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A CASE STUDY ON MAINTENANCE ACTIVITIES IN FERTILIZER COMPANIES

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Abstract

The manufacturing industries is becoming more competitive in recent decade, thus more concern about their operations and management, which makes industries interested in developing modern management system in order to stay competitive in managing their business operations. The present paper discusses the real time implementation of maintenance management discipline for the better performance and availability of the equipment. A particular section is selected, and analysis of OEE and maintenance discipline has shown a remarkable achievement. Six month continuous monitoring of plant by scholar has suggested implementing a maintenance management discipline for continuous performance improvement and maximum availability of equipments.

Key words: OEE, MMS, Maintenance Discipline

I. INTRODUCTION

Traditionally, maintenance role always relate to fire-fighting and stop-the-bleeding scenario. However, in recent years, many companies start to embark into new maintenance management disciplines that utilize latest technology. This trend has been steadily growing in many industries, such as in the airline industry; manufacturing industry and heavy industries likes cement plant, quarry plant, fertilizer plant and oil and gas industry. In this present study, the authors are proposing the use of various disciplines as a maintenance management system framework as a guideline for Mechanical Section in Engineering Department at a selected fertilizer plant which was chosen as the case study in this research. The problems which are of company concern are high downtime recorded for Bucket Conveyor (Equipment code El102) since plant commissioning although the equipment is not the most critical downtime contribution found in Pareto analysis. Then, the development process of the framework will be discussed in details to overcome these problems and to provide a better maintenance management system. Numerous benefits can be associated with a successful implementation of Total Productive Maintenance (TPM) such as reduced downtime, improved reliability of processes, improved spare parts management, reduced cost of production losses and improved corporate competitive advantage. Finally, we conducted before and after comparison, to evaluate the system performance in terms of its downtime reduction and production cost of losses justification.

II. INDIAN FERTILIZER COMPANY

At present, there are 56 large size fertilizer units in the country manufacturing a wide range of nitrogenous, phosphatic and complex fertilizers. Out of these, 30 units (as on date 28 units are functioning) produce urea, 21 units produce DAP and complex fertilizers, 5 units produce low analysis straight nitrogenous fertilizers and 9 manufacture ammonium sulphate as by-product. Besides, there are about 72 small and medium scale units in operation producing single super phosphate (SSP).

Since in India large numbers of fertilizer plants are working to produce fertilizer, and they use oil as a fuel to generate energy. But, due to incomplete combustion of fuel in generator, fertilizer plants produces large amount of solid waste product called carbon slurry. This waste product also creates disposal management problem. Fertilizer plants in India generate large amounts of carbon

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slurry waste due to incomplete combustion of oil fuel. This slurry is stored in large tanks and allowed to dry. The dried cake material, available at very cheap rate, was procured from National Fertilizer Limited, Panipat (India) and powdered. It was found to consist of small, black and greasy granules form. Between, nitrogenous and phosphaticfertilisers, 90% of energy are consumed by nitrogenous fertilisers in the form of feedstock and fuel. Using specific feedstock consumption values (ton of fuel per ton of fertiliser) (Das and Kandpal, 1998; FAI, 1998), and plant wise production of nitrogenous fertilisers (FAI, 1998), fuel consumption as feedstock was estimated. The difference of total fuel consumption and sum of feedstock and fuel use in captive power was used to estimate thermal energy consumption, and distributed to each plant in proportion to production.

Accordingly, fertilizer subsidy is measured basically as the difference between the import parity price and what the farmer actually pays, multiplied by the total consumption of fertilizers. The underlying rationale is that fertilizer is largely a tradable commodity and therefore its relevant price under a free trade scenario would be the import parity price. The subsidy estimated on this basis is very different from what is shown in government budgets, which is primarily the difference between the cost of production of fertilizers under the Retention Pricing Scheme and what the farmer pays.

