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Automatic Control Systems Water Filling and Chemicals on Cylinder Cleaning Engine and Outer Shell

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Abstract— **Manufacturing companies, especially those producing components Shock Absorber for two-wheelers (2W) and four-wheel (4W) seeks to enhance the capacity and quality of production. In the process Shock Absorber four-wheel vehicle, there are several components, one of which is the Outer Shell on Line Cleaning Center. The problem faced is how to increase the capacity, reduce Loss Time production, and reduce the amount of contamination due to leaching Outer Shell is not clean. Contamination is caused by the incompatibility of the comparison between water and chemicals. In this research, we design tools and Chemical Water Charging Auto is as a tool that serves to replenish water and chemicals do automatically without operator. This machine uses Programmable Logic Controller (PLC) Omron CPM1A-20 CDR as input and output control of the machine. These devices are programmed in accordance with the desired work. The results from the manufacture of Water Charging Equipment and Automatic Chemical standardization in terms of chemical mixing ratio is average of 5% ± 0.05. Outer Shell and output may increase the cleaning process from 10,730 pieces to 11,064 pieces per day. In this research, we also consider the safety aspects of the work process of the system instrumentation.**

Keywords- Programmable Logic Controller (PLC); Outer She; automatic control systems; chemical water charging

I. INTRODUCTION

Manufacturing companies, especially those producing components Shock Absorber for two-wheelers (2W) and four-wheel (4W) seeks to enhance the capacity and quality of production. In the process Shock Absorber four-wheel vehicle, there are several components, one of which is the Outer Shell on Line Cleaning Center. Problems faced by companies are how to increase the capacity, reduce Loss Time production, and reduce the amount of contamination due to leaching Outer Shell is not clean. Contamination is caused by the incompatibility of the comparison between water and chemicals. This can occur due to mixing between the water and the chemicals are not appropriate procedure. The operator simply fills during cleaning machine is experiencing an alarm which resulted in the cessation of the engine and reduced chemical solutions and water in the machine.

Water charging is done only as a safety operator against the heater which is in the tank cleaning machine, so that the heater (heater) is not burned at a chemical solution that is in the tank machine having a low position. In charging the operators do not add liquid chemicals appropriate comparison is 5% ± 0.05 of the volume of water in the tank. There is a request to process the Line Cleaning Center which does not stop and the comparison between the chemical solution with water always ± 0.05 versus 5%, then do research to increase (improvement) to make water filling equipment and chemicals Motto 2010 Super Degreaser automatic machine cleaning Cylinder Outer Shell. PLC (Programmable Logic Control) is used as the control system in it, so it is easy to make improvements and analyze process problems such tools. Previously, we have researched about automation control system by using PLC [1, 2, 3, 4, and 5].

II. DESIGN

A. Line Cleaning Center and Cleaning machine Outer Shell

Line Cleaning Center is one part of the production line Shock Absorber for four-wheel vehicles (4W). The production process at Line Cleaning Center is to wash and clean the parts for Shock Absorber Assembling the Outer Shell of oil that sticks and chips after cutting process. After passing through the Outer Shell finished cleaning the Outer Shell will enter into the assembly process. Cleaning Machine Outer Shell is a machine that is used to cleanse the Outer Shell of impurities such as oil, dust, cutting chips. In the washing process, the outside and inside of the outer shell is cleaned by spraying chemicals through the nozzle. Figure 1 shows the process of loading and washing the outer shell.

a b

Figure 1. a. Loading b. washing the Outer Shell

After the washing process, Outer Shell is entered in the drying process. In the drying process, by using Blower system which is spraying hot air onto the surface of the Outer Shell to dry and clean chemicals that still attached to the surface of the Outer Shell.

B. Location of the Outer Shell Shock Absorber

Figure 2 shows the location of components contained in the Shock Absorber, one of which is the Outer Shell, Packing Case Assembly, Extension and Compression Valving on Assembling a Piston Rod Piston Rod to Complete. After that will be filled with the Outer Shell Oil Damper and Welding with Packing Case Assy. Piston Rod then be in Welding Complete with Cover.

