Advanced Science Letters
Vol.22, Number 7, July 2016

Design of Pokayoke Sensor Systems in Drill Oil Hole Machine to Detect the Presence of Drill using Programmable Logic Controller

Syahril Ardi, Aries Al-Rasyid
Manufacturing Production and Process Department
Politeknik Manufaktur Astra, Jl. Gaya Motor Raya No. 8, Sunter II, Jakarta 14330, Indonesia

The process of making pistons for motorcycle unit through several processes, one of them is drill oil hole. In this drill oil hole process, drill is often the case the problem i.e. not emerged, but the problem still qualifies for a visual checked. Therefore, we designed a pokayoke sensor systems using laser sensor system combined with the engine in a main control system based PLC (Programmable logic Controller). Pokayoke sensor systems can detect the presence of drill and can provide feedback to control the machine. Given input signal will be processed through the PLC. If an error occurs such as a broken drill, then it will give a warning to the operator and the alarm buzzer sounds. These systems can detect the drill at a maximum distance of 982 mm and the drill with a minimum diameter of 1 mm. This tool uses magnetic stand as a holder for easy adjusting. In general, this research can improve the process of oil drill hole which can reduce product rejection of the errors are repeated.

Keywords: pokayoke sensor systems, drill oil hole machine, laser sensor system, PLC.

1. INTRODUCTION

In the manufacturing industry which has implemented production management system which is good, so pay attention to matters related to the amount of product that is rejected due to a process that does not meet the standards and production down time due to trouble on a production machine. This is because it will affect the production cost. Industries always make improvements to meet the standards of the process of a product and reduce maintenance time action against the production machines. If the company is able to reduce the rejected products and production down time, then the greater profits to be obtained by the company concerned. In the process of manufacturing a piston, particularly the DOH (Oil Drill Hole), there are still some drawbacks. Among them is rejected due to a process that does not meet the standards and production down time due to trouble on the production machine DOH is still above 3.4% of the total production within one month. This happens because when a broken or broken drill tool, the perforation process is still being done. Operators who run these machines do not know when the drill will break. This is what underlies this research, which is designed pokayoke sensor system that will give early warning of the occurrence of fractures or broken drill tool. The system uses a laser sensor LV-H42 as a detector drill.

The process of manufacturing the piston consists of two main processes, namely: foundry and machining. In this research, it carried out the process of improvement of the system, particularly in the oil drill hole. This is because there is often a broken tool during the process. Pokayoke sensor system serves to provide the first warning to the operator in the event of a broken

*Email Address: syahril.ardi@polman.astra.ac.id

tool when the drill process has been completed. In this research, the systems design and interface between the pokayoke sensor systems with machine control. The design of this system has been able to provide early warning of the occurrence of errors in the manufacturing process oil hole in the piston that the broken drill tool and stop the machine. Previously, we have researched about the applied of pokayoke sensor systems in manufacturing process and machine by using PLC [1, 2, 3, 4, 5, and 6].

2. METHODOLOGY

The process of manufacturing a piston in Manufacturing Company is through several stages of the process. The process lasts from Foundry area, to the area Machining, Surface Treatment area, then through Quality Control before finally-packing and sent to the consumer.

In the area of Foundry, the raw material is in the form of bullion (ingot) aluminum and inserted into the reject piston Melting Furnace for melted and liquefied. Once melted and poured into Holding Furnace, made of material treatment and subsequently poured into molds Gravity Die Casting. Once printed, the next process is Sprue Cutting then Heat Treatment and Machining process continues to the area.

In the machining process, there are several processes, namely: GBF (Guide Bore Finish) - RT (Rough Turning) - PHR (Pin Hole Roughing) - ARG (All Ring Groove) - DOH (Drill Oil Hole) - PHF (Pin Hole Finish) - ODF (Outside Diameter Finish) - CBC (Center Bosh Cutting) - Engraving. Moreover, after the processes in the above there are several important processes before the piston-packing and ready to be delivered to the customer, namely: surface treatment processes as well as visual inspection process.