III. MAINTENANCE MANAGEMENT SYSTEM

Maintenance management (MM) is defined as all the activities of the management that determine the maintenance objectives or priorities, strategies, and responsibilities and implement them by means such as maintenance planning, maintenance control and supervision, and several improving the methods including economical aspects in the organization.This definition of MM is very aligned to other such notions found in modern maintenance literature such as Campbell and Jardine (2001). Campbell (1995), or Shenoy and Bhadury (1998) Still other definitions consider MM as the management of all assets owned by a company, based on maximizing the return on investment in the asset. Wireman (1998) says that MM would include, but would not be limited to, the following: preventive maintenance (PM), inventory and procurement, work order system, computerized maintenance management systems (CMMS), technical and interpersonal training, operational involvement, proactive maintenance, reliability centered maintenance (RCM), total productive maintenance (TPM), statistical financial optimization, and continuous improvement. Each of these initiatives is a building block of the MM process. Another approach to MM definition is offered by Duffuaa et al.(2000). They indicate how a maintenance system can be seen as a simple input—output system. The inputs are the manpower, management, tools, equipment, etc., and the output is the equipment working reliably and well configured to reach the planned plant operation. It shows that the required activities for this system to be functional are maintenance planning (philosophy, maintenance workload forecast, capacity, and scheduling), maintenance organization (work design, standards, work measurement, and project administration) and maintenance control (of works, materials, inventories, costs, and quality oriented management).

Maintenance can play a key role in the long-term profitability of a company in the manufacturing sector, where it can have major impact on delivery, quality and cost. The importance of maintenance has increased, as high productivity and quality can be achieved by means of well-developed and organized maintenance strategies. However, this assumes that maintenance is controlled in such a way that equipment is stopped for maintenance via a systematic schedule. With the recent advances in technology many methodologies, tools, techniques and strategies have been developed and tested. The primary methodologies are Total Productive Maintenance (TPM) and Reliability Centred Maintenance (RCM), with variations being developed to suit individual organisations. In general, there can be considerable benefits, but these are usually demonstrated in large organisations. Unfortunately, the majority of organizations are constrained by certain barriers, with the resulting loss of major benefits.

IV. RESEARCH OBJECTIVES

The present study at hand, attempts to shed some light on the important features and characteristics of effective approaches to performance maintenance management in fertilizer manufacturing industry. For this purpose, the relevant literature related to multiple maintenance discipline is examined, classified and analyzed. Overall, effective performance measurement approaches can play an important role in focusing people and resources on a particular aspect of organizational task (Waggoner et al.,1999).

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V. RESEARCH METHODOLOGY

Based on the problems identified and set research objectives, methodology is prepared to establish a maintenance plan towards world class maintenance management system. Numerous books, journal, websites and thesis have been reviewed to give some insight towards progression of this research project. The selected fertilizer company is observed and basic information is collected there. As per the suggestions received by the maintenance manager the maintenance discipline is adopted and implemented. The overall performance measurement like OEE is measured and performance is evaluated.

VI. OVERALL EQUIPMENT EFFECTIVENESS (OEE)

TPM is a production-driven improvement methodology that has been designed to optimize equipment reliability and ensure efficient management of plant assets (Robinson and Ginder, 1995). The successful implementation of TPM results in the dramatic reduction of wastage and performance losses associated with production facility. TPM focuses upon cutting down various organizational performance losses as a strategy toward affecting manufacturing performance improvements. The various manufacturing and production losses tackled by TPM include:
Equipment losses (failure/breakdowns losses, start up losses, product changeover/set up losses, tool changeover losses, minor interruption loss, speed loss, defects and rework losses, shut down loss); manpower losses (production stoppage losses, line organization losses, measuring and adjustment loss, management losses, operation motion-related losses); and material losses (yield losses, consumables i.e. die-jig-tool losses, energy losses).
TPM employs overall equipment effectiveness (OEE) as a quantitative metric for measuring the performance of a productive system. OEE is the core metric for measuring the success of TPM implementation program (Jeong and Phillips, 2001). This metric has become widely accepted as a quantitative tool essential for measurement of productivity in manufacturing operations (Samuel et al., 2002). The role of OEE goes far beyond the task of just monitoring and controlling the manufacturing system performance. The OEE measure is central to the formulation and execution of a TPM improvement strategy (Ljungberg, 1998). It provides a systematic method for establishing production targets, and incorporates practical management tools and techniques in order to achieve a balanced view of process availability, performance efficiency and rate of quality (Bulent et al., 2000). OEE is calculated by obtaining the product of availability of the equipment, performance efficiency of the process and rate of quality products:

