Design and Development of Low Cost Crevice Testing Equipment for Process Industries

U. Rajkanna, M. Mathankumar, R. Kannappan

***Abstract:** Packaging is very important process in many pharmaceutical, food and manufacturing industries. For packaging most of the industries prefers plastic bottles, tins, glass bottles and plastic covers. At the time of packing it's important to ensure the cans are not damaged. To ensure this handful of techniques are being implemented in the industry. Among them, most common technique is bubble testing method. This method has a drawback of rusting with time and high initial cost. Presence of water in the can may affect the quality of the final product in the can. To overcome these drawbacks PLC and photo resistive effect based system have proposed and developed. This proposed system is classified into transport unit, testing unit and control unit. The transporting unit is a conveyor belt arrangement, testing unit comprises of photo resistive effect based system and control unit to monitor and control overall operation of the system. The control unit rejects damaged cans from the conveyor by monitoring. This system has been developed at low cost and with faster response rate.*

***Keywords:** Crevice Testing, Non Contact Crevice Testing, Photo resistive Based Crevice Testing, Automation, PLC*

I. INTRODUCTION

In most of the industries the bubble testing method and pressurized method are commonly used for detecting leakage in the manufactured containers. One of the oldest systems to detect leak is bubble testing method. From the work [1] it is inferred in bubble testing method pressurized air is filled in a container and dipped under water. The bubbles start to emit from the holes which will be predicted manually. In this method leak rate detection is difficult but needs collection of the bubbles, measure their volume and divide this volume by the measuring time. As easy it sounds, the bubble test needs some precautions when it comes to higher filling pressures. The container with high pressure gas can burst or explode which cause injuries to the operator. So a safety walls between test and operator is necessary and the operator inspects the containers via a mirror. For larger containers larger testing setup is required.

To overcome this alternative bubble testing method is also used. The critical areas of the container (Joints and Welding Spot) are moistened with a foam developing liquid. These liquids develop a very fine and white bubble mushroom.A large leak may blow away any bubbles and therefore the test may be carried out with very low overpressure and then with specified pressure [2].

To overcome these difficulties, like maintaining pressure and detecting the holes manually photo resistive method of leakage detection is preferred in this project. From the work [1], it is inferred that the leak tests with pressure changing methods can monitor total leak rate of a test object continuously which also called as an integral test.This method won't show the location of the leak.Three different pressure changing methods are available in the market they are: the pressure decrease test, the pressure increase test and the pressure difference test. In these pressure change method of leakage detection, it is found that it is not economical to detect the leaks of tins. To overcome this drawback, it is preferred to use pressure on eliminating area alone rather using for the whole process of finding leakage

In the work [3] author developed an image processing based system (non contact type) to identify the cracks in the surface. In this work author uses image processing technology to measure the cracks manually.

In the work [4] author develops a non contact type system based on magneto-resistive sensors to identify the crack. This may be mostly suitable for metal surface cans not for plastic and bottle cans.

These techniques illustrate in economic crisis for testing purpose alone. To overcome this economic crisis, this project aims on detecting leakage of can in effective way with photo resistive method which involves less cost for detecting the leakage of tin in industries. The testing system can be attached to the conveyor section where the tin moves for packing area [5].

II. PROPOSED SYSTEM

The device consists of an enclosure within which a LED strip is placed to act as source and LDR as a sensor. The light passes through the can based on the size of the crevice and falls on the LDR, its resistance value gets changed based on the amount of light falling on it.With this change in resistance the size of the crevice is predicted. The change in resistance value is signal conditioned to voltage and it is given to the PLC. PLC controls the entire operation of the crevice tester.

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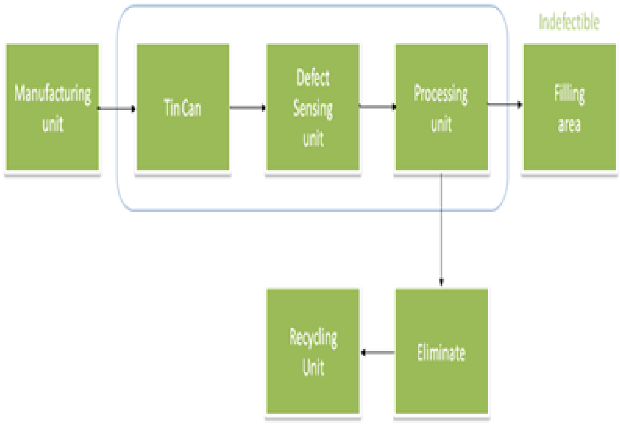

Fig.1 Block diagram of the system

III. HARDWARE DESIGN

The hardware design is majorly classified by three units

i. Defect sensing unit
ii. Processing unit
iii. Elimination unit.

The defect sensing unit is consisting of enclosure which is made of stainless steel for its corrosion resistance and to prevent penetration of external lights which will affect the accuracy of the system. In the inner wall of enclosure LED strips were attached and LDR was attached on the stem of the enclosure. The entire enclosure movement is of pneumatic operated. The battery of 6V, 4.5Ah is used as supply for operating LED strip light and for signal conditioning the LDR.

The processing unit consists of signal conditioning unit and PLC. The PLC used here is Mitsubishi PLC FX5U.The can for testing is placed at centre of the enclosure with the LDR inside the tin. The output resistance from the LDR is given to the signal conditioning circuit and the processed voltage is given to the PLC for further operation. The PLC controls the conveyor and pneumatic piston movements. To identify the position of can in the conveyor proximity sensors were used.

