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Assessment of Indoor Airborne Pollutants of Beam Rolling Mills Factory

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ABSTRACT: Air pollutants from iron and steel making operations have historically been an environmental concern. The factory located at Ahwaz, Iran, has two production lines namely, 630 and 650, which produce iron parallel edge. The objective of the study is to determine indoor respiratory particulate matter (RPM) and FeO concentrations and their comparison with NIOSH standards. This is a cross–sectional study of personnel working in different environmental conditions. There were significant differences in mean concentrations of RPM ($P< 0.05$) in line 650 but not in line 630 as compared to NOISH standard (3 mg/m^3). The FeO concentrations in line 630 and 650 are significantly lower than the NIOSH standard (5 mg/m^3). There is maximum FeO concentration in station 7 (0.8 mg/m^3), due to remains of iron on the billets. In other words, after cutting the beam by saws, carried out with water pressure of 150 Bar and immersing in cooling beds, the temperature decreases from 550 °C to 150 °C. As the result, airborne iron oxide concentrations decrease in the respiratory air zone of workers. There is maximum RPM concentration in station of Billet rejecter for line 630 (7.645 $^{mg}/m^3$), because this station carries out peel action on metal. The primary form of RPM is not directly related to the iron handling but may be related to improper ventilation and exhaust system.

Key words: RPM, FeO, Airborne, Beam Rolling Mills

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INTRODUCTION

Air pollutants from iron and steel making operations include gaseous substances such as oxides of sulfur, nitrogen dioxide and carbon monoxide. In addition, particulates such as soot and dust, which may contain iron oxides, have been the focus of control. Particulate matter (PM) is the general term used for a mixture of solid particles and liquid droplets found in the air. These particles, which come in a wide range of sizes, originate from many different stationary and mobile sources as well as from natural sources. They may be emitted directly from a source or formed in the atmosphere by the transformation of gaseous emissions. Their composition varies with place, season and meteorology (Colls, 2002). Potential health effects depend on the number of particles in the respire range, the chemical composition of the dust and the duration and concentration of exposure. Particles in the atmosphere consist of either solid particles or fine liquid droplets. The greatest effect on health is from particles 10 microns (PM-10) or less in diameter, which can cause and aggravate bronchitis, asthma and other respiratory diseases. Because of the importance of determination of these pollutants, many researchers have tried to evaluate the work places (Hester and Harrison, 1999). Woskie *et al.*, (2002) collected samples for dust, diesel exhaust, quartz, and welding fumes from highway and highway construction workers. Respire quartz exposures exceeded the National Institute for Occupational Safety and Health (NIOSH) norms.(Woskie, *et al.*, 2002 and Kemp *et al.*, 2003). The objective of the present study is to determine indoor respiratory particulate matter and FeO concentrations and their comparison with NIOSH standard. The factory (Iran National Steel Industrial Group – Ahwaz) under study has two production lines namely, 630 and 650, which produce iron parallel edge. This is a cross – sectional study of workers working in different environmental conditions.

MATERIAL & METHODS

Twenty stations in each line 630 and 650 were selected. The instrument measuring RPM and iron oxide were fixed on the workers body in respiratory zone. Total sample size for RPM and FeO fumes was 20 and 17 in line 650, 20 and 13 in line 630 respectively. Air samples were collected using low volume sampling pump (model SKC, made in England) operated at flow rate of 2 L/min^{-1} on membrane filters of pore size 0.5 micrometer and diameter 27mm. Then analytical balance with 0.01 mg precision was used (Swiss make and model no. XT220A-Pecisa; NIOSH, 1997 & ASTM, 1996). The samples of iron oxide content were determined by Atomic Absorption Spectrophotometer method using CTA 3000 Atomic Absorption Spectrophotometer (ChemTech Analytical Instruments Limited, UK) equipped with Air/acetylene flame.

Reagent grade chemicals were used. Concentrated HCl (32%, Merck, Germany), concentrated HNO_3 (Merck, Germany), concentrated $HClO_4$ (Merck, Germany), and concentrated H_2SO_4 (Merck, Germany) were used to dissolve the filters containing metal samples. Stock solutions of 1000 $microgram/mL^{-1}$ 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 glassware were cleaned with a detergent, rinsed with distilled water, soaked in 1:1 HNO3, rinsed in distilled water and then dried. 100 microgram/ml Fe was prepared by adding 10 ml of stock solution (1000 mg/ml) with Calibration standards, 0.5, 1, 2.5, 5, 7.5; 10 microgram /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 concentration. The best fit line for data was calculated and drawn by the instrument software. This line was used to determine the concentration of iron in the samples (NIOSH, 1997 & ASTM, 1996).