OEE=Availability(A)XPerformanceEfficiency(P)XRateofQuality (Q)

Availability(A)= (LoadingTime-Downtime)/LoadingTime X 100

PerformanceEfficiency(P)= Processedamount/(operatingtime/theoreticalcycletime) X 100

RateofQuality(Q)= (ProcessedAmount-DefectAmount)/Processedamount X 100

TPM seeks to improve the OEE, which is an important indicator, deployed to measure success of TPM program in an organization. TPM has the standards of 90 percent availability, 95 percent performance efficiency and 99 percent rate of quality (Levitt, 1996). An overall 85 percent benchmark OEE is considered as world-class performance (Blanchard, 1997; McKone et al., 1999). The OEE measure provides a strong impetus for introducing a pilot and subsequently company-wide TPM program.The methodology of the present research work started from identifying the problem statement, selecting the case study to conduct, collecting and analyzing data from real time, then proposes solution and makes conclusion.

VII. PRESENT STATUS OF SELECTED FERTILIZER COMPANY

The selected fertilizer company has emerged as a separate company following reorganization of the erstwhile FCIL and NFL group of companies in early 1978. The newly formed Corporation under its ambit of control got the operating Units at selected location in the city of Bihar. Considering the shortage of domestic production of urea for meeting the growing demand in the country and availability of well developed infrastructure in various closed units of the Company, the Cabinet has decided to consider the feasibility of reviving the fertilizer Units. After detailed study and recommendations for a revival option, it has been selected a suitable system for study

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and improvement of operational equipment using an effective maintenance management system like TPM, CRM, CBM etc.
Currently the selected company is striving to improve their performance at operational and organizational level. However there is no issue of slow demand of product in the market but the most of the fertilizer company is failing to cope the market demand. For this company is looking for a tool to enhance equipment performance and minimize the hours of breakdown. At the time of start of M.Tech research project the overall equipment average OEE was only 19 % in comparison of 97% world class values. On the basis of frequency and hours of breakdown and more over the criticality of the particular selected equipment EL102 Bucket conveyor is selected. The average breakdown is 690 hours as per the record available from equipment log history book since the plant under consideration. While the present research project, aims to minimize the breakdown from 11.5 hours per month to not more than 5 hours per month.

VIII. LIFE CYCLE MANAGEMENT

Total cost of equipment is started from the machine design until it is out of service. The best way to reduce the costs is by understanding Life Cycle Cost (LCC). To calculate LCC for EL102, there are some data required as listed below:

i. Equipment + installation cost = RS 548 892 (average 3times replacement)
ii. Estimate maintenance cost per year = RS 241 460 (gearbox, roller, pulley, etc.)
iii. Estimate energy cost per year = RS 5 058 (High Voltage Industrial Tariff - E3s)
15kW/day X 24hrs X 30days X RS 28.10 X 12mth = RS 5,058
iv. Net discount rate = 5% (estimated)
v. Equipment lifetime = 3 years
vi. Equipment value final year = RS 0

The value is RS 0 because the rubber is synthetic rubber. So, scrap will classify EL102 conveyor belt as a junk.

The analysis shows that LCC for EL102 is RS 1,220, 221 in 3 years of operation. The biggest costs lie in how the equipment is maintained. By doing this analysis, now we can calculate the savings either in operating or maintenance costs. After doing this analysis, it proves that Purchasing department cannot look entirely at cheapest parts, but need to look further on LCC which also cover running costs. By considering only initial cost is like seeing the tip of iceberg. Maintenance should focus on improving reliability, not on reducing cost because if reliability starts to improve, then cost will definitely go down.
In the selected fertilizer plant, there are about 80 rotating and static equipment such as conveyor, crusher, screen, drum, bucket elevator, bucket conveyor, fan, pump etc. All of this equipment contributes to machine downtime. A breakdown Chart will be constructing in order to identify the most critical equipment that contributes to machine downtime mostly. Figure 1, shows downtime Chart for percentage of 37 machines,which contribute to downtime from 2011 until 2016. The average most frequent 10 equipments are only shown here for information of breakdown.

