Root Cause Analysis of the Major Equipment Breakdown Problems of the Tube Section of a FMCG Company as an Approach to Improve OEE

Papari Das¹, Thuleswar Nath²

¹Final year, M.E., ²Associate Professor, Dept. of Mechanical Engineering, Jorhat Engineering College, Dibrugarh University, Jorhat, India

Abstract — Today’s manufacturing scenario faces a great deal of competition since customers are becoming more and more quality centred and demands among customers are ever increasing. As such to meet the demands of different customers, the manufacturing industries must work with efficiency to become more and more productive. One of the most important ways to increase productivity is to increase the OEE (Overall Equipment Effectiveness) of the machines or equipment. OEE can be improved with the continuous implementation of TPM (Total Productive maintenance). The aim of this study is to focus on the most significant equipment breakdowns of the tube section of a FMCG (Fast Moving Consumer Goods) company and to suggest counter measures to reduce these breakdowns, which would as a result improve the OEE. For the analysis purpose, lean tool Root cause analysis have been used and necessary recommendations made to reduce the most significant equipment breakdowns. This research reveals the tremendous importance of Autonomous Maintenance and Education & Training pillars of TPM.

Keywords — TPM, OEE, Equipment Breakdown, Pareto Analysis, Fishbone Analysis, Root Cause Analysis.

I. INTRODUCTION

Increasing market demand for larger varieties of products and customers’ taste for quality has forced the manufacturing firms to produce and deliver good quality products to customers as and when required without fail. Thus manufacturing firms are working enthusiastically to hold their position firmly in the market against their competitors. As such with the increased level of competition, manufacturing firms are under constant pressure to enhance the performance of their firms. And for better performance, all the equipment of the firms should be in proper working condition. The equipment of the firm should be available whenever required, should perform efficiently to deliver good quality products. This becomes possible only when the six big losses of equipment as specified by Nakajima (1998) are under control.

Maintenance is a necessary process that allows the equipment to operate without failure from sudden unanticipated breakdowns. In regard to the importance of maintenance activities in the manufacturing scenario, the Japanese developed a strategy of overall maintenance of the plant and its equipment in 1971 named TPM (Total Productive Maintenance) as in [4]. Total Productive Maintenance (TPM) is a methodology whose aim is to increase the availability of existing equipment so that further capital investment is reduced as in [4]. OEE is a metric used for evaluating the success of TPM. OEE takes into account the six big losses of equipment and indicates the areas that can be improved by eliminating them. The six big losses of OEE are – Equipment breakdowns, Set-up and adjustments, Idling and minor stoppages, Reduced speed, Defects in the process and Reduced yield/Start-up losses as in [11]. OEE depends on three factors, namely, availability, performance and quality which take into account the six big losses. Equipment breakdowns reduce the availability factor of OEE.

Root cause analysis is a lean tool used to identify the root causes of problems so that the problems can be eliminated at their base. In this project, root causes of equipment breakdowns have been analysed and vital counter measures suggested to eliminate the root causes. If root causes are eliminated, breakdowns of equipment would reduce which would reduce the downtime of machine and ultimately increase the OEE.

II. PROBLEM STATEMENT

Inspite of producing for 24 hours-2 shifts, 12 hours each and even after the implementation of TPM since last few years, the OEE of the various manufacturing lines of the company is far below the world class OEE i.e. 85%. The reason for this low level of OEE are the sudden unwanted stoppages of production due to which the machines are not utilized effectively, hence the efficiency is affected. The major reasons for these unwanted stoppages are equipment breakdowns even though the company has been implementing TPM in all areas possible.

This project would focus on the most significant equipment breakdowns, as reduction of major equipment breakdowns is very important to make the equipment or machines produce without negatively affecting the productivity of the company. From literature study it is clear that equipment breakdowns are a major contributor to low OEE in many industries. Elimination of the major equipment breakdowns would certainly improve the OEE of the product lines.
III. OBJECTIVE OF THE STUDY
Improvement of OEE of tube section of a FMCG company by-
1. Identifying the root causes of major equipment breakdowns.
2. Suggesting counter measures to reduce or eliminate the root causes identified so as to reduce equipment breakdowns.

