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Original Research Article

DMAIC METHOD APPLYING IN COAL HANDLING PLANT TO REDUCE POWER CONSUMPTION

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ABSTRACT

The method is based on five most important steps summarized in the acronym (DMAIC): Define Measure, Analyze, Improve and Control. Application of the method on the maintenance& operation processes with using maintenance methods during the five phases of the method will help to reduce costs and losses in order to strive for optimum results in terms of profit and quality. In India at present maximum power production done by the coal based thermal power plant. Power plant has Coal Handling Plant for conveying coal receiving point to boiler. There are so many wastage and extra power consumption for this purpose. In coal handling plant of coal based thermal power plant, coal handling process involves a number of activities from loading and unloading to stockpile. This procedure can be carried out by coal the conveying structure which includes a large number of mechanical equipment and drives. The important activities under coal handling include bunkering loading/unloading, dumping, transporting stacking, reclaiming etc. which are done with the help of various mechanical equipment and electrical drives. Every organization wants to profit as much as possible and increases their production rate by using maximum effort for care and maintain.

This research work presents a practical analysis for monitoring the operational performance of equipment drives, which shows the objectives of identification of major causes of production losses which are born from malfunctions, breakdowns, and bad operating programme. So that reduces power consumption for per MT of coal. Overall we can improve the efficiency of the plant. The primary focus of this research work is to monitor equipment

performance in coal handling plants and its contribution to the thermal power plant for overall operation.

KEYWORDS: DMAIC Method, Reduce power consumption, Coal handling plants.

1. INTRODUCTION

Lean Six Sigma is a methodology that relies on a collaborative team effort to improve performance by systematically removing waste; combining lean manufacturing/lean enterprise and Six Sigma to eliminate the eight kinds of waste: Time, Inventory, Motion, Waiting, Over production, Over processing, Defects, and Skills (abbreviated as 'TIMWOODS').For a productive enterprise, the main difficulties and inefficiencies lie in the choice of maintenance actions and operation process especially when the machine plays a vital role in the production process. Thus, given the importance of maintaining process and its impact on the performance of production facilities, optimization methods have been developed.

This DMAIC method can apply in different-different manufacturing industry. We can apply this in coal based thermal power plant also to increases the efficiency of coal handling plant.

Motivations:

- Performance measurement is a key strategy for organizational improvement. Without monitoring the equipment, a company cannot increase their production rate. So, DMAIC is a valid and accurate method for increasing the efficiency of coal handling equipment.
- To improve the efficiency of the material handling process in an industrial environment and Inspection of coal handling equipment to improve plant productivity.

2. LITERATURE REVIEW

Mishra, et al. (2013) emphasized the use of GPS in DCS for a prevalent and indispensable optimized control and monitoring system in coal handling plant. This information is used to construct the global view of the monitoring phenomenon or objects. [1]

M, Kanmani. et al. (2014) proposed a fault detecting and monitoring sensors that give better accuracy, reliable operation in real-time in order to protect the belt conveyor and also reducing the human errors by using delta series PLC and SCADA. [2]

Maiti, J. et al. (2004) proposed Lean Maintenance – Concept, Procedure, and Usefulness. In this paper, authors are presented a systematic approach for eliminating the waste which are excess production, excess processing, delays, transportation, inventory and defect through continuous improvement. [3]

Sharma, S. (2013) proposed for reduction of failure in stacker cum reclaimer for thermal power plant. In this paper author installs safety devices such as impact idlers for reducing the impact wear of the belt due to force produced on the belt at the time of loading, programmed interlocking for protection of damage to the belt. [4]

Zaman, M. et al. (2013) implemented Six-sigma methodology for reducing rejection in a welding electrode manufacturing industry. In this paper, author gives an overall idea about DMAIC (define– measure – analyze –improve – control) technique. [5]

3. PROBLEM IDENTIFICATION:

Problems during Operation and maintenance:

Major problem of any industry is high power consumption or higher auxiliary power consumption .Here we want to reduce to power in coal handling plant for coal handling in terms of KW/MT of coal.

- Sometimes the drive motor are running in idle condition, means at that time no material is handled or transferred from one place to another.
- Sometimes minor breakdown causes to idle the whole system or plant.
- In some old plant less number of automatic systems is used that take more time in process and have low efficiency.

Problems during rainy season:

- In rainy season coal mud formed by coal spillage and coal dust.

