TEMPERATURE SENSOR PLACEMENT FOR MULTIPLE FAULT DETECTION

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Dedicated to my beloved mother, sisters and miss Yeong Chew Hui for their never ending support

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ABSTRACT

Sensors play a very important role in all kind of industrial plant. Types of sensor can vary from level, flow, pressure and temperature. In an industrial plant, a huge quantity of sensors are being installed for monitoring purpose. These sensors involve complex installation architecture due to cable and installation cost. Each and every single sensor only detects a single fault. In industrial plant, pipeline plays a very important role in ferrying chemical fluids around and across the plant. In order to secure the quality, quantity and safety of the pipeline, all type of sensors are being installed to monitor the chemical fluids in the pipeline. This research paper aims to develop a desired simulation where the best location of sensor placement optimization for multiple faults detection using Fuzzy method. Fault will include vary problems such as temperature below or above limit at the inflow and outflow of the pipe and the pipe leakage. This will provide a fault detection and give a warning signal to the operator. From the above method being applied, the complexity architecture of the system and installation cost can be reduced in every industrial plant. It can also be environmental friendly as less resource is being used to establish the system for the industrial plant.

ABSTRAK

Penderia memainkan peranan yang sangat penting dalam kilang perindustrian. Penderia boleh dikategorikan kepada penderia aras, penderia aliran, penderia tekanan dan penderia suhu. Terdapat banyak penderia yang dipasang dalam kilang perindustrian untuk memantau situasi di dalam kilang. Kuantiti penderia yang banyak akan mengakibatkan rangkaian pemasangan yang kompleks dalam kabel dan kos pemasangan yang tinggi. Setiap penderia dipasang hanya untuk mengesan satu kerosakan sahaja. Paip di dalam kilang perindustrian memainkan peranan yang penting dalam penghantaran cecair di dalam dan luar kilang perindustrian. Untuk menjamin kualiti, kuantiti dan keselamatan paip, pelbagai penderia dipasang untuk memantau cecair di dalam paip. Kajian ini dikaji bertujuan untuk membangunkan simulasi untuk menentukan lokasi terbaik untuk memasang penderia yang optimum untuk mengesan pelbagai kerosakan menggunakan kaedah Fuzzy. Kerosakan yang berbeza boleh dikategorikan kepada suhu rendah atau tinggi daripada had pada aliran masuk dan aliran keluar pada paip dan kebocoran paip. Kerosakan boleh diketahui dan amaran akan diberikan kepada pengendali. Dengan menggunakan kaedah diatas, kerumitan rangkaian sistem dan kos pemasangan boleh dikurangkan di dalam kilang perindustrian. Ia juga boleh mengurangkan pencemaran alam sekitar dari aspek pengurangan menggunakan sumber dalam pemasangan sistem di dalam kilang perindustrian.

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D	-	diameter
h	-	heat transfer coefficient
k	-	thermal conductivity
l	-	length
R	-	resistance
T	-	temperature
U	-	overall heat transfer coefficient

CHAPTER 1

INTRODUCTION

1.1 Introduction

Industrial plant is defined as a factory or place where power is produced or an industrial process takes place. Industrial plant is being widely built to meet the needs of mankind in terms of consumption and energy. These plants are huge type of construction and it contains a huge number of equipments and pipelines. These equipment require monitoring and controlling to obtain the output of the final product with best quality as possible and with the best safety factor.

The equipment and pipelines are equipped with different type of sensors to help monitor and control the process. The most common type of sensor found in an industrial plant range from temperature, flow, level and pressure. Each type of measurement requires unique type of sensor to sense and has different type of characteristic. Typically it can be concluded that temperature sensor are use to sense temperature, flow sensor are used to sense flow, level sensor are use to sense level and pressure sensor are use to sense pressure.

