

Risk Assessments for Blast Furnace in Steel Industry

T.Deebak

PG Scholar, Department of Mechanical Engineering, Sona College of Technology, Salem, Tamilnadu, India

ABSTRACT: Blast furnace is a tall reactor to process iron ore into pig iron, modern day blast furnace size range varies. Blast furnace iron making process is a complex task it has potential hazards like fire and explosion, CO poisoning, hot metal sparks, heat stress, emission of air contaminants like particulate matter, sulphur dioxide and nitrogen oxides etc. Organization need to take necessary steps to manage the hazards and its consequences to perform work safely. This paper aims to provide the necessity of risk assessment techniques for implementing safety in an integrated steel plant. Various reliability engineering and risk assessment techniques are applied to improve the blast furnace safety to prevent the blast furnace workers from accidents. Risk assessment was carried in an existing steel plant blast furnace capacity of 0.5MTPA (Metric Ton Per Annum). Failure mode effect analysis one of the systematic risk assessment technique is applied to the each activity of the blast furnace operation to find out the potential failure modes and its effects with detection. Risk priority number helps to find out the highest hazardous activities which need more attention than the other activities. Safety precautions suggested in this paper can prevent the occurrence of workers from fatal accidents and injuries by using an insulating wool in the outer layer of blast furnace.

KEYWORDS: Blast furnace, Insulating medium, Insulating wool, Safety

I. INTRODUCTION

Blast furnace plays a vital role in an integrated steel plant for producing pig iron which is then converted into various grades of steel in an electric arc furnace. Raw materials like iron ore, coke, limestone are charged at the top of the blast furnace through skip car system. Coke is almost pure carbon act as a fuel as well as reduces the iron ore into pig iron. Hot air from stove is blasted in to the furnace making the coke burn much faster than the normal and temperature rises to 1200 degree Celsius. Pulverized coal is injected through the velocity of 160 to 240 m/s to furnace to reduce the fuel consumption. Due to temperature rise various chemical reactions take place inside the blast furnace carbon monoxide reacts with unburned coke to form carbon dioxide that reduces the iron oxides in ore. The molten iron is very dense so it runs to the bottom of the furnace. Impurities are removed by the lime stone used as one of the raw material. Slag is an impurity which is lighter stays above the molten metal used for various purposes outside the plant. Blast furnace gas produced from the process is cleaned in gas cleaning plant and used as a fuel in captive power plants, Vacuum decomposing boiler. Excess blast furnace gas is burn using flaring system. Molten iron and slag is removed from different tap holes at regular intervals. Operation in blast furnace exposes workers to wide range of hazards that would cause fatal accidents. In past blast furnace explosion has shown many tragic and fatal accidents, so controlling the blast furnace operation is a complex task for the blast furnace workers and safety professionals. To prevent the accidents and unnecessary failures an effective risk assessment is important..

II. LITERATURE REVIEW

From the literature survey it is clear that some researches on FMEA have been carried out by previous researchers on the other hand still a lot of applied research in the above field is required as to explore the fruitful application of the FMEA technique in the area of blast furnace process. Some of the past research work are discussed as under.

Arun chauan et al. (2011) conduct a case study and implement failure mode effect analysis in a casting industry to identify the potential failure modes and its effects along with the prevention measures. Prevention suggested in this paper decrease the loss of cost and time.

Hoseynabodi et al. (2010) applies failure mode effect analysis method to wind turbine systems with aid of reliability analysis tool software and compare the result between FMEA and reliability field data. These results are useful for future wind turbine systems design to prevent failures at the design stage.

Narayanagounder et al. (2009) addressed the limitation in traditional FMEA and proposed a new approach to overcome these limitations. The risk priority code was used to rank failure modes, when two or more failure modes have the same RPN. They proposed a new method to rank failure modes. An analysis of variance was used to compare the means of two risks priority number values when there is a disagreement in ranking scale of severity, occurrence and detection.

H.shiroyehzad et al. (2010) applied FUZZY-FMEA preventive technique to decrease the failure rate in ERP implementation with the failure cause and effect by implementing fuzzy number.

Burlikowskwa et al. (2011) describes about a new approach about production development and cost reduction using failure mode effect analysis.

Popovic et al. (2010) describes about the implementation of risk analysis parameter into the FMEA method and inconsistencies of the traditional method.

