Fault Detection & Diagnosis of Air-Seperator Breakdowns in Ginning Industry using Root Cause Analysis

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Abstract—In today’s fast growing scenario manufacturing industries are facing a frequent technology changes lead to greater competition in the market. In order to survive many of industries using advanced manufacturing facilities to improve and increase both quality and productivity of the product continuously. Machine breakdowns occurring due to failure of key elements which are engaged in drive systems. To increase the productivity, either increase the availability of existing machines or mitigate the existing machine breakdowns. Total productive maintenance aims to increase the availability of existing equipment so no further capital investment is needed. Availability of machines can be increased by reducing the downtime or Breakdowns of the machines. The main objective of this study is to find out the major breakdowns causing production losses to the company and to suggest counter measures by which these problems can be reduced. In the study a Root cause analysis is conducted to find the causes of breakdowns and some parallel improvement opportunities were also identified for implementation so as to reduce the downtime. As well as improve the productivity and efficiency of the plant. Study is on one of the most efficient accessories in the ginning industries is the air-seperator which is helpful to improve the quality as well as the productivity of the industry.

Keywords: Breakdowns, Cause and effect diagram, Pareto Chart, Total productive maintenance

I. INTRODUCTION

The ginning industries have gone through significant changes in the last decade. New firms in markets have increased competition dramatically. Most of them focus on product quality, production time and cost of product. Because of these, a company should introduce a quality system to improve and increase both quality and productivity continuously. Total productive maintenance (TPM) is a methodology that aims to increase the availability of existing equipment hence reducing the need for further capital investment. TPM can be defined in terms of overall equipment effectiveness (OEE) which in turn can be considered a combination of the operation maintenance, equipment management, and available resources. The goal of TPM is to maximize equipment effectiveness. It is a function of availability, performance rate, and quality rate. Of the six major categories of losses that affect OEE, Breakdown loss is used for calculating the availability of equipment. Root cause analysis (RCA) is a method of problem solving that tries to identify the root causes of faults or problems that cause operating events RCA practice tries to solve problems by attempting to identify and correct the root causes of events, as opposed to simply addressing their symptoms. By focusing correction on root causes, problem recurrence can be prevented. The objective of study is to find out the major breakdowns in the company which causes a production loss and to suggest counter measures to minimize the effect.

Ginning is the first effective process of cleaning and separating the impurities and seeds from the cotton. After the cotton has been picked, it is taken to the ginning-mills, where the fiber, called cotton lint in the trade, is separated from the seed. Ginning processes are important in determining the cotton fiber quality for the production of cotton yarn.

Construction - Air separators are vital accessory in a pneumatic conveying system in a ginnery. Pneumatic conveying is the most widely used system for transportation of both raw cotton and lint conveying in ginneries. In this system the movement of air through conveying pipes propels seed cotton. Any pneumatic conveying system consists of a suction fan, a ducting line, an air separator and a cyclone. Air-Separator is the machines that separate raw cotton from conveying air in a pneumatic conveying system. In addition to this primary function, Air-separator also removes limited quantities of dust and fine trash from the seed cotton. Air-Separators are used at various locations in the ginning plant. Ginners use Air-separators to feed cotton into other machines such a lint cleaners and press. Air Separator unit can be divided into two parts. The top part of the unit can be described as separator and the bottom part as vacuum dropper. A Separator consists of a curved screen and rotating vanes fitted onto a rotor that has a certain running speed. Seed cotton is carried and wiped by the air flow through the wipers and curved screens. The wiper has two rotating vanes, rubber flights are mounted on the rotating vanes. The impurities are separated from the seed cotton by passing over the holes on the curved screen. The screen and the air flow are adjusted in such a way that the action of the seed cotton flow keeps the section wiped and clean. This section of the separator is self-cleaning. The bottom section of the separator is called as vacuum dropper. The purpose of vacuum dropper is to provide an air seal for the upper section while allowing the discharge of seed cotton from the pressurized air handling system. The vacuum dropper consists of a minimum of eight rotating vanes fitted onto a rotor. Any sort of operational trouble in air separator results in downtime and production loss. To achieve maximum efficiency with minimum downtime, emphasis should be given to the proper setting, adjustments, trouble shooting and maintenance of an air separator.
Production may be stopped due to many reasons like breakdown of machine, maintenance work, labor issues, problems in the method of production etc… Excluding all other factors like materials, method, man, etc... It is necessary to reduce the breakdown (down time) of machine or equipment’s in the manufacturing facilities for the efficient nonstop production to meet the demands. Breakdowns are the most common causes of efficiency loss in industries. Eliminating unplanned down time is critical to improving Overall Equipment Efficiency. It is not only important to know how much Down Time your process is experiencing (and when) but also to be able to attribute the lost time to the specific source or reason for the loss. This study have conducted on the breakdowns of machines (separator) in the ginning industries or equipment’s of the company and to find out the root causes of these breakdown so as to eliminate them and to decrease the downtime and the break down cost of the industries caused due to these breakdown. In this machine chain and sprockets are the most important power transmission elements Efficiency of the separator is totally depend on the performance of the drive accuracy which will retard due to the malfunctioning of the drive elements i.e. sprockets and chain design. The catastrophic failure of dispensing system occurring due to the frequent failure of the drive sprocket. After the rigorous analysis and the brainstorming session revealed the occurring defects which leads to sprocket failure thus are discussed further.

III. METHODOLOGY

The Root Cause Analysis is a four-step process involving the following:

1) Data collection
2) Cause charting
3) Root cause identification
4) Conclusion
5) Improvement opportunity.

