UNIVERSITI TEKNOLOGI MARA
CAWANGAN KUALA TERENGGANU

# MEC299

# SIMULATION OF VARIATION OF FLOW IN DIFFERENT TYPES OF PIPE FITTINGS USING COMPUTATIONAL APPROACH

MUHAMAD AZIM NAJMI BIN NOR AZHARI

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SUPERVISOR:

MOHD ZAMIN BIN MOHD JUSOH

**ABSTRACT**

Pipe fittings such as valve, bend, tee, elbow, contraction and expansion are integral part any piping system found in chemical and allied industrial processes. However, Two types of energy loss predominate in fluid flow through a pipe network; major losses, and minor losses. Major losses are associated with frictional energy loss that is caused by the viscous effects of the medium and roughness of the pipe wall. The objective of this experiment is to analyze the variation of flow in different types of pipe fittings using computational approach. This experiment contains selection of pipe fittings, Modeling of selected pipe fittings in SolidWorks and ANSYS Software, after completing the Modeling the Analysis is carried out in ANSYS. The expectation of this experiment is should be increase as well as the value of head loss. Hence, the head loss should directly proportional to the square of the flow rate. In conclusion, multiple trials and errors simulating are required and possibly going to occur to obtain the perfect result on this experiment.

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# CHAPTER 1: INTRODUCTION

## 1.1 Background of Study

Pipe fittings such as valve, bend, tee, elbow, contraction and expansion are integral part any piping system found in chemical and allied industrial processes. These are mainly used to control the flow rate and change the direction of flow, which causes energy loss in addition to that caused by the fluid flow through straight pipes. Flow of fluids in a piping system is accompanied by both skin and form friction, resulting in pressure or energy loss. Skin friction, which is responsible for pressure loss in straight pipe flow, is the friction between the pipe wall and the fluid and also between the fluid layers. Whereas, form friction is caused by pipe fittings as the fluid is subjected to sudden velocity and direction changes. (Perumal & Ganesan, 2016)

Fittings for the piping systems can be expensive and require a proportionally large labour element to install, therefore correct selection and use is of vital importance to a well installed piping system. Every type of piping material has a range of fittings that can be used with it and some piping materials can have multiple different ranges of fittings that can be used. For example, copper piping systems can be installed by bending the pipe and therefore using no elbows, using soldered copper fittings or compression brass fittings depending on the type of service being transferred in the copper pipe. Fittings are available with ends to match the piping installation therefore the following information will not differentiate between welded, threaded or compression but will concentrate on the orientation and the use of the fitting. (Jivani et al., 2019)

Despite the considerable amount of work in pipe bends, a large scatter exists in the reported experimental values.6 This disagreement amongst the reported values of head loss coefficients is mainly due to ignorance of one or more parameters, which may affect the pressure drop making these values unreliable.  As previously pointed out by Crawford et al, the inconsistencies in the reported experimental values may also occur due to uncontrolled flow in the bend entry and exit sections. Moreover, inadequate accuracy in the measurement of pressure drop also results in incorrect predictions of the head loss coefficient (K). Conducting high fidelity experiments for accurate prediction of pressure drops in pipe fittings is often tricky and expensive. However, in recent times the advent of authoritative computational sources and efficient numerical algorithms, computational fluid dynamics (CFD) has become a potential candidate for pressure drop predictions and flow visualization through piping networks. (Gajbhiye et al., 2020)

CFD has been used as a useful tool for hydrodynamic prediction, design, scale-up, and optimization of several chemical engineering equipment. Some of the commonly used chemical engineering equipment, that have investigated using CFD to understand the underlying flow physics involved are: pipes and pipe bends, particulate flows, packed bed reactors, fluidized bed reactors, bubbly flows, and heat exchangers. CFD has gained a lot of importance in the previous three decades owing to the wide application and promising results, which it offers at a nominal cost. CFD mainly facilitates in prior evaluation of chemical processes via following five steps and that is estimation of engineering design parameters, understanding the transport phenomena of chemical engineering processes under consideration, developing relationship between fluid mechanics and design objectives of system under consideration, design optimization and scale-up of the system under consideration, and safety assessment of postulated worst-case scenario, which could be involved while the equipment is in operation. The inclusion of basic and advanced courses on CFD in the Chemical Engineering curriculum is thus felt to be of utmost importance in recent times as also reported by Adair et al . An elaborated view of the use of various CFD models for understanding the dynamics of the flow structures and relating them with flow parameter optimization for design and scale-up of multiphase reactors has been elaborated in Joshi et al and Mathpati et al. (Gajbhiye et al., 2020)

### 1.2 Problem Statements

In fluid flow through a pipe network, two types of energy loss predominate: major losses and minor losses. Major losses are associated with frictional energy loss caused by viscous effects of the medium and pipe wall roughness. Minor losses, on the other hand, are caused by pipe fittings, flow direction changes, and flow area changes. Because of the piping system's complexity and the number of fittings used, the head loss coefficient (K) is empirically derived as a quick way of calculating minor head losses.(Habib & Kabir, 2018)

However, this experiment will be conduct in a lab at the lab of our