The efficiency of an industrial plant can be increased by lowering the cost of installation and maintenance. One of the ways is by reducing the number of sensors in the plant. The numbers of sensors being reduced has to ensure that the plant can operate normally and safely. The method proposed in this paper is by using fuzzy logic to determine the location of the sensor to be installed on the pipeline and by using the mathematical model of the pipeline to estimate the temperature of a point on the pipeline. The estimated temperature of the pipeline is then compared with the actual temperature measured from the sensor on the pipeline. The difference of the

estimated temperature and the actual temperature will determine if there is fault detected. The bigger the difference, the higher possibility of fault had happen.

A plant model will be use for the case study of this paper and it comprises of two type of case study. One of it is a straight pipeline while the other one is a T-junction pipeline. A mathematical model of the heat loss per length of the pipeline is used to calculate the temperature of the pipeline. The parameters included are the heat coefficient of pipe material and outside insulation surface and thermal conductivity of pipe material and insulation material. Other factors such as air flow outside of the pipe are being ignored. The mathematical model is only applicable to cylinder type of pipeline. on the simulation part, fuzzy logic is used to determine the location of the sensor on the pipeline. Mamdani type of fuzzy logic is used as it is the most common type of fuzzy logic. Mamdani uses the "if then rule" for the simulation.

The Fuzzy logic from the simulation after applying the rules is able to determine the best location of the sensor to be installed on the pipeline. Both case studies, which comprises straight pipeline and T-junction pipeline's sensor location had been determined by using Fuzzy logic. The overall heat coefficient of pipeline is used to estimate the temperature at a specific point on the pipeline. With the parameters of the pipeline provided, the temperature of the pipeline at each point is able to be estimated.

1.2 Problem Statement

Industrial plants are important in civilization as it plays an important role in processing raw materials product for mankind as mentioned by Yang *et al.* (2009). These industrial plants are equipped with sensors for monitoring and controlling purposes. These sensors plays a crucial role in extracting data and information related to the plant for further action and safety purposes as mentioned by Luigi

Fortuna *et al.* (2007). In order to increase the safety, quality and reduce cost, optimizing sensor placement for multiple fault detection is crucial. Finding the best location of sensor placement plays a crucial role in extracting information and data. With the best location of sensor placement, the faults can be detected at the shortest time frame. Apart from detecting the fault in the shortest time frame, the best location of sensor placement can also help to minimize cost in terms of installation and maintenance wise. With the aid of software, trial and error way can be avoided to obtain results and it helps to save cost.

1.3 Objective

Objectives of this project are

1) To simulate the faults for piping design of process plan. To be able to get as much fault as possible with less sensor.
2) To get optimal sensor location for sensor placement in order to detect as much fault as possible.

1.4 Scope of project

This paper consists of two case studies which are straight pipeline and T-junction pipeline. Each pipeline is being represented by mathematical model. Both mathematical models of pipeline is used to estimate the temperature of the pipeline. Both cases are then optimized using Fuzzy logic method. This is to determine the best location of the sensor of the pipeline. The results are then shown and discussed.

1.5 Thesis Content

The preceding sections briefly summarized the introduction and objectives of the research work. An introduction of the paper is being discussed at the beginning of this chapter. Follow by the problem statement of the paper. There are a total of two objectives in this paper. The scope of project of this paper is discussed after the objectives. This section presents the outline of the thesis. The remainder of the theses is organized into five main chapters.

Chapter 2 discusses literature review on other method used to detect faults on pipelines. It also gives a summary on common types of sensor used in industrial plants. Two cases are being studied and Fuzzy logic method is explained in this chapter. The mathematical model of the pipeline is being discussed in Chapter 3. It provides the formula to be used to estimate the temperature of the liquid at a point on the pipeline. The mathematical of both cases for straight pipeline and T-junction pipeline are discussed.

Fuzzy logic is used in optimization for this paper and the rules and MATLAB simulation is being shown in Chapter 4.The rules are being created and used in the rule editor of MATLAB in chapter 4. Results and discussion is being discussed in Chapter 5 with each simulation of the result being shown. The simulation is simulated at every point possible. While the conclusion and future work is discussed in Chapter 6.

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