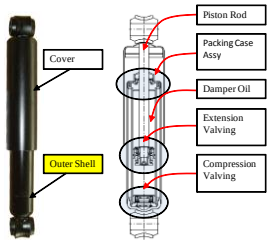

Figure 2. Shock Absorber

C. Flow Process

Based on work systems Cleaning Machine Outer Shell and the working system of water charging equipment and automated chemical process then are made to the existing flow in the process. Figure 3 shows the process flow Cleaning Machines.

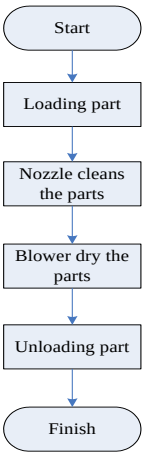

Figure 3. Flow Process of Cleaning Outer Shell Machine

The first phase, Outer Shell entered the loading process, the process loading Outer Shell waiting to get into the next stage of washing steps were carried out by spraying chemicals by using the nozzle to the surface inside and outside of the Outer Shell. In the next process is the drying process by using a blower, which aims to dry the entire surface of the Outer Shell of chemicals that linger after the washing process. The next process is the process of unloading, whereas in the Outer Shell is already through the process of washing and drying process will be sent to the assembly process.

Conditions of low 1 will occur if water filling equipment and chemicals automatically get a voltage of 220 V. Before the push button start is pressed, make sure the emergency stop position is in off or not depressed position and the selector switch are in the position of an automated process. If proximity is detected high levels that existed at the height of a float tank, the low one condition will not be active. When it does not detect the proximity of high level float altitude, resulting in proximity so as the active low 1 solenoid, solenoid 2, and the pump will be active simultaneously. Solenoid 1 will not be active when proximity is detected again high altitude levels of chemicals. It indicates the volume of water and chemicals for tank cleaning machines are already in a high position. Solenoid 2 and the pump will not be activated if there is a timer that the PLC has finished counting.

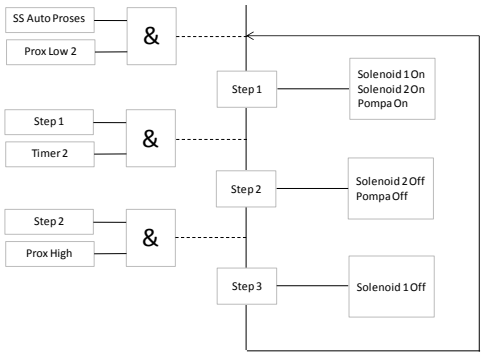

Figure 4. Flow processes at conditions of low 2

Figure 4 shows the process flow of water filling device and automatic chemical substances in conditions of low 2. Conditions of low 2 will occur if high proximity and proximity detecting low altitude 1 is not a float in the tank cleaning machines, thus activating solenoid 1, solenoid 2 and pump. Solenoid 2 and the pump will not be activated if there is a timer that the PLC has stopped counting. Solenoid 1 will not be active when high proximity detection buoys at high levels contained in the cleaning machine.

Furthermore, in Figure 5 is a flow process during initial charging conditions. What distinguishes the initial charge with the low 1 and low 2 is at the beginning of the charging process is only done when the engine is being depleted tank cleaning in cleaning machines. Then, make sure the selector switch is in the auto position of the charging process.

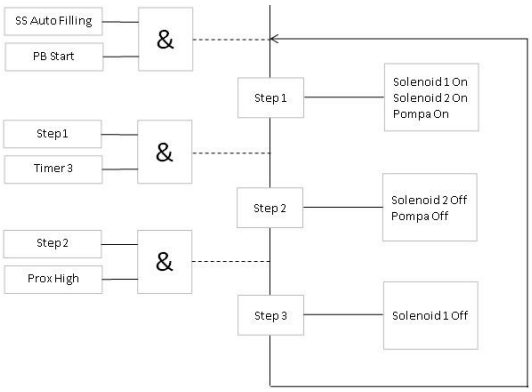

Figure 5. Flow processes at the initial charge

In the process of charging automatic water and chemicals, pumps and solenoid 2 will stop working when the timer is on the PLC has finished counting. It is based on the calculation of the ratio between the chemical discharge that comes out of the pump with solenoid 2 by 5%. Where 5% of the chemical is calculated based on the amount of water present in the discharge tank on the engine cleaning. While the function of the timer that is on the PLC is to turn off the pump and solenoid 2 in order to achieve the target of mixing chemicals is 5%.

