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Development of Maintenance Schedule and Root Cause Analysis Based on Computerized Maintenance Management System for a Fertilizer Plant

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***Abstract*—**This paper deals with development of Computerized Maintenance Management System (CMMS) for a fertilizer plant. The software is advanced, easy to use, less complex, less expensive and also less time consuming. It consists of number of modules like detailed information of equipment, maintenance procedures, work order and employees detail. The objectives of CMMS are to reduce overall downtime, overall yearly maintenance cost and occurrence of failures of the equipment and to get day-by-day maintenance plan and strategy. In this regard, the behavioral chart for urea prilling unit at Fertilizer plant has been developed in form of Root Cause Analysis (RCA). Besides this, a maintenance program has also been proposed and used for the purpose of maintenance planning of the urea prilling unit. The outcome of software has been consulted with the concerned plant individuals and found to be extremely favorable for improving the performance level of the concerned plant.

***Keywords*—**Computerized maintenance management system, root cause analysis, maintenance schedule, urea prilling system.

I. Introduction

CMMS are progressively being used to accomplish the maintenance of modern industrial systems. It is a new method of maintenance which uses computers for rapid and resourceful determination. Secondly, data-life-time is shrinking as a result of the shop-floor certainties, which are real-time in nature. The enterprise now is to procure facts about discrete machines, based upon real interfaces rather than construed behavior from ancient data. Lastly, the mode that facts are being retrieved has reformed. The era of the legacy maintenance schedule of big bunch reports, are being exchanged by active, online inquiries and instantaneous responses. Elliot [1] highlighted that in age of computerization, an engineering department has more advanced equipment to maintain and control of maintenance. Bamber et al. [2] state that the maintenance organizations can improve their agility and cost effectiveness through implementing and deploying a latest generation CMMS. CMMS are now a necessary part of managing and controlling assets, plant and equipment maintenance in modern manufacturing facilities management and service industries. A properly utilized CMMS can assure planning and organizing various jobs for effective plant maintenance. The CMMS not only offers valued figures to take decisions, but also uses advanced and effective tools to confirm an enhanced availability and continued throughput. RCA [3] is a common terminology found in the reliability literature to avoid future occurrence of failures by pinpointing the causes of the problems. It is a structured technique of investigation that aims to identify the true causes of a problem and to take necessary actions to eliminate identified failures. The purpose of RCA is to uncover the underlying reasons (root causes). RCA provides comprehensive classification of causes related to 4M's i.e. Man, Machine, Materials and Methods and thus helps in establishing a knowledge base to deal with the problems related to process/product reliability and maintainability. On the basis of RCA, a maintenance schedule is prepared and planned to improve the performance level of the plant.

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II. Literature Survey

CMMS is used to control maintenance in latest industrial systems [4]. Development and executing a maintenance programme is a challenging process which suffers from many problems. It often suffers from lack of orderly and reliable practice. Labib [5] states that numerous elements are motivating the requirement for facts to provision maintenance management. Presently, a number of CMMS are available (e.g. Proview CMMS, MEX (Maintenance Experts) CMMS, COGZ CMMS, Smart Maintenance CMMS etc.), but all these suffer from many deficiencies, which results in a need to develop new CMMS. Long back, the principles of CMMS were applied to maintenance of hospital equipment, where critical breakdowns could lead to the development of life threatening situations. In recent years, industries have come to recognize the value of these systems as a maintenance performance and improvement tool [6]. The advent of the technology during the last few years has further boosted their popularity. Frank [7] discussed a policy for optimal scheduling replacement intervals of technical systems only on the basis of cost parameters. It was based on the assumption that a system is replaced by a new one as soon as the maintenance cost the replacement cycle reaches or exceeds a given level. Naamura et al. [8] discussed the application of the maintenance scheduling for pump systems in the thermal power stations for reducing the maintenance cost during the entire period of operation, while keeping the current reliability level of the pump system [9]. Rajiv et al. [10] developed performance evaluation system for screening unit of paper plant. Shyjith et al. [11] discussed the best practices in maintenance management. Sharma and Kumar [12] highlighted the best

maintenance method. Anil et al. [13] developed performance modelling of the skim milk powder production system of a dairy plant using RAMD analysis.

