Original Article

MONITORING AIRBORNE IRON OXIDE FUMES IN BEAM ROLLING MILLS FACTORY, IN AHWAZ, IRAN

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ABSTRACT

Objectives: To determine the indoor iron Oxide (FeO) concentrations in two production lines 630 and 650 and compare them with REL- NIOSH.

Methodology: National Institute for Occupational Safety and Hygiene (NIOSH) No 550 is used for the determination of FeO concentrations in Beam Rolling Mills Factory. The total size sample was 80 for indoor FeO in each production line 630 and 650 respectively. Samples (FeO) were collected using low volume sampling pump operated at flow rate of 2 L/min-1 on membrane filters with pore size 0.5 micrometer and 27mm diameter. CTA 3000 Atomic Absorption Spectrophotometer was used.

Results: There is a significant difference between mean FeO concentrations in lines 650, 630 and NIOSH (5 mg/m^3) ($P< 0.05$).

Conclusion: It is not a serious health problem for workers. 100% Mean value of Iron oxide concentrations i.e., 20 stations in production lines 650 and 630 are at a safe level.

KEY WORDS: Iron oxide fumes, Pollutant, Monitoring, Beam Rolling Mills Factory.

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INTRODUCTION

Beam Rolling Mills Factory was erected in Ahwaz in 1963. It aimed at producing various types of plain and ribbed bar and angles. The Beam Rolling Mills Factory has two production lines 630 and 650 with nominal capacity of 190,000 and 195,000 ton per year, respectively and is capable of producing various types of beams. This production line has two furnaces with a capacity of 20 and 40 tons per hour, and the raw materials in this line consist of billets with dimensions of 200, 200, 130 and 130 mms with a length of 4m, and with approximate weight of 515 to 1220kg. The factory where this study was conducted had 481 workers.[1] The study objective was to determine the indoor iron Oxide (FeO) concentrations in two production lines 630 and 650 and compare

them with Recommended Exposure Limits-National Institute of Occupational Safety and Health (REL- NIOSH) standard.[2]

Some studies have been conducted on facilities with workers exposure to iron oxide and other substances such as silica, radon gas, diesel exhaust, corn oils, and thermal decomposition products of synthetic resins. However, OSHA agrees with the ACGIH that, "at this time, it is not generally accepted that exposure to iron oxide dust or fume causes cancer in man" and concluded that exposure to iron oxide, dust and fume is not carcinogenic.[3-5]

The American Iron and Steel Institute described siderosis as "simply a description of a condition that appears on radiographs". OSHA disagrees with Mr. Hernandez' statement, assessment of the health effects is potentially associated with exposure to iron oxide", because the Agency believes that any occupational exposure that causes foreign substance to lodge in to body tissues is undesirable. However, the Agency concurs with NIOSH's Dr. Brooks that additional research is necessary to determine why the lung is unable to clear iron-containing dusts after inhalation.[6]

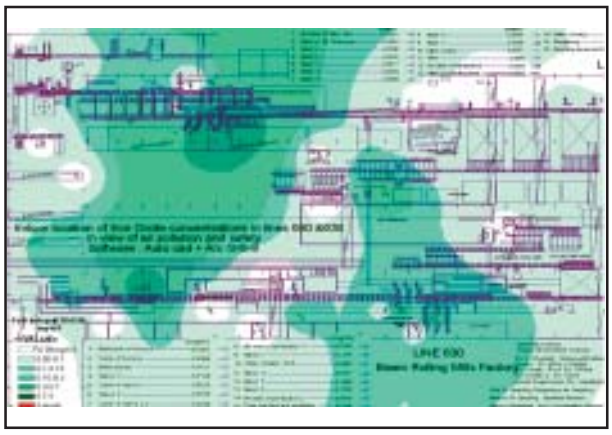
Accordingly, OSHA finds it appropriate to retain the Agency's former PEL for iron oxide dust and fume of 10mg/m,[3] measured as total particulate.[7]