A. DATA COLLECTION AND ANALYSIS:

After rigorous breakdown analysis of six months data obtained from the shift log book of the company and is tabulated. The breakdown % for each element over time period of occurrence with its frequency is:

Chain drive failure contributes:

1) Sprockets wear & tear - 65 %
2) Chain wear - 8 %
3) Chain roller damage - 4 %
4) Chain vibration/Fluctuation - 12 %
5) Noise in the drive - 11 %

Breakdown data collected consist of all % elements breakdowns that occur in a ginning industry emphasizing on drive system failure leads to production stoppages which affect the productivity as well as increase the overall cost incurred. For that selecting the drive, after rigorous analysis the various % of the failure are find.

B. CAUSE CHARTING AND ROOT CAUSE IDENTIFICATION:

Cause-and-effect diagrams or Ishikawa diagrams (Fish bone diagram) is one of the seven basic tools of quality, which is used to identify potential factors causing an overall effect. It was used in the study to identify the root cause of the major breakdowns identified in the previous section. A Pareto chart, where individual values are represented in descending order by bars, and the cumulative total is represented by the line. The left vertical axis is the frequency of occurrence, and right vertical axis is the cumulative percentage of the total number of percent occurrences. The purpose of the Pareto chart is to highlight the most important among a (typically large) set of factors. In quality control, it often represents the most common sources of defects, the highest occurring type of defect.

C. ROOT CAUSE ANALYSIS OF THE SPROCKETS:

Fig shows the initial cause and the effect of the failure. The cause of the breakdown are the improper design, improper lubrication, increase the chain tension impact force acting on the sprockets noise & vibration on the drive etc. A Pareto chart was constructed as per the frequency of occurrences of each causes of failure. This shows the variation From the chart it is clear that sprockets breakage is the major cause of the breakdown to failure.

Fig. 1: Initial Cause and Effect Diagram

A detailed study was conducted on causes for breakdown due to failure and final cause and effect diagram is prepared as given in Fig. Reasons for vibration of the chain were the lower tension of the chain due to its stretching or wearing and wearing of other parts of the machine. Chain becomes loose due to stretching or wearing due to its longer and continuous use. Due to improper meshing in between chain and the sprockets there is a wear of the sprockets. Contamination due to improper cleaning on the equipment was also identified as a reason for chain drive failure. These causes can be eliminated by design proper drive for this equipment also by performing proper maintenance techniques like preventive maintenance, planned maintenance etc. The major reason for drive failure was the breakdown caused due to sprockets breakage in the machine. The different causes of breakage was improper design of sprockets (drive), improper checking methods employed for incoming sprockets from suppliers, and pinion getting stuck at the sprocket of the machines. By adopting proper design procedure, inspection method for incoming material, these causes can be avoided. Chain get stuck at the sprocket due to contaminations (like lubricant and dust mixture), over speed, A proper implementation of
design and tightening of mechanism can avoid the occurrence of this breakdown. Fig 2 shows the final cause and effect of the drive from this find out various remedies for the causes are discussed follows.

![Fig. 2: Final Cause and Effect Diagram of Chain Drive](image)

<table>
<thead>
<tr>
<th>Breakdown</th>
<th>Causes</th>
<th>Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprockets teeth broken</td>
<td>abstraction</td>
<td>Check chain &amp; sprockets clearance/replace</td>
</tr>
<tr>
<td>Wear &amp; tear of sprockets</td>
<td>1) misalignment</td>
<td>Correct alignment of the chain and sprockets</td>
</tr>
<tr>
<td></td>
<td>2) Improper lubrication</td>
<td>Proper lubrication</td>
</tr>
<tr>
<td></td>
<td>3) Increase chain tension</td>
<td>Maintain chain tension</td>
</tr>
<tr>
<td></td>
<td>4) change in relative velocity</td>
<td>Maintain the velocity of the sprockets</td>
</tr>
<tr>
<td>vibration</td>
<td>1) Load fluctuation are large</td>
<td>reduce the fluctuation with fluid coupling.</td>
</tr>
<tr>
<td></td>
<td>2) Design of the sprockets is not proper</td>
<td>Design proper sprockets</td>
</tr>
<tr>
<td>Noise</td>
<td>1) Improper installation</td>
<td>Correct the alignment</td>
</tr>
<tr>
<td></td>
<td>2) Excessive worn sprockets</td>
<td>Replace the sprockets</td>
</tr>
<tr>
<td></td>
<td>3) Lack of lubrication</td>
<td>Provide proper lubrication</td>
</tr>
<tr>
<td>Riding up of chain on sprockets</td>
<td>Elongation of the chain due to sprockets wear</td>
<td>Replace the sprockets.</td>
</tr>
</tbody>
</table>

Table-1: Root Cause Analysis of the Sprockets

IV. CONCLUSION

From cause and effect diagram, the root causes of breakdowns caused due to chain drive failure and breakdown was identified and sprockets failure is greatly reduced up to 5 to 10%. Proper alignment of shaft leads to damping of the overall vibration and noise have been greatly reduced. Hence ultimately occurrence of the machine breakdown is completely reduced which significantly improve the machine productivity, reduced maintenance cost and time. Improper alignment checking of the unit after readjustment was identified as the root cause for the drive breakdown.

V. FUTURE SCOPE

In the case of the sprockets to avoid this breakdown an improvement in the present setup can be made. By using proper remedies can eliminate this causes also some of major causes which required sprockets replacement for this, further drive optimization can be achieved by the incorporation of modified tooth profile of the existing sprockets.

REFERENCES