III. Description of Plant

The fertilizer plants are complex and repairable engineering systems, comprising of various systems namely urea prilling, urea crystallization and urea decomposition etc. These systems are arranged in hybrid configurations. One of the most important functionary units of fertilizer plant is urea prilling unit, which is discussed in this paper [14]-[16]. In this process, a pneumatic pipe to the top of a prilling tower conveys the dried urea available from urea crystallizer. Urea crystals recovered in the cyclone are fed to the melter using a screw conveyer where it melts by the steam and fall down into the head tank and then distributed equally at the top of the prilling tower. The urea from prilling tower falls down where it is cooled and converted into small pieces by stream of air. At the bottom of prilling tower, urea is collected then it is sieved and further sent to packaging section [17].

The urea prilling system of fertilizer plant has three main subsystems:

A. Subsystem 1 consists of four units' cyclone, screw conveyer, melter and strainer arranged in series. The failure of anyone causes the complete failure of the system.
B. Subsystem 2 consists of 12 distributers; 10 are operating at a time and two remains in standby. Complete failure of the system occurs when more than two distributers remain in failed state.
C. Subsystem 3 consists of one unit i.e. belt conveyer used to carry the prilled urea. Its failure causes complete failure of the system.

IV. CMMS for Urea Prilling Unit at Fertilizer Plant

The maintenance task of the processing plant for which the CMMS is established is totally responsive. The plant's computer system and its process were complex and time consuming [3]. Furthermore, maintenance managers did not have time to process the task. Moreover, a lot of weaknesses were detected in existing CMMS. Keeping all these constraints in mind, a CMMS is proposed and developed in this paper using MS Visual Studio.ne. This CMMS is based on existing Proview CMMS, but customized to the needs of the company. However, computer system becomes more robust and versatile by the addition of more features [6]. Fig. 1 shows the main menu of developed CMMS.

A. Phases for Developing CMMS

The several phases for the development of CMMS of fertilizer plant are shown in Fig. 2.

V. RCA and Maintenance Schedule

RCA has been performed for the identification of causes related to inconsistent performance of urea prilling unit of fertilizer plant. Fig. 3 shows RCA with cause and effect diagram and is used to diagnose an unreliable mechanical system with respect to operator's errors, attitude and with respect to machine problems such as misalignments, leakage which may result in loss of operational efficiency etc. [3]. On the basis of RCA, a maintenance schedule is suggested and utilized for the purpose of maintenance planning to improve the performance level of the urea prilling unit of the concerned plant.

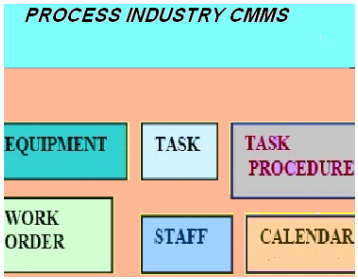

Fig. 1 Main Menu of Process Industry CMMS

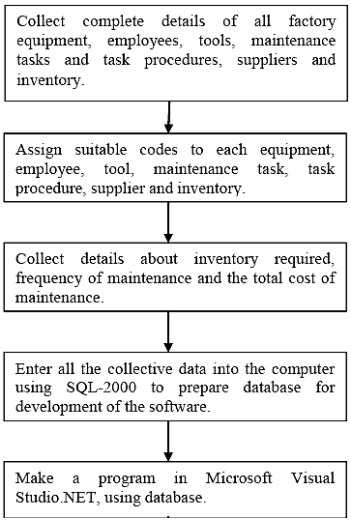

Fig. 2 Phases for developing CMMS

TABLE I
MAINTENANCE PLAN

S.No	Components	Check/Remarks	Schedule
1	All Stationary and rotary equipment and Burner	Regular checks by maintenance department	Daily
2	Pumps	Monitoring unbalance, misalignment, looseness	Weekly
3	Bearings	Lubrication, noise	
4	Filter	Check the leakage	
5	Gearbox	Check the oil level	
6	Valves	Check the leakage	
7	Pumps	Check the vibration level	Fortnightly
8	Bearings	Check the temperature, noise	
9	Pumps	Greasing, sleeve and coupling inspection	Quarterly
10	Stationary and rotary equipment	Overhauling	Annual
	Two-three weeks shutdown through planned maintenance schedule. Check each component of all systems		

