2014 International Conference on Robotics and
Emerging Allied Technologies in Engineering (iCREATE)
Islamabad, Pakistan, April 22-24, 2014

Filtration of Faulty Dried Plates of Lead-Acid Battery with Digital Image Processing

Fahad Rasool*, Muhammad Nabeel#, Ali Imran Najam**

*Department of Electrical Engineering
University of Engineering & Technology (UET)
Peshawar, Pakistan
rasul.fahd@gmail.com
#Department of Electrical Engineering
National University of Computer & Emerging Sciences (NUCES)
Islamabad, Pakistan
eemuhammad.nabeel@gmail.com
**NECOP Design Center
Center of Excellence in Applied Sciences & Technology (CESAT)
Islamabad, Pakistan
alimranajam@gmail.com

***Abstract*— The positive plates of lead acid batteries are dried in Tunnel Drying Oven in order to remove moisture. During the drying process, plates are suffered from paste crackness, thermopassivation and burning. Also moisture level is not achieved up to mark and some un-formed plates that need to be filtered out. Digital Image Processing technique is exploited to filter out the faulty plates after the process of drying. In addition, an automated moisture check is also introduced in the existing procedure of TDO. The validity of the proposed model and algorithm is investigated through observations and experiments.**

Keywords—TDO, lead acid battery, positive plate, image processing.

I. INTRODUCTION

Tunnel Drying Oven (TDO) is a horizontal shaped oven used to dry and de-moisturize positive plates of lead-acid batteries. It consists of a steel conveyor belt, with adjustable speed, that carries plates, air blower, temperature and burner controller to control the inner temperature and the flames ratio.

Positive plate grids or frames are composed of the antimonial lead which is then pasted with the active material called lead-oxide where the pores are filled with electrolyte. The mechanical structure of the plate during charge and discharge cycle serves as an electrical conductor and carries current. In TDO, it happens, some of the plates that are in pipeline suffer from burning, thermopassivation and crackness. Also the un-formed and moisturized plates are required to be eliminated in order to make the production process healthy.

Presently, filtering of faulty plates is carried out manually after the drying process. There is no automated solution present for this problem so far to the best of author's knowledge. The major drawback of manual filtration is the requirements of excessive man power and time. It also offers hindrance in the production process. Faulty plates, if not filtered out, create the problem in the assembly section and damage the whole battery.

Digital image processing is an advanced technology and is applied in several industries to overcome their problems. Interest is developed in the methods of digital image processing and two principle areas are observed: storage of processed image data and improvement in pictorial ammo for human interpretation and the embodiment in perception of autonomous machine. Today, the applications of digital image processing are ubiquitous. Oprea et al. [3] presented an application of digital image processing for the detection of broken aspirin tablets in drugs industry using object oriented image processing software.

In order to rectify the problem, an integration of TDO with digital image processing is presented to filter out the faulty plates.

This paper is organized as follows: The problems with positive plates after drying process and its solution are discussed in Section II. In Section III the integration in current TDO model with digital image processing and an automated moisture check is proposed. The algorithm designed to perform the proposed integration in TDO is discussed in Section IV. Further, the experiments and the observations are recorded in Section V. Finally, Section VI concludes the paper.

II. AUTOMATED SOLUTION OF TDO USING IMAGE PROCESSING

Drying process is carried out to dry and de-moisturize the formed plates. During this process, the paste volume and the pores cross-section are decreased which result in the shrinkage of paste. In many cases cracks occurs due to extensive paste shrinkage, or detachment of paste from grid happens which results in disruption of electrical path in the plate which interferes in the compilation of active materials. It also creates

problem during charging and discharging cycle. The plate size increases when the sulfate is absorbed by the active material during discharge and decreases as they pull out sulfate during charging. It results in shedding of the paste and when it reaches the plates underneath of the lead acid battery, short circuiting occurs at the respective cell. To wipe out paste cracking and shedding, it is necessary to keep a check on it and then to eliminate such plates.

