

Power Saving on Piston Washing Machine Modification by Utilizing Air Pressure and Programmable Logic Controller

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Abstract - Washing the piston is the last process in the manufacture of the piston in the area of machining. Some of the washing process is still manually operated piston. This machine is made to wash the piston operates automatically. In this study the authors use an experimental method. This machine uses air pressure as the driving force, ranging from a pressure tube and propeller - propeller. This machine is expected to save the use of electric power. Piston washing machine using pressurized tubes as water pumps and propellers as a player jig. While the actuator using a pneumatic system. This engine control system using Omron PLC CPM2A. In order to control the washing machine needs piston then the mechanical and electrical system design.

Keywords: piston washing machine, pressurized tubes, PLC

I. INTRODUCTION

Along with the increase in production from year to year, it takes a series of additional machines for the pathways that produce specialty racing pistons. This path will be producing racing pistons. To create a new production line in the area of machining, the company requires 10 machines in order to process the piston. The process of making the piston are GBF (Guide Bore Finish) - RT (Rough Turning) - PHR (Pin Hole roughing) - ARG (All Ring Groove) - DOH (Oil Drill Hole) - PHF (Pin Hole Finish) - ODF (Outside Diameter Finish) - CBC (Bosh Center Cutting) - Grafir - Washing Piston. The last process in the machining area is washing the piston. Piston washing process performed to clean the remnants of scrub and coolant attached to the piston. In order for the

piston which has made producing quality and quantity expected, there was made a washing machine piston. With the development of applied will be able to provide improved benefits to the company.

This research focused on how to make a device that can drain the water with a minimum pressure of 2 bars. The water which flowed from reservoirs that is under to the wash that is above the air pressure to replace the water pump motor. The water is then used to clean the piston.

II. REVIEW THE CONTROL SYSTEMS

The control system is a collection of several mechanical devices and electronic equipment that works on an ongoing basis to carry out his duties as a system. The task of a control system is to control a series of events or to keep the number of variables remain constant value, typically associated with handling stability, accuracy and eliminate hazardous conditions in a manufacturing production process [1].

A common form of controller is a controller with an electric circuit by closing and opening the switch will activate the control mechanisms such as turn on a relay which then connects to the output stream such as a lamp.

Data Collection. In the manufacture of a machine will inevitably have some standard tools or measures that should be applied. Washing machine standard pistons have several of them are [2]:

Water pressure > 2Bar

Jig spins > 1 round each process.

Water temperature 50⁰-60⁰

Piston washing machine designed to clean the piston from the remnants of scrub and liquid cooling (coolant) attached to the piston that is used during machining process. This machine is operated semi-automatic because it still required the operator to place the piston into a piston engine and took it upon completion.

PLC choosing is based on the use of their input and output. The control circuit on the engine piston washer uses 17 inputs and 14 outputs. Here we design a new PLC program tailored to the engine, as we have done some previous researches [3, 4].

III. DESIGN AND DEVELOPMENT

The design includes mechanical as pressurized tubes, propellers, nozzles and jig base, designing electrical panels such as the manufacture of boxes and box keys and program design.

A. Mechanical Design

In mechanical design there are four tools that will be created to support the pressure tubes as water pumps, propellers instead of a stepper motor, a nozzle instead of a long nozzle and the base as a mounting jig.

B. Pressure Tubes

In designing the tube that must be considered is the need for water in the wash. In this trial is known that the air pressure of 4 bar to spray water from a water bottle as far as 13 meters with a 5mm hole out. Then the author tries again with a tube diameter of 4 inches with a height of 50 cm and the water exit holes 8mm. The tube is then filled with water and pressurized 4bar. The result can spray water about 7.8 meters away. Table 1 show the tubes experiment.