METHODOLOGY

National Institute for Occupational Safety and Hygiene (NIOSH) No 550 is used for the determination of FeO concentrations in Beam Rolling Mills Factory. In the period of 8 hour four samples of FeO are taken in each sampling station. The time of sampling was 50 minutes for FeO. The total size sample was 80 for indoor FeO in each production line 650 and 630 respectively.[3,8]

Calibration of flow rate pump was carried out with an electronic bubble meter (Dry cal DC- Lit Bios. England) and curved line of calibration was obtained. During sampling from workers respiratory area, climatic parameters (temperature, relative humidity, air pressure) were recorded. Samples (FeO) were collected using low volume sampling pump (SKC, England) operated at flow rate of 2L/min-1 on membrane filters with pore size 0.5 micrometer and 27mm diameter. In production line 650, numbers of FeO concentrations were 16 samples with number of replications four times in duration of eight hours. In line 630, the numbers of FeO concentrations were 15 samples with number of replications four times.

Reagents: Reagent grade chemicals were used. Concentrated HCl (32%, e.g kg/L, Merck, Germany), concentrated HNO_3, concentrated $HClO_4$ and concentrated H_2SO_4 (Merck, Germany) were used to dissolve the filters containing metal samples. Stock solutions of 1000microgram/mL of Fe were purchased from Chem. Tech analytical (made in UK). Standard solutions of each metal were prepared by successive dilution of these stock solutions. Before use, all the glasswares were cleaned with a detergent, rinsed with distilled water, soaked in 1:1 HNO_3, rinsed in distilled water and then dried. 100 microgram/ml Fe was prepared by adding 10ml of stock solution (1000mg/ml) with Calibration standards, 0.5, 1, 2.5, 5, 7.5, 10microgram/ml were prepared by diluting appropriate amount of this solution. The calibration standards were aspirated in the air/acetylene flame and the resulting absorbances were recorded. Calibration curve was constructed by plotting absorbance versus metal



Plan-1: Location Evaluation of FeO Concentrations in Lines 630 and 650

Table-I: Comparison mean value of FeO concentration* of separation in lines 630 & 650 with NIOSH standard for 8 hours in terms of mg/m^3.

Source	No. of sampling	No. of station	Mean	Standard deviation	P-value	95% CI	
						Lower	Upper
630	38	13	0.90	± 0.11	0.001	-4.96	-4.23
650	54	17	0.14	± 0.23	0.001	-4.97	-4.84

P<0.05

* Air Respiratory Zone NIOSH std. = 5 mg/m^3 Replication= 2-4 Statistical Method. T- test

concentration. The best straight line for data was calculated and drawn by the instrument software. This line was used to determine the concentration of iron in the samples.

Sample preparation: The samples and blank filters (one blank for each of the 10 samples) were transferred to 25ml beakers. Enough blank for each of the 10 samples) were transferred to 25ml beakers. Sufficient volume of concentrated HNO_3 was added to cover the filter. Each beaker was covered with watch glass and placed on a hot plate (140^{o}C) in a fume hood. Ten 10 minute was sufficient for most samples to digest the residue. The samples were dissolved and a light yellow solution was obtained. In cases where the samples did not dissolve till 30 minutes in concentrated HNO_3, hydrochloric acid, mixed nitric acid and sulfuric acid were used. The digested samples were transferred to 10ml volumetric flask and diluted to the mark. The concentrations of iron in sample solutions were determined using the above calibration curve. Calibration curve were constructed by plotting absorbance versus metal concentration. The best straight line for data were calculated and drawn by the instrument software. This line was used to determine the concentration of iron in the samples. CTA 3000 Atomic Absorption Spectrophotometer (ChemTech Analytical Instruments Limited, UK) was used. Air/acetylene flame was used for the quantitative determination of iron.[9]

RESULTS

There is a significant difference between mean FeO concentrations in lines 650, 630 and NIOSH standard value (5mg/m^3) (P< 0.05). The average of FeO concentration in lines 650 and 630 is 0.23 and 0.11mg/m^3, respectively, with confidence interval of 95% which is much lower than NIOSH standard value (Table-I). Because, after doing different phases of milling process, there is an erosion of oxides on the billets. As the result, airborne iron oxide fumes decrease in worker's respiratory air zone. Meanwhile, there are differences in calibrations and number of stands in line 650 and 630.