When positive plates are dried in an oven at temperature above 70°C, they lose some part of their energy. This phenomenon is called thermopassivation [1]. The passivation of the plate manifests itself by an abrupt fall of its discharge potential [2]. Also at t>70°C some of the portions of plate gets burned which results in hindrance of electrical current flow during the electrochemical process. The increase in temperature beyond 70°C is required in some cases when the de-moisturization of the plate is not achieving its required level which is below 1%, so the plates are further dried in the second shift. Some of the plates that are left with moisture and uncharged portions have white spots, which need to be eliminated.

In this work, a solution for filtering of faulty plates is presented using digital image processing. A standard plate image is compared with the image data of incoming plates using digital image processor. Furthermore, a model using automated moisture check is also discussed.

III. PROPOSED MODEL

In this section integration in the current model of TDO with digital image processor and automated moisturizing checker is presented. The proposed model is shown in Fig. 1. Transportation of plates from the burner section is carried out by steel conveyor belt. The plates after the flame section of TDO is picked by a digital image processing section by means of contact switch. This switch changes its state after defined time interval. In ON state, a selected single plate move towards digital image processing section, where image data of the incoming plate is matched with the standard reference image of healthy plate. If the matching is successful, the plate is passed to the output section. In case, the image data exceeds the threshold matching value than it is passed to the reviewing section and given in (1). In OFF state plates are passed straight forward to output section.

$$y \leq \text{threshold}\,(\%) \qquad (1)$$

where, 'y' is the compared value of the incoming image data with standard reference image and is calculated in percentage.

The moisturizing section is connected to the output of TDO via contact switch having the time interval value greater than that of digital image processor. When the contact switch is in ON state, moisture of the selected plate is tested and if the moisture overflows the threshold, a buzzer turns on indicating the moisture problem in the respective group of plates.

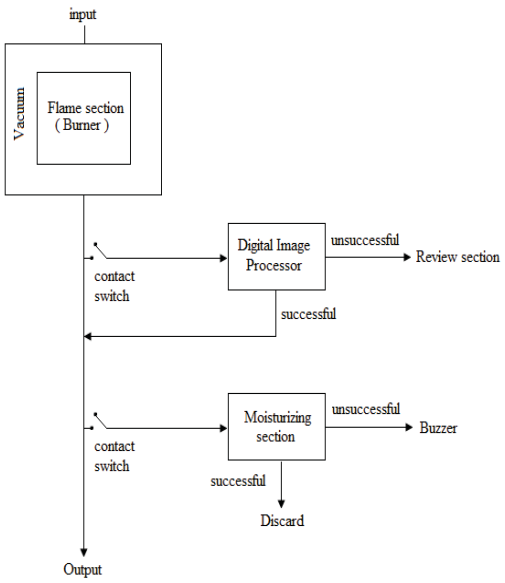

Fig. 1. Integrated Model of TDO

IV. PROPOSED ALGORITHM

The algorithm proposed for filtering of faulty plates from the pipeline is shown in the Fig. 2. It breaks down the images in number of cross-sections and performs comparison. At the end it combines the manipulative percentages of each cross-section for final percent comparison. Contact switch turns ON at defined time interval T1. The algorithm is discussed as follows:

For Digital Image Processing Section:

Step 1: Read input image.

Step 2: Display input image.

Step 3: Read standard reference image.

Step 4: Display standard reference image.

Step 5: Break images into equal number of cross-sections.

Step 6: Perform cross-sections percent comparison.

Step 7: If any percent comparison exceeds threshold, forward the object to reviewing section, else, perform comparison for next cross section.

Step 8: Manipulate and combine data of all cross-sections.

Step 9: If combined percent comparison exceeds the threshold, forward the object to reviewing section, else, output section.

For Moisturizing section:

Contact switch turns ON at defined time interval T2>T1, a plate goes to moisturizing section for moisture checking.

Step 10: If moisture exceeds the threshold value, buzzer triggers, else discard.

V. EXPERIMENTS AND OBSERVATIONS

This section deals with the observations and simulations performed. Using the proposed algorithm, different plates such as cracked, thermopassivated/burned, uncharged and healthy have been experimented with standard reference plate image. In practical cases, there are panels instead of plates that are composed of couple of plates, while experiments are performed on single plate for simplicity.

