DESIGN & IMPLEMENTATION OF AUTOMATED FILLING AND CAPPING MACHINE USING PLC

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MAY 2008
“I hereby declared that I have read through this report and found that is has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation & Automation)

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Date: MAY 2008
DESIGN AND IMPLEMENTATION OF AUTOMATED FILLING AND CAPPING MACHINE USING PLC

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Thesis submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Degree of Bachelor in Electrical Engineering (Control, Instrumentation and Automation)

Fakulti Kejuruteraan Elektrik
Universiti Teknikal Malaysia Melaka

MAY 2008
DECLARATION

I hereby, declare this thesis entitled “Design & Implementation of Automated Filling and Capping Machine using PLC” is the result of my own research and design except as cited in the references.

Signature : _____________________________
Name : MOHD ASNAWI BIN SAIMON
Date : MAY 2008
DEDICATION

*For my beloved mother, Hajjah Tukijah Binti Haji Sakur and father, Haji Saimon Bin Sharimin.*
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Alhamdulilah, firstly I am grateful to almighty Allah S.W.T because at last I have finished my Bachelor Degree Project 2 (PSM 2) and my report without any problem. It is difficult to finish this Bachelor Degree Project 2 (PSM 2) report without the help.

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ABSTRACT

In this report, the design and implementation of automated filling and capping machine using PLC is discussed and presented. This system is suitable for liquid product that required exact amount of liquid to be filled in the bottle such as perfume. This is a batch operation where a set amount of inputs to be process is received as a group, and an operation produces the finish product. This project is the combination of PLC, pneumatic system, and electrical DC motor system. This project is divided into four sections; the conveyor section, the loading section, filling section, capping section and the whole sections is controlled by PLC.
ABSTRAK

Kertas kerja ini membincangkan serta menerangkan rekabentuk dan perlaksanaan mesin pengisian dan penutup menggunakan PLC. Sistem ini sesuai untuk produk berasaskan kepada cecair yang memerlukan pengisian pada kadar yang tetap ke dalam botol seperti minyak wangi. Operasi secara berkumpulan ini melibatkan sejumlah bahan melalui proses diterima secara berkumpulan dan menghasilkan produk yang siap. Projek ini adalah kombinasi PLC, sistem pneumatik dan sistem motor elektrik arus terus. Projek ini dibahagikan kepada empat bahagian; bahagian pembawa, bahagian pemuat, bahagian pengisi, bahagian penutup dan semua bahagian-bahagian ini dikawal oleh PLC.
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CHAPTER 1

INTRODUCTION

1.1 Introduction

In this modern era, the entire industrial task has become dependant to the automation. Automation system has taken over the conventional method to complete the process. Automation becoming increasingly important in the manufacturing process because computerized machine are capable of handling repetitive tasks quickly and efficiently. Machines used in industrial automation are also capable of completing any tasks that are not capable to human workers. In this project, machine with automation system is used to do the filling and capping process. It also will reprise as a training kit to describe the process of filling and capping using the combination of DC electrical motor and pneumatic system that are controlled by PLC (Programmable Logic Controller).

1.2 Project Overview

This system is suitable for liquid product that required exact amount of liquid to be filled in the bottle such as perfume and any other medicine products. This is a batch operation where a set amount of inputs to be process is received as a group, and an operation produces the finish product. This project is the combination of PLC, pneumatic system, and electrical DC motor system. This project is divided into four sections; the loading section, the conveyor section, filling section, capping section and the whole sections is controlled by the Omron CQM1-H PLC. The mechanical part of the project consists of mechanical drawing, measuring, welding and
fabricating process, while electrical part consists of electrical drawing, electrical wiring and programming.

1.3 Problem Statements

This machine is designed to combine the filling and capping process in a single machine. This project will reduce the usage of man power because all of the work will be done by machine. Human held filling process will cause inexact volume of liquid into the bottle. So using automated system will set the volume of the liquid exactly the same for each bottle. Human cannot give the enough pressure to cap the bottle, so it will use the high pressure mechanism to press the cap on the bottle. If all the process is done manually, it will cost lot of time to complete the task. This machine will also reduce the human error while doing this process manually. It also can be used as a training kit to describe the function of dc motor and pneumatic system.

1.4 Objectives of the Project

The project is aimed to meet the following objectives:

- To design and implement automated filling and capping machine
- To learn the concept of pneumatic system, electrical DC motor system
- To implement hardware installation, wiring, mechanical mounting
- To learn troubleshooting and analyzing
- To learn PLC programming

1.5 Scope of the Project

All projects have their own scope or limitation as a guideline throughout the completion of the project. The project scope for the implementation of this project is:

i. Design and develop the complete automated system that is use to apply the filling and capping system in term of hardware and software development.
ii. The hardware development and implementation consist of mechanical structure, dc motor electrical system, pneumatic system, PLC and sensing device. The PLC will be the main controller for the system.

iii. The programming or software development and implementation consists of CX-Programmer for Omron CQM1-H PLC.
CHAPTER 2

LITERATURE REVIEW

This chapter will explain and discuss about source or article that related to the project. It is consist of the products that have been appeared in the market nowadays. This chapter is also contained the theory of the components, equipments and programming languages that is used in the project.