A maximum FeO concentration is found in station Stand number seven, station cabin of stand number one for line 650 and 630 0.82, 0.42mg/m^{-3}, respectively. It is much lower than NIOSH value standard (5mg/m^3), (Table-II&III) (Fig-1&2) because, Stand 7 is located next to/ near stands four five and six. By considering the wind direction, iron oxide fumes in stand 7 for line 650 is higher than in stand number one for line 630. At a result, it is not a serious health problem for workers.

DISCUSSION

Hundred percent mean value of Iron oxide concentrations i.e. 20 stations in production lines 650 and 630 are at a safe level (Plan-1). The average of FeO concentration in lines 650

Table-II: Indoor mean and standard deviation value of Iron oxide concentrations in production line 630 (mg/m^3).

Source	No. of sampling	No. of station	Mean	Standard deviation	P-value	95% CI	
						Lower	Upper
630	38	13	0.12	± 0.13	0.005	0.04	0.20

P<0.05

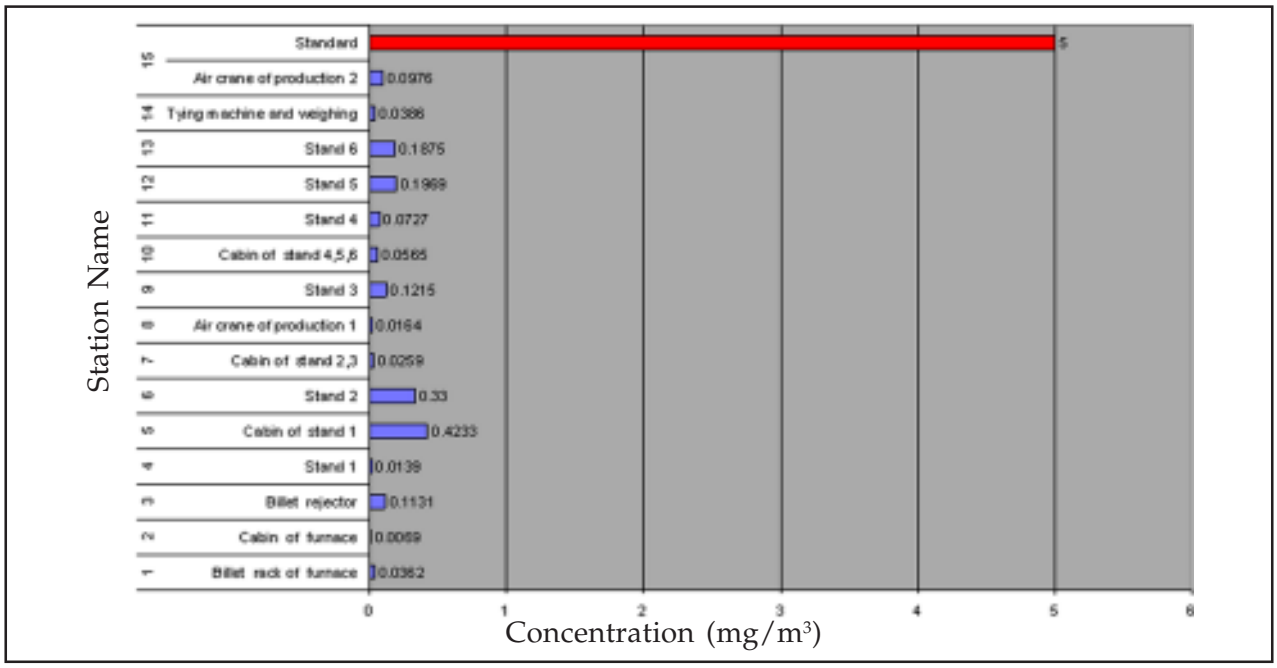


Figure-1: Comparison mean value of FeO Concentrations with NIOSH standard for 8 Hours in Line 630 of different Stations

and 630 is 0.23 and 0.11mg/m^3, respectively, with confidence interval of 95% which is much lower than NIOSH standard value (Table-II&III), because, after doing different phases of milling process, there is an erosion of oxides on the billets. In other words, after cutting the beam by saws, it is carried out with water pressure at 150 Bar and immersed in cooling beds, the temperature decreases from 550°C to 150°C. As the result, airborne iron oxide fumes decrease in worker's respiratory air zone. Meanwhile, there are differences in calibrations and number of stands in line 650 and 630. A maximum FeO concentration is found