The samples and blank filters were transferred into 25 mL beakers. Each beaker was covered with watch glass and placed on a hot plate (140 ^{0}C) in a fume hood. The samples were dissolved and a light yellow solution was obtained. The digested samples were transferred to 10 mL volumetric flask and diluted to the volume the concentrations of iron in sample solutions were determined using the above calibration curve (NIOSH, 1997 & ASTM, 1996).

RESULTS & DISCUSSIONS

Table 1 shows difference between mean RPM concentrations in line 650 and NIOSH standard value (3 mg/m^{-3}) ($P< 0.05$). It is higher than the standard. The mean value of RPM concentrations was in 630 and 650 lines (3.09 and 3.78 $mg/m^{-3)}$ respectively. Figure 1 illustrates maximum RPM concentration in station of Cabin of saws and minimum RPM concentration in station Stand 2 for line 650 (6.32 and 2.11 $mg/m^{-3)}$ respectively. Figure 2 illustrates maximum RPM concentration in station of Billet rejecter and minimum RPM concentration in station Stand 4 for line 630 (7.64 and 1.65 mg/m^{-3}) respectively. Table 2 summarizes the results of comparison of the mean of respire iron oxide concentrations with NIOSH standard value (5 mg/m^{-3}). There is a significant difference between mean FeO concentrations in line 650 and NIOSH standard value ($P< 0.05$). It is much lower than the standard. The mean value of FeO concentrations was in 630 and 650 lines (0.90 and 0.14 mg/m^{-3}) respectively. Figure 3 illustrates that maximum FeO concentration for station of Stand 7 and minimum FeO concentration in station Saws for line 650 (0.82 and 0.0 mg/m^{-3}), respectively. Figure 4 illustrates maximum FeO concentration in station of Cabin of stand 1 and minimum FeO concentration in station Cabin of furnace for line 630 (0.42 and 0 mg/m^{-3}) respectively.

CONCLUSION

Table 1 illustrates, the mean of RPM concentrations in respiratory air zone are significantly different ($P< 0.05$) in line 650 but not in line 630 as compared to NIOSH standard

Table1. Comparison of mean concentration values of RPM* with NIOSH (mg/m³)

Source	Number of sampling	Mean	Standard deviation	P- Value	95% CI		
					Lower	Upper	NIOSH standard
Line 630	20	3.09	±1.43	0.76	-7.57	-6.23	3
Line 650	20	3.78	±1.03	0.03	0.30	1.26	

*Respiratory particulate matter

Table 2. Comparison of mean concentration values of FeO* with NIOSH (mg/m³)

Source	Number of sampling	Mean	Standard deviation	P- value	95% CI		
					Lower	Upper	NIOSH standard
630	13	0.90	±0.11	0.001	-4.96	-4.23	5
650	17	0.14	±0.23	0.001	-4.97	-4.84	

(3 mg/m^3). The reason lies behind two furnaces of 20 and 40 tonnage in line 650, but, there is one furnace in line 630. In final mills actions in line650, there are four numbers of working stands and saw machines, but in line 630, there are three numbers of working stands and one saw machine. As a result, the average of RPM concentrations in line 650 (3.78 mg/m^3) is higher than line 630 (3.09 mg/m^3) with interval confidence of 95%. As depicted in fig. 1, there is a maximum concentration in station number 1 for Cabin of Saws in line 650 (6.32 mg/m^3). The iron cutting carried out by four saw machines that are located around the station 13 can be the major reason. High speed of the saws that generate high air velocity can cause turbulence in the air and due to this the dust does not settle fast. Meanwhile miss location of SawsCabins, push particulate pollutants in toworking environment. Fig. 2 illustrates, that there is a maximum RPM concentration in station of Billet rejecter in line 630 (7.645 mg/m^3). As Billet rejecter carries out peel action on metal and primary stand in one hand and proximity to entrance, billet storage and transport plat form, on the other hand, the pollution load in this station is more than other stations. Processing of production results in emission of some particulate matter.

