International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 10, Issue 7 (July 2014), PP.20-24

Reliability-Centered Maintenance (RCM) of Quenching Car Used In Coke Oven Plants

Vijay Chaturvidani[1]*, Dr. Alok Singh[2]
[1]Department of Mechanical Engineering
[1]Maulana Azad National Institute of Technology, Bhopal, India

Abstract:- Quenching car is the machine used in the coke oven plants which is used to transport the red hot coke to the quenching tower for quenching operation. Reliability centered maintenance tool is applied for the maintenance of the quenching car to focus on the frequently failed components.

Keywords:- Coke oven plant, Quenching car, Reliability Centered Maintenance.

I. INTRODUCTION

Coke oven plants now a days plays a vital role in the steel production plants. In coke oven plants coal is converted into coke by heating the coal blend charge in the coke ovens in the absence of oxygen at a temperature of 1000^{o}C-1050^{o}C for a period of 16-19 hours. The heating process required in the coke making process to remove the volatile components present in the coal such as carbon content (about 60-80%), hydrogen , sulphur and ash contents. The main purpose of heating the coal is to improve the physical and chemical properties, to improve the strength, to withstand breakage and for giving desired size. The heating process is done in coke oven battery. Coke oven batteries (as shown in fig. 1) is a set of ovens of about 10-100 ovens that are made of high quality silica and other types of refractory brick in a series that are 6.1m tall, 12.2m long and less than 60cm wide which includes heating flues. The coke production process comprises of five main stages: Coal charging, Firing, Coking, Coke pushing and Coke Quenching. For all these process to be done there are mainly four machines are used. They are:-

1. Coal charging car.
2. Coke pusher car.
3. Door extractor.
4. Quenching car.

In this process firstly, the coal is collected in coal tower through conveyer belts. A specific amount of coal is discharged from the coal tower into a coal charging car which transports the coal to the coke oven battery. This charging car is situated on the roof of the coke oven battery. This charging car is driven by electric motors that can travel along the length of the battery on a wide gauge rail. The charging car is positioned over the empty oven and then removes the lids on the charging ports and the coal is discharged from the hoppers of the charging car into the oven.

After charging the coals in the oven, the peaks of coal are levelled by using a coke pusher machine in which a steel bar is cantilevered which can move translatory by rack and pinion mechanism enter through a small door on the side of the oven. This levelling process results in perfect utilisation of 3-dimensional space and for uniform coking and also provides the proper space for the gases that evolve during coking process and makes their exit easier. Coke pusher car is situated on the side of the coke oven battery and can travel along the length of the battery. After the levelling process the chuck door is closed, the lids are replaced on the charging ports and sealed with a wet clay mixture and then the heating proceeds for 16-19 hours.

At the end of the coking process, doors on both ends of the oven are removed and the red hot coke is pushed from the oven by a ram that is extended from the pusher machine. Then the coke is pushed through a coke guide into a coke quenching car which is positioned on the back side of the battery on a wide gauge rail that can travel along the length of the battery. The quench car carries coke from the oven to a quench tower where it is quenched with water.

After quenching the quenched coke is discharged onto an inclined coke wharf to allow the excess water to drain and to cool the coke to a reasonable handling temperature. Gates along the lower edge of the wharf

control the rate of coke falling onto a conveyor belt, which carries the coke to a crushing and screening system. The coke is then crushed and screened to the proper size for the blast furnace operation.

Fig.1. Coke oven battery (front-side view)

