VALVE FLOW CONTROL USING PWM (PIC)

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Bachelor in Mechatronic Engineering

MAY 2009

“I hereby declared that I have read through this report entitle “Valve Flow Control Using PWM (PIC)” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronic Engineering

Signature : ………………………………………………

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Date : ……………………………………………….

VALVE FLOW CONTROL USING PWM (PIC)

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This report is submitted in partial fulfillment of requirements for the degree of bachelor in mechatronic engineering

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MAY 2009

"I declared that this report entitle "Valve Flow Control Using PWM (PIC)" is the result of my own work except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree."

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Name : Ahmad Faizul Bukhari B. Mat Tahir

Date : May 2009

For my beloved father and mother

Mohd Yusoff B. Solan and Harisun Bte. Salleh

In appreciation of supported and understanding.

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Alhamdulilah, praise be to Allah, the Cherisher and Sustainer of world, most Gracious, most Merciful Lord.

Praise be to Allah for enabling me to completed this Valve Flow Control using PWM (PIC16F877A) Microcontroller project and report for my “Projek Sarjana Muda”.

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Finally, I would like to honor my parent, for supporting me steadfastly and their appreciated advice through my project completion.

ABSTRACT

This project purposely is to design the Valve Flow control for Turbine Meter where to control the average Flow rate by given K.factor of the Turbine Meter. This valve is fully controlled by servo motor to control average flow rate using Pulse Width Modulation (PWM) by varying the servo duty cycle on fixed base frequency to match the flow requirement. Base frequency is a K.factor given by turbine meter and it is the ratio of Total Pulse to Total Volume that passing through the turbine meter. Pulse that has been generating by turbine meter will be calculated to compare with base frequency and display on the LCD and also to control the servo motor. Base frequency and flow requirement must be key-in as input data by human interfacing that very useful data for calculation in this project. Overall of the process is to control average flow rate by servo motor and display the flow rate value. The hardware finally will be implementing to successfully conclude this project.

ABSTRAK

Projek ini adalah untuk merekabentuk aliran injap bagi mengawal Meter Turbin di mana ianya juga berfungsi mengawal purata aliran yang berdasarkan factor-K meter turbin. Injap ini adalah dikawal sepenuhnya oleh motor servo untuk mengawal kadar aliran menggunakan Pemodulatan Lebar Denyut (PWM) secara berbeza-beza kadar pusingan tugas pada frekuensi asas untuk memenuhi keperluan aliran. Frekuensi asas adalah factor-K bagi meter turbin dan ia adalah nisbah jumlah denyut untuk jumlah isipadu keseluruhan yang melalui laluan meter turbin. Denyutan yang telah dijana oleh meter turbin akan dikira dan di bandingkan berasaskan frekuensi asas dan dipamerkan melalui LCD dan juga berfungsi untuk mengawal motor servo. Frekuensi asas dan keperluan kadar aliran mestilah dimasukkan sebagai “input data” oleh pengguna yang amat berguna bagi pengiraan dalam projek ini. Keseluruhan proses adalah untuk mengawal purata kadar aliran oleh motor servo dan memaparkan kadar aliran. Akhir sekali, litar akan di persembahkan untuk menamatkan dengan jayanya projek ini.

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CHAPTER 1

INTRODUCTION

1.1 Background

Process plants consist of hundreds or even thousands of control loops that are networked together to produce a product. Each of these control loops is designed to keep some important process variable such as pressure, flow, level, and temperature within a required operating range to ensure the quality of the end product. Each of these loops receives and internally creates disturbances that detrimentally affect the process variable. Interaction from other loops in the network provides a disturbance that influences the process variable.

The most common final control element in the process control industries is the control valve. The control valve manipulates a flowing fluid, such as gas, steam, water, or chemical compounds, to compensate for the load disturbance and keep the regulated process variable as close as possible to the desired set point [1].

This project focuses on development of valve control using pulse width modulation (PWM) of PIC 16F877A for turbine meter where to control the average flow rate by given k.factor of the turbine meter. The valve will be controlled by servo motor using PWM by varying the servo duty cycle on fixed base frequency to match the flow requirement.

In order to obtain forward and reverse bias pulse width modulation (PWM) need to be generated. PWM is a signal waveform that can be produced by PIC 16F877A as per the requirement of for servo motor. A technique for the generation of PWM waveform is to store the lookup table of digital words corresponding to pulse and notch width at different magnitudes of fundamental in memory for later conversion into PWM waveform [2].