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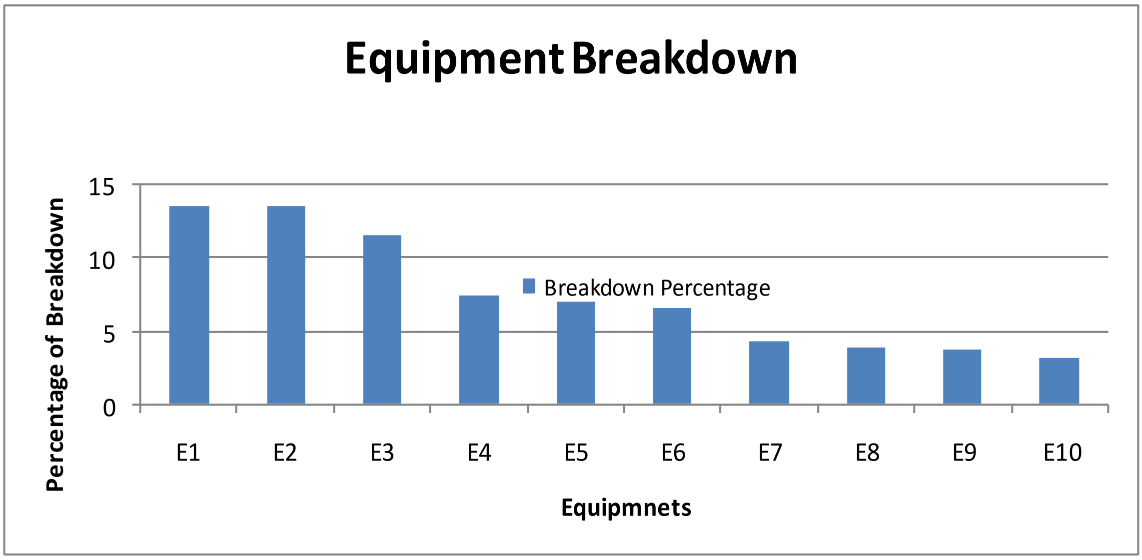

Figure 1: Chart for mechanical equipment downtime from 2011 to 2016

From the downtime Chart, it shows the most critical model that contributes to the highest downtime was for CR213B i.e E2, followed by E1 (D212), E3 (D211), E4 (S211B), E5 (EL102), E6 (CR213A) and so forth. EL102 contribute almost 11.4% downtime during 5 years plant operates. EL102 was selected as a case study although the equipment is not the most critical downtime contribution because:

i. CR213B - Highest downtime for CR213B occur because there are problem on crushing efficiency and activity for replacing roller on year 2013. After that, all replacing roller activity was only done during annual Turnaround events. So, the downtime is not significant for the improvement analysis because it is not repetitive failure. It is more about internal factors rather than proper planning.

ii. D212 - Highest downtime for D212 occur because there are problem on fluid coupling on year 2012 (600 hours downtime) and at that time, there are no spare part for fluid coupling. Until 31st march 2016, those types of breakdown do not happen again. So, the downtime is not significant for the improvement analysis.

iii. D211 - Highest downtime for D211 occur because there are activity on replacing rubber panel that contribute almost 463hrs since 2011 until 2013. After improving the quality of rubber, until now, that types of breakdown do not happen again. So, the downtime is not significant for the improvement analysis.

iv. EL102 – This is recent and repetitive failure. Downtimes happen on 2011, 2012, 2013 and 2016. After so many improvement we already made during this period, the failure still occur. Rubber quality is not an issue because only one manufacturer supplies this bucket conveyor. The plant can order the material from super high quality rubber manufactures likes Bridgestone, Yokohama or Goodyear Rubber but the return of investment taken so many years. So it can be considered as non-valuable investment in terms of financial. In order to pro-long this bucket conveyor lifetime is by having proper planning of maintaining it.

