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# Estimation of Toxic Gases and Control: Case Study Pakistan Steel Mill, Karachi

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**Abstract:** The study carried out for the period of June to September 2011 at 5 most hazardous departments of Pakistan Steel Mill Karachi, i.e. Steel Making Plant, Iron Making Plant, Coke Oven by Production Plant, Sintering plant and hot Strip Mill, focused the survey on Toxic gases i.e. Carbon Monoxide, Nitrogen Dioxide, Hydrogen Sulphide, Sulfur Dioxide, Chlorine Gas, and Hydrogen Cyanide, by use of particular meters for analysis and control. Carbon monoxide (CO) was found 38-39 ppm in July & August against the standard value of 35 ppm, resulting 11.4% above the acceptable limit. Whereas, chlorine (Cl2) was found 0.6 to 0.8 ppm crossing acceptable limit i.e. 0.5 ppm; for whole survey period at Coke Oven By-Production (COBP) Plant, only resulting 60% beyond the acceptable limit as prescribed by NEQs. During survey about 64% employees were found not satisfied regarding safety measures provided there, resulting most of employees affected by various diseases like, high blood pressure, lung disease, tuber closes, skin disease, asthma, allergy, diabetes, eyes diabetes, depression, hypertension. Environmental Management System (EMS) may be introduced in Pakistan Steel Mill to control toxic emissions in order to overcome negative impacts on employees' health and to improve the working efficiency as well as production.

**Keyword**, Toxic, hazardous, emissions, disease, health, Steel Mill Karachi

## 1. INTRODUCTION

Occupational health and safety are the main concerns of any industry for better performance of employees and production especially in under developed countries. Frequent harms of the industry are poor workplace, structure design, adverse environment, and improper management. That may result in disabilities, poor worker health, thereby reducing worker efficiency and quality (Cunninghama, 2010). The purpose of this study is to promote Health & Safety culture for the people working in polluted environment of steel industry. The employees working in such industrial environment are all the times at greater risk and challenges (Fahim *et al.*, 2010).

## 2. MATERIALS AND METHODS

In order to measure various toxic gases at ground level i.e. Carbon Monoxide, Nitrogen Dioxide, Sulfur Dioxide, Hydrogen Sulphide, Hydrogen Cyanide and Chlorine Gas. The toxic meters / gas detectors used (*Recon Series 2011*) were as under:

| | |
|---|---|
| ***Carbon Monoxide (CO)*** | ***RECON/CO, 02541-1200*** |
| ***Sulfur dioxide ($SO_2$)*** | ***RECON/$SO_2$, 02541-1000*** |
| ***Nitrogen dioxide ($NO_2$)*** | ***RECON/NO2, 02541-1100*** |
| ***Hydrogen Sulfide ($H_2S$) and Hydrogen Cyanide (HCN)*** | ***RECON/HSN, 02541-0200*** |
| ***Chlorine ($CL_2$)*** | ***RECON/CL2, 02541-000*** |

Analysis of toxic gases at ground level, their impact at various departments i.e. Steel Making Plant, Iron Making Plant, Coking oven by production plant, Sintering Plant and Hot Strip Mill of Pakistan Steel Mill Karachi and their remedies upon the health of employees was monilored.

## 3. RESULTS AND DISCUSSION

### Carbon monoxide

Carbon monoxide leaked through the process of iron and steel manufacturing at blast furnace, converter and coke oven etc., is causing acute poisoning during work. Carbon monoxide (CO), often referred as a "silent killer," is an injurious gas and its prolonged exposure to living beings can lead to brain damage and even death. The harmfulness of CO is dependent on both, the concentration of the gas and the exposure time. Thus, a small concentration of the CO when exposed for a large period of time can be fatal just like a large concentration of the CO for a small period of time. Fires are the most common source of CO. In steel mills, where gas fired blast furnaces are used, have a high risk of CO overflow because of the improper combustion of the gas due to a lesser concentration level of oxygen. Thus, continuous exposure to the gas may cause: dizziness, headaches, nausea, contributing to the serious consequences to the health or even death (Hole and Pande, 2009).The results of CO measured during survey at PS are shown graphically in **(Fig 1),** it is observed that CO was found beyond limits in the Coke Oven & By-Production (COBP) Plant during the month of July and August i.e. 38 ppm and 39 ppm respectively against

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threshold limit value of 35 ppm, but in other departments the CO was found within acceptable limits, it is also observed that long exposure of CO near threshold limit value in COBP and Sintering Plants may harm to the employees' health.