1.2 Project objectives

The main objectives of this project are to design the valve flow control for turbine meter using microcontroller (PIC). This project consists of hardware and software elements. Below are the objectives of the project:

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1. To design the valve flow control system
2. To develop and design the programming language of the system
3. To design and control the servo motor using microcontroller
4. To control the average flow rate by input data of base frequency

1.3 Problem statement

Microcontroller is more stable compare to the microprocessor in order to generate the pulse width modulation (PWM) waveform. The microcontroller circuit is also simpler and easier to control. Therefore, the microcontroller is cheaper than microprocessor.

Beside, the control valve assembly typically consists of the valve body, the internal trim parts, an actuator to provide the motive power to operate the valve, and a variety of additional valve accessories which can include positioners, transducers, supply pressure regulators, manual operators, snubbers or limit switches. With this accessories, well known it become more expensive.

1.4 Scope of project

With wide variety of turbine meter uses such as in pipelines, this project purposely to design simple valve flow control using PIC 16F877A microcontroller with servo motor to control the average flow rate. In order to achieve the objective of the project, a programming language needs to be developed. Finally the flow rate value will be displayed.

1.5 Project methodology

This section explained the method involved in the project. The first step is gathering information regarding the turbine meter, servo motor, PWM, PIC 16F877A. Then the circuit is designed and simulated using the Proteus Design Suite software to ensure the designing circuit in well operated. Finally, after the circuits are tested, the circuit is fabricated. The figure 1.1 below shows about the flow chart of entire project.