Flow machining process, as follows:

a. GBF (Guide Bore Finish) is the process of making the guide bore diameter (inside) and the piston in order to cut the legs straight.
b. RT (Rough Turning) is the process of cutting outer diameter and head (roughing).
c. PHR (Pin Hole Roughing) is the process of making a pin hole, but it was still rough pin hole, and also made the snap ring groove.
d. ARG (All Ring Groove) is the manufacture of ring grooves, amounting to as much as 3 grooves.
e. DOH (Oil Drill Hole) is the process of making a hole in the oil ring groove with the drilling process.
f. PHF (Pin Hole Finish) is the process of making a pin hole and also made the snap ring groove.
g. ODF (Outside Diameter Finish) process is similar to the process of turning rough, but the process is more smoothing function outside diameter and head. At this stage is the stage of finishing of the outer diameter.

Based on observations of the factory, we made an improvement on the process Oil Drill Hole (DOH). Here the use of sensors that can be used to detect the tool from the drill process. This system will serve as a first warning to the operator in the event of a broken tool when the drill process has been completed. The authors conclude some important points to make the automatic detection device, namely:

a. Pokayoke sensor systems will be added to the machining line which produces motorcycle pistons.
b. We don't design a tool in the form of whole machine, simply add or modify an existing machine.
c. A sensor system created must have clear indicators, to be easily identified and understood by the operator.

Conditions on line machining Manufacturing Company is a majority of each process performed by one machine only. Machines based on the DOH are not based CNC PLC control, so it can be modified to increase drill automatic detection tools. But the line that is used to add a detector is on line 19, because on the line there are only two types of pistons which always produced the type KFV and KPHF. In addition DOH existing machines on line 19 is more likely to be modified.

When the piston reject due to a problem of the drill holes have been up to the customer, it will hurt the company. This is because there is a process that is wasted, it is necessary to replace the piston replacement pistons reject, and delivery of goods to be late. If the reject piston there is up to the customer, it will make the name of the company fell. To prevent the piston reject due to a problem of the drill hole is not up to the customer, it requires the involvement of additional workers in Visual section just to check whether or not the drill holes on the piston [7, 8, 9, and 10].

A. Specifications Engine Oil Drill Hole Line 19

Machine oil drill hole (DOH) is designed to make a hole in the piston oil. This machine uses two self-feeders to perforate the piston in different positions, with different angles. Oil hole drill machine is operated semi-automatically. So that this machine can be described as its function needs to be made flowchart machine movement. Figure 1 shows the machine DOH L19.

Fig 1. DOH L19 Machine

B. Specifications of LV-H42 Sensor and Amplifier LV-21A

Keyence LV-H42 sensor is one of several types of Digital Laser Sensor existing and circulating in the market. This sensor uses the measurement of media in the form of infrared laser which has a wavelength between 620nm up to 670nm. These sensors are included in the group displacement sensor is a sensor that works based on changes in the position of the work piece to the position sensor.

The sensor works with system transmitted - received. It means that the waves emitted infrared laser, is received after reflected by the work piece. In addition the sensor is equipped with a LED indicator that shows the level of emission of infrared waves. At this sensor also has LEDs that will light up according to the difference in reflectivity results prearranged.

Amplifier Type LV-21A is a control component of the sensor type LV-H42. This amplifier can be seen from the results of the intensity of infrared light waves received by the sensor LV-H42. At this amplifier we can set the maximum level of sensitivity of the light waves received by the sensor. Moreover we can make the adjustment to the intensity or sensitivity can be adjusted to the distance from the work piece. This means we can adjust the distance of the work piece to be detected to what extent, according to the maximum value of the sensitivity possessed sensor. The power supply or power used is 24V DC according to specifications owned amplifier. Output type amplifier LV-21A is transistor NPN output, with load voltage between 5-40 V DC with a maximum current of 100mA.

3. DESIGN, TESTING, AND ANALYSIS

A. Design Process

Based on data and observations in the field, the cause of the rejected piston particularly in case no drill and drill is not transparent, obtained some facts. The results of discussions with the industry produce several important parts that can be used as a reference in the resolution of problems.

Some of the problems and become root causes, especially in the case rejected piston drill, namely:

a. The drill hole in the piston does not exist.
b. The drill hole in the piston is not transparent.
c. Drill often broken.
d. The operator does not know the life time tool.
e. The operator does not know when the drill will break.
f. Absence pokayoke system.
g. There is no tool usage procedure.
h. There is no steering bushing.