The elimination unit consists of the pneumatic piston arrangement which is controlled by the PLC where once the crevice is detected in the defect sensing unit the processed signal will be given to the PLC where it will actuate the piston to eliminate the defected can.

IV. SOFTWARE DESIGN

The programming is done using PLC. The program is done to take access over the control flow. The algorithm is as follows

Step 1: Start the motor

Step 2: Wait for the can to get its position

Step 3: Once the can gets its position the conveyor is stopped.

Step 4: Once the conveyor is stopped the enclosure encloses the can for testing the crevice

Step 5: Wait for the sensor signal to detect the crevice

Step 6: Depending on the value the actuation is done through mechanism

V. RESULT

Initially the trigger pulse should be given to the PLC to start the process and it is done by the key X1. After the pulse from that port the conveyor starts to run with the help of exciting 12V DC motor by the coil Y0. Canes start to move on the conveyor. Figure 2 indicates ladder logic for that sequence

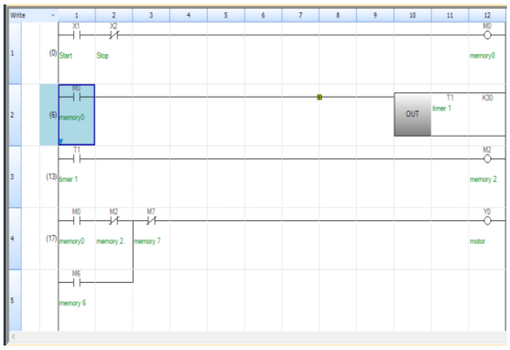

Fig.2 Motor startup process

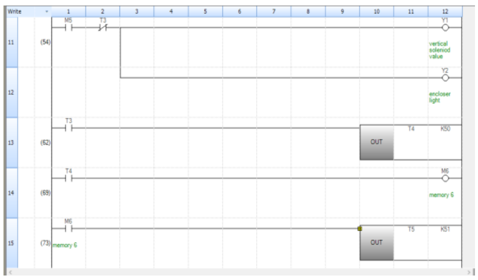

Fig. 3 Enclosure control process

After some nominal timing (T1) of the tin can at the sensing unit the conveyor stops by the latch memory M2 and the enclosure starts to move downward with the help of double acting pneumatic cylinder (DAC) by the output coil Y1 and after it completely closes the tin can, the led source is turned on with output coil Y2. And it also starts the timer (T4) for the detector to determine the tin cans is creviced or not, after the process the enclose returns to its position. The memory latch M6 again turns on the conveyor by exciting the DC motor. Figure 3 indicates the ladder logic for enclosure control.

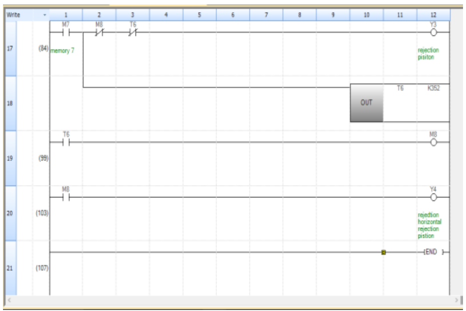

Fig.4: Rejection process

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According to the value of detector the rejection process is take place. If the detector perceive the crevice in a tin can the timer (T5) turns on, after the nominal timing it exits the horizontal (rejection) cylinder to eliminate the creviced tin cans from the conveyor or if the value of the detector is less than some determined level the rejection process does not take place, the tin cans allowed to move forward. Figure 4 indicates the ladder logic for can eliminating process.

Figure 5 shows the relation of crevice level and change in resistance. Figure 6 shows the entire hardware arrangement of crevice can testing device.

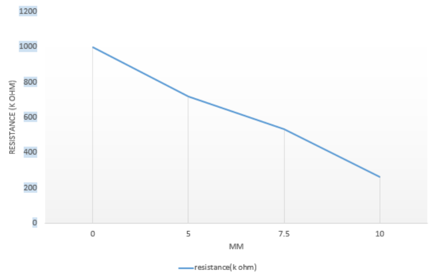

Fig.5 Crevice Prediction Graph

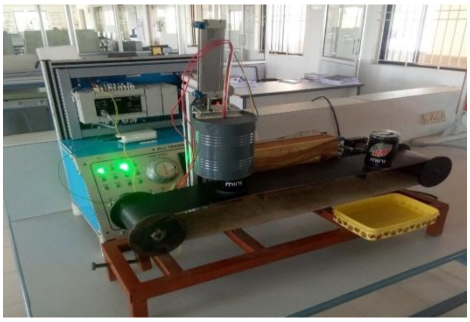

Fig.6 Hardware setup

The developed prototype can process the 3 numbers of cans per minute and the conveyor belt length is about 580mm by that it can queue up to 3 tin cans in a row for the operation of crevice checking at a time.

VI. CONCLUSION

This developed system is successfully tested for different sizes of crevice and out of that the leakage is predicted for medium and large sized holes or cracks. Based on this prediction the signal conditioning is performed for even predicting the very small sized cracks. The hardware side was also altered so that the casing suits the tough environment where external light can enter. After these modulations the device showed accurate results in predicting crevice of the tin cans. This developed system has a major contribution in reducing the time of measurement of size of the crack and doing it in an economical way. Rejection unit in the developed system helps in selecting only the best cans for package section which improves the production rate of the industry.

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