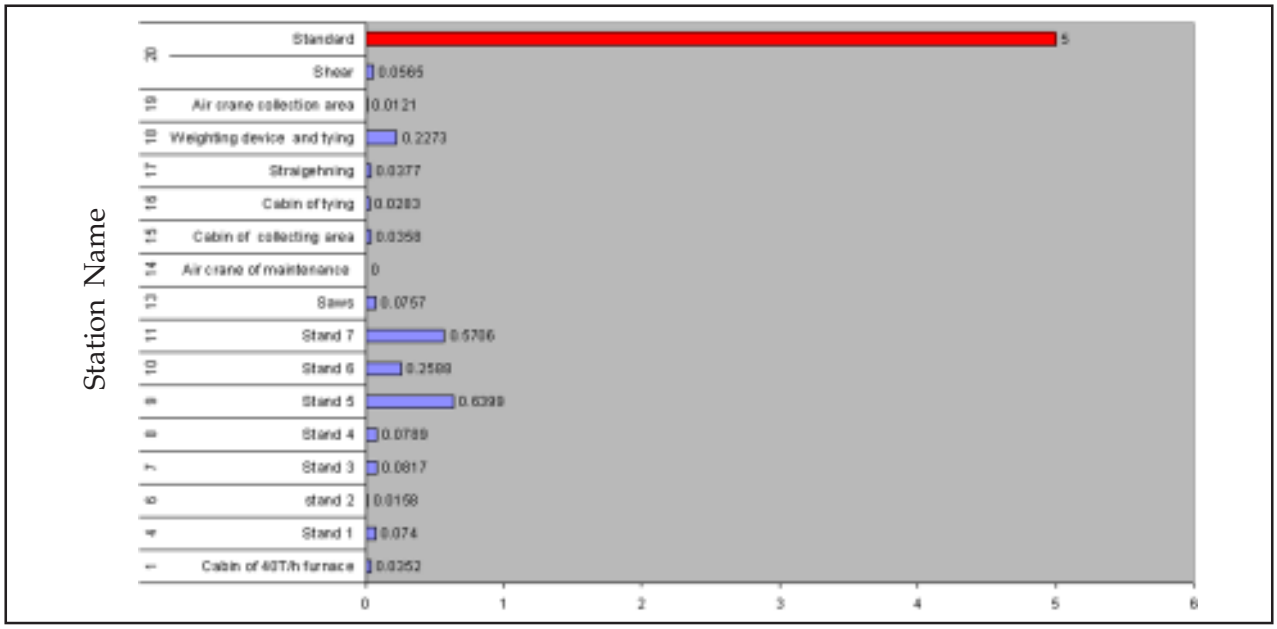


Figure-2: Comparison Iron oxide Concentrations among Sampling Stations in Line 650

Table-III: Indoor mean and standard deviation value of Iron oxide concentrations in production line 650 (mg/m^3).

Source	*No. of sampling*	*No. of station*	*Mean*	*Standard deviation*	*P-value*	*95% CI*	
						Lower	*Upper*
650	54	17	0.12	± 0.19	0.014	0.29	0.22

P<0.05

in station Stand number 7, station cabin of stand no. one for line 650 and 630 0.82, 0.42mg/m^{-3}, respectively, it is much lower than NIOSH value standard (5mg/m^3), because, Stand 7 is located next to/ near stands 4, 5 and 6. By considering the wind direction, iron oxide fumes in stand 7 for line 650 is higher than in Stand No. one for line 630. As a result, it is not a serious health problem for workers. Management should look into these facts and should take corrective measurers for the well being of the workers. The workers must be educated to use personal protective equipments i.e. respiratory mask etc. There is a significant difference between mean FeO concentrations in lines 650, 630 and NIOSH standard value (5 mg/m^3) (P< 0.05).

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