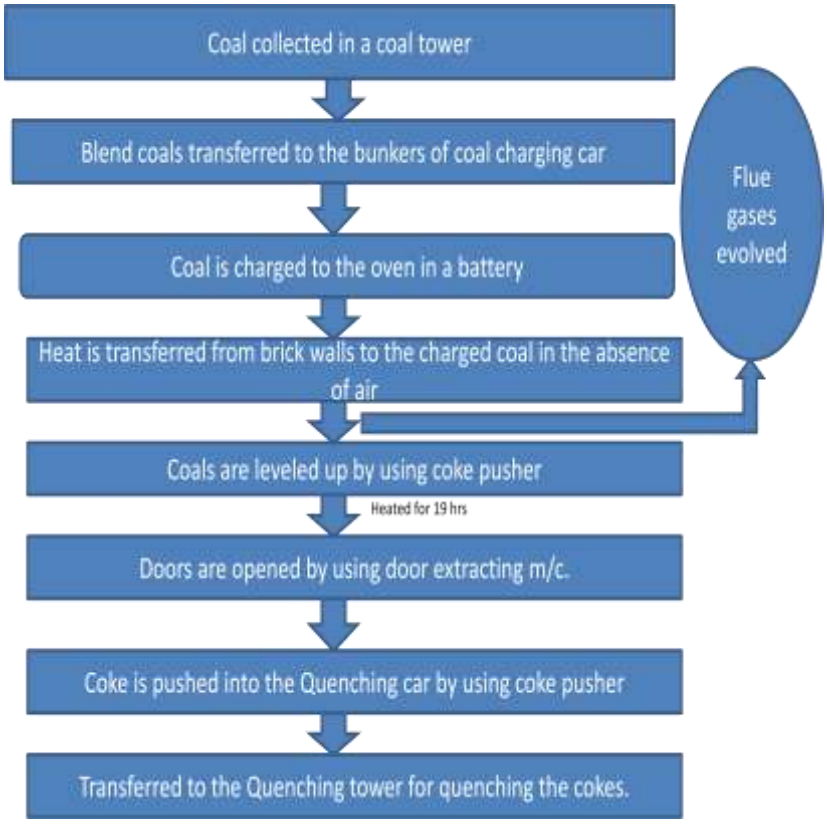

Fig.2. Process flow chart of coke oven plant

II. QUENCHING CAR

As per the Steel Authority Of India Limited, Bhilai (C.G.) the Quenching car is the most critical equipment used in the coke oven plant. The down time and break down of quenching car can affect the whole production of the plant. Therefore we have to pay extra attention towards the quenching car for their maintenance strategies. The coke quenching car is used for receipt of hot coke from coke oven transportation of coke to the quenching tower where it is quenched by water and then transportation of the cooled coke to the coke wharf and unloading. The Basic components of quenching car: Chassis, Bogie, Coke receiving box Coke dumping wharf, Duct damper, Control car Loco and wagon, Hood, Gas discharge plenum, Shutter gate.

Table 1. Specification of coke quenching car

SPECIFICATIONS	VALUES
Chamber volume,(m^3)	216
Capacity, (ton)	12
Gauge length (mm)	1520
Type of mechanism for locks fitting	Lever-pneumatic
No. of pneumatic cylinders	2
Length on auto coupling axis,(mm)	15320
Overall dimensions, (mm) -width -height	 4220 4165
Product weight (kg)	57770

This table tells about the specification of coke quenching car. This table gives information like weight, dimensions, capacity of coke which can occupied at a time and chamber volume. Cast iron plates are used for manufacturing the body of coke quenching car for the heat resistant.

Fig.3. Coke quenching car

III. RELIABILITY CENTERED MAINTENANCE (RCM)

It states that "an approach that employs reactive, preventive, and proactive maintenance practices and strategies in an integrated manner to increase the probability that a machine or component will function in the required manner over its design lifecycle with minimum maintenance". [5] RCM is first initiated within the aircraft industry in the year 1960. RCM is a technique for developing a Preventive Maintenance program. Preventive Maintenance will not prevent all failures. The preventive maintenance is introduced to avoid the occurrence of failures of the system and reduce potential consequences of failures. [1] RCM can be applied for the maintenance of quenching car to obtain the most effective Preventive Maintenance program. It will also results in the reduction of Preventive Maintenance activities and its cost or even in improving the availability of the system. RCM technique provides a framework for utilizing the system in a more systematic manner. In this technique we can reduce the maintenance cost by focussing on the most important function of the system and avoiding the maintenance activities that are not strictly necessary. The main steps involved in the RCM are:

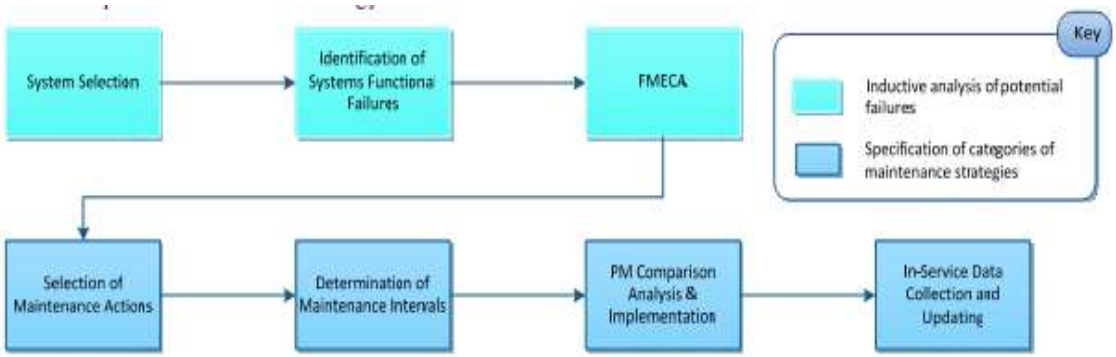

Fig.4. Steps involved in rcm [5]

Fish Bone Diagram

Fishbone diagrams (also called Ishikawa diagrams, cause-and-effect diagrams or Fishikawa) are diagrams that show the causes of a certain event. The Ishikawa diagram is used for quality defect prevention and to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. The design of the diagram looks like a skeleton of a fish. Fishbone diagrams are worked right to left, with each large "bone" of the fish branching out to include smaller bones containing more detail. [3] This approach can be applied for the maintenance of quenching car to identify the main cause of failure in the system which results in effective maintenance program. So here I have applied the tools of RCM for the maintenance of quenching car as the frequently problem associated with this machine of getting derailed from the track and also applied the Fish Bone Diagram (Ishikawa Diagram) to get the analysis of the root cause of the failure. Similarly we can apply this tool to other failures also to get the root cause of the failures and hence to improve its performances.

