Maintenance Optimization for Critical Equipments in Process Industries

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***Abstract*— In the highly uncertain economic climate of the moment, a major priority for companies is to improve operational efficiency. Maintenance departments have traditionally been budgetary "black holes". So, companies are trying to find methods to optimize the production and utilization of their assets. The present work describes new methodology designed to optimize planning of maintenance. An analysis of maintenance related researches shown that there are many research articles available concerning processing plant. However, Very few studies focus on critical examination of maintenance practices in plate and coil mill.**

This research work on Maintenance optimization executes at Welspun Corp. Ltd., Anjar, Kutch. In present study, Experimental investigations conducting to assess the influence of various equipments in terms of MTBF, MTBR, MTTR. Analysis of data will help to find out the critical components in plant. The goal of this dissertation work is to analyse the maintenance data and recommend optimized maintenance plan.

Keywords*— *Plate and coil mill, Analysis, Maintenance

I. INTRODUCTION

Maintenance activities are those use resources in physically performing those action and tasks attendant on the equipment maintenance functions for test, servicing, repair calibration, overhaul, and modification so on. It can be performed on an individual machine or entire group of machines simultaneously. Realizing the need for continuous improvement most companies have initiated the focused program covering various aspects of maintenance. The need for the hour is to offset the continual increase in input cost through optimized maintenance operations.

Optimization is an effective tool for improving the effectiveness of the system and hence, the cost will be reduced. Proper maintenance of plant equipment can significantly reduce the overall operating cost, while boosting the productivity of the plant. Management personnel often consider plant maintenance an expense, yet a more positive approach is to view maintenance work as a profit centre. In consideration of this new perspective, the requirements for maintenance management have change drastically from the old concept of 'fix-it-when-broken' to a more complex approach, which entails adopting a maintenance strategy for a more integrated approach and alignment. Furthermore, the high level of complexity of today's industrial plants requires an elevated level of availability and reliability of such systems. The development of new technologies and managerial practices means that maintenance staff must be endowed with growing technical and managerial skills.

The main objectives related to maintenance are: ensuring system' basic functions (availability, efficiency, and reliability); ensuring system life through proper connections between its components (asset management); and ensuring safety for human operators, environment and system itself. Proper maintenance of plant equipment can significantly reduce the overall operating cost, while boosting the productivity of the plant. Management personnel often consider plant maintenance an expense, yet a more positive approach is to view maintenance work as a profit centre. In consideration of this new perspective, the requirements for maintenance management have change drastically from the old concept of 'fix-it-when-broken' to a more complex approach, which entails adopting a maintenance strategy for a more integrated approach and alignment. Furthermore, the high level of complexity of today's industrial plants requires an elevated level of availability and reliability of such systems. The development of new technologies and managerial practices means that maintenance staff must be endowed with growing technical and managerial skills.

Increased reliability could be achieved through increased maintainability. This has emphasized the importance of maintenance, especially for the systems designed to operate in less friendly environment. An efficient maintenance process could be achieved through optimized preventive maintenance methods, considering also the influences of palliative maintenance actions.

II. LITERATURE SURVEY

T. Sahoo, P.K.Sarkar, A.K.Sarkar proposed **"Maintenance Optimization for Critical Equipments in process industries based on FMECA Method"** and showed the feasibility of conducting an optimum method of maintenance. This approach was based on the analysis FMECA. The implementation of this approach showed its contribution in reducing maintenance costs.

Godwin Barnabas, Maran , Nixon and Ambrose Edward proposed **"Maintenance cost optimization for the process industry"** and concluded that the usage of AHP provides priority in selecting the various maintenance policies and by linking this with GP various goals has been achieved.

J. Ashayeri, A. Teelen, W. Selen proposed **"A Production and maintenance planning model for the process industry"** and developed a model using branching strategy and performance of model which minimized several production and maintenance related cost factors during long or medium term planning horizons, taking into account the probability of break-downs.

Mahesh Pophaley, Ram Krishna Vyas proposed **"Plant maintenance management practices in automobile industries: A retrospective and literature review"** and concluded holistic design for maintenance methodology.

DuyQuang Nguyen and Miguel Bagajewicz proposed **"Optimization of Preventive Maintenance Scheduling in Processing Plants"** and concluded A new maintenance model based on the use of Monte Carlo simulation and integrated with GA optimization.