III. SCOPE AND OBJECTIVES

1. To identify the most major hazard and common risks in industry.
2. To figure out reasonable solutions
3. To improve the safety in furnace.
4. To reduce the heat dissipation in the furnace area

IV. METHODOLOGY

The methodology adopted in this project is given below:

- Identifying the hazards in industry
- Data collection from labors
- Data collection through plant survey
- Implementing the process by safety worksheet
- Analyzing for maximum risk
- Arriving with a solution
- Conclusions, recommendations and suggestions for future study.

V. FAILURE MODE EFFECT ANALYSIS

Failure mode effect analysis was originally developed by NASA to improve and verify the reliability of space program hardware. FMEA is one of the most important and widely used tools for reliability analysis. It is intentional to be a proactive action process carried out in advance implementing new or changes in products or process ideally FMEA are conducted in the design or process development stages, although conducting it on existing products and processes may possibly have benefits in effective FMEA identifies corrective actions required to reduce failures to assure the highest possible yield safety and reliability. Failure mode effect analysis is four types system, design, process, service. System FMEA focus on systems and sub systems in early concept stage to demonstrate balancing among the operational components. Design FMEA minimizes the effect of failures in sub and main assemblies it maximizes the design quality and reduces cost. Process FMEA identifies the deviation in the process flow, materials, methods, people and environment. Service FMEA maximizes customer satisfaction through quality and reliability. Even though it is widely

used reliability technique it has some limitation in prioritizing the failure modes and output may be large for even simple systems, may not easily deal with time sequence, environmental and maintenance aspects.

5.1 Steps in FMEA

To conduct FMEA there are some necessary steps as to follow.

The 7 FMEA Steps

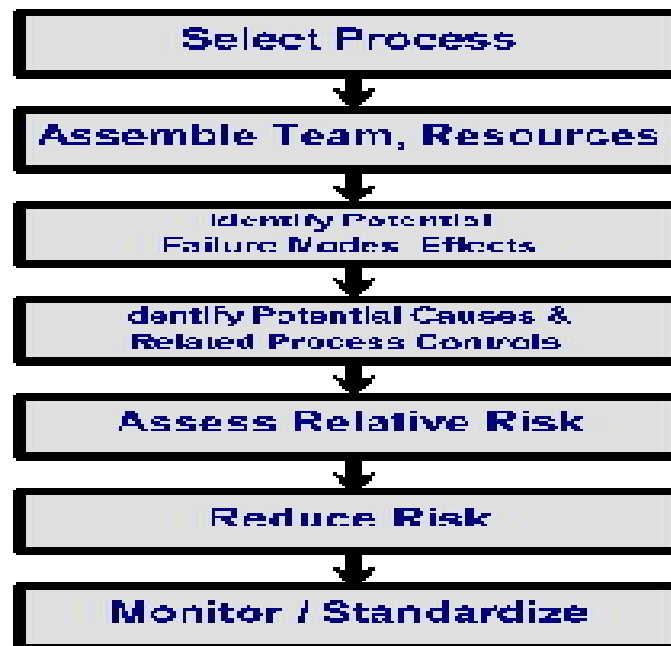


Fig5.1 Step in FMEA

5.2. FMEA implementation

Case study is conducted and FMEA technique is applied to the blast furnace in an integrated steel plant. Blast furnace is used for the production of pig iron for steel making in steel plant. Blast furnace is manufactured by CERIS technology china capacity of 0.5 MTPA. Failure mode effect analysis is executed by a multidisciplinary team of experts in blast furnace operation with the help of process flow chart the analysis team identifies the components in process. For the analysis break down details; accident reports are taken.

And the main problem face in the furnace area is that over heat dissipation from the blast furnace. And this is reduced by extending the conveyer length and re arrangement made in the design. The main thing is that to create an insulating medium around the outer area of furnace to reduce the heat.