D. Problems in Line Cleaning Center

The problem that facing companies today is the time required for mixing water with chemicals takes 5 minutes on each charge, so the production process in Cleaning Machine will stop charging when the water with chemicals. This happens because there is a heater in the tank cleaning machine. To prevent burning heater on Machine Cleaning resulting from reduced water and chemical tank machine. At the time of loss of water and chemicals in tank cleaning machine, the operator will fill the water in the tank cleaning machine manually without adding chemicals during the water filling process. Figure 6 shows the charging process manually.

Figure 6. Water Charging

Another problem encountered is the mixing of water and chemicals that do not fit the standard of 5% ± 0.05 chemical substances contained in the tank cleaning machine. Reduced water tank cleaning machine is because the liquid evaporates due to the heat generated by the heater, the fluid sticks to the Outer Shell after the washing process or even liquid splashed out by spraying when washing Outer Shell.

III. CONCEPT DESIGN

Based on the working system of water charging equipment and chemicals automatically, then be made to design a control system includes input, output and process of the PLC. Input needed on water filling equipment and chemicals are push buttons, selector switches, emergency stop, and proximity sensor. While the required output is a relay, solenoid valve, pump, and relay [5, 6, 7, 8, 9, and 10]. Figure 7 shows the design of the control system. Figure 8 shows the face of machine.

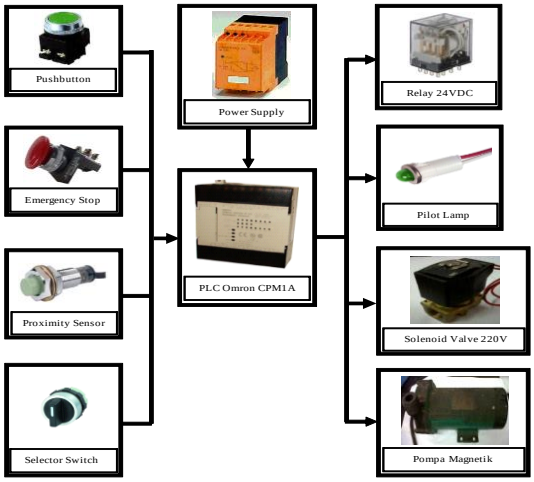

Figure 7. Design Control Systems

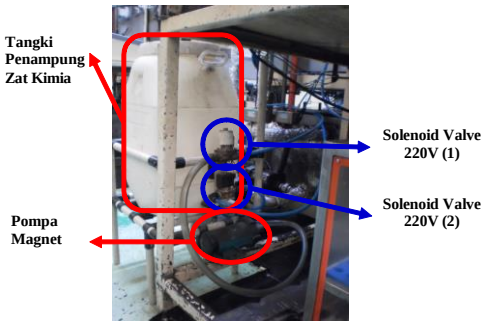

Figure 8. The face of machine

Volume of tank cleaning machines in a state of full = 110 litre.
Pump Debit = 0,015 litre / second.
Standard mixing = water 95%: chemical 5%.
Filling of water and chemicals at Low Level 1 condition.
The volume of the tank at the time of *Level Low* 1 = 92 Litre

