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Determination of air pollution status in Iran Central Iron Ore Company, Bafgh/Summer 2013

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ABSTRACT

Without a doubt the most comprehensive way to achieve sustainable development, is environmental protection and control environmental pollutions. This study was carried out to determine the status of air pollution in Iran Central Iron Ore Company in the summer of 1392 in the desert area Bafgh. Air sampling of the company performed at 11-point and parameters Co, No, No2, So2 and H2s was measured. Then resulting data evaluated using SPSS and Excel software. The results showed that the contamination factor (PI) for all parameters measured at the level of 100% of sample contamination is low. Also according to the IPI and MCd index, all of contamination measured showed very low levels of pollution. In general, air of Iran Central Iron Ore Company, in turn measured summer 92 has no pollutant. However, it is suggested changes to check and monitor the pollution in different seasons.

Keywords: *Air pollution, Bafgh, PI, IPI, MCd.*

INTRODUCTION

Investigation of the environmental effects of extraction and processing of mineral resources has become an indispensable part of feasibility studies or mineral projects in developing countries. In recent years, increased activities of extraction and processing of metals has given rise to the intensification of environmental pollutions. The first step in finding a remedy and preventing the development of this plight is gaining knowledge about the extent and status of the pollution (1). Environmental pollutions such as air pollution are among the most important challenges facing industrial and developing societies. Air pollution is the presence of one or several pollutants in the open air such as gases, vapors, dust, odor, concentrated smog, and mist with sufficient quantity, properties, and retention time that is harmful to the lives of humans, animals, and plants as well as properties, or unacceptably inhibits convenient use of life and properties (4).

Extraction and exploitation from mines is one of the emission sources of dust and air pollution. Its resulting air pollution is also related to drilling, blasting, loading and unloading, crushing, and graining operations. The transportation of prospecting vehicles along with trucks also intensifies this phenomenon.

Air pollutions and the role of numerous industries in developing them have been explored by many researchers. Zakerian et al. (2002) investigated the quantitative distribution of gas pollutants and dust of coal in the Eastern Alborz Coal Mine of Shahrood. This study revealed that the level of dust is several times more than the allowable limit across various parts of the mine (9).

According to the study of Molashahi, et al. (2012), titled "Air pollution zoning using a novel magnetometric method on tree leaves in Tehran's area", it was revealed that the regions located in South east of Tehran were among the most polluted. Among the 22 regions of Tehran, regions 14 and 15 were identified to be the most polluted regions (6).

Rezaipoor et al. (2015) examined the air pollution status of Iranian Central Iron Ore Company located in the desert region of Bafgh in June 2012. They concluded that the air of this region was free of any kind of pollution in June 2012 (7).
Hashemi and Akbari (2012) studied the zoning of oil contaminants in Persian Gulf using remote sensing technologies and the geographical information system. They found that the pollution source might be stemming from the Persian Gulf War, since the maps clearly indicate the density of pollution in the northwest of the Persian Gulf (5).
Delkhosh and SeifAghaei (2004) investigated the amount of coal particles emitted from air in the workplace and Damghan's coal mine. They revealed that the level of air pollution in the studied regions is far beyond the allowable limit, thus requiring effective and immediate measures to eliminate the pollution (3).
The Iran Central Iron Ore Company – Bafgh (Choghart) is one of the iron ore mines in the center of Iran extracted through the open pit method. The aim of this study was to determine the air pollution status within the range of the Central Iron Ore Company situated in the desert region of Bafgh, in order to implement controlling measures more effectively in the emission centers.

MATERIALS AND METHODS

Studied Region

Bafgh City with a population of about 50000 people is located 120 km south east of Yazd. The climate of Bafgh is warm and dry such that the maximum and minimum temperatures have been recorded to be 50 and -15 degrees in summers and winters, respectively. Precipitation in this city is largely in the form of rainfall and is 55.7 mm per year, on average. Bafgh is one of the cities possessing rich mines in Iran including Choghart Iron ore, Asphordi phosphate, as well as the lead and Zinc of Kushk. The Iran Central Iron Ore Company (Choghart Mine) is situated 7 km off the Bafgh City within the range of northern 31 °40' 30" and 31 °43' 30" and eastern 55 °25' 40" and 55 °29' 40".

Mine extraction is selectively done using open pit and staircase methods. After dividing the mine into specific blocks and drilling pits with diameters of 165, 115, and 200 mm using percussion and rotary pneumatic drilling instruments, the blasting operation was done according to the explosion plan. The stones resulting from the explosion from various fronts of the job and according to the available grade are transferred to the crushing company, processing company, and waste warehouse.