VI. DESIGN

The design of the furnace is changed due to the increase of safety measures and to maintain the workers safety. The conveyer design is changed in the steel industry to maintain a proper safety purpose. And there is a problem in the conveyer arrangements and it is overcome by the new design. And the new design is mainly deals with the increasing

of conveyer length and the arrangement. The two things going to change in the existing model and the one thing is conveyer redesign and other one is the insulating medium that is used to reduce the heat dissipation level and to improve the workers safety

6.1 Existing model of conveyer

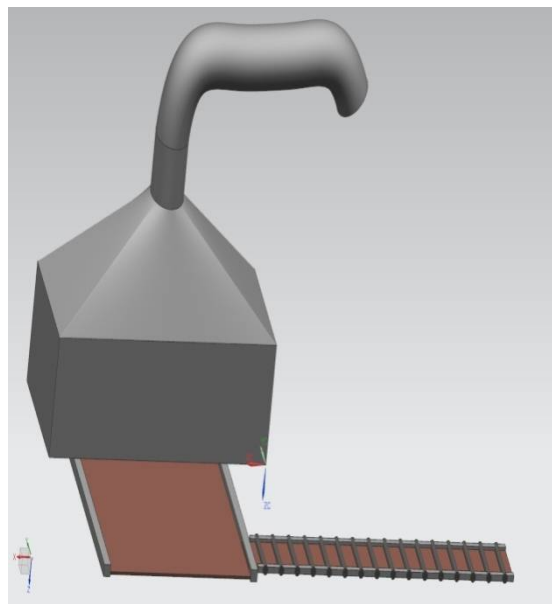


Fig 6.1 Existing model of conveyer

This is the existing model of a furnace in the steel industry and there is some drawback in this and the main drawback is the worker safety and this is mainly large amount of heat dissipation and the high levels of fumes and dust. So there is some changes are made in the design to increase the workers safety.

6.2 Re modeled conveyer

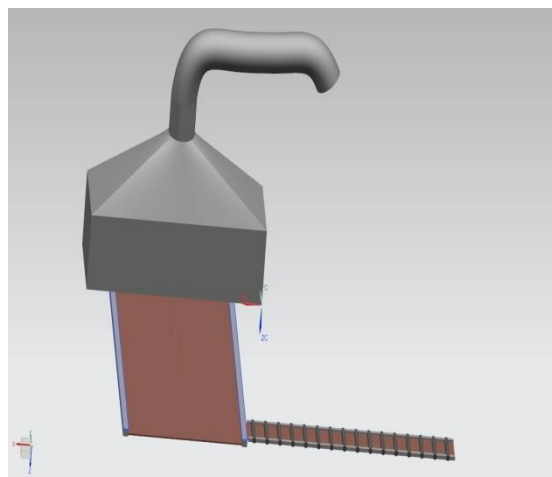


Fig 6.2 Re modeled conveyer

This is the re designed model of the conveyer and the length of the conveyer has been changed and the roller bar conveyer setup has been moved parallel to improve the safety aspects and to improve the workers safety. The main focus to change the conveyer length is that to improve the workers safety and to reduce the heat, dust and fumes from the furnace to the workers. This design leads to improve the safety and reduce the hazard level in the furnace area.

6.3 Existing furnace model

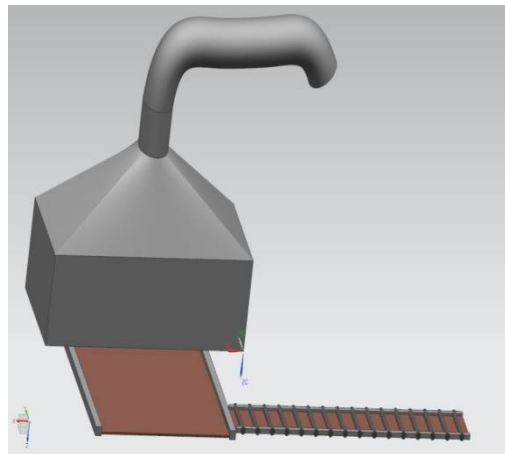


Fig 6.3 Existing furnace model

This is the existing model of the furnace which is present in the steel industry. And there are some drawbacks in this model and the hear dissipation is in higher level in this model up to 200 Celsius temperature at the surrounding area of furnace. And there is a large amount of dust and fumes came out from the furnace and this can be overcome by the some changes that has been made in the furnace to improve the safety and to overcome the safety issues in it.