Volume tank *full* – Volume tank *Level Low* 1
110 Liter – 92 Liter = 18 L (to be added)
% chemical = 18 x 5% = 0.9 litre

$$\text{Time} = \frac{0.9}{0.015} = 60 \text{ seconds}$$

Filling of water and chemicals at Low Level 2 conditions.
Volume tank at Low Level 2= 59 Litre
Volume tank *full* – Volume tank *Level Low* 2
110 Liter – 59 Liter = 51 L (to be added)
% chemical = 5% = 2.55 Litre

$$\text{Time} = \frac{2.55}{0.015} = 170 \text{ seconds}$$

Filling of water and chemicals at an empty tank conditions.
Volume tank when empty = 110 Litre
% chemical = 110 x 5% = 5.5 Litre

$$\text{Time} = \frac{5.5}{0.015} = 366.66 \text{ seconds}$$

IV. TESTING AND ANALYSIS

The control system has been created and all input devices - output installed on the machine to go through the testing phase. The purpose of the test itself is to find a variety of potential or cause system failure. Basically creation tool control system of water charges and auto chemicals using PLC, the largest percentage of system failure from a device input - output and cable connection, rather than a failure caused by an internal error of the PLC itself.

Testing is done by providing the operational voltage of 220 volt machine. After connecting the power cord to the machine outlet and breaker position elevated to the position on. Then the condition that occurs is:

- PLC received an input voltage of 220 volts; PLC indicator light is lit, indicating that the PLC has been active.
- Power supply indicator light is lit, indicating that the power supply is active.
- Pilot lamp Ready Machine On a yellow light, indicating that the power supply has resulted in an output of 24 volts.
- Pilot lampAuto Filling Lamp On yellow and green lights, indicating that the power supply has resulted in an output of 24 volts and conditions Selector Switch on automatic filling positions.

- Pilot Emergency On the red lamp is lit, indicating that the power supply has resulted in an output of 24 volts and Emergency Stop condition is active or repressed.

A. PLC Input Output Testing

Testing PLC inputs and outputs on the water filling device and automatic chemical is done by connecting the PLC to the PC (Personal Computer) and given input manually manipulating the PLC, and then a function of the input can be seen on a program that is run through the machine CX programmer software 9.3. Test data input can be seen in Table 1 and the test output in Table 2. Table 1 shows the test input consisting of a selector switch, push button, emergency stop, and proximity sensor. The results of the entire testing these components are OK. This indicates that the component is in normal or good. Table 2 is a test of the output consists of one solenoid valve, solenoid valve 2, pumps, and three pieces of pilot lamp. The overall results on testing output states output components are in good condition or normal.

B. Testing Machine Operatiing Systems

After testing the input and output, we then tested the system work on water filling equipment and chemicals which aims to automatically discover various potential or cause system failure. Table 3 is the result of work on system testing tools. Testing the charging system is working on a tool automatic water and chemicals. The results of testing that have been done stating that the system can work in accordance with the work program and the desired results.

C. Results of Design Engineering and Control Systems

After testing, the next step is to look at the results, whether the results of the manufacturing equipment and control systems are in accordance with the expected or not. Results manufacture of machinery and control systems is evaluated from three things: Time Loss results, results of production capacity and product yield Outer Shell. Results manufacture of machinery and control systems are described as follows:

TABLE 1. INPUT TESTING

No	Input	Description	Name of Program	Checking	Parameter	Conditions	
						Okay	Not Good
1	0.01	Auto/Man SS	Selector switch auto/manual	Move position of the switch	PLC input indicator lights 0.01 are lit	v	
2	0.02	Push Button Start	Push Button Start	Press the push button	PLC input indicator lights 0.02 are lit	v	
3	0.03	Emergency Stop	Emergency Stop	Press the emergency stop, and release the emergency stop	PLC input indicator lights 0.03 are lit	v	
4	0.04	Proximity High	Proximity Sensor Level High	metal bonding to the surface of proximity sensor	PLC input indicator lights 0.04 are lit	v	
5	0.05	Proximity Low 1	Proximity Sensor Level Low 1	metal bonding to the surface of proximity sensor	PLC input indicator lights 0.05 are lit	v	
6	0.06	Proximity Low 2	Proximity Sensor Level Low 2	metal bonding to the surface of proximity sensor	PLC input indicator lights 0.06 are lit	v	