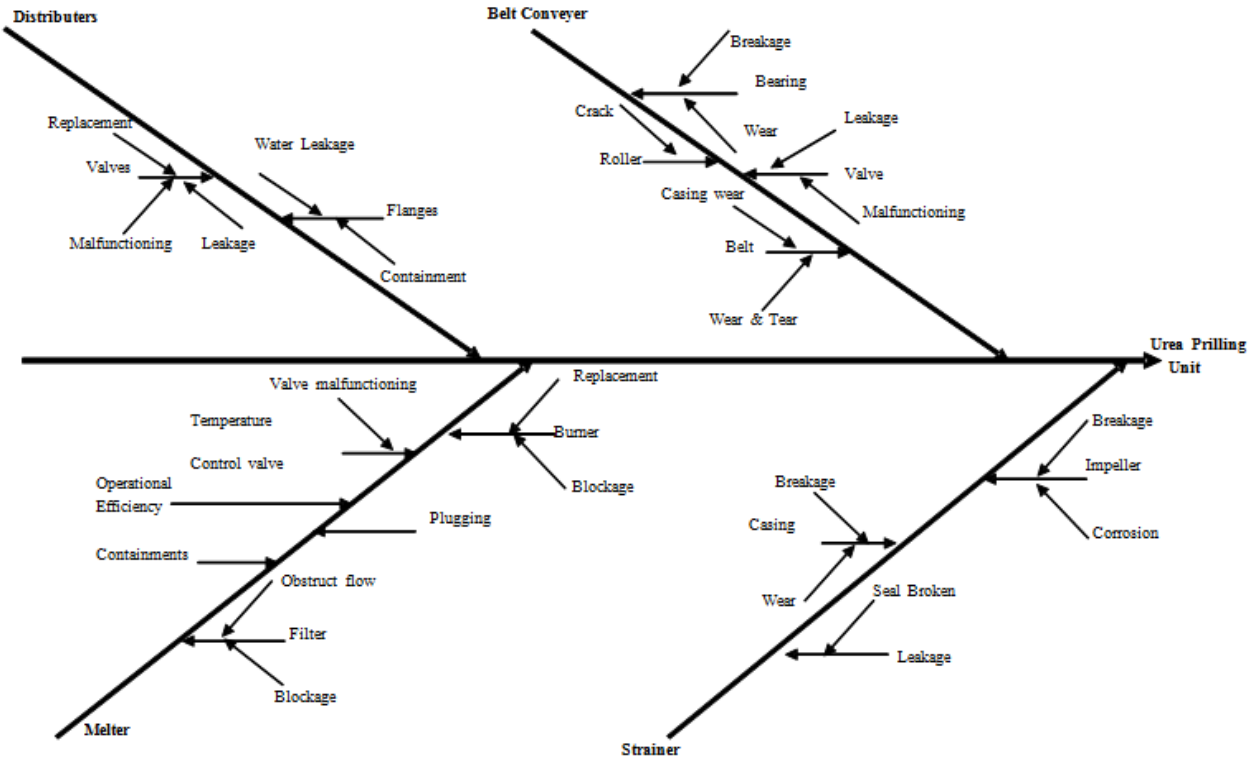

Fig. 3 RCA of Urea Prilling Unit of Fertilizer Plant

VI. Conclusion

In the present work, a CMMS has been developed for a urea prilling unit. The purpose of execution of the method is to streamline and mechanize a current method which further improves proficiency. The results of executing an active program in terms of improved plant effectiveness and production are outstanding. In actual fact, executing CMMS is a dramatic structural change that can affect work-floor management system and worker accountabilities etc. Due to use of computer, there is saving in time resulting in to increase in plant proficiency and reduction in mental exhaustion of the employees. Moreover, manual record keeping is reduced up to a large extent. The qualitative analysis of the urea prilling unit using RCA helped to create a knowledge base to deal with the problem related to process/ product unreliability by listing out all possible failure causes. Besides, the maintenance planning for various subsystems and components of urea prilling unit at fertilizer plant has also been carried out. The findings of this paper might be very helpful in the maintenance management i.e. maintenance planning and control of urea prilling unit at fertilizer plant, as illustrated with the help of maintenance schedule, as given in Table I.

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