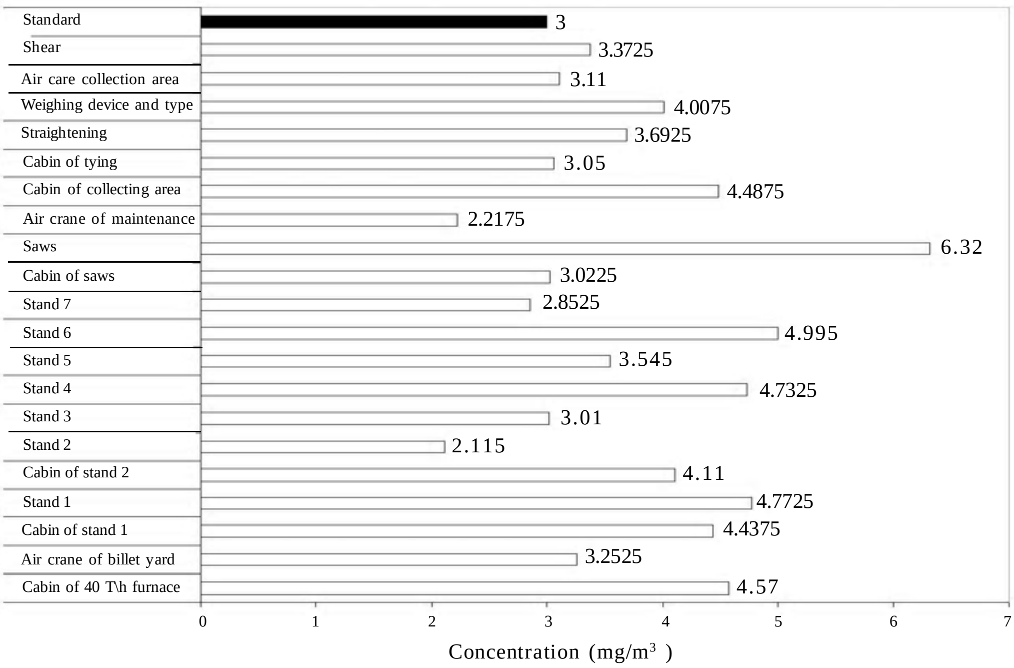

Fig. 1. Comparison of RPM Concentrations with NIOSH Standard in Line 650

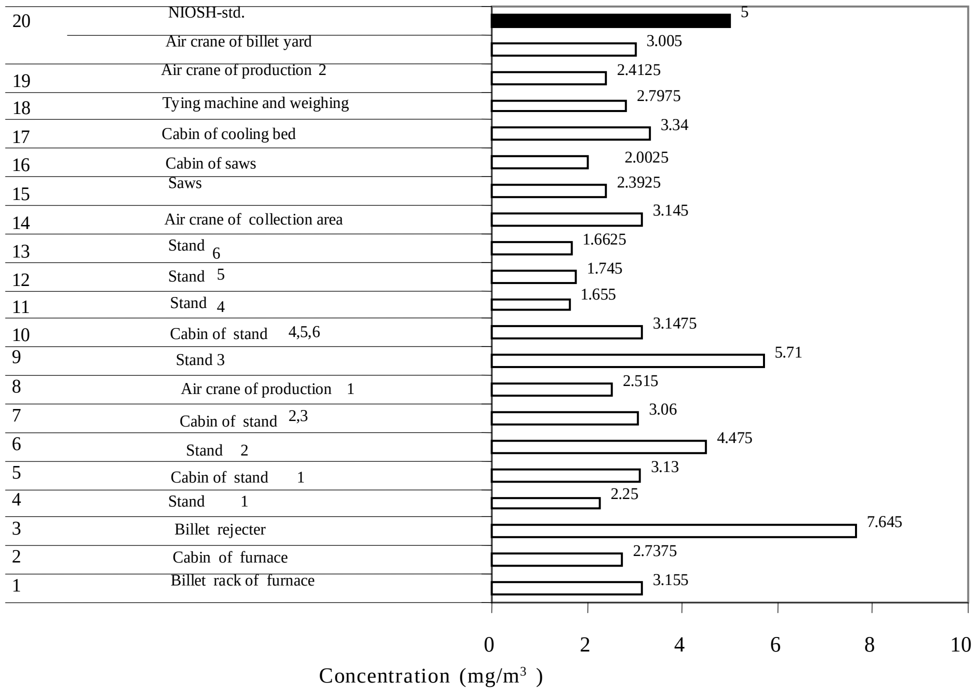

Fig. 2. Comparison of Mean value RPM Concentrations with NIOSH Standard in Line 630