IV. CASE STUDY
This case study has been conducted in one of the most important FMCG (fast moving consumer goods) company located in Guwahati, Assam. The company has ISO 9001-2008, 14001 certification and products made by the company are different types of cosmetics that have a huge demand in the market in and outside India.

The study will be carried out in the tube section as because it is the section with the lowest OEE among all sections and production is interrupted very often in this section due to equipment breakdowns. There are total of nine product lines in the tube section and two product lines with the lowest OEE has been considered for the study and necessary suggestions have been recommended to eliminate the major reasons of equipment breakdowns. The study has been conducted for four months through constant reviewing on the shop floor, studying and understanding the machines under study, interviewing and brainstorming maintenance personnel and operators about the unwanted equipment stoppages.

V. RESEARCH METHODOLOGY
A. OEE data collection
The OEE data of the 9 product lines of the tube section have been collected for a period of six months (01/08/14 to 31/01/15) from the web portal of the company. Among the 9 product lines, 2 product lines having 4 machines, 2 machines per product line i.e 1 filling machine and 1 packing machine having the lowest OEE have been selected for the analysis purpose of equipment breakdowns.

As seen from the OEE data analysis, “WIMCO-4+VP” and “PACMAC-6+HICART” machines had the lowest average OEE and hence these two product lines were taken up for the analysis purpose. WIMCO-4, PACMAC-6 are the filling machines. HICART, VP are the packing machines.

B. Analyses of equipment breakdown reasons
Equipment breakdown, a downtime loss is the sudden unwanted stoppage of the equipment due to failure or improper working of some parts of the equipment, in most cases due to improper maintenance of the equipment.

The various problems contributing to equipment breakdowns were reviewed from the log-sheets for a period of same six months as the OEE data collection period. Thereafter, Pareto were plotted to identify the reasons contributing to 80% of the breakdown time of the equipment.

As seen from Fig. 1, wrinkle problem, offcentre problem, filling problem, electrical problem and sealing problem constitute almost 80% of the total maintenance time for all the breakdown problems for WIMCO-4 machine.

As seen from Fig. 2, timing out, willet or coding problem and SPC timing out problem constitute 85.9% of the total maintenance time for all the breakdown problems for VP machine.

As seen from Fig. 3, offcentre problem, sealing problem, wrinkle problem, heater problem, batch number coding box problem and conveyor problem constitute 82.1% of the total maintenance time for all the breakdown problems for PACMAC-6 machine.

As seen from Fig. 4, coding problem, autocollator problem, timing out problem, linkup problem, carton chain timing out problem, drum & landing problem and closing setting problem constitute 80.9% of the total maintenance time for all the breakdown problems for HICART machine.

1) Root Cause Analysis:
After identifying the major problems of equipment breakdown from the Pareto analyses, fishbone diagrams or Ishikawa diagrams were drawn for all the problems of equipment breakdown that accounts for 80% of the total maintenance time, for all the four machines under study to determine the root causes of the major problems, by conducting thorough interviews and brainstorming sessions with operators, maintenance personnel and experts from the company. Fishbone diagram is one of the seven basic Quality Control tools used for identifying the root causes of problems.

In this project, Fishbone diagrams have been constructed mostly based on the categories of man, machine, method and material. After identification of the root causes, vital recommendations are made to eliminate the root causes.

VI. RESULTS AND RECOMMENDATIONS
After the root causes for various equipment breakdowns were identified and analysed, counter measure plans of breakdowns of the selected machines is constructed as shown in tables I, II, III, IV, V, VI, where counter measures are suggested to eliminate or reduce the root causes. The counter measure plans for the two filling machines have been shown in tables I, II, III and the counter measure plans for the two packing machines have been shown in tables IV, V, VI. The format of the counter measure tables has been formed in partial reference to [4].

The counter measure plans for the the two filling machines (WIMCO-4 and PACMAC-6) have been suggested in the same tables (table I, II, III) as because the root causes of breakdowns of these two machines are identical. Similar is the case with the two packing machines.
machines (HICART and VP) whose counter measure plans are shown in tables IV, V, VI.