TABLE I. TUBES EXPERIMENTS

Tools	Air Pressure (bar)	Output Diameter	Distance (m)
Water Bottle	4	5 mm	13
Small Tube	4	8 mm	7.8
Large Tube	4	0.5 inch	3.1

Once there was made known to the needs of water-pressure tube design using 6-inch diameter pipe with a height of 20 cm, so that the volumes to be generated is 3.6 liters. Figure 1 shows the design of pressure tubes.

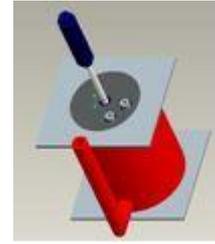


Figure 1. Design of pressure tubes

The workings of the tube when the water runs out then the cylinder will push the lid. Because the tube submerged in water then the water will automatically enter into the tube. Once the tube is full, then the cylinder will close again. Furthermore, the tube will be filled by the pressurized air through hole A about 4 bar. Because of air pressure, then the water will be pushed out through the water hole. Holes B are used to remove any residual pressure in the tube before the cylinder tube uncapped.

C. Propeller

Propeller will be used to replace the rotating piston motor stepper. Propeller will be installed together with the jig. Jig is a holder to put the piston in piston washing machine. Propeller is driven using air pressure. If the air pressure on the propeller, the blades will rotate.

Before doing the design, the authors carried out tests using propeller is rather small. Fin blades - blades are made of iron plate measuring 40mm x 15mm x 1mm. Furthermore, the propellers coupled with jigs and given the wind pressure of 4 bars. The result is the jig can rotate quickly. Figure 2 shows the propeller design.



Figure 2. Propeller design

D. Nozzle

Nozzle is a device that can produce a spray. Nozzle is used to distribute the flow of water and wind to the surface of the piston. Previously nozzle has only one hole so that the spray is not about the entire surface of the piston. Therefore, the spray nozzle can be modified so that the entire surface of the piston. Figure 3 shows the nozzle design.

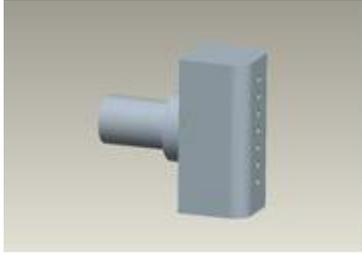


Figure 3. Nozzle Design

E. Jig Base

Jig base is used to place the jig, cylindrical, and the nozzle. Base placed in the tank leaching. In the figure, the base changed its position to be slightly down and approached the door. This serves to facilitate the laying of the operator in placing the piston. Because previously been in the middle - the middle of the tank washing hands is quite difficult to reach a jig. Figure 4 show the design jig base.

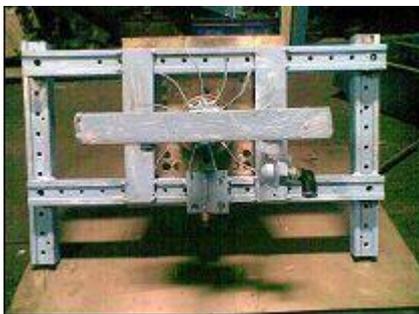
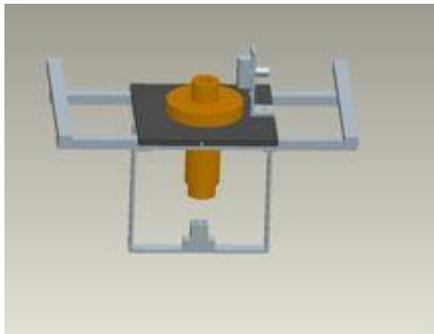


Figure 4. Design Jig Base

F. Design of Pneumatic Controls

The design of pneumatic controls is driven by air pressure and controlled by solenoid valve. In carrying out this pneumatic system will be controlled by the PLC in order to move a predetermined sequence. All movement of the cylinder will move according to the program ordered by the PLC.