TABLE II. OUTPUT TESTING

No	I/O Address	Name of Program	Descriptions	Checking	Parameter	Conditions	
						Okay	Not Good
1	10.00	Solenoid valve 1	output to activate the relay, to turn on the solenoid valve 1	measure the current in the relay coil, using a multimeter	There are 220 volt AC voltage at the relay coil	v	
2	10.01	Solenoid valve 2	output to activate the relay, to turn on the solenoid valve 2	Press the push button	There are 220 volt AC voltage at the relay coil	v	
3	10.02	Pump	output to activate the relay, to turn on the pump	Press the emergency stop, and release the emergency stop	There are 220 volt AC voltage at the relay coil	v	
4	10.04	Auto filling lamp		observe the green pilot lamp	The green pilot lamp is turn on	v	
5	10.05	Ready machine lamp	pilot lamp yellow, an indication that the engine gets a voltage of 220 volts	observe the yellow pilot lamp	The yellow pilot lamp is turn on	v	
6	10.06	EMG lamp	pilot lamp red, alarm indication on the machine	observe the red pilot lamp	The red pilot lamp is turn on	v	

TABLE III. TESTING THE SYSTEM WORK ON TOOLS

No	Check point	OK	NG
1	flow process machine has been made in accordance with the sequential work processes	v	
2	if the emergency stop pressed, then all the process will stop and the red indicator light will illuminate	v	
3	when the engine is running, the indicator light will turn yellow	v	
4	when the first solenoid, solenoid 2, and the pump is on, then the process of filling the water and chemicals	v	
5	When the proximity sensor low 1 is active, then the solenoid 1, solenoid 2, and pumps will active.	v	
6	When the proximity sensor low 2 is active, then the solenoid 1, solenoid 2, and pumps will active.	v	
7	when the proximity sensor high is active, then solenoid 1 will stop the process	v	
8	when the timer stops counting, then solenoid 2 and pump will stop the process	v	
9	if the selector switch on auto filling positions and push button start is active, then solenoid 1, solenoid 2, and pump will active	v	

D. Results of Loss Time

The results were obtained Loss Time is counting Loss Time on any water filling is done calculating how long the operator and the machine stops during the water filling. The goal is to compare Loss Time after and before the automatic filling equipment.

TABLE IV. COMPARISON OF WATER FILLING AND AUTOMATIC CHEMICAL

No.	Item	Loss Time (minute)
1	Manual Filling (Main Power)	5
2	Automatic Filling (Machine)	-

As before improvement, filling water and chemicals is done manually with an estimated time of 5 minutes. While the improvement after the estimated timing of the manual process can be eliminated. That is because the machine at the time of the chemical liquid is reduced, the engine no longer stops and the process of filling the water with chemicals made by the machine automatically. After obtaining the results of a water filling and automatic chemical substances, then we can make a comparison of the production process (Loss Time), the ratio is obtained by reduction in Loss Time is 5 minutes. Figure 9 shows the graphical comparison Loss Time.

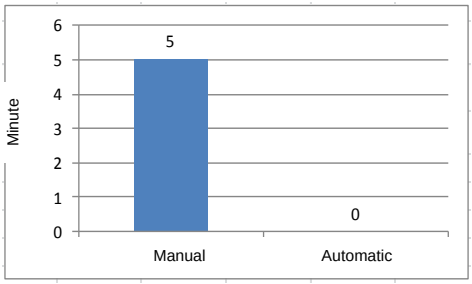

Figure 9. The graphical comparison Loss Time.

E. Results of Production Capacity

Output results in engine cleaning Outer Shell can be calculated manually. As is known the output before the average improvement is 3600 pieces. Output increases will reduce the risk of shortages Outer Shell. So when the stock is well maintained Outer Shell Cleaning process is going well. Figure 10 shows graphic of comparison production capacity.