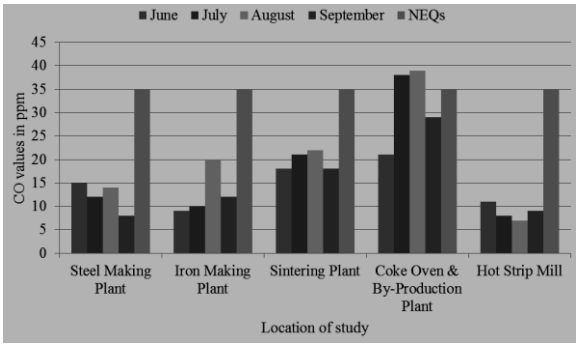


**Fig. 1 Graphical presentation of Carbon monoxide (CO)**

## Sulfur dioxide ($SO_2$)

Sulfur dioxide ($SO_2$) is a non-combustible, colorless toxic gas. The largest man-made sources of sulphur dioxide are fossil fuel combustion and coal burning from manufacturing of iron and steel. The major health problems associated with long exposure of sulphur dioxide includes harmful effects on breathing, alterations in pulmonary defenses, respiratory illness, and intensification of existing cardiovascular disease. The higher concentration above 400–500 ppm if inhaled for a period of few minutes can be fatal (Rafiei, *et al.*, 2009). The sulphur dioxide in atmosphere mixed with water vapor produces sulphuric acid and causes the acid rains. The average results of Sulfur Dioxide ($SO_2$) measured at Pakistan Steel Mills various departments are illustrated in **(Fig. 2)**, it is observed that $SO_2$ was found within limits but it is near the threshold limit value i.e. 2 ppm in the Coke Oven & By-Production (COBP) and Sintering Plants, it is observed that long exposure of $SO_2$ near threshold limit value in COBP and Sintering Plants.

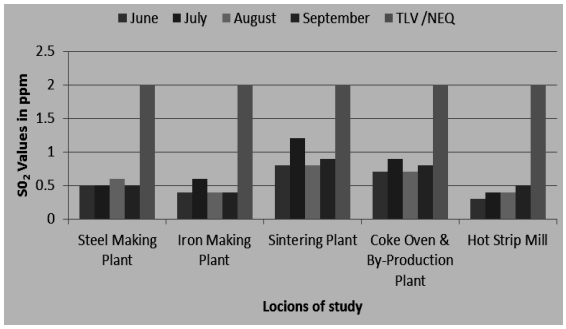


**Fig. 2. Graphical presentation of Sulfur Dioxide ($SO_2$)**

## Nitrogen dioxide ($NO_2$)

Nitrogen dioxide ($NO_2$) gas has a reddish-brown color and a bitter odor. The sources of $NO_2$ are various industrial operations of iron and steel production. Breathing in nitrogen dioxide is toxic; its exposure can irritate the respiratory tract and lungs at low concentrations (Rafiei, *et al.*, 2008).. Exposure of Nitrogen dioxide in poorly ventilated or enclosed areas can cause suffocation and smothering. Prolonged exposure can cause numbness, decrease in mental performance and create other health problems. The average values of Nitrogen Dioxide ($NO_2$) measured during survey of various departments at Pakistan Steel Mill are shown in **(Fig. 3).** the results are within threshold limits but even very small increase in $NO_2$ release is dangerous.