In 2016, target downtime for mechanical section setting by management was 7 hours/month based on 2014 downtime basis. Although there is a lot of reduction in downtime year-to-year, 2011 bring a new challenge to achieve target downtime. Downtime target set by management for mechanical section in 2016 - 17 was 5 hours/month. In order to achieve 2016 target, proper plan need to be done. All mechanical personnel need to be focus on maintaining equipment either normal crew or shift.

Employees must be educated and convinced that TPM is not just another "program of the month" and that management must totally commit to the program and the extended time frame necessary for full implementation. This project will bring 12 new maintenance disciplines as a core framework to the efficient planning in order for plant to achieve world class maintenance management system.

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REAL EXAMPLE OF OEE IN THE SELECTED COMPANY

Below in Table 1, is an example of real machine production data to help the company and to understand the concept of OEE and the calculation of this available data. This example will show the calculation of Simple OEE and the Simple OEE Metrics of Availability, Performance, and Quality rate.

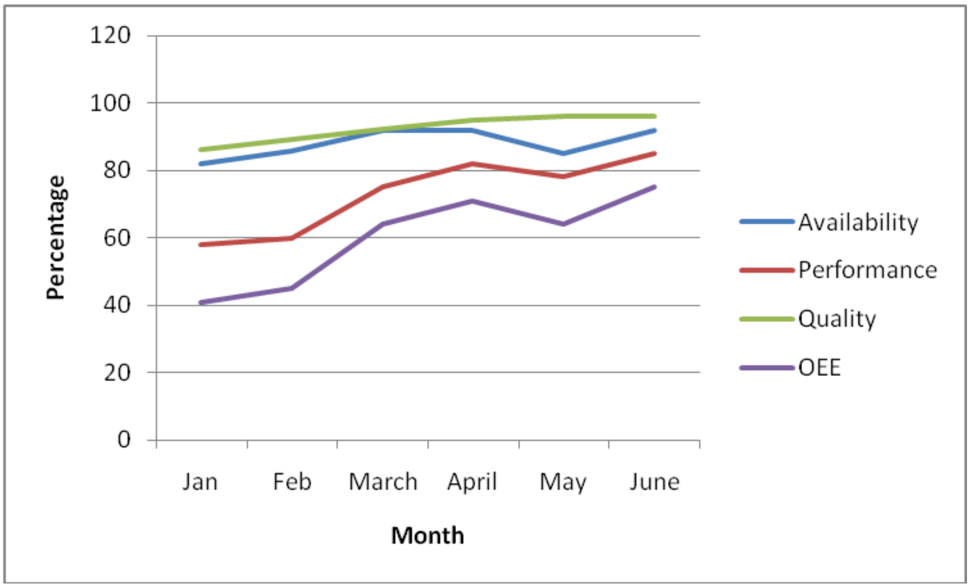

Figure 2: The value of OEE and its factors during case study

IX. CONCLUSION

The present chapter represents the salient findings of results. As the data obtained from real time observation and compared graph of the availability, performance and quality rate along with OEE is showing the remarkable improvement as per the expectation of the author.Overall equipment effectiveness (OEE) model for some operating systems of a fertilizer plant have been developed using the availability, performance and quality rate from previous 19% to remarkable achievement 69%. This has been used to evaluate the system's performance. The steady state availability expressions for some operating systems of a fertilizer plant have been derived. The effect of behavior of each subsystem on the system's performance i.e. steady state availability has also been analyzed through availability calculations and plots. Such models are found to yield realistic results as failure rates of selected equipment EL102 of a system go on increasing, the system availability decreases. The present research work can be extended, where time dependent failure and repair rates would be considered. Then, the performance model seems to be an appropriate one because most of the subsystems/systems in the fertilizer plant are such that they are exposed to continuous wear

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