2.1 First Review: Vibrac® Low Volume Capper

Figure 2.1: Capping Machine
2.1.1 Standard features

The Vibrac® Low Volume Capper bench top system is designed to provide years of trouble free capping and de-capping of threaded bottles up to 15 inches in height. In a matter of minutes, the machine may be adjusted for different containers. The height is adjusted by means of a hand cranked rack and pinion assembly. Production rates of 10 to 30 units per minute are typically achieved. So whether the application is in a start up operation, a rework station, a laboratory or a low volume manufacturing plant, the Low Volume Capper can meet the requirements.

- Sturdy, low maintenance construction.
- Precise torque control with a permanent magnet clutch.
- Quick container and cap changeover.
- Both foot-operated and fixture actuated cycling.

2.2 Second Review: Automatic Gravity Filler GI 2100

Figure 2.2: Filling Machine
2.2.1 Construction features

304 Stainless steel heavy duty stainless steel welded C frame. It has 20 Gallon stainless steel overflow tank and stainless steel cover for overflow tank. It also consist 20 Gallon feeding tank with float valve and stainless steel cover for feeding tank. The 20 hose are made with 304 stainless steel feeding manifold. All contact parts are stainless steel, sanitary, Teflon, viton and hoses. The machine is mounted on 4 heavy duty casters. The machine is leveled by 1 inch 304 stainless steel leveling screws.

2.2.2 Control panel features

The machine was controlled by Omron PLC for all logic functions, special modifications on programs available for special adaptations. Front panel filling time adjustment through Omron Timer. Front panel conveyor speed control for machine sold with conveyor. Front panel mounted bottle counter. Front panel Start and Emergency STOP for easy access. Front panel nozzle code for changing nozzle quantities. The fiber optic sensors are set by Omron standard for container gating. It was expandable to 20 nozzles to increase speed.

2.2.3 Main components feature

This machine uses 40 Gallon per minute double diaphragm pump for feeding tank supply. Hardened Stainless steel calibrated shafts with linear bearings for nozzle rack movement smoothness and durability. It has 8 inch stroke air cylinder with magnetic sensors for nozzle up and down movement. Hand wheel and shaft mounted stoppers for height and stroke adjustment.

2.2.4 Standard features

Nozzle spacing is fully adjustable through top screw. Container height can be adjusted from 1 to 16 inches high. Meanwhile the nozzle stroke can be adjusted from 0 to 8 inches. Entry and exit bottle gating cylinders adjustable, sideways, up and down
and inside and outside. Air filter regulator, safety lockout valve and valve activated by float on tank are mounted on the pump. Spacing and additional bottle control obtained by flow controls mounted on air gating cylinders.

2.2.5 Requirements

110 Volts, 60Hz, 15 Amp and 10 CFM @ 80 p.s.i.

2.3 Third Review: Filling Concept

![Figure 2.3: Time Gravity Filler](image)

Time gravity filler concept has been chosen because the operation is really simple. This is the most economical type of filling machine for a limited range of applications. It is especially well suited for corrosive chemicals. It will operate based on gravity law which is the mass will go down to ground. When the solenoid valve is activated, the liquid will flow through downward into the bottle. The time of valve open also determine the volume of liquid been filled into the bottle.
2.4 Conclusion

After reviewing all the review above, it is true that there are many modern filling machine and capping machine in the market. The machine equipped with latest technology of hardware that can perform the given task efficiently with almost no errors. The project is trying to combine the two systems above into one system that operates sequel one after another. The project only includes the basic concept of filling and capping system compared to the real machine. It is suitable for teaching process as a training kit.

2.5 Theory

2.5.1 Programmable Logic Controller (PLC)

2.5.1.1 Introduction

A programmable logic controller (PLC) is a digital electronic device that uses a programmable memory to store instructions and to implement functions such as logic, sequencing, counting, and arithmetic in order to control machines, processes, and has been specifically designed to make programming easily.

Figure 2.4: Application of PLC
2.5.1.2 Basic operation of PLC

PLCs consist of input modules or points, a Central Processing Unit (CPU), and output modules or points. An input accepts a variety of digital or analog signals from various field devices (sensors) and converts them into a logic signal that can be used by the CPU. The CPU makes decisions and executes control instructions based on program instructions in memory. Output modules convert control instructions from the CPU into a digital or analog signal that can be used to control various field devices (actuators). A programming device is used to input the desired instructions. These instructions determine what the PLC will do for a specific input. An operator interface device allows process information to be displayed and new control parameters to be entered.

Figure 2.5: PLC process block diagram