Design of pokayoke system on the process of mounting actuator bracket based on programmable logic controller in automotive manufacturing industry

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Abstract. This research was conducted in automotive manufacturing industry company in Indonesia. There is one Key Performance Index that needs to be fixed, that is the process mounting actuator bracket. The type of trouble that can occur on the actuator bracket is on the quality of the mounted bracket. The bracket mounting process is carried out using three bolts on each side which must be mounted with a predetermined torque value of 5.4 Nm. Manually process can cause bolt on one side or more. Based on data from the Quality Assurance network, the process diagnostic table or tightening has shown less optimal installation process of actuator bracket on actuator brake in Jundate Trimming. The absence of line stop detection on a jig can cause a torque process error on one or more bolts. We modify the mechanical design of the pokayoke system. While the jig design is not modified there is only the addition of clamp systems that serves to determine the position of the work piece, proximity sensor as a detector work piece, and push button as a button to distinguish the work piece between ABS work piece and VSC on jig. This pokayoke system is based on Programmable Logic Controller control. This pokayoke system design prevents the occurrence of damaged bolts on screw threads when mounting an imperfect actuator bracket.

1 Introduction

In the automotive manufacturing industry, there is one problem in one of the manufacturing process, which is mounting actuator bracket. In the item, the bracket actuator installation must be installed by three bolts with a predetermined torque value of 5.4 Nm.

When installation process, the three bolts are not expected to err in the process of tightening. This is because it relates to quality and safety factors. Therefore, it needed a system that aims to avoid mistakes. We design pokayoke systems to eliminate the repair process that occurs due to errors in the tightening process. In this paper, we discuss how to design and make appropriate pokayoke system, and how to test pokayoke system actuator bracket that has been designed and made in order to produce better quality [1, 2, 3, 4, and 5]

2 Methodologies and design

2.1 Mounting process actuator bracket

Flow process mounting actuator bracket starts from checking harigami actuator, there is code on harigami that have been adjusted at actuator to be processed. Then, retrieve the brake actuator in the flow rack, and check the day for the actuator bracket. Setting the brake actuator in the prepare table, fasten the actuator bracket on the brake actuator with bolts. There are three bolts to

be attached and fastened, then the third torque of the bolts.

Check the three bolts that have been plugged in with a visual check. Actuator brake used there are two types, namely type ABS and VSC type. The bracket actuator mounting process is included in rank S (safety). If the installation process is not perfect will cause the function of actuator brake does not work optimally, so the braking process can be disrupted and can cause serious accidents. Fig.1 shows Bolt position attached to Actuator Brake.

Fig. 1. Bolt position attached to actuator brake.

2.2 Problem occurred a solution

Based on the QA network process diagnostic table (tightening) shows less optimal installation process of bracket actuator on brake actuator in Jundate Trimming. The absence of a line stop detection on a jig can cause a torque process error on one or more bolts. This affects the achievement of the value of QA network process diagnostic table (tightening).

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Problems that do not affect the QA network process diagnostic table (tightening) are on the value of tightening failure detection (line stop with the detection of miss or shortage of tightening points) which reaches the value with the achievement of 5 points.

Therefore, the value of tightening failure detection i.e. line stop with detection of miss or shortage of tightening points, serve as the basis for making improvements that are expected to improve the achievement of QA network process diagnostic table (tightening).

Assessment process of QA network process diagnostic table (tightening) by looking at the value of occurrence prevention and outflow prevention.

If the occurrence prevention value has reached a value of 5 or more (rank 1) then for the outflow prevention value regardless of the final value of the QA network process diagnostic table (tightening) is double maru.

To increase the value of the QA network process diagnostic table (tightening), then it is designed an additional tool on the bracket actuator jig mounting. The concept to be made is to add a clamping system to the jig. This clamping system will clamp the work piece and will be released when a torque process occurs on all three bolts. Torque process on the three pieces of bolts integrated with the system counter, so that the clamp will be released when the torque process is complete and counter counts the number of bolts in torque with a predetermined torque value of 5.4 Nm. This system is called the pokayoke system, the error prevention system.

2.3 Design concept

Based on the problems previously described, and how to overcome them, we designed a concept in making pokayoke system using PLC. Fig 2 shows an illustration of the design concept of pokayoke block diagram of the system.

Fig. 2. Block diagram of pokayoke system.

2.4 Pokayoke system design

Fig. 3 shows the design of Pokayoke System. This picture shows the design of mechanical design of pokayoke system. For the unchanged jig design there is only the addition of a clamping system that serves to define the position of the workpiece, the proximity sensor as the detector of the workpiece and the push button as a button to distinguish the workpiece between the ABS workpiece and the VSC on the jig.

