-3.231e-01	3.221e+00	-4.108e+03	2.303e+03
Bend in pipe	1.122e-01	1.122e+00	-1.199e+02	2.365e+02
Obstruction in pipe	9.242e-01	9.424e+000	-1.478e+00	7.111e+04

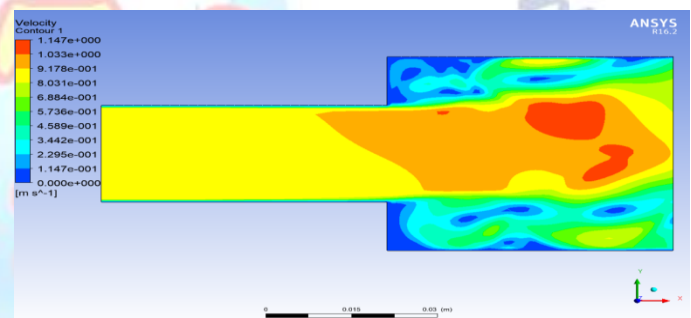


Figure 9: Velocity for Sudden Expansion

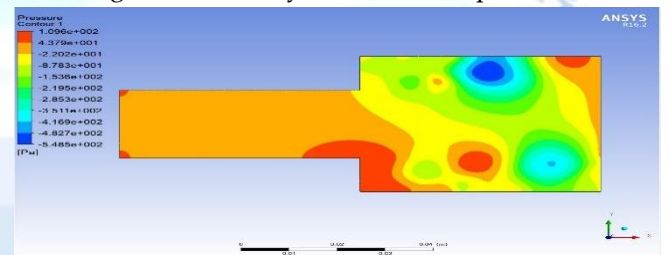


Figure 10: Pressure for sudden expansion

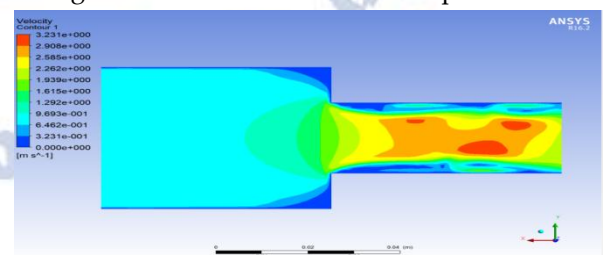


Figure 11: Velocity for Suddent Contraction

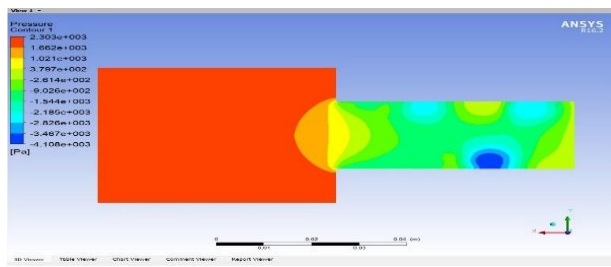


Figure 12: Pressure for sudden contraction

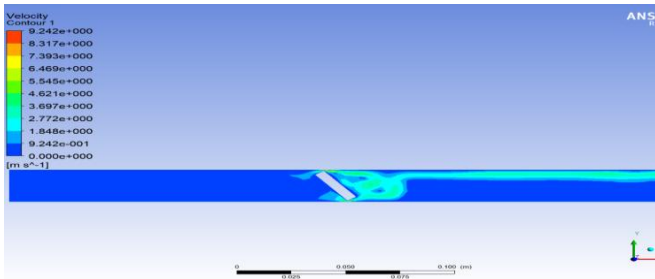


Figure 13: Velocity for Obstracles in pipe

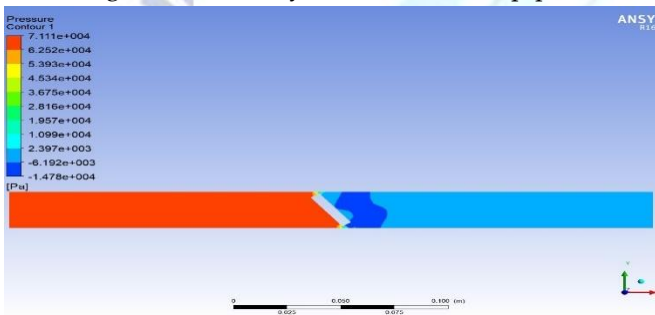


Figure 14: Pressure for obstracle in pipe

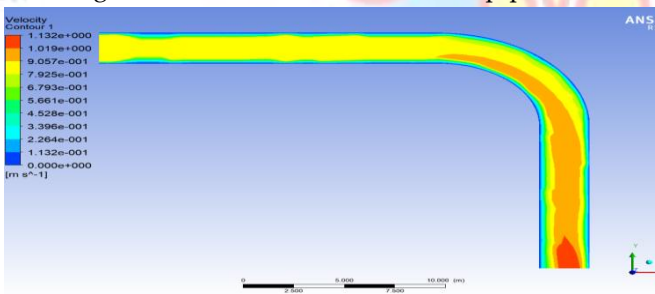


Figure 15: Velocity for Bent in pipe

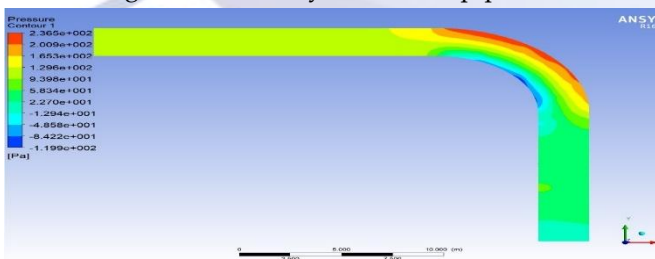


Figure 16: Pressure for bent in pipe

The flow through sudden change of pipe diameter (expansion, contraction, bend in pipe, obstruction in pipe) was numerically simulated with water by unsteady flow in k-epsilon scheme. The major observations made related to the pressure and velocity contours in the process of flow through these pipes. Sudden expansion creates more severe formation of flow

eddies than sudden contraction. Also, the losses are more at the expansion as compared to contraction in the pipe begins. In the sudden contraction, vane contracta's are formed at the point of contraction and effect of viscosity is negligible on the pressure drop through sudden contraction. The pressure drop increases with higher inlet velocity and hence with higher mass flow rate. This point is the most susceptible point for pipe damage. So, to increase the life of the pipe in cases of sudden contraction & expansion, bend, obstruction in pipes must be designed in view of the above observations making the corners more round so as to minimize the losses in the pipes. To conclude, this examination results indicate that FLUENT can be used with high degree of accuracy to visualize the minor losses due to minor appurtenances and accessories

6. CONCLUSION

The objective of this laboratory was to conduct an investigation why Bernoulli's equation fails to adequately depict the behaviors of fluids experiencing significant increase or contraction. This was accomplished successfully by demonstrating the disparity between the fluid's loss of potential energy and the quantity of kinetic energy obtained from the fluid's overall velocity. The missing potential energy was found to have been transformed to rotating kinetic energy, causing vortices to form right before and after contraction and relaxation. The fact that the reverse differential pressure created by abrupt expansion hypothetically would cause a larger energy differential, a phenomenon that was observed, contributed to the understanding.

The flow through sudden change of pipe diameter (expansion, contraction, bend in pipe, obstruction in pipe) was numerically simulated with water by unsteady flow in k-epsilon scheme. The major observations made related to the pressure and velocity contours in the process of flow through these pipes. Sudden expansion creates more severe formation of flow eddies than sudden contraction. Also, the losses are more at the expansion as compared to contraction in the pipe begins. In the sudden contraction, vane contracta's are formed at the point of contraction and effect of viscosity is negligible on the pressure drop through sudden contraction. The pressure drop increases with higher inlet velocity and hence with higher mass flow rate. This point is the most susceptible point for pipe damage. So, to increase the life of the pipe

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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