UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FLOW PROCESS MEASUREMENT AND CONTROL USING PID CONROL SCHEME

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Industrial Automation & Robotics) (Hons.)

by

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DECLARATION

I hereby, declared this report entitled "Flow Process Measurement and Control Using PID Control Scheme" is the results of my own research except as cited in references.

Signature : ……………………………………

Author's Name : ……………………………………

Date : ……………………………………

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation and Robotic) with Honours. The member of the supervisory is as follow:

…………………………………….

(Project Supervisor)

……………………………………

(Project Co-Supervisor)

ABSTRAK

Pengukuran Proses Aliran dan mengguna Skim Kawalan PID untuk kawalan adalah projek yang digunakan dalam sistem kawalan proses. Tujuan projek ini adalah untuk mengukur kadar air aliran dalam paip dan kadar air aliran ini akan dikawal oleh Skim Kawalan PID. Sistem ini menggunakan PID sebagai pengawal untuk mengawal keseluruhan sistem dan injap kawalan bermotor adalah elemen kawalan dalam sistem ini. Turbin meter aliran adalah elemen pengukur dalam sistem. Turbin meter aliran diguna dalam sistem kerana meter ini boleh mengesan aliran air dalam paip dan mengukur kadar aliran air yang alir dalam paip. Rotor yang berada dalam turbin meter aliran akan berpusing apabila mempunyai air mengalir melalui turbin meter aliran dan rotor itu akan berpusing pada kadar yang sama dengan kadar aliran isipadu. Injap kawalan bermotor adalah elemen kawalan dalam sistem kerana injap kawalan ini boleh buka atau tutup dengan sebahagian atau sepenuhnya. NI myRIO adalah pengawal yang diguna dalam sistem. NI myRIO punya input analog akan bersambung kepada turbin meter aliran manakala NI myRIO punya output analog akan bersambung kepada injap kawalan bermotor. Kesimpulannya, projek ini akan menggunakan perisian LabView untuk menunjukkan data kadar aliran.

ABSTRACT

Flow Process Measurement and Control Using PID Control Scheme is a project that used in the process control system. The purpose of this project is to measure the flow rate of fluid that flow in the pipeline and this will controlled by using a PID control scheme. PID is the controller of the system that control the whole system and the motorized control valve is the flow control element in the system. The measuring element in the system is turbine flow meter. Turbine flow meter is used in the system because it can detect the flow in the pipeline and measure the flow rate of fluid that flow in the pipeline. Once the fluid flow through the turbine flow meter, the rotor inside the flow meter will start rotate at a rate proportional to the volume flow rate. Motorized control valve is flow control element in the system because it can partially or fully opening or closing. NI myRIO is acts as the controller in the system. The analog input of NI myRIO is connecting to the turbine flow meter and the analog output of the NI myRIO is connecting to the motorized control valve. In conclusion, this project will developed by using LabView software to show the result of the fluid flow rate.

DEDICATION

To my lovely and beloved parent,

Looi Kim Chee

My siblings,

Tang Pei Theng, Tang Pei See, Tang Pei Pei and Tang Pei Pin

My supervisors,

En. Ahmad Muzaffar bin Abdul Kadir

and Pn. Rosnaini binti Ramli

Dedicated in thankful for the supporting, best wishes and encouragements.

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A	-	Cross-sectional area of flow
B	-	Strength of the magnetic flux
D	-	Diameter of pipe
E	-	Induced voltage
L	-	Length of pipe
Kc	-	Proportional gain
PE	-	Polyethylene pipe
Q	-	Volume flow rate
Re	-	Reynolds number
SP	-	Set point
Ti	-	Integral time
V	-	Volume of fluid
f	-	Friction factor
g	-	Gravitational force
k	-	Proportionally constant
t	-	Time taken
v	-	Average velocity
h_L	-	Head loss
ΔP_L	-	Pressure loss
$\dot{m}$	-	Mass flow rate

ρ	-	Density of fluid
υ	-	Velocity of fluid
μ	-	Dynamic viscosity of fluid
ν	-	Kinematic viscosity of fluid
$\dot{W}_{pump}$	-	Pumping power

