Application Of Fuzzy Logic Modelling In Fluid Friction Of Bore Pipe

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ABSTRACT – Fuzzy logic modelling is a type of artificial intelligence that can help to calculate and predict output from experiment. Thousands of data can be applied and prediction can be made based on these data. Thus, saving time and reducing cost in handling experiment. This research introduces a fuzzy logic modelling in fluid friction in order to forecast the head loss in pipe. Then the mean absolute error is calculated to compare the value forecast by fuzzy logic modelling and the experimental value. The analysis shows that the modelling can be used as an approach to find the head loss in bore pipe.

1. INTRODUCTION

Fluids play a major role for production machinery and serve for very different tasks as lubricating, tempering, cleaning, transmitting force and energy [1]. A fluid friction is the resistance to an object's movement through a fluid or gas. A specific measure of energy is required to move a given volume of liquid through a pipe. In other word, an energy or pressure difference must exist to make the liquid to move. A part of that energy is lost to the resistance to flow. This resistance to flow is called head loss because of friction.

The objective of this study is to predict the head loss because of the friction by using fuzzy logic modelling. Fuzzy logic is a basic concept that refers to all theories and technologies that employ fuzzy set [2]. Fuzzy logic can lead to the improvement of human-like capacities for artificial intelligence, at times referred to as artificial general intelligence that representation of generalized human subjective capacities in programming so that can looked with a surprising undertaking. The Fuzzy Logic has become an important tool in different applications, such as engineering and business issues [3].

The estimation of head loss in bore pipe for this research is acquire by doing the fluid friction experiment and further prediction by using fuzzy logic modelling.

2. METHODOLOGY

2.1 Experiment method

The purpose of the experiment is to determine the relationship between head loss of fluid friction and velocity flow of water through smooth bore pipes and to affirm the head loss friction factor. The experiment is done by using apparatus C6-MKII-10 Fluid friction as shown in Figure 1.

Figure 1 C6-MKII-10 Fluid friction

2.2 Fuzzy Logic Toolbox

A Matlab fuzzy logic toolbox is utilized to help with the fuzzy logic modelling to forecast the estimation of head loss. After obtaining the forecasting value from the fuzzy logic modelling, the value compared with the experimental value to see the error.

3. RESULTS AND DISCUSSION

Figure 2 shows the values of head loss that obtain from experiment and Figure 3 shows the values of head loss obtained by using fuzzy logic modelling. The comparison between both data is shown in Figure 4 for analysis.

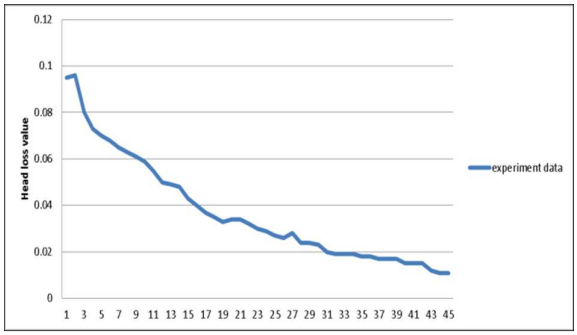

Figure 2 The experimental data

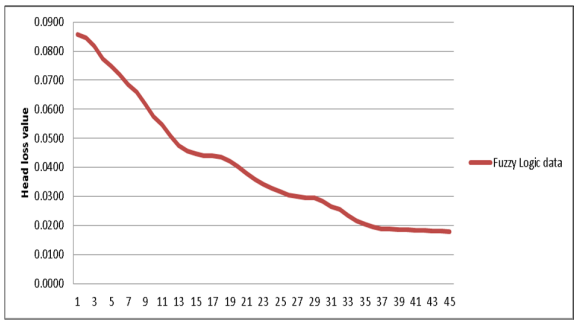

Figure 3 The fuzzy logic modelling data

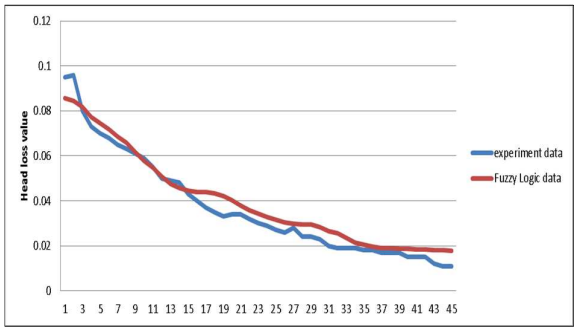

Figure 4 Comparison between experiment data and fuzzy logic modeling data

Based on Figure 4, the predicted value from fuzzy logic modelling gave closes value to the experiment value. This is because the fuzzy logic modelling is a machine learning that trained with the previous data. The result also can be determined by the calculating the Mean Absolute Error (MAE).

$$\text{MAE} = \frac{1}{n} \sum_{i=1}^{n} |Y_i - X_i|$$

where

Y_i = Value of prediction data (fuzzy logic modelling)

X_i = Value of actual data (experiment)

n = Number of data.

From the calculation, MAE value is 0.0042. The error is less than 0.05 which can be consider as very small error. This shows that the fuzzy logic modelling gives a good performance and it can predict the head loss value with very small error. Furthermore, fuzzy logic modelling is suitable for determine the friction head loss in bore pipe without conducting an experiment.

4. CONCLUSION

This study was carry out to apply the fuzzy logic modelling in fluid friction of bore pipe. The analysis was done by using Matlab fuzzy logic toolbox and the data is compare by calculating the MAE. Based on the result, fuzzy logic modelling can forecast the head loss value with small error which MAE value of 0.0042. This analysis shows that the modelling can be used as an approach to find the head loss in bore pipe. Subsequently, this approach can save time and cost in conducting experiments.

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