Problems during summer and winter season:

- In summer and winter season coal dust are formed and pollute environment. This is suppress by water spray

4. METHODS

COAL WILL BE TRANSFERRED FROM TRACK HOPPER TO STACK YARD

1) Check that Work permit (PTW) on various related system has been returned & cancelled.
2) Check that walkway and belt conveyor is free from combustible material.
3) Check that other associated equipments are running or in healthy condition. Like Fire water line is charged, Readiness of pump house motors, DE & DFDS System, Centrifugal and Axial fans and P&V System.
4) Emergency/Local Push Button should be released for every drive & check oil level in scoop coupling tank and gear box.
5) Check that RCC Water storage tank is filled
6) Check that Power Supply is made available for all the Drives.

7) Check for all permissive is available at PLC panel.
8) Check FG1/FG2 (at TP2) position according to the belt conveyor which is to be used
9) Proper communication must be there between field operator and desk engineer by PA system.
10) Start Lubrication system of long travel drive of Stacker and Reclaimer.
11) power supply should be normal for automatic rail clamp, pcrd & ccrd and long travel vfd drive, boom conveyer, intermediate conveyer & belt feeder
12) Start Long travel drive, Luff Drive & slew drive to position the Boom for stacking coal.
13) Start respective motors of Boom Conveyor Belt, Intermediate Conveyor Belt & Belt Feeder Conveyor in sequence.
14) Start SCOC Pump1 & Fan 1 of BCN 5D2
15) Release brake for BCN 5D2
16) Start SCOC Pump2 & Fan 2 of BCN 5D1
17) Release brake for BCN 5D1
18) Start BCN 5d2 motor
19) Give Open command to Scoop coupling Actuator of BCN 5D2
20) Start RBF 1 in Reverse direction if BCN 4A is to be used or Start RBF 2 in Reverse direction if BCN 4B is to be used
21) Start SCOC Pump of BCN 4A/4B
22) Release brake for BCN 4A/4B
23) Start BCN 4A/4B Motor
24) Give Open command to Scoop coupling Actuator of BCN 4A/4B
25) Start SCOC Pump 1 of CRUSHER ½
26) Start CRUSHER 1/2 Motor
27) Give Open command to Scoop coupling Actuator of CRUSHER ½
28) Start VGF 1/2 for respective CRUSHERS.
29) Start ILMS ¾
30) Start SCOC Pump of BCN 3A/3B
31) Release Brake for BCN 3A/3B
32) Start BCN 3A/3B Motor
33) Give Open command to Scoop coupling Actuator of BCN 3A/3B
34) Start BCN 2A
35) Release Brake BCN 1A.
36) Start BCN 1A

37) Start Oil circulation pump and air cooler fan of (Hydraulic system)paddle feeder 1/2 from LCP
38) Start Hydraulic drive and DSS 1/2 Pump of Paddle Feeder 1/2 from LCP
39) Start Paddle wheel from LCP and Long Travel drive for movement of Paddle feeder ½
40) and start Coal Feeding.

RECLAIMING COAL FROM STACK YARD TO BUNKERS

1) Check that Work permit (PTW) on various related system has been returned & Cancelled
2) Check that walkway and belt conveyor is free from combustible material
3) Check that other associated equipments are running or in healthy condition like Fire water line is charged, Readiness of pump house motors, DE & DFDS System, Centrifugal and Axial fans and P&V System
4) Emergency/Local Push Button should be released for every drive & check oil level in scoop coupling tank and gear box.
5) Check that RCC Water storage tank is filled
6) Check that Power Supply is made available for all the Drives
7) Check for all permissive is available at PLC panel
8) Check all flap gate's 5 to 10 (at all TP's) position according to the belt conveyor which is to be used
9) Proper communication must be there between field operator and desk engineer by PA system
10) Position the TTR 1/2 and Flap gate for respective Bunker and Start Metal Detector BCN 10 or BCN 9A/9B
11) Start BCN 10(For feeding in bunker A,B,C,D&E) and BCN 11(For feeding in bunker F,G,H&J) whichever is required.
12) If BCN 11 is started then start BCN 9A/9B OR If BCN 10 is started then don't start BCN 9A/9B
13) Start RSC 1/2 Motor to feed BCN 10 or BCN 9A/9B whichever is required by moving RSC ½
14) To start PCN 8A/B first charge VFD Transformer From CHSS Panel 4,Charge VFD panel
15) Start ILMS ¾
16) Start PCN 8A/B Motor by keeping its Set Point (SP) at 35% and increase slowly afterward.