B. Design the system

Referring to the results of field observations and the view of the sensor performance specifications owned by the sensor, then the design is made to have the following criteria:

a. Placement of the device does not interfere with operator ergonomics.
b. Design the system easily moved and driven so as to facilitate the setup.
c. Design the system can be set as desired.
d. The distance between the sensor head with a drill not less than 11cm.
e. The sensor used is easy to do the setting.
f. Have output which can be connected to the PLC.
g. The detection should be stable.

Figure 2 shows the design and realization of pokayoke sensor system.

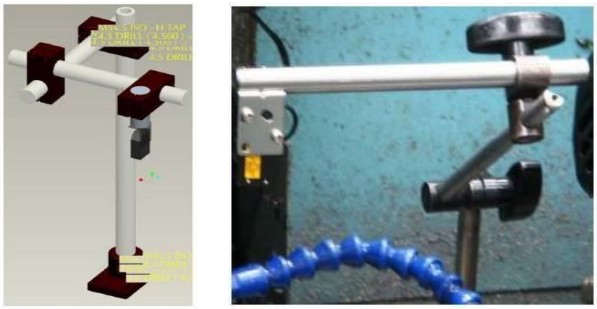

Fig 2. Design and realization of pokayoke sensor systems

C. Program Mode Setting for Amplifier LV-21A

Program settings are made to the amplifier LV-21A is a program to determine the output which is used when the tool works and produced. Setting program on LV-21A amplifier is divided into several parts:

1. Output Conditions

Amplifier LV-21A has two modes of setting the state of the output produced. The output will produce a logic output state if the detection of the received undergoes sudden changes within a certain time. The table below will explain the condition of the output in the event of changes:

Power Mode settings

There are three power mode settings that are owned by the amplifier LV-21A. However, that is used here is just one of them. At the time of display amplifier figures show the intensity of the light received, press the "M" for three seconds, so that the display changes to show the value of some settings After that press the UP or Down button, so that the display becomes "S" is the power settings on the mode SUPER, After that press the button "M" for three seconds, so that the display turns back figures show the intensity of light received.

Sensitivity settings

At the moment there is no work piece to be detected in front of the sensor, press the "S" slowly.

Then place the work piece to be detected in front of the sensor, and press the button "S" gently for three seconds until the LED calibration indicator (orange LED) and LED monitor settings (green LED) has blinked.

Changing Program Start Position on PLC

At the start position the old program, the machine will run after all the conditions are met, OK then the next process will be run in accordance with the process flow DOH machine. Programs start a new position; the engine will run after checking the condition of the drill, if the drill is OK, then the next process will be run in accordance with the process flow DOH machine. If it turns out drill NG (broken), the buzzer will sound and the alarm light will be lit and the machine will stop. Flow process engine DOH after experiencing engine additions to the PLC program, also experienced a conversion. Figure 3 shows the process flow DOH machine after the addition.

PLC programs that exist on the machine DOH line 19 needs to be changed and added. Before the program start position will be active if all sensor input requirements of the machine have been met. Start position will be active if DRILL LS 1, LS DRILL 2, ORIGIN STOP, AND LS unclamp been met.