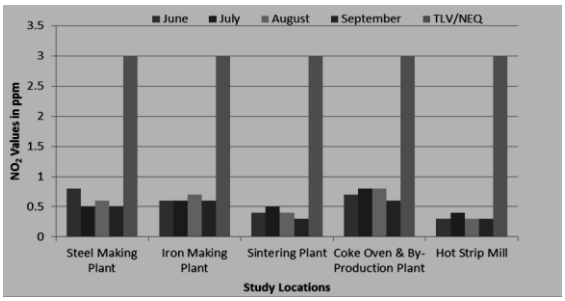


**Fig: 3. Graphical presentation of Nitrogen Dioxide ($NO_2$)**

## Hydrogen sulfide ($H_2S$)

Hydrogen sulfide ($H_2S$) is formed by mixing sulfur with hydrogen gas and heating it at 450 C°. It is a by-product of many industrial operations, such as iron smelters, coke ovens, petroleum refineries and petrochemical plants. In Iron and Steel manufacturing, Hydrogen sulfide is used to coat iron and steel, it helps to prevent iron and steel from rusting. Hydrogen sulfide ($H_2S$) is a very toxic gas, possesses a severe inhalation hazards [1a]. Its exposure may cause nose, throat & lung irritation, cough, headache, hoarseness, shortness of breath, digestive upset and loss of appetite. The average values of Hydrogen Supplied ($H_2S$) during survey of various departments at Pakistan Steel Mill are shown in **(Fig. 4)**. The results are within limits and have no any alarming situation regarding $H_2S$ release in the mentioned departments, but even a small increase of $H_2S$ quantity for long time exposure may cause problems and diseases to the employees.

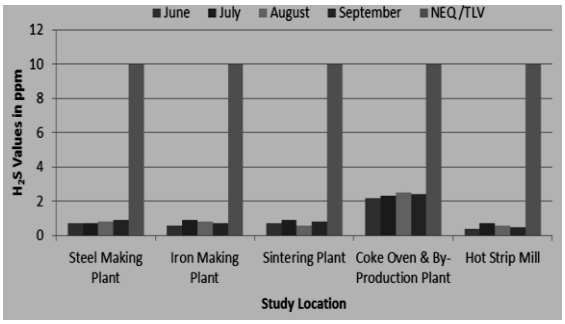


**Fig. 4. Graphical presentation of Hydrogen Supplied ($H_2S$)**

**Hydrogen cyanide (HCN)**

Hydrogen cyanide (HCN) is extremely toxic gas, if absorbed through lungs, eyes or skin. The signs of hydrogen cyanide exposure in smaller concentrations cause nausea, salivation, vomiting, hypertension, dyspnea, dizziness, weak pulse, confusion, anxiety, stiffness of the jaw, gasping, blindness, damage optic retina, suffocation, sudden loss of consciousness and death (Somavia, 2005). The average values of Hydrogen Cyanide (HCN) measured during survey of various departments at Pakistan Steel Mill are shown in **(Fig. 5)**. The results are within acceptable limits but as HCN is highly toxic gas therefore its release of small concentration is dangerous for the people working in that environment for a prolonged exposure.