17) Start RBF 3/4 Motor in forward direction For BCN 6A start RBF 3 and For bcn 6B start RBF 4.
18) Start SCOC Pump 1 of BCN 6A/6B.
19) Release brake for BCN 6A/6B
20) Start BCN 6A/6B Motor
21) Give Open command to Scoop coupling Actuator of BCN 6A/6B
22) Start SCOC Pump1 & Fan 1 of BCN 5D1
23) Release brake for BCN 5D1
24) Start SCOC Pump2 & Fan 2 of BCN 5D2
25) Release brake for BCN 5D2
26) Start BCN 5D1 motor
27) Give Open command to Scoop coupling Actuator of BCN 5D2
28) Start Lubrication system of long travel drive of Stacker and Reclaimer.
29) power supply should be normal for automatic rail clamp, pcrd & ccrd and bucket wheel drive, slewdrive, luff hyd. drive, long travel vfd drive, boom conveyer, intermediate conveyer & belt feeder.
30) Start Long travel drive, Luff Drive & slew drive to position the Boom for Reclaiming coal.
31) Start respective motors of Belt Feeder Conveyor Intermediate Conveyor Belt Boom Conveyor Belt in sequence.
32) Start Bucket Wheel Hyd. system and start coal reclaiming from stockyard

COAL WILL BE TRANSFERRED FROM TRACK HOPPER TO BUNKER

1) Check that Work permit (PTW) on various related system has been returned & Cancelled
2) Check that walkway and belt conveyor is free from combustible material
3) Check that other associated equipments are running or in healthy condition as Fire water line is charged, Readiness of pump house motors, DE & DFDS System, Centrifugal and Axial fans and P&V System
4) Emergency/Local Push Button should be released for every drive & check oil level in scoop coupling tank and gear box.
5) Check that RCC Water storage tank is filled
6) Check that Power Supply is made available for all the Drives
7) Check for all permissive is available at PLC panel
8) Check all flap gate's 1 to 10 (at all TP's) position according to the belt conveyor which is to be used

9) Proper communication must be there between field operator and desk engineer by PA system.
10) Position the TTR 1/2 and Flap gate for respective Bunker and Start Metal Detector BCN 10 or BCN 9A/9B
11) Start BCN 10(For feeding in bunker A,B,C,D&E) and BCN 11(For feeding in bunker F,G,H&J) whichever is required.
12) If BCN 11 is started then start BCN 9A/9B OR If BCN 10 is started then don't start BCN 9A/9B
13) Start RSC 1/2 Motor to feed BCN 10 or BCN 9A/9B whichever is required by moving RSC ½
14) To start PCN 8A/B first charge VFD Transformer From CHSS Panel 4,Charge VFD panel
15) Start ILMS ¾
16) Start PCN 8A/B Motor by keeping its Set Point (SP) at 35% and increase slowly afterward.
17) Start RBF 3/4 Motor in forward direction For BCN 6A start RBF 3 and For bcn 6B start RBF 4.
18) Start SCOC Pump 1 of BCN 6A/6B.
19) Release brake for BCN 6A/6B.
20) Start BCN 6A/6B Motor.
21) Give Open command to Scoop coupling Actuator of BCN 6A/6B
22) Start RBF 1 in Forward direction if BCN 4A is to be used or Start RBF 2 in Forward direction if BCN 4B is to be used
23) Start SCOC Pump of BCN 4A/4B
24) Release brake for BCN 4A/4B
25) Start BCN 4A/4B Motor
26) Give Open command to Scoop coupling Actuator of BCN 4A/4B
27) Start SCOC Pump 1 of CRUSHER 1/2.
28) Start CRUSHER 1/2 Motor
29) Give Open command to Scoop coupling Actuator of CRUSHER ½
30) Start VGF 1/2 for respective CRUSHERS
31) Start ILMS ¾
32) Start SCOC Pump of BCN 3A/3B
33) Release Brake for BCN 3A/3B

34) Start BCN 3A/3B Motor

35) Give Open command to Scoop coupling Actuator of BCN 3A/3B

36) Start BCN 2A

37) Release Brake BCN 1A

38) Start BCN 1A

39) Start Oil circulation pump and air cooler fan of (Hydraulic system)paddle feeder 1/2 from LCP

40) Start Hydraulic drive and DSS 1/2 Pump of Paddle Feeder 1/2 from LCP

41) Start Paddle wheel from LCP and Long Travel drive for movement of Paddle feeder

42) Than Start Coal Feeding

Shut-Down/Stopping Procedure

1) Stop Paddle feeder-1/2 so that coal feeding is stopped.
2) Stop upstream belt conveyor (SCOOP IN) by checking its emptiness and stop motor of respective Belt Conveyors BCN -1A,2A,3A/3B,4A/4B……..10&11.