6.4 Redesign of furnace with insulating medium

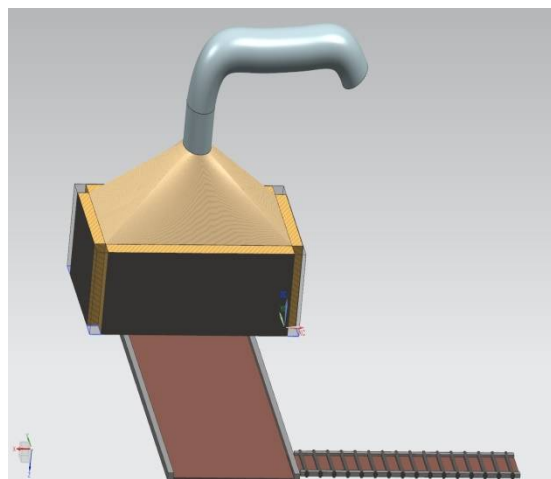


Fig 6.4 Redesign of furnace with insulating medium

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization

Volume 6, Special Issue 8, May 2017

International Conference on Advances in Biotechnology, Civil & Mechanical Science (ICABCMS-17)

17th & 18th March 2017

Organized by

Selvam College of Technology, Namakkal, Tamilnadu, India

This is the redesigned furnace with the insulating medium to reduce the heat dissipation and increase the safety and this involved in the reduce of hazard. The main motto is to increase the safety in the furnace area to workers and to reduce the heat dissipation to surroundings.

6.5 Insulating wool

The insulating wool is used as a insulating medium to reduce the heat dissipation .

Advantages:

- Natural Air-Conditioner
- Naturally Fire Resistant
- Naturally Absorbs Noise
- Naturally Absorbs Pollutants
- Environmentally Friendly
- Low Embodied Energy

VII. CONCLUSION AND RECOMMENDATION

The safety in the furnace is more important and it should be prioritize by every project. The success of every project mostly is determined by the ability of the safety team to minimize the risk factors and the implementation of the project should be proper. For a project to be successful the following recommendations are hereby presented:

- Adequate planning should be provided before the commencement of project.
- Safety, rules and regulations in site should fully be maintained from the initial to final stage..
- Durable and quality materials for construction should be supply and use properly.
- Efficient and Economical use of all the available resources should be adopted by all associates of safety team.
- Effective communications and corporations between all members of safety team should be adopted.
- Well trained and experienced workmen should be employed where necessary

REFERENCES

- [1]. Narayanagounder, s and Gurusami, k 2009- "A New Approach for Prioritization of Failure Modes in Design FMEA using ANOVA", Journal of word Academy of science (Engineering and Technology), Vol.49,2009,pp.524-532.
- [2]. Hughes, N., Chou, E, Price, C.J and Lee, M.1999, "Automating mechanical FMEA using functional models", Proceeding of the Twelfth international Florida AI Research Society Conference, (AAAI Press, Melno, CA), pp.394-398. [3]. Shirouyehzad, H, Badakhshian, M, Dabestani, R, Panjehfoulan, H. 2010 "FMEA Analysis for Identification and Control of Failure preferences in ERP Implementation", The journal of Mathematics and Computer Science, Vol.1 No.4 (2010) pp.366-376.
- [4]. Arabian-Hoseynabadi, H, Oraee, H, Tavner, P.j. 2010 "Failure Modes and Effect Analysis (FMEA) for Wind Turbines", International Journal of electrical power and energy system.32 (7), pp-817-824.
- [5]. Arunchauhan, Raj Kamal Malik, Gaurav Sharma, "Performance Evaluation of casting Industry by FMEA", International Journal of Mechanical Engineering Application Research. Vol 02, issue; pp.113-121.
- [6]. ValdimirPopovic, BrankoVasic, MilojPetrotic, 2010, "The possibility of FMEA method Improvement and its Implementation into Bus Life Cycle", Journal of Mechanical engineering 56 (2010) 3.pp.1-7.
- [7]. Rhee, s. and k.ishli, "Life Cost- Based FMEA Using Empirical Data", Proceeding of the ASME 2003 DETC/CIE Conference, Illinois, pp.48-50
- [8]. Dossee, T. and Boyer, H. Practical Heat Treating. Journal of Materials Processing Technology, 1997, 14(7): 235-257.
- [9]. George, E. Totten: Steel Heat Treatment Handbook, 2nd Edition; 2002, pp 91-105.
- [10]. Netsushori, K.: Various Heat Treatment Technology. Trends and prospects of heat treatment in 21st Century.3rd Edition. 1998, pp. 201-233.
- [11]. Olanrewaju, S.O.: Practical approach to metal hardening in our metallurgical industries, NMS Conference, National Metallurgical Development Center (NMOC), Jos, 2000, pp 615.
- [11]. Oyawale, F. A. (2007): Design and Prototype development of a mini-Electric Arc Furnace. Pacific Journal of Science and Technology. 2007, 8(1):12 – 16.