

ASSESSMENT OF SAFETY AND STUDIES ON HAZARDOUS GAS PRODUCTION IN STEEL PLANT

Neelotpal Neelot^{#1}, K.N. Karthick^{#2}

#1 PG Scholar, Department of Mechanical Engineering, Knowledge Institute of Technology, Tamilnadu, India.

#2 Assistant Professor, Department of Mechanical Engineering, Knowledge Institute of Technology, Tamilnadu, India.

#1neelotpal20@gmail.com

Keywords— *Steel Plant, Production of Industrial Gases, Hazard, Safety.*

ABSTRACT

Assessment of safety in production, handling of gases and its uses are the key factors of this project work. The work is mainly focused on identifying the various hazardous gases which comes out from various sources namely Blast furnace gas, coke oven gas, mixed gas and converter gas. The amount of various gases constituents present in the plant is been studied. A study on raw coke shows the level of gases present and which is helpful on eliminating the hazardous gases during the production of steel in the plant.

1. INTRODUCTION

1.1 Profile of Steel Industries

Steel industry is one of the most important industries in India. During 2014 through 2015, India was the third largest producer of raw steel and the largest producer of sponge iron in

the world. The industry produced 91.46 million tons of total finished steel and 9.7 million tons of pig iron. Most iron and steel in India is produced from iron ore.

Steel Plants are located in different States like (Karnataka, Chhattisgarh, West Bengal, U.P, Odisha, Andhra Pradesh, Tamil Nadu, Maharashtra, Jharkhand, etc.) in India. India is first and main producer of steel rails, as well as a major producer of wide steel plates and other steel products.

The Gas Safety Rules aim to give detailed and specific procedures, which are required for prevention and liquidation of gas hazardous situation in the Steel Plant.

In this paper summaries these principles and rules, so that these can be brought to the notice and practice of all the personnel in various shops/departments.

The danger which may arise due to exposure of people to dangerous gases like (B.F gas, Converter gas and Coke oven gas) fall into

three categories [or a combination of these]. Gas poisoning [mainly carbon monoxide].

- Explosion
- Fire

1.2 Steel Plant Production

- Rail
- Wire rod
- Plate
- Angle
- Channel
- Wheels
- Blades, etc.

1.3 OBJECTIVE

Prevention of hazardous condition leading to lowering of gas poisoning, explosion and fire in gas lines and equipment's and connected accessories.

Updating maintenance methods to avoid hazardous conditions in the gas networks and gas hazardous aggregates. To create awareness among all working people about the basic principles of Gas Safety rules to be followed.

2. LITERATURE REVIEW

1. D. L. Doushanov, et al., (2008) published a paper on the title **Control of pollution in the iron and steel industry**; The iron and steel industry cause significant effects on environmental media: air- process water with

organic matter, oil, metals, suspended solids, benzene, phenol, acids, sulphides, sulphates, ammonia, cyanides, thiocyanates, thiosulfates, fluorides (scrubber effluent); soil - slag, sludge, Sulphur compounds, heavy metals, oil and grease residues, salts.

2. Satyendra, et al., (2013) published a paper on the title **Coke oven gas generation and usage**; During the carbonization of coking coal in a coke oven battery for the production of coke, around 25-30% of the coal charged is driven off as effluent gases rich in volatile matter and moisture. This gas is known as coke oven gas (CO gas). In the non-recovery or heat recovery coke ovens this gas is burnt in the oven itself and provides the required heat for the carbonization of coal. In case of by product battery, the evolved gas is removed as raw gas and is treated in a by-product plant to give a clean fuel gas.

3. K.MithunN.Karthikeyan, et al., (2014) published a paper on the title **Studies on gas and pipeline safety in steel industry's**; This paper deals with, Identification of hazards present in the gas pipeline and storage of steel industries, to study about plant gas pipeline installation as per NFPA, OISD, norms, to study about available fire protection facilities, safety organization and safety system of the plant and to recommend better suggestions to enhance safety of the plant.