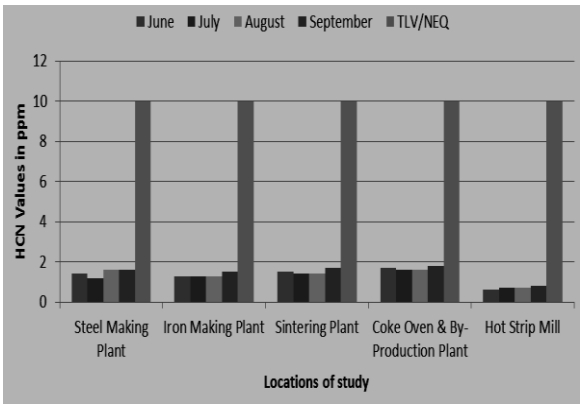


**Fig..5. Graphical presentation of Hydrogen Cyanide (HCN)**

**Chlorine ($Cl_2$)**

Chlorine ($Cl_2$) is a poisonous gas; its exposure may bother the respiratory system. It has a tendency to accumulate at the bottom of non-ventilated spaces due to being denser than air. Chlorine gas may react with flammable materials as it is strong oxidizer. It is detectable with concentrations of as low as 0.2 ppm, and at 3 ppm by smell. Its exposure at 30 ppm may cause vomiting, coughing and at 60 ppm may damage lungs. Chlorine gas can be fatal at about 1000 ppm after a few deep breaths. Its lower concentration breathing can irritate the respiratory system, and its direct exposure to eyes can harm the eye sight. The chlorine mixed with water is not a dangerous for human health (Shah, *et al.*, 2010). The results of Chlorine Gas (Cl2) measured during survey at Pakistan Steel Mill are shown in **(Fig. 6)**, it is observed that Chlorine Gas (Cl2) was found beyond limits in the Coke Oven & By-Production (COBP) Plant during the months of June, August and September i.e. 0.7 ppm, 0.6 ppm and 0.8 ppm respectively against standard value of 0.5 ppm, but in other departments the Chlorine Gas (Cl2) was found within acceptable limits.

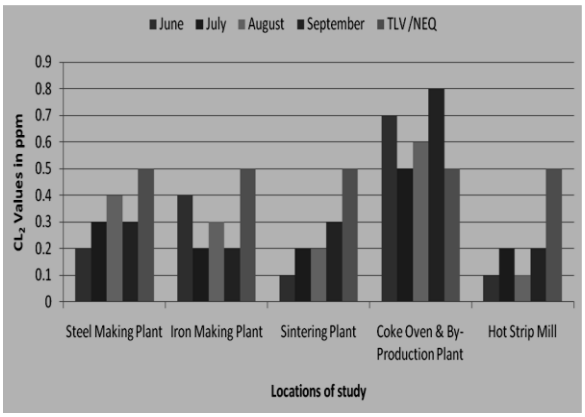


**Fig..6. Graphical presentation of Chlorine Gas ($Cl_2$)**

**Public Opinion**

The employees' opinion showing over all safety awareness and measures taken at Pakistan Steel Mill Karachi found 16 % employees agreed, 20 % were unknown, 64 % were disagreed, shown in **(Fig 7)**.

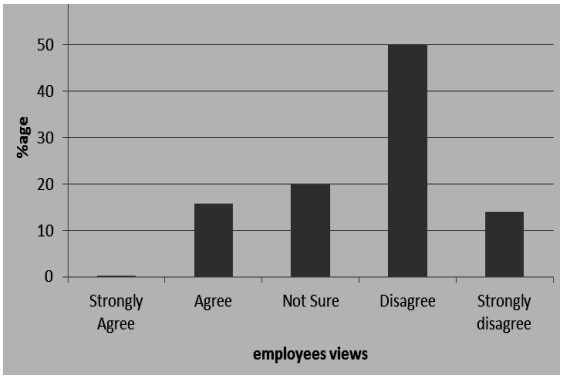


**Fig. 7. Graphical presentation of Employees Safety Survey**

## 4. CONCLUSION

Analysis shows that Carbon monoxide (CO) released is 38, 39 ppm in July and August and is crossing the standard value of 35 ppm, resulting 11.4% above the acceptable limit. Whereas chlorine (Cl2) was found to be 0.6 to 0.8 ppm crossing acceptable limits i.e. 0.5 ppm for whole survey period at Coke Oven & By-Production (COBP) Plant. Only resulting 60% beyond the acceptable limits as prescribed by NEQs. During survey about 64% employees were not satisfied in regard of safety measures provided there, resulting most of employees affected by various diseases like, High blood pressure, Lung disease, T.B., Skin disease, Asthma, Allergy, Diabetes, eyesight weak, Depression, hypertension. Environmental Management System (EMS) can be establishing in Pakistan Steel Mill to control toxic emissions, in order to overcome health impacts on employees and improve the working efficiency as well as production.

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