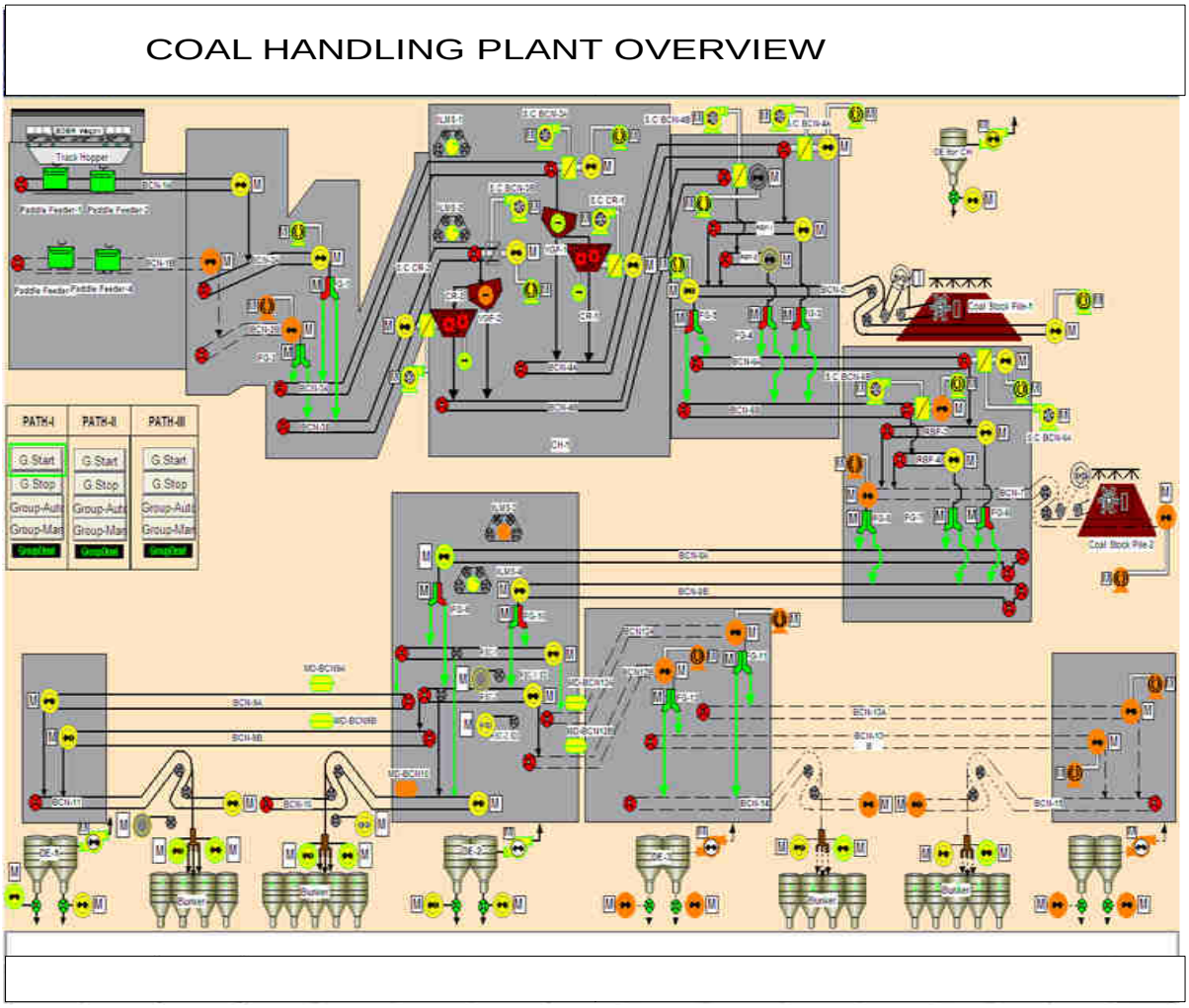

Fig. 1 .Overview of coal handling plant

5. RESULT DISCUSION

Lean Six Sigma is a methodology that relies on a collaborative team effort to improve performance by systematically removing waste; combining lean manufacturing/lean enterprise and Six Sigma to eliminate the eight kinds of waste: Time, Inventory, Motion, Waiting, Over production, Over processing, Defects, and Skills (abbreviated as 'TIMWOODS').we can use this method and implements in the process and work culture of the field and make favorable and maximum output from resources in safe manner. By help of DMAIC methods we want to reduce power consumption in coal conveying in Coal Handling Plant of 600 MW and take data during 6 Sep'2015 to 20 Sep'2015.