4. Satyendra, et al., (2015) published a paper on the title **Nitrogen gas and its usage in steel plant**;

Nitrogen is a non-reactive component of the atmosphere which is not life supporting. The percentage of nitrogen in air is 78.06 % by volume or 77 % by weight of the air. Nitrogen is produced in large quantities and at high purity as a gas or liquid through the liquefaction and distillation of ambient air at the cryogenic air separation plants. It is also produced on commercial scales as a lower purity gas by adsorption technologies (pressure swing adsorption, PSA), or diffusion separation processes (permeation through specially designed hollow fibres). Nitrogen is often stored as a liquid, although it is used primarily as a gas. Liquid storage is less bulky and less costly than the equivalent capacity of high-pressure gaseous storage.

3. PROBLEM IDENTIFICATION

Typical hazards founded in steel plant due to gases: -

Industrial Gases & Vapours: -

Materials hazardous to health may occur in the work place atmosphere either as gases, vapours or aerosols. Gases are incondensable at room temperature and vapours are derived from volatile liquids. Under ordinary conditions, gases remain in the gaseous state even when present at high concentrations. Vapours or other hand may condense at high concentrations. Gases and vapours can therefore be considered similar and same device can be used for sampling.

Chemicals Used in Steel Plant: -

Large quantities of gases/chemicals are used and emitted us at different department of steel plant like blast furnace, converters and coke ovens in the process of iron and steel manufacturing.

These gases contain large amount of carbon monoxide, sulphur dioxide, oxides of nitrogen and other aromatic hydrocarbons, these gases are hazardous to health above a certain concentration. Many chemicals are essential for health in small quantities but are highly toxic in large quantities.

Effect of Exposure: -

Inhalation: - The air borne contaminants can be inhaled directly in to the lungs such as gases, vapours, dust and fumes.

Absorption: - Absorption through skin can occur quite rapidly if the skin is cut or abraded. Some substance are absorbed by way of the opening through hair follicles such as organic lead compounds and other nitro compounds.

Ingestion: - In the workplace people can unknowingly eat or drink harmful chemicals. Toxic compounds are capable of being absorbed from the gastrointestinal tract into the blood.

TYPE OF GAS	HAZARDS
Carbon dioxide	Simple asphyxiant
Carbon monoxide	Toxic, flammable

Hydrogen	Flammable
Methane	Flammable
Nitrogen	Simple asphyxiant
Nitrogen dioxide	Highly toxic, oxidizer, corrosive

Table 1-Types of Gases and its Hazards

4. METHODOLOGY

Study of hazardous gases in steel plant, we found that there are four major dangerous gases in this plant (both poisonous and explosive).

- **Blast furnace gas**
- **Coke oven gas**
- **Mixed gas**
- **Convertor gas**

Blast furnace gas: -Blast furnace (BF) gas is a gaseous by product which is generated while producing hot metal (liquid iron) in a blast furnace. The total amount of carbon monoxide (CO) and carbon dioxide (CO₂) gases by volume in the BF gas at the top of the blast furnace is around 40 % of the total gas volume. The CO/CO₂ ratio can vary in a blast furnace from 1.25:1 to 2.5:1. Higher percentage of CO in the gas makes the BF gas hazardous. The hydrogen content of the gas can vary from 2 % to 5 % depending upon the type and amount of fuel injected of the blast furnace..

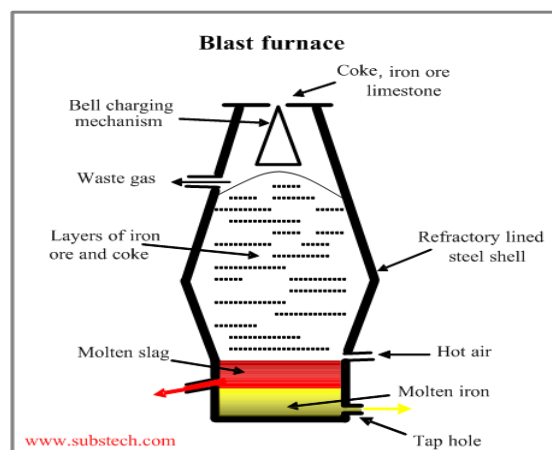


Figure 1:-working process of blast furnace, taken from www.substech.com

Coke oven gas: -Coke oven gas is normally used in coke oven battery heating, heating in other furnaces and for power generation. Coke oven gas can be used as such or can be mixed with BF gas and/or Converter gas before being used as fuel in the furnace. During the carbonization of coking coal in a coke oven battery for the production of coke, around 25-30% of the coal charged is driven off as effluent gases rich in volatile matter and moisture. This gas is known as coke oven gas (CO gas).