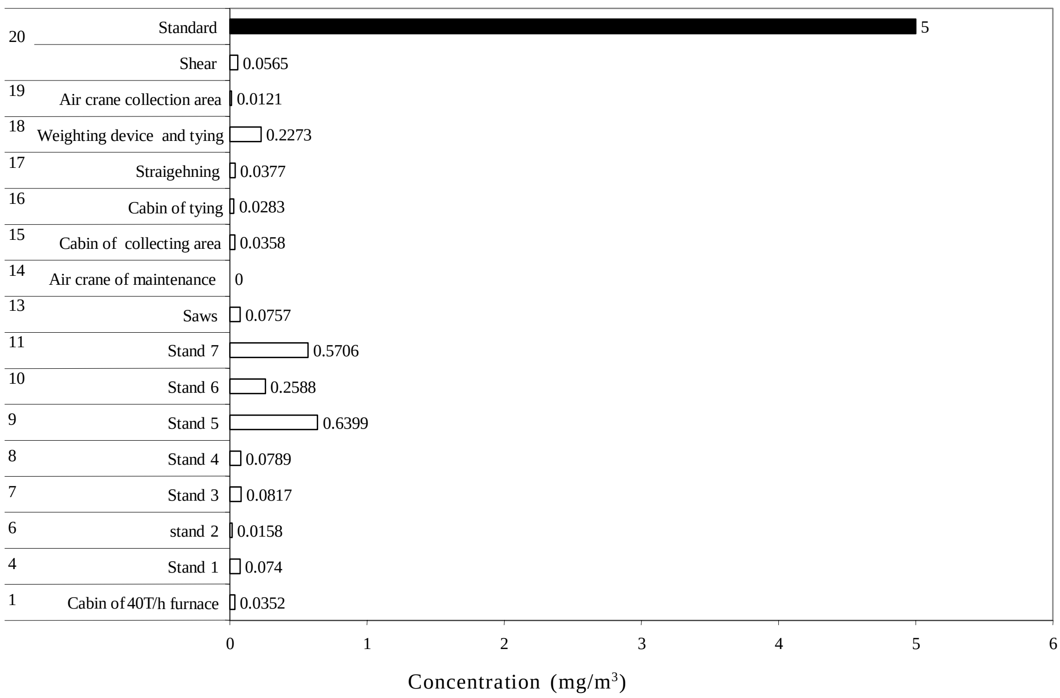

Fig. 3. Comparison of FeO Concentrations with NIOSH Standard in Line 650 in terms of mg/m^3

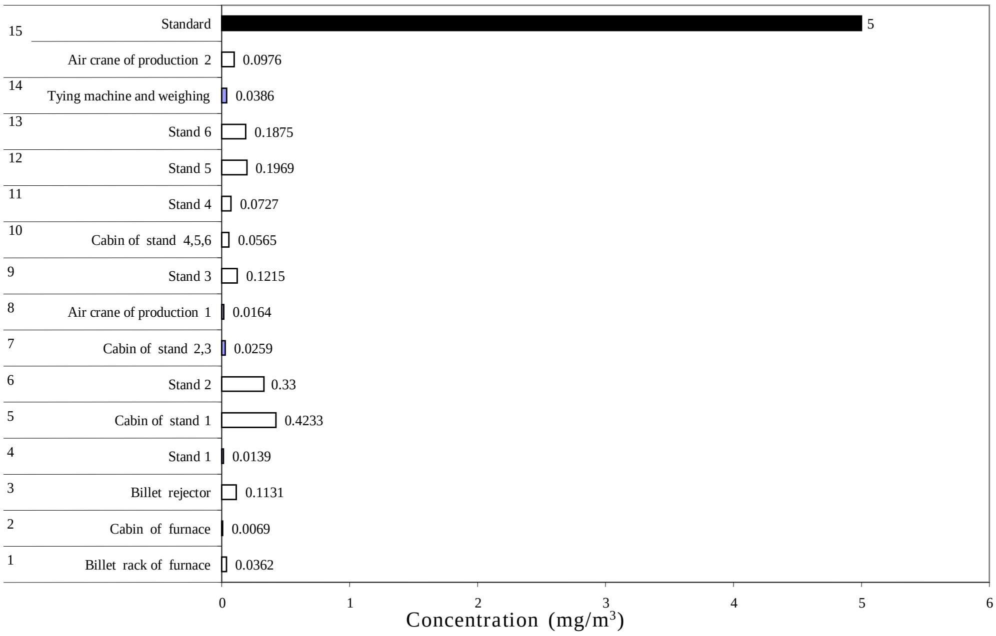

Fig. 4. Comparison of FeO Concentrations with NIOSH Standard in Line 630 in terms of mg/m^3

The average FeO concentrations in lines 650 and 630 (0.23 and 0.11 mg/m^3) respectively with interval confidence of 95% which is much lower than NIOSH value standard. Due to temperature decreases from 550 °C to150 °C, airborne iron oxide fumes decrease in worker's respiratory air zone. Considering the wind direction, Iron oxide fumes in Stand 7 of line 650 are higher than in stand 1 of line 630. As a result, it is not a serious problem on health of workers.Therefore, it can be concluded that pollution load is more in RPM. It is recommended that the equipment of all sampling workstations, especially in stations of Air crane cabin of Billet yard, Cabin of stands 2, 3, 4, 5, 6, and Billet rejecter be house kept and corrected. The workers should be trained to use personal protective equipments including respiratory mask.

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