A. Results

From tables I, II, III, it is seen that 46% of the total root causes occurs due to improper CLIT (cleaning, inspection, lubrication, tightening) which is the most important phase of Autonomous Maintenance, 30% of total root causes occurs as a result of lack of training of operators, supplier problem accounts for 9.3% of the total root causes, another 9.3% of the total root causes occurs due to failure of some parts that are unavoidable and for the rest 4.6% of the total root causes Kaizens have been suggested to eliminate them.

From tables IV, V, VI, it is seen that 55.55% of the total root causes occurs due to improper CLIT of packing machines under study, 19% of the total root causes occurs due to lack of training of operators, supplier problem accounts for 16% of the total root causes and the rest 8.3% of the total root causes needs direct replacement when failed.

B. Recommendations

The root cause analysis suggests that majority of root causes of equipment breakdown of the selected machines occurs due to poor Autonomous Maintenance (Jishu Hozen) of the equipment and due to lack of training of the operators as discussed in the results section. Hence following recommendations are made:

1. Operators should be informed about the tremendous importance of Autonomous Maintenance to keep their equipment in proper working condition. It is seen from shop floor visits that almost all operators tend to neglect the JH activities even though there are JH (Jishu Hozen) plans in the company and maintenance activities take place only when the equipment malfunctions. Hence it is of utmost importance to let the operators know about the benefits of Jishu Hozen pillar of TPM to reduce the downtime of machines due to equipment breakdowns.

2. Training and Education should be imparted to operators on a regular basis for proper handling of the equipment which would reduce the downtime due to improper setting of various parts of the equipment.

The root causes identified, problems caused by the root causes, reasons of the root causes, counter measurement plans, necessary Kaizens, time necessary for JH activities and method of JH activities are suggested in table (I, II, III, IV, V, VI) for the selected machines which will provide good benefit to the company if implemented. The counter measures, Kaizens, method and time of JH are suggested after interviewing and discussing with the operators, maintenance personnel and TPM group members from the company.

VII. Conclusions

As seen from the analysis Jishu Hozen (JH) or autonomous maintenance is a very important TPM pillar that keeps the equipment in a reliable condition and prevents forced deterioration of the equipment. Hence JH is a must to prevent the equipment from breaking down which would in turn increase the OEE of the equipment.

Training should be imparted to the operators for proper handling of the equipment and to take up JH in a more serious manner. Proper JH would uplift the condition of the equipment.

REFERENCES


Fig. 1 Pareto Analysis of equipment breakdown problems of WIMCO-4 machine

Fig. 2 Pareto Analysis of equipment breakdown problems of VP machine
Fig. 3 Pareto Analysis of equipment breakdown problems of PACMAC-6 machine

Fig. 4 Pareto Analysis of equipment breakdown problems of HICART machine
### TABLE I
COUNTER MEASURE PLAN FOR POOR AUTONOMOUS MAINTENANCE OF WIMCO-4 and PACMAC-6

<table>
<thead>
<tr>
<th>Category</th>
<th>Root causes identified from Fishbone Analysis</th>
<th>Problems caused by the root causes</th>
<th>Reason for the root causes</th>
<th>Recommended Counter measurement plan</th>
<th>Method of CLIT</th>
<th>Time suggested for CLIT (mins)</th>
<th>Recommended Kaizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>machine</td>
<td>wrinkled heater, machine parts</td>
<td>wrapping, machine parts</td>
<td>daily lubrication</td>
<td>pressurized air</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>electrical</td>
<td>cleaning, electrical</td>
<td>wrinkled heater</td>
<td>monthly lubrication</td>
<td>pressurized air</td>
<td>45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Root causes:**
- Wrinkled heater and machine parts
- Cleaning, electrical

**Reasons for the root causes:**
- Wrinkled heater
- Machine parts

**Recommended counter measurement plan:**
- Daily lubrication
- Monthly lubrication
- Pressurized air

**Recommended Kaizens:**
- Training and Education-monthly training to operators on machine operation.

### TABLE II
COUNTER MEASURE PLAN FOR IMPROPER TRAINING TO OPERATORS OF WIMCO-4 and PACMAC-6

<table>
<thead>
<tr>
<th>Category</th>
<th>Root causes identified from Fishbone Analysis</th>
<th>Problems caused by the root causes</th>
<th>Reason for the root causes</th>
<th>Recommended Counter measurement plan</th>
<th>Recommended Kaizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>machine</td>
<td>improper setting of wrinkle guard</td>
<td>wrinkle</td>
<td>electrical</td>
<td>improper rotating setting</td>
<td></td>
</tr>
<tr>
<td>electrical</td>
<td>improper setting of wrinkle guard</td>
<td>wrinkle</td>
<td>electrical</td>
<td>improper rotating setting</td>
<td></td>
</tr>
</tbody>
</table>