G. Control Panel

In order to control the piston washing machine, it takes a control circuit. The control circuit is arranged in a control panel. The control panel is made in accordance with a layout that has been designed. The control panel box is measuring 700mm x 200mm x 400mm. Within this panel there is a mounting plate 2 mm thick; in the design of electrical control plate is made. To be tidier in the process of wiring, then used duct cable to close the cable lines. Inside the control panel there are electronic devices such as MCB, PLC, Transformers, Power Supply, etc. Figure 5 and 6 show the layout of box panel and button box.

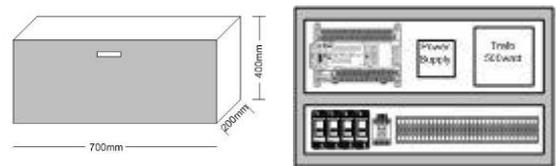


Figure 5. Layout of Box Panel

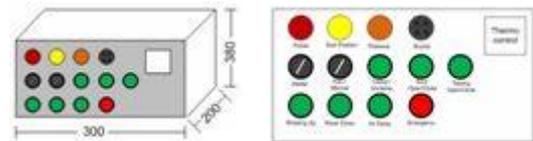


Figure 6. Button box

To be able to operate the washing machine piston, it takes a control circuit. Box keys are used to place the buttons for easy to reach by the operator's hands. In the washing machine is used 2 pieces of piston selector, 7 pieces buttons, and 2 emergency stop. The buttons used are: heater, auto / manual, clamp / unclamp, door open / door close, tube open / close tube, rotary jig, water spray, water spray, and emergency stop.

H. Programming

Programming machine made, has two types of programs, namely the program manual and automated programs.

1) Programming Manual

To save the use of push-button, then we use a button on and off. PLC program is made for the Push Button clamp / unclamp, Push Button Door open / close door, Push Button tube open / close tube, rotary jig Push Button, Push Button Water spray, water spray Push Button. Figure 7 shows the manual clamp/cnclam programming.

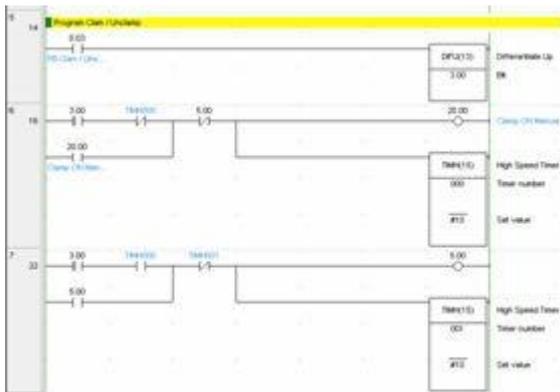


Figure 7. Manual Clamp/Unclamp Programming

2) Automatic programming

The program automatically created to facilitate the operator in using the machine because it just by pressing a single button. Figure 8 show program start position, clamp, and the Doors Close

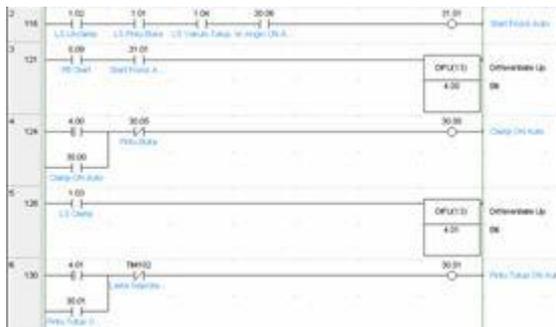


Figure 8. Program Start Position, Clamp, and the Doors Close

IV. TESTING

Machines that have been made to go through the testing phase, both hardware and software. The purpose of this test is to find a variety of potential or cause system failure. Basically making the control system uses PLC system failure derived the greatest percentage of sensors, actuators and cable connections, than failures caused by internal errors of the PLC itself.

Tests on the washing machine piston includes mechanical testing, electrical testing such as, current, voltage and testing programs such as input and the output.