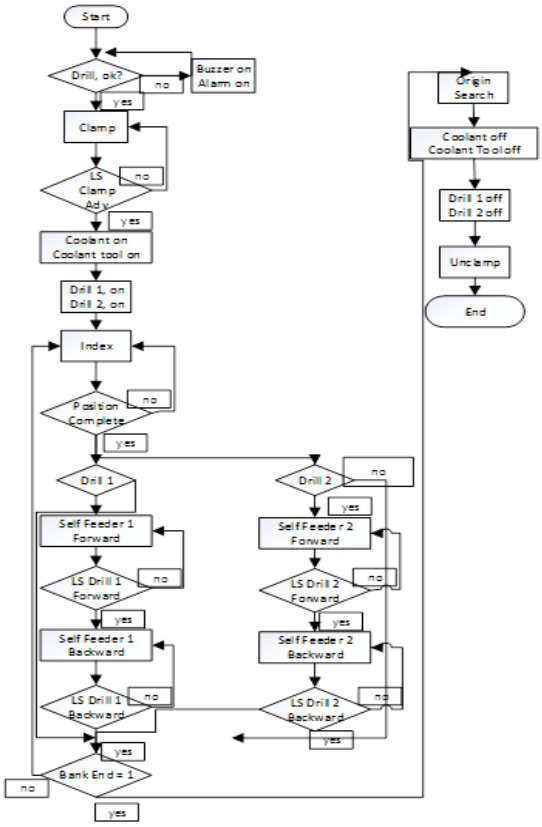

Fig 3. Flow process DOH machine after the addition

D. Testing

Testing of the program, divided into three, namely: testing machine PLC program DOH line 19 are has been changed and modified, the testing program settings that have been made in the LV-21A amplifiers, and testing of electrical circuits on the system indicator. In addition, there are some technical issues that must be considered in the test.

1. Testing Program Start Position on PLC Machine

To start the program position that has been made, the address used is not changed from the electric wiring, but to address the PLC must not duplicate or double.

2. Testing Program Amplifier LV-21A

Calibration is done is when the amplifier is not installed on the machine. Testing is done by operating the machine by using a 24V DC power supply. Table 1 shows the results of testing calibration amplifier LV-21A.

Table 1.
Testing calibration amplifier LV-21A

No	Testing	OK	NG	Descriptions
1	Farthest distance detection at FINE mode	v		Using the measuring tool, the farthest distance in optimal detection + 245mm
2	Farthest distance detection on TURBO mode	v		Using the measuring tool, the farthest distance in optimal detection + 485mm
3	Detection farthest distance in SUPER mode	v		Using the measuring tool, the farthest distance in optimal detection + 970mm

3. Sensitivity Testing

Pokayoke sensor systems have some adjustment of the sensitivity mode. However, that is used here is the default setting mode of amplifier LV-21A. Sensitivity testing is done before the appliance is installed on the machine. This is done to obtain the required sensitivity in accordance with the state of the machine. Table 3 shows the results of testing the sensitivity of the LV-21A.

Table 2.
Sensitivity testing LV-21A

No	Testing	OK	NG	Descriptions
1	Maximum sensitivity of sensor	v		Sensitivity settings following the default mode of the amplifier LV-21A
2	Minimum Sensitivity of sensor	v		Sensitivity settings following the default mode of the amplifier LV-21A

4. CONCLUSIONS

This paper has discussed the design of pokayoke sensor systems that can detect the presence drill and can give feedback to the machine control system. Given signal will be processed by the PLC and will alert the operator in the form of sound and the alarm buzzer, if an error occurs that is broken drill during the process. The process engine cannot run if an error occurs. This pokayoke sensor system can provide a signal to the operator when an error occurs. The engine cannot run in the event of a broken drill, so as to prevent any error process. Pokayoke sensor system can detect drill and gives the output signal to the machine PLC. Pokayoke system can also detect drill at a maximum distance of 982 mm with a minimum of 1 mm diameter drill. In addition, pokayoke system using magnetic stand as a cradle for easy adjusting.

REFERENCES

[1] Ardi, S., Otomatisasi Sistem Kontrol Mesin Paint Marking Berbasis Kendali PLC dan Sistem Sensor Pokayoke pada Line WFW (Wahana Flywheel) Machining Otomatisasi Sistem Kontrol Mesin Paint Marking Berbasis Kendali PLC dan Sistem Sensor Pokayoke pada Line WFW (Wahana Flywheel) Machining, Prosiding The 5th Annual Engineering Seminar 2015, UGM, Yogyakarta, Indonesia.

[2] Ardi, S., Jimmy, M., Agustono, R., Design of Pokayoke Sensor Systems in Engraving Machine to Overcome Upside Defect Production using Programmable Logic Controller, Proceeding Internation Conference on QiR 2015 UI.

[3] Ardi, S., Ponco, A., Kurnia, A. F., Design Control Systems of the Out Diameter Finish Machine Based on Programmable Logic Controller, Proceeding International Conference On Instrumentation, Communication, Information Technology and Biomedical Engineering 2013, Page: 307 – 312, ISBN: 978-1-4799-1650-4.

[4] 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.

[5] 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.

[6] 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

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

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

[9] 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.

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