**Root causes:**
- Improper setting of wrinkle guard

**Reasons for the root causes:**
- Improper rotating setting

**Recommended counter measurement plan:**
- Training and Education-monthly training to operators on machine operation.

### TABLE III
COUNTER MEASURE PLAN FOR OTHER BREAKDOWN ROOT CAUSES FOR WIMCO-4 and PACMAC-6

<table>
<thead>
<tr>
<th>Category</th>
<th>Root causes identified from Fishbone Analysis</th>
<th>Problems caused by the root causes</th>
<th>Recommended Counter measurement plan</th>
<th>Recommended Kaizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>material</td>
<td>bent, oval tube</td>
<td>wrinkled</td>
<td>packaging material of bad quality</td>
<td>change supplier/vendor</td>
</tr>
<tr>
<td>machine</td>
<td>improper length of batch size</td>
<td>wrinkled</td>
<td>purchased cooling digits out of specification</td>
<td></td>
</tr>
<tr>
<td>machine</td>
<td>improper length of batch size</td>
<td>wrinkled</td>
<td>purchased cooling digits out of specification</td>
<td></td>
</tr>
<tr>
<td>method</td>
<td>improper length of batch size</td>
<td>wrinkled</td>
<td>purchased cooling digits out of specification</td>
<td></td>
</tr>
<tr>
<td>machine</td>
<td>metal sensor damage</td>
<td>wrinkled</td>
<td>direct replacement</td>
<td></td>
</tr>
<tr>
<td>machine</td>
<td>metal sensor damage</td>
<td>wrinkled</td>
<td>direct replacement</td>
<td></td>
</tr>
<tr>
<td>machine</td>
<td>metal sensor damage</td>
<td>wrinkled</td>
<td>direct replacement</td>
<td></td>
</tr>
<tr>
<td>machine</td>
<td>metal sensor damage</td>
<td>wrinkled</td>
<td>direct replacement</td>
<td></td>
</tr>
</tbody>
</table>

**Root causes:**
- Bent, oval tube
- Improper length of batch size
- Metal sensor damage

**Recommended counter measurement plan:**
- Change supplier/vendor
- Direct replacement

**Recommended Kaizens:**
- Use of good quality filter cloth
- Installation of cooling fans

**Notes:**
- Use of good quality filter cloth
- Installation of cooling fans
### TABLE IV
**COUNTER MEASURE PLAN FOR POOR AUTONOMOUS MAINTENANCE OF HICART and VP**

