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A Survey on Software integration to achieve Poka-yoke in pre-packing tightness automation

Sahana C[1], Nayanashree S[2], Monish H S[3], Poornima V[4],
Dr. Jitendranath Mungara, Professor, Dept. of ISE, New Horizon College of Engineering, Bangalore, Karnataka.
[1234]B.E students, Dept. Of ISE, New Horizon College of Engineering, Bangalore, Karnataka.
Corresponding Auther: Sahana C

Abstract: *Errors seem an inherent qualification in manufacturing industry that causes re-designing of pumps and resource waste. The failure of PF pumps can cause serious damage in the engine management system. How can all defects in a complex manufacturing process can be prevented if no statistical process control is used? This can be overcome by using the mechanism of poka yoke. In this paper, by using the concept of poka yoke an application is developed in which the defects that occur in the PF pumps are detected at the earlier stages. This paper also talks about the necessity of mistake proofing in tightness automation, how to achieve poka yoke in tightness automation, applications and system design. This concept provides great opportunities to bring quality of the pumps delivery and increase the productivity of pumps which is a significant growth for the company.*
Keywords: *Poka yoke, PF pumps, Safety, Quality, Tightness test.*

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I. Introduction:

Nowadays the main aim of the companies is to achieve high productivity, value of the product in the market and to satisfy the customer. This can be achieved by using the techniques of poka yoke. Poka yoke was introduced by Dr. Shiego Shingo. Poka yoke uses programmable logic controller (PLC) to define its structure and implementation for smooth automatic operation. It is a concept which is used to ensure the quality of the product. Prevention is the basic principle of effective poka yoke. It makes the whole system error proof that means no one can make mistakes although someone wants to make mistakes intentionally. Manufacturing industries make use of these techniques for high production. This technique is applied even in the software field. This concept helps us to detect the mistake at early stages so that it can be corrected immediately and eliminating those defects at the initial stages. Poka yoke is used in pre-packing tightness automation to achieve zero defect products. In order to avoid defected pumps early detection in terms of calibration and data interlocking is used. Clear propagation of tightness automation is provided in various stages and effective analysis is made. It is a fully automated testing station for testing tightness of the pumps to avoid errors. In pre-packing tightness automation, the defects in the PF pumps are detected. The defects that occur in PF pumps are air leakage, pressure check, leakage in pump joints etc. This kind of defects in the pumps will affect the performance and productivity of the pumps. This can be overcome by using the concept of poka yoke.

II. Necessity of poka yoke in tightness automation:

Having the concept of poka yoke in the operation is the best strategy because the defects will be detected at the early stages. Many things can go wrong while designing the pumps, this mistake will result in defective product and dissatisfaction of the clients at the end or even it may lead to serious damage in the engine management system. Defects in any kind are wasteful and if they are not discovered, they leave the customer's expectations of quality unfulfilled. The concept of poka yoke is used in tightness automation for testing the PF pumps to detect errors. The workers who do not know how to work can make some errors while designing the pumps which can be rectified by using the techniques of poka yoke which prevents the defects in the process. The defects that occur in PF pumps are: Pressure check, Air leakage, Leakage in pump joints. If PF pump has one of these defects, it leads to a serious damage in the engine. Negligence of workers increases the chance of penetrating an error into the process and result in defect in the end products. This can be overcome by using the mechanism of poka yoke in which the pumps are tested at initial stages. The techniques of poka yoke doesn't let these errors spread in the downstream flow and prevent it as soon as possible. If your operation does not have poka yoke then detecting the defects in the pump would be difficult leading to expensive performance. During the mass production there is a chance of missing some of elements (i.e. nuts, bolts etc.) in the pump. This defect in the pump will lead to a failure of engine which in turn affects the productivity of pumps which is a significant

loss to the company[1]. To overcome this failures poka yoke station is used. The defects in the product and dissatisfaction of the users can be avoided by using this concept. This automatically increases the graph of production which is a healthy growth for the company. By using poka yoke one can quickly identify the flaws before proceeding into further processing. It can be convinced that utilizing this concept can improve the standards of the PF pumps in the market and results in high productivity.

III. Achieving Poka Yoke In Tightness Automation:

The implementation of poka yoke is usually easy as the workers and management can see the immediate benefits. The only difficult part is the process of poka yoke getting started. Poka yoke can be achieved in different ways. One way is through automation. Since the pumps are assembled in indoor environment, it becomes very easy to adopt automation. Automation is for tightening the bolts especially in the steel joints. Specific torque is applied to fasteners such as nuts or bolts to shut off when preset torque is reached[2]. So that the specification is matched to a particular application and eliminating the defects. Using poka yoke mechanism the serious issues in the pump can be eliminated at the initial stages.