III. IDENTIFIED INDUSTRY

(3.1) company profile

Today, the Welspun Group is present in Line pipes, Home Textiles, Infrastructure, Energy and Oil & Gas, Plate & coil mill. Among them my dissertation work executes at Plate & Coil Mill Division (PCMD).

Welspun City takes pride in housing one of the only three Plate & coil mills of its kind in the World. This mill with a capacity of producing plates up to 4.5 meters width and Coil up to 2.8 meters wide is all set to improve Welspun's operational capabilities.

(3.2) Plate and Coil Mill division

Welspun Corp Limited (Plate & Coil Division) - having a capacity of 1.5 million tons per annum offers heavy Plates & Coils from their latest, state-of-the-art VAI / SIEMENS, 4 high reverse rolling steckel mill for challenging application including line pipe, structural steels, pressure vessel and boiler quality plates, ship building & offshore construction. The plates & coils have been supplied to major projects like Bangalore Metro rail project, Mumbai International Airport project, water and oil and gas pipeline projects, wind power projects etc.

Product range:

The Plant has a 4.5 m wide rolling stand and is capable of rolling Plates / Coils in the following dimensions:

Plates : Dimension Range		Coil : Dimension Range	
Width	1500-4500 mm	Width	1500-2800 mm
Thickness	8 - 140 mm	Thickness	8 - 25 mm
Length	up to 24 Meters	Coil weight	Max. 45 MT

Table 1 Product Detail

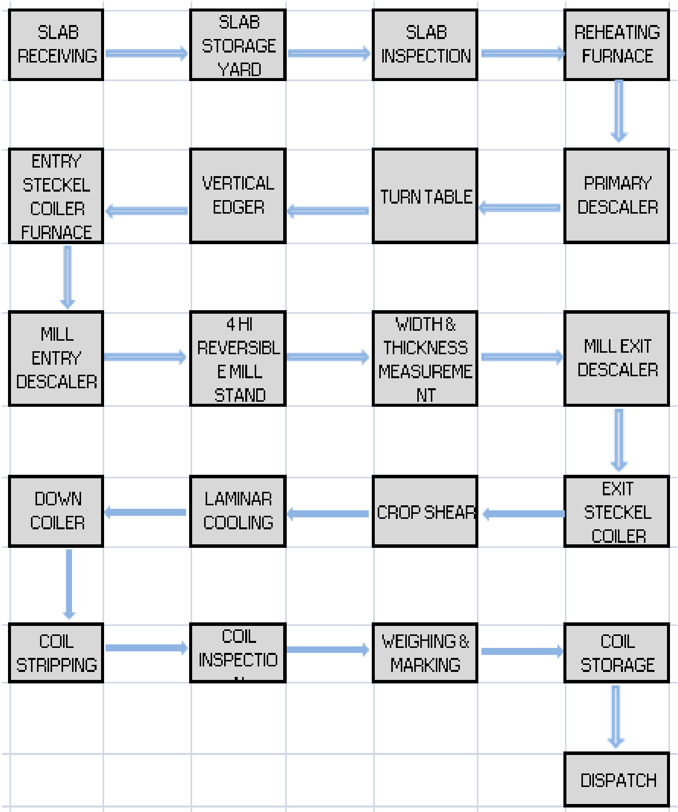

Fig. 1 Process flow diagram of plate and coil mill

Data collection:

As a Part of case study we have selected plate & coil mill in welspun pvt. Ltd. In plate & coil mill plant we have collected historical data with the information of Delay, MTTR, MTBF.

Month	Available Time (min)	Delay	Freq of failure	MTTR	MTBF
MAY.15	44640	9001	74	122	482
JUN.15	43200	10031	68	148	488
JUL.15	44640	18611	67	278	388
AUG.15	44640	15896	49	328	593
SEP.15	43200	4024	69	58	568
OCT.15	44640	7998	51	157	718
NOV.15	43200	10929	54	202	598
DEC.15	44640	7243	63	115	594

Table 2 Month wise plant delay

IV. ANALYSIS OF MAINTENANCE DATA

a. Survey Results:

After analysing the data and brainstorming with managers of company we have found some critical components of plant which need more care to be taken while planning of maintenance at particular are given below:

- Reheating furnace (RHF) :
  Slabs are heated in continuous side (top & bottom) fired walking beam type reheating furnace of a capacity of 200tons/hr. The fuel used for reheating furnace is natural gas. The furnace is divided into four zones i.e. recuperative, preheating, heating and soaking zones. The furnace is equipped with automatic combustion system, waste gas exhaust system, recuperator and modern instrumentation and control system.
- Descaler
  It is a device used to remove oxide layers from during the reheating process by high pressure water jet with the help of reciprocating pump. The delivering pressure is 250-300bar. Water is pressurized by descaling pumps driven by 7 motors (2 pumps each motor).
- Steckel mill coiler furnace (SMCF)
  It is also called Steckle mill Coiler furnace (SMCF). Two coiler furnaces are located at entry and exit side of the mill. It is used when coil rolling is done and the function of the coiler furnace is to maintain the temperature of the strip during the rolling process as the length of the strip is more when compare to plate rolling.
- Downcoiler
  It is used for the production of the coils. It is named so, because wrapping of the strip and production of coil is done below the floor or zero level. It is capable of coiling material between 5mm and 25mm in thickness and width up to 2800mm (this is the world's widest coil Steckle mill).

Month wise delay data for above four component are given below with freq. of failure and MTTR:

	Equipment	Available time	Delay	Frequency of failure	MTTR
May-15	RHF	44640	185	3	62
	DESCALAR	44640	221	3	74
	SMCF	44640	178	2	89
	DOWN COILER	44640	333	8	42

	Equipment	Available time	Delay	Frequency of failure	MTTR
Jun-15	RHF	43200	328	4	82
	DESCALAR	43200	125	2	63
	EN SMCF	43200	48	1	48
	DOWN COILER	43200	43	1	43

	Equipment	Available time	Delay	Frequency of failure	MTTR
Jul-15	RHF	44640	540	8	68
	DESCALAR	44640	-	-	-
	EN SMCF	44640	100	1	100
	DOWN COILER	44640	1637	17	96

	Equipment	Available time	Delay	Frequency of failure	MTTR
Aug-15	RHF	44640	-	-	-
	DESCALAR	44640	437	3	146
	EN SMCF	44640	225	3	75
	DOWN COILER	44640	594	4	149

	Equipment	Available time	Delay	Frequency of failure	MTTR
Sep-15	RHF	43200	30	1	30
	DESCALAR	43200	-	-	-
	EN SMCF	43200	-	-	-
	DOWN COILER	43200	202	3	67

	Equipment	Available time	Delay	Frequency of failure	MTTR
Oct-15	RHF	44640	53	1	53
	DESCALAR	44640	47	1	47
	EN SMCF	44640	-	-	-
	DOWN COILER	44640	203	4	51

	Equipment	Available time	Delay	Frequency of failure	MTTR
Nov-15	RHF	43200	107	2	54
	DESCALAR	43200	63	1	63
	EN SMCF	43200	123	2	62
	DOWN COILER	43200	120	1	120

	Equipment	Available time	Delay	Frequency of failure	MTTR
Dec-15	RHF	44640	338	7	48
	DESCALAR	44640	-	-	-
	EN SMCF	44640	221	2	111
	DOWN COILER	44640	871	10	87

Table 3 Month wise & equipment wise delay

And from above components downcoiler is the most critical component we found in point of view of maintenance.

DOWNCOILER DELAY				
Month	Available Time	Delay	Delay (Freq)	MTTR
MAY.15	44640	333	8	42
JUN.15	43200	43	1	43
JUL.15	44640	1637	17	96
AUG.15	44640	594	4	149
SEP.15	43200	202	3	67
OCT.15	44640	203	4	51
NOV.15	43200	120	1	120
DEC.15	44640	871	10	87

Table 4 Month wise Downcoiler delay data

Down coiler consists following parts:

- Top Pinch roll & Bottom Pinch roll
- Wrapper rolls
- Wrapper Arms
- Hydraulic system and water piping
- Downcoiler Side guides
- Mandrel
- Strapping machine

V. RESULTS AND FUTURE SCOPE

In present study From analysis, we have seen that downcoiler is the most critical component. So now with the help of this analysis we have to do Failure Mode and Effect Criticality Analysis (FMECA) to identify critical parts in Downcoiler and prioritize them with the help of CAD tool so that we can prioritize each preventive action according to part for particular causes of failure.

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