<table>
<thead>
<tr>
<th>Category</th>
<th>Root causes identified from Fishbone Analysis</th>
<th>Problems caused</th>
<th>Reason for root causes</th>
<th>Recommended Counter measurement</th>
<th>Method of CLIT</th>
<th>Time suggested for CLIT (mins)</th>
<th>Recommended Kaizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>machine</td>
<td>untimely cleaning of vacuum filter</td>
<td>SPC landing, timing out</td>
<td>weekly cleaning</td>
<td>visual</td>
<td>weekly cleaning</td>
<td>dry cloth</td>
<td>30</td>
</tr>
<tr>
<td>method</td>
<td>loose chain of drum</td>
<td>SPC landing, timing out</td>
<td>monthly cleaning</td>
<td>visual</td>
<td>monthly cleaning</td>
<td>dry cloth</td>
<td>30</td>
</tr>
<tr>
<td>machine</td>
<td>loose chain of drum</td>
<td>SPC landing, timing out</td>
<td>monthly cleaning</td>
<td>visual</td>
<td>monthly cleaning</td>
<td>dry cloth</td>
<td>30</td>
</tr>
<tr>
<td>method</td>
<td>loose connection of machine parts</td>
<td>SPC landing, timing out</td>
<td>weekly tightening</td>
<td>spanner</td>
<td>weekly tightening</td>
<td>key</td>
<td>30</td>
</tr>
<tr>
<td>machine</td>
<td>loose bolt in drum</td>
<td>SPC landing, timing out</td>
<td>daily inspection and tightening</td>
<td>visual</td>
<td>daily inspection and tightening</td>
<td>drill</td>
<td>30</td>
</tr>
<tr>
<td>method</td>
<td>loose bolt in drum</td>
<td>SPC landing, timing out</td>
<td>weekly tightening</td>
<td>spanner</td>
<td>weekly tightening</td>
<td>spanner</td>
<td>5</td>
</tr>
<tr>
<td>machine</td>
<td>loose bolt in drum</td>
<td>SPC landing, timing out</td>
<td>monthly inspection and tightening</td>
<td>visual</td>
<td>monthly inspection and tightening</td>
<td>drill</td>
<td>30</td>
</tr>
<tr>
<td>method</td>
<td>loose bolt in drum</td>
<td>SPC landing, timing out</td>
<td>monthly tightening</td>
<td>spanner</td>
<td>monthly tightening</td>
<td>spanner</td>
<td>5</td>
</tr>
<tr>
<td>machine</td>
<td>loose bolt in guard</td>
<td>SPC landing, timing out</td>
<td>monthly tightening</td>
<td>spanner</td>
<td>monthly tightening</td>
<td>spanner</td>
<td>5</td>
</tr>
<tr>
<td>method</td>
<td>loose bolt in guard</td>
<td>SPC landing, timing out</td>
<td>monthly tightening</td>
<td>spanner</td>
<td>monthly tightening</td>
<td>spanner</td>
<td>5</td>
</tr>
<tr>
<td>method</td>
<td>loose connector of cylinder and air pipe</td>
<td>autocollator</td>
<td>daily inspection and tightening</td>
<td>visual</td>
<td>daily inspection and tightening</td>
<td>drill</td>
<td>30</td>
</tr>
</tbody>
</table>

### TABLE V
**COUNTER MEASURE PLAN FOR IMPROPER TRAINING TO OPERATORS OF HICART and VP**

<table>
<thead>
<tr>
<th>Category</th>
<th>Root causes identified from Fishbone Analysis</th>
<th>Problems caused by the root causes</th>
<th>Reason for root causes</th>
<th>Recommended Counter measurement plan</th>
<th>Recommended Kaizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>man</td>
<td>new operator</td>
<td>any problem</td>
<td>being analysed</td>
<td>Training and Education</td>
<td>operators not properly trained</td>
</tr>
<tr>
<td>machine</td>
<td>SPC coding</td>
<td>SPC coding</td>
<td>autocollator</td>
<td>drum, SPC landing, timing out</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE VI
**COUNTER MEASURE PLAN FOR OTHER BREAKDOWN ROOT CAUSES FOR HICART and VP**

<table>
<thead>
<tr>
<th>Category</th>
<th>Root causes identified from Fishbone Analysis</th>
<th>Problems caused by the root causes</th>
<th>Reason for root causes</th>
<th>Recommended Counter measurement plan</th>
<th>Recommended Kaizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>machine</td>
<td>solenoid valve jam due to bad quality of make-up</td>
<td>SPC coding</td>
<td>ink and make-up of bad quality</td>
<td>change supplier/vendor</td>
<td></td>
</tr>
<tr>
<td>method</td>
<td>in SPC, bad SPC</td>
<td>SPC coding</td>
<td>ink and make-up of bad quality</td>
<td>change supplier/vendor</td>
<td></td>
</tr>
<tr>
<td>machine</td>
<td>sealing tape damage</td>
<td>autocollator</td>
<td>failed parts that cannot be repaired</td>
<td>direct replacement</td>
<td></td>
</tr>
<tr>
<td>machine</td>
<td>wear and tear of cutting blade</td>
<td>autocollator</td>
<td>failed parts that cannot be repaired</td>
<td>direct replacement</td>
<td></td>
</tr>
<tr>
<td>method</td>
<td>untimely change of ink filter</td>
<td>SPC coding</td>
<td>prolonged use of same ink filter</td>
<td>install new ink filter in every 5 months</td>
<td></td>
</tr>
</tbody>
</table>