A. Pressure Tubes

Water tubes were tested by measuring the pressure of water coming out when given air pressure and measure the level of the leak. Testing the water pressure use a pressure gauge. Standard water pressure water spray is applied to at least 2 bars. Because the pressure achieved by 4 bar water tube, then its worth. The volume of water released can be tailored to the needs. Within three seconds the tube can spend as much as 0.5 liters of water.

B. Propellers

Propellers are used to rotate the jig are driven by air pressure. The standards applied are minimal jig can rotate at 3600 or one round in one process. Because the rotor can rotate by 3600 more than one round in one process, then the use of propellers fit for use.

C. Nozzle

How to input nozzle testing is a way to see the position of the water jets coming out of the nozzle is whether it is about the entire piston surface or not. From the observations, the spray nozzle can be on the entire surface of the piston so that the use of the nozzle is very good.

D. Jig Base

Testing jig base is done by seeing the hand position while placing the piston on the jig. Previously, the laying of the piston is done automatically. From interviews to the operators who put the piston to the jig, the result is a fairly easy process.

E. Electric Testing

Electrical testing is performed to determine whether the circuit is electrically connected properly or not. Testing is done by measuring the output voltage of the transformer. The voltage is the voltage of AC 220 issued Volt. The tools used for testing is a digital multimeter. After testing, the voltage is 229 Volt issued. Then proceed by measuring the output voltage of power supply. Voltage is issued 24 Volt DC voltages. The tools used for testing is a digital multimeter. After testing, the voltage is 23.8 VDC issued.

F. Input-Output PLC

Way of testing the input device is the manual way, i.e. connecting the PLC to personal computer (PC). In the test input, each key is pressed and then seen the light on the PLC whether lit or not. Magnetic sensor is to activate it in a way closer to the sensor on the cylinder. How to test the output is to connect the PLC to personal computer (PC) and manipulation through the program. When one of the addresses in the program output "ON", it can be seen in the light on the PLC whether lit or not.

G. Process Testing

The test process is performed to determine the suitability of the program with a process flow that

has been made. Table 2 shows the testing the input device results.

TABLE II. TESTING THE INPUT DEVICE TESTULTS

No	Check Points	True	Wrong
1	The process sequence in accordance with process flow diagrams.	√	
2	Heater can heat the water.	√	
3	The starting position is: Piston Unclamp, doors open, vacuum lid, and fill pressure solenoid inactive.	√	
4	At the Start Position indicator lights lit.	√	
5	The process of washing the piston will be active after rotating jig for one second.	√	
6	The drying process will be active after the washing process pistons for three seconds.	√	
7	Jig will spin until the drying process is complete.	√	
8	Buzzer will be activated when the water in the tank in a state of less water.	√	

H. Washing Testing Results

Washing test results conducted to determine how clean the piston is washed with washing machine piston. To determine the cleanliness of the piston is done by three media namely coolant, scrubs, and oils. How to test it is dipped into the media testing piston until the piston is dirty, then the piston is washed using a washing machine piston. Indicator of the level of cleanliness is not any scrub remaining oil in the hole, then the piston does not contain the oil slick or not. Table 3 shows the results of washing piston

TABLE III. RESULTS THE WASHING PISTON

Media	Clean	Un-clean
Coolant	√	
Scrub	√	
Oil	√	

V. CONCLUSIONS

Mechanical manufacture of washing machines use a piston with air pressure as the power source can be done. Pressurized tube can remove a large enough water pressure of 4 bars. Water released within 3 seconds as much as 0.6 liters. The propellers can rotate the jig quickly. Nozzle with many parallel holes, it will be able to clean the entire surface of the piston. Base is converted into a little jig to the bottom and near the door can be easier for the operator in placing the piston.

Manufacture of electrical control piston washing machine components used in accordance with the needs of the engine based on the voltages and currents. Replacement CPM2A Omron PLC 60 I / O with Omron PLC CPM2A 40 I / O is more appropriate for the needs of I / O is much less than before.

CPM2A Omron PLC program (ladder diagram) has been created and can function properly in accordance with the existing process flow.

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