Fig 1: PF pump

By using the concept of traceability and interlocking, software is developed to achieve zero defect pumps[3]. Initially the inlet and outlet of the PF pumps are fixed to the fixture and dipped in the oil tank for 20sec and a fixed pressure is applied to the pump, if any bubble appears from the pump then that pump is defected. These pumps are sent to the previous step. There is a unique bar code (Data Matrix code) on each and every pump. This data matrix code is two dimensional barcode consisting of black and white "cells" or modules. This cells are arranged in either square pattern or rectangular pattern which is known as matrix. In this the information can be text or numeric data. In this code the cell which are light represents 0 and the cell which are dark represents 1 or viceversa. The length of the data can be from few bytes to 1556 bytes. The length of the data depends on the number of cells in the matrix. This code can be read quickly by the barcode reader. When the barcode is scanned the required data is extracted from the pattern that is present in both horizontal and vertical component of the image. The purpose of the barcode on the pump is to track the pump. The barcode is scanned only for the pumps that are in good condition. When the barcode reader scans the code on the pump, the pumps serial number, MFD and type number will be displayed in tightness application, this data will be stored in the database. The concept of interlocking is used to check whether the pump has gone through all the stages before it is scanned. If not then the pump will not proceed for further process. In this way the quality of the pump is achieved. Elimination leads to eliminating the possibility of errors, in which the task of redesigning of pumps or the process is no longer necessary by using the mechanism of poka yoke.

Fig 2: Data matrix code

Fig 3: Barcode Reader

Barcode Reader

IV. System Design:

System design is the process of defining the architecture, components, modules, interfaces and data for system to satisfy specific requirements[4]. System design could be seen as the application of systems theory to product development. Design is the creation of a plan or convention for the construction of an object or a system (as in the architectural blue print, engineering drawings, business processes, circuit diagrams and sewing patterns.). Design has different connotations in different fields.

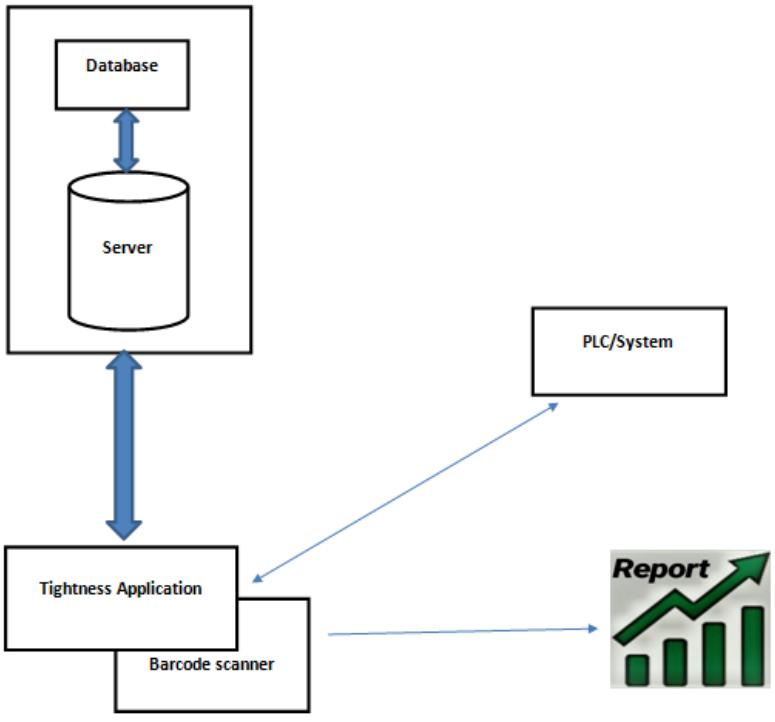

Fig System design

The system architecture consists of following components:

- **Server**

It is used to process the database queries. Server helps us to store and retrieve the data in the form of files.

- **Database**

It is a software that runs on the server.

Database is an organized storage collection of employee details (employee id and employee password) and pump details (pump type, MFD and pump number).

- **Tightness Application**

It is used store the information about the pumps that are in good condition, and link the particular pump back to employee who is involved in the process of tightness testing.

- **Scanner**

This component is used to scan the good pumps and store the information of pump such as pump number, manufacture date and serial number.

- **System/PLC logic**

Programmable Logic Controller tracks all the operations involved in tightness testing of PF pumps.

V. Back End Operation:

- Tightness Application is developed on .Net platform with 4.0 framework 64-bit.
- Windows communication service interacts with the application which is responsible for data communication.
- Oracle Database store the schema where all details regarding a particular pump is stored.

VI. Applications:

- **Traceability**

Using this application, a pump can be linked back to particular operation involved in the process of tightness testing.

- **Interlocking**

With the help of Programmable Logic Control, interlocking is achieved to ensure that the pump has undergone through all the stages.

VII. Future enhancement:

- The system currently focuses only on checking the leakages in the PF-Pump.
- Only the pumps that are in good condition are manually scanned using scanner and the details are stored in the database.
- It can be further enhanced to include sensor test, the amount of leakage and to indicate its selection/rejection with green/red light depending on the extent of bubbles the pump releases when dipped in tank containing oil.
- In future the system can be made to display the number of selected and number of rejected pumps on LCD or LED monitor for quick references of track of fine pumps.

VIII. Conclusion:

The fundamental principle behind Poka-yoke is to find errors at their sources and to prevent their conversion to defects. Since mistake proofing is powerful concept it is simple and effective. We conclude that by using scanner and data interlocking system that defects in the pumps are avoided. It uses database system to store the information about the PF pumps, which are in good condition. This paper describes the concept of mistake proofing and illustrates how it is applied to the manufacturing industry. The information of the employee is stored in the database for processing the pumps which helps in interlocking and traceability. Several experiments were carried on the pump by varying the pressure at the end of the nozzle.

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