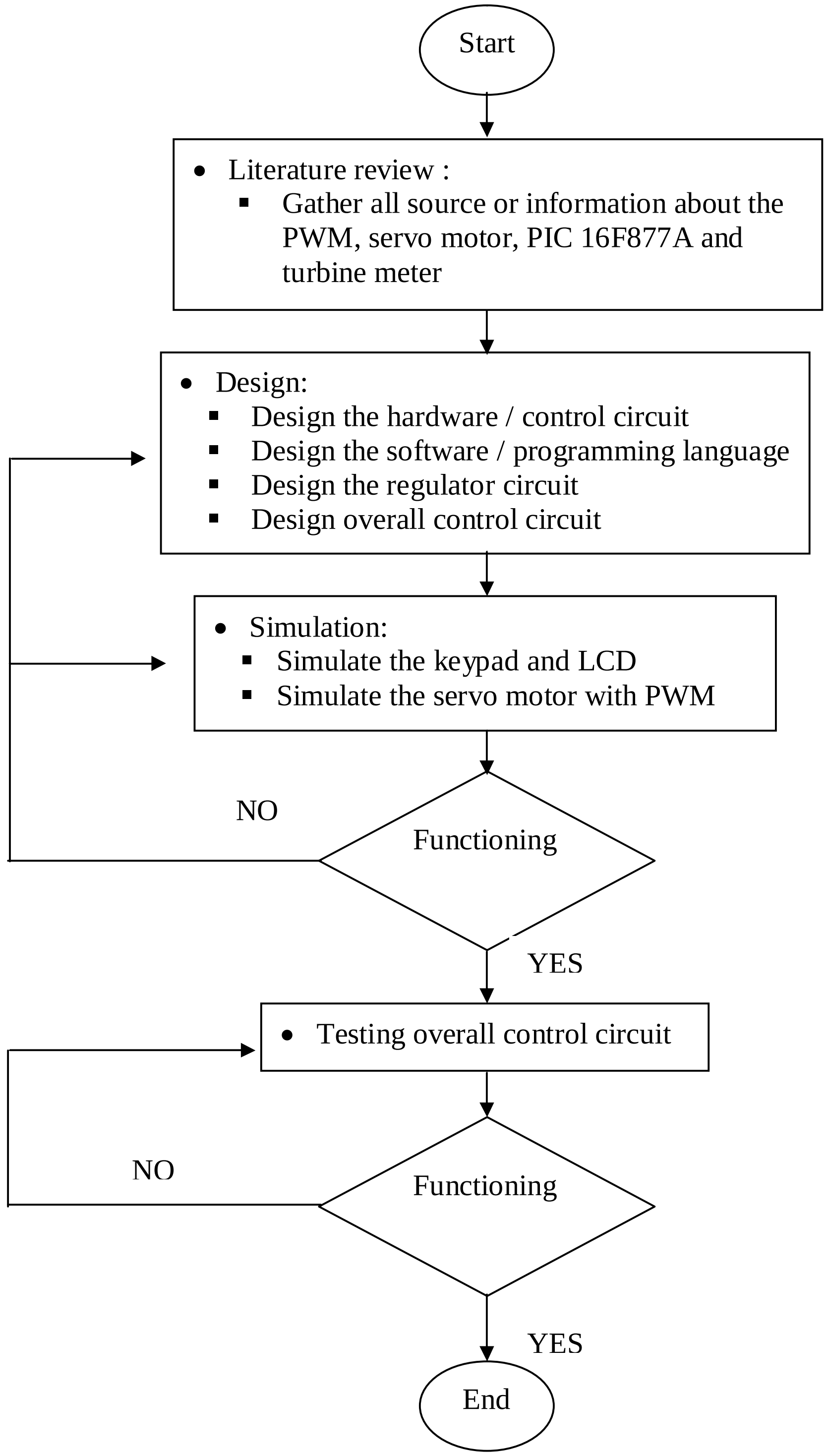

Figure 1.1: Flowchart of project

1.6 Summary

This chapter shows how the process of the controlling valve using PIC 16F877A. The objective, problem statement and scope as well as project methodology also already explained in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter introduces the ideas of starting the project. The theory of the flow control is described in this chapter. These references are used to gain an understanding of the concepts required to implement a working algorithm which would meet the project requirements.

2.2 Derive the frequency of a turbine meter

Every turbine flow meter has a unique k-factor or ratio of input pulses per unit of flow. As the turbine rotates within the flow meter an electronic pulse is created each time a turbine blade passes the face of the magnet. The total number of pulses equivalent to one unit of flow is the k-factor.

Each pulse generated represents a discrete amount of volumetric throughput. Dividing the total number of pulses generated by the specific amount of liquid product that passed through the turbine flowmeter determines the K-Factor. The K-Factor, expressed in pulses per unit volume, may be used with a factoring totalizer to provide an indication of volumetric throughput directly in engineering units. The totalizer continuously divides the incoming pulses by the K-Factor (or multiplies them with the inverse of the K-Factor) to provide factored totalization. The frequency of the pulse output, or number of pulses per unit time, is directly proportional to the rotational rate of the turbine rotor. Therefore, this frequency of the pulse output is proportional to the rate of the flow.

By dividing the pulse rate by the K-Factor, the volumetric throughput per unit time of the rate of flow can be determined. Frequency counters or converters are commonly used to provide instantaneous flow rate indication. Plotting the electrical signal output versus flow rate provides the characteristics profile or calibration curves for the turbine flowmeter [3].

2.3 Basic construction of turbine flowmeter

2.3.1 Turbine meter

The basic construction of the turbine flowmeter incorporates a bladed turbine rotor installed in a flow tube. The rotor is suspended axially in the direction of flow through the tube. The turbine flowmeter is a transducer, which senses the momentum of the flowing stream. The bladed rotor rotates on its axis in proportion to the rate of the liquid flow through the tube. Figure 2.1 below show the construction of turbine flowmeter. The first element of turbine meter is their blade that functions as flux cutter. Pickup coil housing is where the pickup coil will be placed. It is functions as pulse generator that will be sent to control monitor. Finally the straightner is an element in stabilizing the flow of liquid through the flowmeter