Figure 3 shows the un-formed plate image data comparison that is left with white spots which creates hindrance in the electric current flow with the standard reference plate image. Further, the comparison of cracked plate image is shown in Fig. 4, while the thermopassivated and burned plate image is compared and shown in Fig. 5. Finally, healthy plate image is compared and is shown in Fig. 6.

VI. CONCLUSION

In this paper, we have presented application of digital image processing in TDO to filter out faulty dried plates of lead-acid battery and automated solution for moisture check is also introduced which benefits in the shape of more accuracy and reducing the need of man power. A proposed model and algorithm with experiments and observations are also presented. The implementation of this algorithm is possible in various environments of digital image processing. In addition it can be embodied in multiplex automated testing and manufacturing machines.

REFERENCES

[1] D. Pavlov and S. Ruevski, "Thermopassivation of the lead dioxide plate of lead-acid batteries," J. Electrochem. Soc. 1979, vol. 126, issue 7, pp. 1100-1104.

[2] V. Iliev and D. Pavlov, "Self discharge and passivation phenomena in lead-acid batteries during storage," Journal of Electrochemical Society – J Electrochem. Soc. 1982, 129(3).

[3] S. Oprea, I. Lita, M. Juriana, D. A. Visan and I. B. Cioc, "Digital image processing applied in drugs industry for detection of broken aspirin tablets," Electronics Technology ISSE '08, 31st International Spring Seminar, Budapest, 2008.

[4] LabatScience. "Thermopassivation of positive battery plates," Internet: http://www.labatonline.com/2_1_2_5.html, Sept. 2013 (online).

[5] PulseTech. "Pulse Technology." Internet: www.pulsetech.net, Sept. 2013 (online).