Chapter 1

Introduction

1.0 Introduction

The purpose of this project is to design a flow process system to do the flow process measurement and control using PID control scheme. This chapter will briefly discuss the overview of this project. Measurement is the act or process of measuring something that we want to know about the system. In this project, flow rate of the water flow in the pipeline will be measured and controlled via PID control scheme. Nowadays, flow process play an important role in the industry area as the flow process measurement is the quantification of bulk fluid movement, either liquid or gas. Flow process measurement is very important in industry area because some application require the ability to conduct accurate flow measurement to such an extent that they influence product quality. Therefore, this process cannot be neglected. In this chapter, the background of the project, problem statement, project objective, work scope and report outline will be discussed.

1.1 Background of the Project

The title of this project is Flow Process Measurement and Control using PID Control Scheme. This project is to measure the flow rate of fluid flow in the pipeline by using a sensor and maintain the fluid at a certain flow rate that required. Since the fluid need to maintain at a certain flow rate, therefore a PID control scheme will be used to control the flow rate of fluid. The raw material used in this project is tap water because the viscosity of water is low and easy to measure as compared to other type of liquid. The flow rate of fluid will be measure by using industrial type of flow meter called turbine flow meter. This flow meter is the sensor in the flow process. The details about the turbine flow meter will be discussed in Chapter 2.

1.2 Problem Statement

As the flow process play an important role in industry area, thus the measurement of flow rate of fluid flow in the pipeline must be accurate and consistent. If not, inaccurate measurement of flow may cause a serious or even disastrous results and affect the system. Therefore, to avoid this problem happen in the project, calibration of sensor need to be done before taking the measurement of flow rate of fluid. Calibration is the process of making an adjustment or marking a scale so that the reading of an instrument agree with the accepted and the certified standard. Without calibration, measurement result may be false and misleading.

Since the flow process is the secondary process in all the system, so how this secondary process can affect and relate to the main process. Therefore, the problem statement is how does the main process affect the secondary process and what is the effect to the secondary process.

1.3 Project Objective

The objectives of this project is to design a system that can:

(a) measure the flow rate of fluid that flow in a pipeline by using industrial type of flow meter
(b) control the fluid at a certain flowrate that required by a PID control scheme
(c) investigate the effect of the flow rate to the level process and temperature process

1.4 Work Scope

The work scope of this project is to design a system that can measure the flow rate of fluid that flow in pipeline and control it so that can maintain at a certain flowrate required. Besides that, the minimum and maximum flowrate due to the accuracy of the sensor will be investigated too.

NI myRIO is the controller that will be used to control the system and the control element is the flow control valve. Motorized control valve is the flow control element used in the system. This control valve will control the fluid flow in the pipeline and when the control valve is opened in the condition of 50% and 100%, the flowrate of the fluid will be measured and compare it. This result will be shown in the software LabView.

The sensor that will be used is the industrial type of flow meter is called turbine flow meter. It will be used to take the measurement of the flowrate of fluid flow in the pipeline. This flow meter is operated by a rotor blade that is made of ferromagnetic material. When the fluid flow through the rotor, the rotor will start rotating and then a voltage pulse is induced. The transmitter processes the pulse signal to determine the flow rate of the fluid flow in the pipeline.

1.5 Report Outline

This report is divided into five chapters and each of the chapter is explained briefly as below.

In Chapter 1, this is introduction about the project. In this chapter, background of the project, problem statement, objective and the work scope of the project will be discussed.

In Chapter 2, this is the literature review of the project. In this chapter, all the information about the project will be explained and discussed.

In Chapter 3, is the methodology of the project. In this chapter, it will shows how the project will be carried out and explain in detail the methods that been used in project.

In Chapter 4 is the project result. This chapter consists of discussion and results of the project.

Chapter 5 is the conclusion of the project. This is the last chapter of the project. The conclusion of the whole project will be discussed in this chapter.

Chapter 2

Literature Review

2.0 Introduction

In this chapter, all the information related to the flow and the components that involve in the Flow Process Measurement and Control using PID Control Scheme are described. This project is to measure and control the flow in the flow process. This chapter is the literature review to get an idea about the specification of sensor, theory of flow, concept of flow and any information that related to the project.