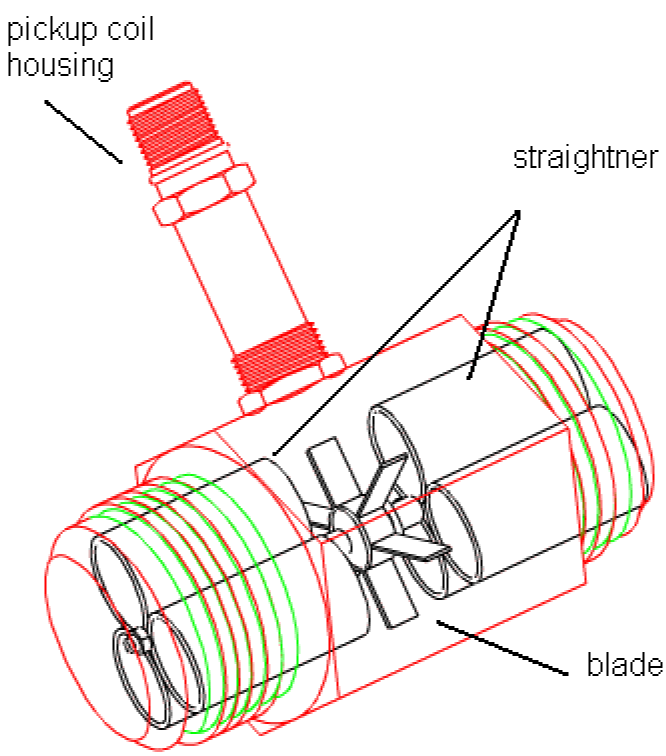

Figure 2.1: Turbine flowmeter

2.3.2 Signal Output

Electrical output is generated using the principle of reluctance. A pickup coil, wrapped around a permanent magnet, is installed on the exterior of the flow tube or the meter body immediately adjacent to the perimeter of the rotor (Figure 2.2). The magnet is the source of the magnetic flux field that cuts through the coil. Each blade of the turbine rotor passing in close proximity to the pickup coil causes a deflection in the existing magnetic field. This change in the reluctance of the magnetic circuit generates a voltage pulse within the pickup coil. Each pulse generated represents a discrete amount of volumetric throughput. Dividing the total number of pulses generated by the specific amount of liquid product that passed through the turbine flowmeter determines the K-Factor.

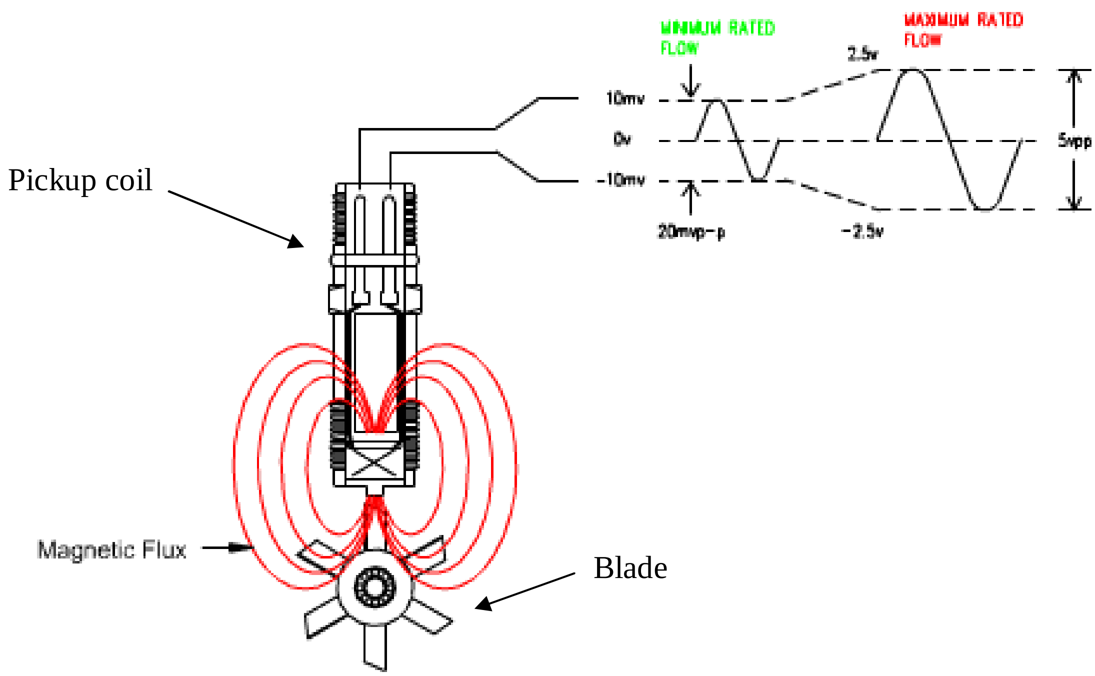

Figure 2.2: Pickup coil

2.4 The pic16f877a microcontroller

2.4.1 Microcontroller

A microcontroller (or MCU) is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas a general purpose microprocessor requires additional chips to provide these functions.

A microcontroller is a single integrated circuit with the following key features:

- central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors
- input/output interfaces such as serial ports
- peripherals such as timers and watchdog circuits
- RAM for data storage
- ROM, EEPROM or Flash memory for program storage
- clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit

This integration drastically reduces the number of chips and the amount of wiring and PCB space that would be needed to produce equivalent systems using separate chips.