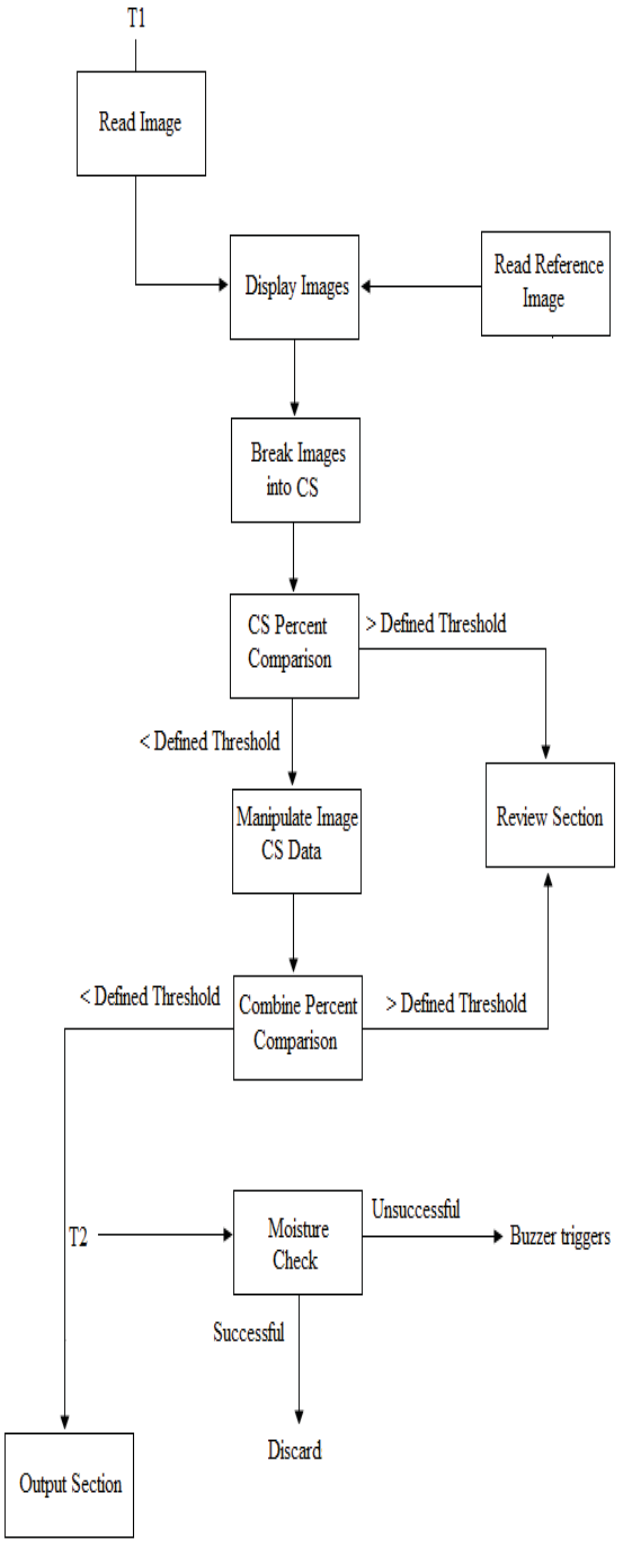

Fig. 2. Algorithm to handle the integration of digital image processing and moisturizing section

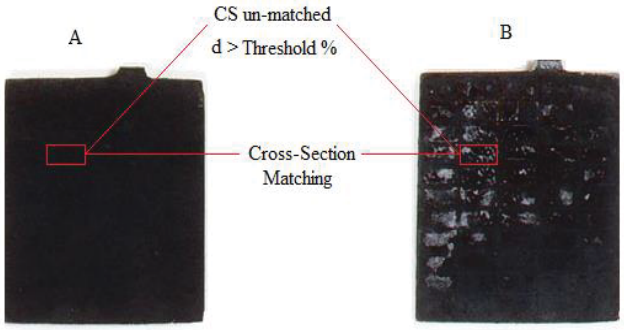

Fig. 3. Comparison of un-formed with standard reference plate image

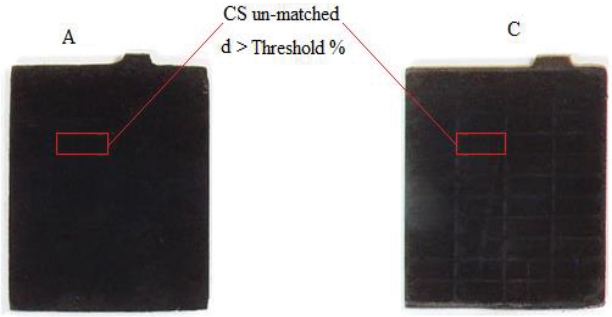

Fig. 4. Comparison of cracked with standard reference plate image

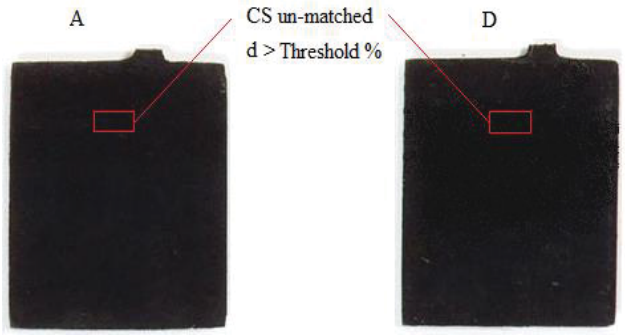

Fig. 5. Comparison of burned and thermopassivated with standard reference plate image

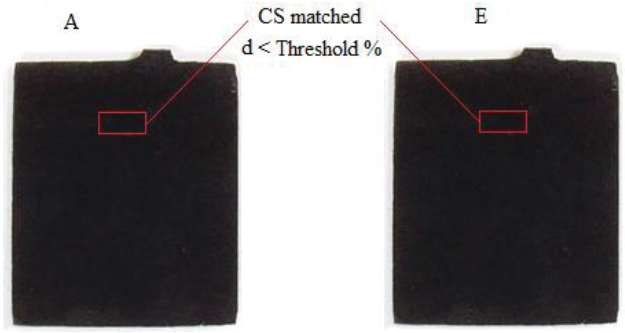

Fig. 6. Comparison of healthy with standard reference plate image