2.1 Type of flow

There are 3 types of different flow of fluid in pipe:

(a) laminar flow
(b) turbulent flow
(c) transitional flow

2.1.1 Laminar Flow

Laminar flow is a flow that happen when the fluid flow in parallel layers or move slowly in layers in pipe with no mixing between the layers. The velocity of the fluid flow the fastest in the centre part of the pipe flow and cylinder touching the pipe isn't moving at all (Vinodh Reddy Chennu 2016). This flow is highly ordered fluid motion. Figure 2.1 show the form of laminar flow.

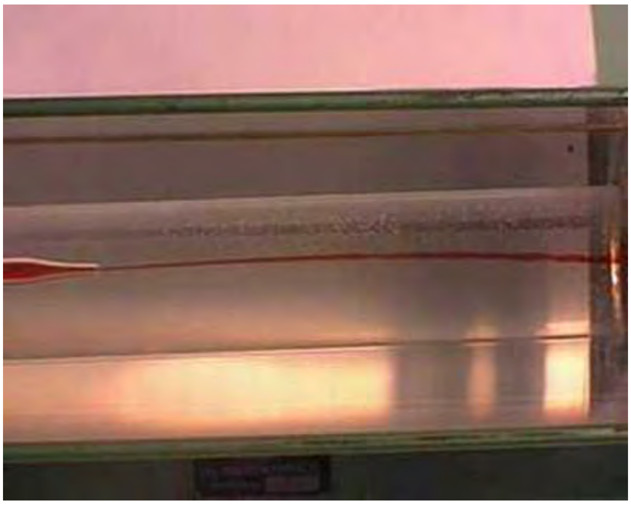

Figure 2.1: Laminar Flow

2.1.2 Transitional Flow

Transitional flow happen when the laminar flow and turbulent flow is mixing together with turbulent flow in the centre of the pipe and laminar flow near the edge of pipe (Vinodh Reddy Chennu 2016).

2.1.3 Turbulent Flow

Turbulent flow happen when the fluid is moving fast with mixing between layers (Vinodh Reddy Chennu 2016). The speed of fluid is continuously changes in both magnitude and direction. This flow is highly disordered fluid motion. Figure 2.2 show the form of turbulent flow.

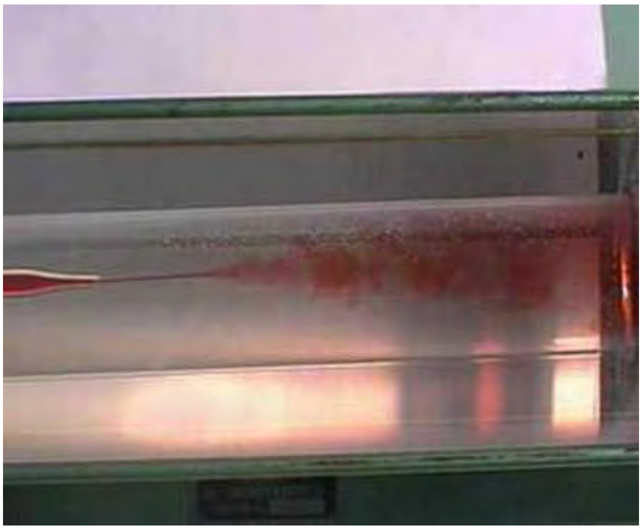

Figure 2.2: Turbulent Flow

2.2 Characteristic of Flow

Since different types of flow have different characteristics. Therefore, Reynolds Number (Re) is used to determine the types of flow whether the flow is laminar, turbulent or transition. Reynolds number (Re) defined as the ratio of inertial force to the viscous force. It is used to forecast the velocity of fluid flow at which turbulent occur.

$$\mathrm{Re} = \frac{\text{Inertial force}}{\text{Viscous force}} = \frac{\rho v L}{\mu} = \frac{vL}{v}$$

ρ = density of fluid (kg/m^3);

υ = velocity of fluid (m/s);

L = length of pipe (m);

μ = dynamic viscosity of fluid (kg/m s);

ν = kinematic viscosity of fluid (m^2/s)