Convertor gas: -During the process of steel making in basic oxygen furnace (BOF), converter gas is generated at a rate around 75 to 95 Cum /ton of crude steel. This gas has got a calorific value of 1600 to 1800 Kcal/N Cum of the gas. The composition of converter gas is Carbon mono oxide in the range of 58 % to 65 %, Carbon dioxide in the range of 15 % to 20 %, nitrogen in the range of 15 % to 20 % , hydrogen around 1 % and oxygen around 0.2 %. Density of converter gas is 0.865

Kg/Cum.LD gas is normally mixed with the blast furnace gas in various proportion and the mixed gas is used for heating purpose in various furnaces.



Figure 2:- Hot metal being charged in converter

As we can see in the (fig- 3), pipe is in the **U-shape**. This pipe line is filled with gas which is (both explosive and poisonous) used for different process. This pipe line is spread in whole plant of Steel industries.

If any leakage happened from this pipe or any activities going to be happened in this line, first we filled the water in **U-Shape** pipe line to stop passing the gas from one place to another place (or one line to another line).



Figure 3:- U-Shape pipe connected to gas pipe line.

CONCLUSION

Identification of Chemical Hazards in a STEEL PLANT plays a vital role in preventing Explosions, Fire and Toxic Gas release. HAZOP helps in identifying all the possible hazards and their effects, and source of hazard thereby preventing it. Also, several papers have studied about control system for hazardous chemicals leakage and Sensor and Actuator system is studied.

The various types of gases are used in STEEL PLANT is listed and absorbed the different types of hazardous gases which comes from COKE OVEN GAS. Also studied the typical analysis & properties of these gases in this paper, its gives the more importance to analyse the risk and outcomes of hazards due to gases. Categorisation of different gases in different places also be mentioned in this paper.

Based on the above, it is recommended that during installation/fabrication of piping system for gas pipe line, proper procedures may be implemented, followed by visual inspection through qualified inspector(s) including pre-service and in-service inspection.

REFERENCES

1. Allis, R., Chidsey, T., Gwynn, W., Morgan, C., White, S., Adams, M., Moore, J., 2001. Natural CO₂ reservoirs on the Colorado Plateau and southern Rocky Mountains: Candidates for CO₂ sequestration.

*Proceedings of the First National
Conference on Carbon Sequestration*

2. R. Leon and N. Wayne Green. *An improved technique for the hydrodesulphurization of coal chars.* 1974
3. J. M. Michael and Robert W. Dunlap. *Economics and Alternatives for Sulphur Removal from Coke Oven Gas. Journal of the Air Pollution Control Association.* 1975; 25_10.1019-1027.
4. *National Emission Standards for Hazardous Air Pollutants (NESHAP) for Coke Ovens: Pushing, Quenching, and Battery Stacks -Background Information for Proposed Standards,* 2001.
5. Bhatia S.C. *Environmental Pollution & Control in Chemical Process Industries.* Khanna Publishers. 2001.
6. *Technical EIA Guidance Manual for Coke oven plants (Govt. of India)* 2010; 317-323.
7. H. M. Freeman, "industrial pollution prevention *Handbook*", Mc.GrawHill.Inc., New York, USA, 1995, P 99- 100.
8. Frank Sowa, Bjorn Otten, Johannes Kamp and P. Emanuele, *Advanced Technologies for Desulphurization of Coke Oven Gas.* 2009.
9. Keith Wright, "Coke oven gas treatment, tar, liquor, Ammonia "The coke oven managers' year book. 2005; 222-257.
10. Bhatia S.C. *Environmental Pollution & Control in Chemical Process Industries.* Khanna Publishers. 2001.