Table 1: Log book entry of CHP

Sr. No.	System Running (Hrs: Min)	power consumption in MW	Power consumption (excluded lighting of 5MW)	Direct Bunkering in MT	Stacking in MT	Reclaiming in MT	Total coal conveying in MT (bunkering+ stacking + reclaiming)	KW/MT (MW*1000/ total coal conveying)
1	0	5	0	0	0	0	0	0
2	0	5	0	0	0	0	0	0
3	12:30	14	9	0	0	4652	4652	1.9346518
4	17:48	18	13	200	1218	8132	9550	1.3612565
5	15:35	18	13	1090	0	6253	7343	1.7703936
6	18	18	13	962	0	6924	7886	1.648491
7	19	20	15	0	0	6649	6649	2.2559783
8	19	19	14	919	1472	6650	9041	1.5485013
9	20	18	13	0	1273	7900	9173	1.4172027
10	20	19	14	1345	2882	4789	9016	1.552795
11	19	21	16	1352	2895	7705	11952	1.3386881
12	19	21	16	1067	4086	7074	12227	1.3085794
13	20	21	16	452	3363	9428	13243	1.2081855
14	16:20	22	17	1925	1808	5964	9697	1.7531195
15	16:20	21	16	2376	1863	5492	9731	1.6442298

In month of July'2015 power consumption for coal conveying was 1.9 KW/MT. We take this data for calculations and calculate the percentage of power saving after applying DMAIC method.

Calculate power consumption KW/MT on daily data and take difference with 1.9 KW/MT (previous month average data). Then calculate percentage increases and decreases of power consumption for coal conveying.

Table 2 Calculations

Sr. No.	KW/MT (MW*1000/total coal conveying)	X= 1.9-power consumption in KW/MT	power saving in % KW/MT =X*100/1.9
1	0	0	0
2	0	0	0
3	1.9346518	-0.0347	-1.8238
4	1.3612565	0.53874	28.3549
5	1.7703936	0.12961	6.82139
6	1.648491	0.25151	13.2373
7	2.2559783	-0.356	-18.736
8	1.5485013	0.3515	18.4999
9	1.4172027	0.4828	25.4104
10	1.552795	0.34721	18.2739
11	1.3386881	0.56131	29.5427
12	1.3085794	0.59142	31.1274
13	1.2081855	0.69181	36.4113
14	1.7531195	0.14688	7.73055
15	1.6442298	0.25577	13.4616

6. CONCLUSIONS

The objective of the proposed work is to make study of system of the coal handling and associated equipment explicitly and make suggestive measures for improvement of coal handling system of machinery like TTR,, belt conveyor system, reversible belt feeder, stacker, reclaimer etc. under the backdrop of the aforementioned scenario the objectives of the present research work consists of the following.

- A brief review of equipment and its system of cyclic operation such as bunkering conveying, stacking, and reclaiming.
- Collection and collation of field data for the losses of availability, performance and quality of the equipment yearly basis.

- Development and recommendation of appropriate methodology for monitoring the candidate machinery and suggestive measures for improvement of their availability and performance.
- In India at present maximum power production done by the coal based thermal power plant. Power plant has Coal Handling Plant for conveying coal receiving point to boiler. There are so many wastage and extra power consumption for this purpose.
- In this research an attempt was to reduce power consumption for per MT of coal, reduce coal wastage or spillage and so that the efficiency of the plant can be improved.
- The method is based on five main steps summarized in the acronym (DMAIC): Define Measure, Analyze, Improve and Control. Application of the method on the maintenance& operation processes with using maintenance methods during the five phases of the method will help to reduce costs and losses in order to strive for optimum results in terms of profit and quality.
- Calculate power consumption KW/MT on daily data and take difference with 1.9 KW/MT (previous month average data). Then calculate percentage increases and decreases of power consumption for coal conveying.
- Identification of major causes of production losses which are born from malfunctions, breakdowns, and bad operating programme. So that reduces power consumption for per MT of coal.
- In month of July'2015 power consumption for coal conveying was 1.9 KW/MT. We take this data for calculations and calculate the percentage of power saving after applying DMAIC method. After applying this method we reduce 6% to 36% power consumption KW/MT for coal conveying.

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