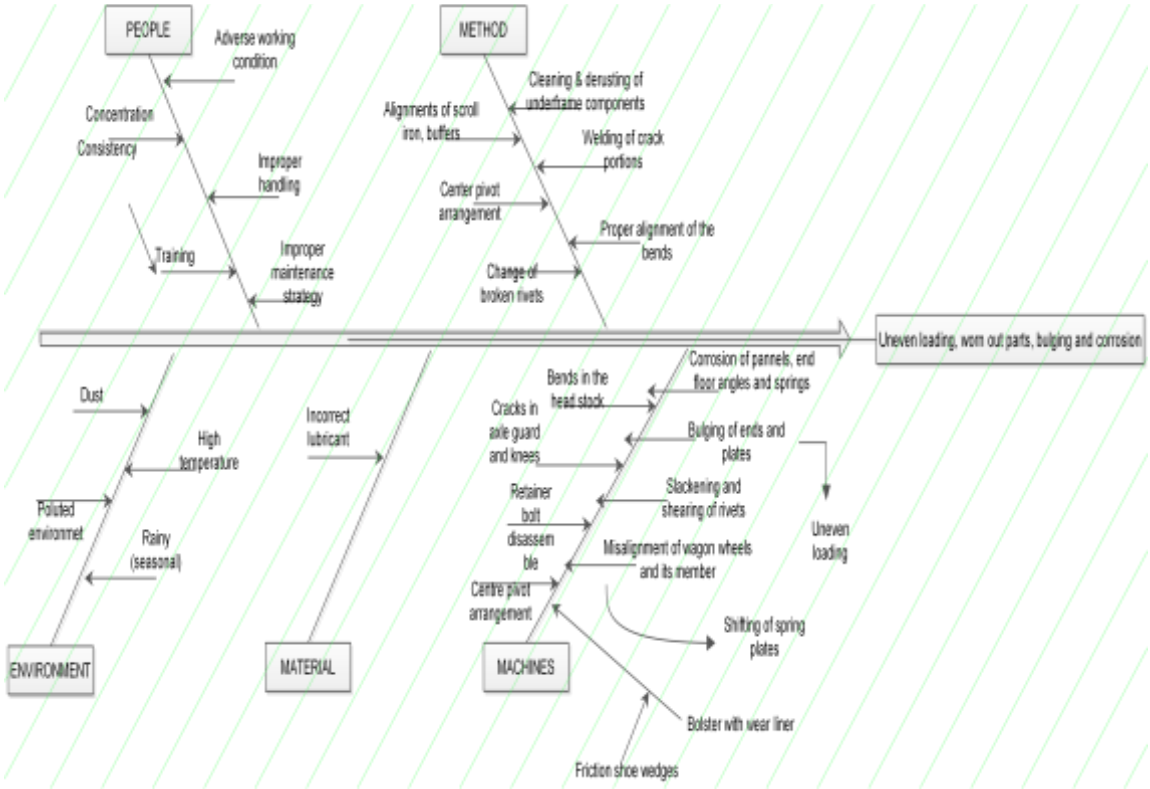

Fig.5. Fish Bone Diagram of Coke Quenching Car Failure

IV. CONCLUSIONS

The concept of RCM is utilized to enhance the preventive maintenance activities.The RCM concept provides the possibility of conducting an optimization method of maintenance. This approach is based on the analysis of FMECA. It also identifies the components where special attentions should be paid. It allowed better control system while identifying weak links and knows the types of maintenance applied to each subsystem and component. Fishbone Diagram tool is used to analyze the data and it gives the root cause of the component failure.

REFERENCES

[1]. M. Rausand, "Reliability Centered Maintenance," Reliability Engineering and System Safety, vol. 60, pp. 121-132, 1998.

[2]. J. T. Selvik and T. Aven, "A framework for reliability and risk centered maintenance," Reliability Engineering and System Safety, vol. 96, pp. 324-331, 2011.

[3]. Sanjyot S. Borker and Prabir Kumar Bandyopadhyay," Better moisture control in coke manufacturing-a case study" Indian Journal of Science and Technology, Vol. 4 No. 9 , 2011

[4]. B. Yssaad, et. al., Reliability centered maintenance optimization for power distribution systems, Electrical Power and Energy Systems 55 2014

[5]. Joel Igba, et. Al., A Systems Approach towards Reliability-Centred Maintenance (RCM) of Wind Turbines, Conference on Systems Engineering Research, 2013.

[6]. Conor Walsh and Patricia Thornley, "The environmental impact and economic feasibility of introducing an Organic Rankine Cycle to recover low grade heat during the production of metallurgical coke", Journal of Cleaner Production 34 [2012].
[7]. B. Ravi Kumar, et. al., "Fatigue failure of helical compression spring in coke oven batteries", Engineering Failure Analysis 10 [2003].
[8]. Steel Authority of India Limited, Bhilai.
[9]. (Design Bureau of coke chemical machine building) – http://www.kbkxm-kbk.com/index.php?lang=en&id=catalog&prod=413