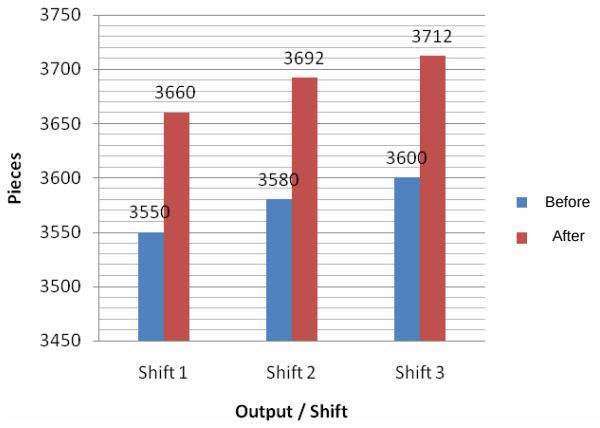

Figure 10. Graphic of Comparison Production Capacity

After Outer Shell is improvement, then the production capacity increased to 2.55%. Previously, the average amount of production is 10,730 pieces per day increased to 11,064 pieces per day.

V. CONCLUSION

In this paper, we have discussed the design and testing of automatic control systems water filling and chemicals on cylinder cleaning engine and outer shell based PLC. We make water filling equipment and chemicals automatically, then Loss Time that occurs when the charging water and chemicals from 15 minutes / shift being abolished. This means that there is no Loss Time when filling water and chemicals. Outer Shell and output may increase the cleaning process from 3550 pieces to 3660 pieces on shift 1, 3580 pieces to 3692 pieces on shift 2, and 3600 pieces to 3712 pieces on third shift. PLC programs that have been created on the water filling

equipment and chemicals can automatically standardized chemical comparison of 5% ± 0.05, standardization is based on the calculation of chemical comparisons using the timer on the PLC, so the preservation of cleanliness Outer Shell on cleaning after doing the checking process visually.

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REFERENCES

[1] Ardi, S., Pratama, R. A., Power Saving on Piston washing Machine Modification by Utilizing Air Pressure and Programmable Logic Controller, Prosiding Seminar Nasional SciETec 2012, ISBN 978-602-97961-1-7, pp. TE15-1 – TE15-5.

[2] Ardi, S., Prasetyo, D., Design of Inspection Tool for Checking The Existence and Position of Hole Stopper Piston 5D9 Using Sick Inspector Camera at Automation Center Bosh Cutting & Engraving Machine, pp. C-77 – C-80, Proceeding SNEEMO 2011, 2011, ISBN 978-602-19043-0-5.

[3] Ardi, S., Hidayat, M., Azhari, Y., Design of Sensory Station System for Modular Mechatronics System at Politeknik Manufaktur Astra, Prosiding SNPPTI 2011, ISSN 2086-2156, pp. 246 - 249, 2011.

[4] Ardi, S., Lin Prasetyani, Reza Guntur Budianto, "Pokayoke Control System Design using Programmable Logic Controller (PLC) on Station Final Check Propeller Shaft", Halaman: C-74 – C-80, Proceeding Annual Engineering Seminar 2013, ISBN: 978-602-98726-2-0

[5] Ardi, S., Alfan Subiantoro, Design Control System for Radio Battery Function Checking using Programmable Logic Controller (PLC), AICST 2012, Page: 185 – 194, Proceeding The 2nd ACIKITA International Conference on Science and Technology (AICST), 2012, ISBN: 978-602-18102-1-7.

[6] Rullan, A., Programmable Logic Controllers versus Personal Computers for Process Control, Computers ind. Engineering, Nos 1-2, pp. 421-424, 1997.

[7] J. Swider, G. Wszolek, W. Carvalho, Programmable controller designed for electro-pneumatic systems, Journal of Materials Processing Technology 164-165 (2005), pp. 1459-1465.

[8] G. Valencia-Palomo, J.A. Rossiter, Programmable logic controller implementation of an auto-tuned predictive control based on minimal plant information, ISA Transactions 50 (2011), pp. 92-100.

[9] Wang, R., Song, X., Zhu, J., Gu, M., Computers in Industry 62 (2011), pp. 23-31.

[10] Bayindir, R., Cetincevic, Y., A Water pumping control system with a programmable logic controller (PLC) and industrial wireless modules for industrial plants-an experimental setup, ISA Transaction 50 (2011), pp. 321-328.