Fig. 3. Design of Pokayoke system.

In accordance with the design concept in Fig.3, the realization of the mechanical manufacture of pokayoke system can be seen in Fig. 4. In this case there is no change in the jig, but there is only the addition of clamp system to clamp the workpiece. Fig. 4 shows the Mechanical design of the Pokayoke system.

Fig. 4. Mechanical design of Pokayoke system.

2.5 Electrical design

From the equipment specification that has been described previously, then obtained an electrical design of Pokayoke control system. The electrical design states that a 220VAC power source is supplied to MCB and Power Supply. 220VAC voltage connected to Power Supply and forwarded to PLC input. The received voltage of Power Supply will be converted to DC voltage and 220VAC voltage will be converted to 24VDC.

The DC voltage generated by the Power Supply is fed to a PLC that serves to activate common on inputs and outputs so that the PLC can receive signals provided by input devices and can instruct the output devices to execute commands according to programs stored in memory. The voltage at the common PLC output also passes the voltage to the relay coil to enable or contact the input or output connected with the relay [9, 10, 11, and 12].

Fig. 5. Pneumatic system design.

2.7 Programming design

To design a program, to make it easier in the making, the thing that needs to be done is the design of the program flowchart. Fig. 6 shows the flowchart of the Pokayoke control system program.

The process begins with positioning the workpiece on jig A or B. When the workpiece has been detected, the indicator light is on. If the indicator light is on, press

Fig. 6. Flowchart programming.

2.6 Pneumatic system design

Fig. 5 shows the pneumatic design of the pokayoke system. The clamping system design on pokayoke system consists of 2 pieces of pneumatic cylinder. Which of them is as a clamp or clamp for workpieces both VSC and ABS. In this system use 2 pieces solenoid valve and use 2 pieces proximity switch. Both proximity switches are used as a signal to the existence of workpiece.

the clamp button. If the clamp button has been pressed, jig clamp will clamp the workpiece. Next is the torque process on all three bolts. If the torque process is complete and the total torque has been reached, the counter checker will provide information by displaying a total visual torque. Simultaneously the indicator light is on. Then press the unclamp button and the clamp will be released the process will continue to repeat.

3 Research and discussion

3.1 Testing

There are several types of testing of this modified pokayoke system. The testing consists of: testing of input devices to PLC, testing of PLC output devices, as well as testing the working system of pokayoke system. It aims to ensure the functioning of the system after modification can run like the expected machine work system.

Tests performed on PLC input components in pokayoke system are done by way of monitor mode in CX-Programmer software. Monitor mode is a state where the PC (personal computer) is directly connected to the machine so it can be used to monitor the condition of input components, outputs and contacts in the PLC. Testing gives parameter OK if input component given trigger will trigger contact on ladder diagram CX-Programmer become green. While testing the output component, including solenoid component A, and solenoid B.

3.2 Evaluate results after design and implementation

The cause of the creation of a pokayoke system is the data value of the QA network process diagnostic table (tightening) that is at the value of the tightening failure detection (line stop with the detection of miss or shortage of tightening points) which has been described in chapter 3. Which causes the value of the QA network process diagnostic table (tightening) did not reach the expected target [1, 2, 3, and 4].

3.3 Achievement of QA value network process diagnostic table (tightening).

One of the benefits expected after making the pokayoke system is to increase the value of QA network process diagnostic table (tightening). From the data before the modification was recorded the achievement of the bracket actuator mounting process did not reach the target of double marru.

After the creation of the pokayoke system, the results of the QA network process diagnostic table (tightening) score reached the double marru target. The achievement of the double marru target is due to the value of the QA network process diagnostic table (tightening) that is in the value of tightening failure detection (line stop with the detection of miss or shortage of tightening points) has been reached, which initially has no value due to the absence of line stop detection [5, 6, 7, and 8].

4 Conclusions

The design of the pokayoke system in the mounting of the actuator bracket is to improve the process of mounting the actuator bracket. In this case it is to prevent errors in the torque process on one of the bolts

with a standard torque of 5.4 Nm. This pokayoke system design prevents the occurrence of damaged bolts on screw threads when mounting an imperfect actuator bracket. The design of this pokayoke system can also eliminate the process of repair caused by poor installation and require additional cost for the repair process. This Pokayoke system is still a potential for miss tightening, then it takes a tool that can detect the position of bolts that have been processed by using the nut runner.

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