High-grade iron ore sent to the crushing company are crushed by jaw and conical crushers, thereafter they are stored by screens in two agglomerated fractions (maximum: 10 mm) and long kiln (10-25 mm). They are then transported to the points of consumption. Low-grade iron ore or high-grade phosphor ore extracted from mines are first crushed into sizes lower than 300 mm, then homogenized, and finally transferred to the processing company for concentration. The crushed ores are softened by an autogenous mill and converted into a high grade. Thereafter, the materials are transferred to concentrated warehouses and finally to a waste dam.

Methodology

In order to determine the status of air pollution of the Iranian Central Iron Ore Company – Bafgh, samples were taken from the city's air in September 2013. Measurement of the parameters of CO, NO, NO_2, SO_2, and H_2S was done using the Babuk A Device at 11 points. The obtained data were categorized by Excel Software, with the pollution level of the measured parameters being estimated by a pollution index (PI).
The pollution index is used to assess an environment. For air, this index is used in the form of the ratio of the concentration of an element (C_i) in the air samples to the background level of that element in the region (B_i) (Formula 1). In this research, in order to calculate the air pollution index, the Environmental Protection Organization Standard was utilized instead of the background value, with its values provided in Table 2 (8).

(1) $$PI = \frac{Ci}{Bi}$$

Based on the pollution index, three pollution groups of low (PI≤1), moderate (1<PI≤3), and high (PI≥3) were defined. The classification of PI is provided in Table 1 (2).

Table 1. Qualitative classification of PI.

PI classification	Values PI
Low pollution	PI≤1
moderate pollution	1<PI≤3
high pollution	PI≥3

Table 2. The values of the studied parameters based on the environmental protection organization standards.

Air polluting parameter	H_2S	SO_2	NO_2	NO	CO
Standard	400	500	50	25	35

In order to determine the variations in pollution, IPI and MC_d indices were used. The pollution level was calculated by Relation 2, and the pollution load index was presented in 1980 by Tomilenson. In this relation, PI_1 to PI_n represent the pollution factors calculated for the first sample until the n_{th} measured sample.

(2) $IPI = (\prod_{i=1}^{n} PIi)^{1/n}$

Hakanson (1980), presented another index called pollution degree, which was modified by Abraham in 2005 as MC_d index.

(3) and (4) $MCd = \sum_{i=1}^{n} \frac{PIi}{n}$ and $Cd = \sum_{i=1}^{n} PIi$

Classification of IPI and MC_d parameters is provided in Tables 3 and 4 (2).

Table 3.Qualitative classification of the IPI cumulative index.

IPI classification	valuesIPI
Low pollution	PI≤1
moderate pollution	1<PI≤2
high pollution	PI≥2

Table 4. Qualitative classification of the modified pollution degree MC_d.

classification of the modified pollution degree	valuesMC_d
Very low degree of pollution	$MC_d \leq 1.5$
low degree of pollution	$1.5 \leq MC_d < 2$
moderate degree of pollution	$2 \leq MC_d < 4$
high degree of pollution	$4 \leq MC_d < 8$
Very high degree of pollution	$8 \leq MC_d < 16$
extreme degree of pollution	$16 \leq MC_d < 32$
Very extreme degree of pollution	$MC_d \geq 32$

RESULTS AND DISCUSSION

Using PI index and based on the standard of the environmental protection organization, the pollution level of parameters measured in the air of the Iron Ore Company in the desert region of Bafgh was estimated, with the results provided in Table 5.

Table 5. PI values for the samples of the Central Iron Ore air in September 2013.

Measurement site	**H_2s**	**So_2**	**No_2**	**No**	**Co**
Next to the Tickner	0.015	0.0008	0.004	0.08	**0.103**
Next to the railway station	0.012	0.0012	0.002	0.032	**0.080**
Next to the transportation	0.015	0.0012	0.008	0.056	**0.091**
Entrance of the new warehouse of explosives	0.011	0.0004	0.016	0.12	**0.069**
Extraction site	0.013	0.0012	0.008	0.056	**0.091**
Bahabad Road before overpass	0.012	0.0016	0.012	0.06	**0.069**
Bahabad Road after overpass	0.011	0.0012	0.012	0.08	**0.074**
Agglomeration entrance	0.011	0.0016	0.012	0.096	**0.091**
Between Buildings 1 and 3	0.011	0.0012	0.012	0.064	**0.109**
Choghart Square	0.014	0.0008	0.004	0.024	**0.069**
Steel Road	0.012	0.004	0.008	0.056	**0.074**

According to Table 5, the PI value for the levels of carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and hydrogen disulfide (H_2S), indicate that 100% of the samples lie within the low pollution range. Following this, in order to determine the pollution changes and complete the trend of identifying the pollutant parameters of the iron ore company in the desert region of Bafgh, IPI and MC_d indices were used according to the environmental protection organization's standards, with the results summarized in Table 6.

Table 6. The values of IPI and MC_d for the samples in the central iron ore air, September 2013.

Measurement site	IPI	Mcd
Next to the Tickner	0.009	0.066
Next to the railway station	0.020	0.016
Next to the transportation	0.039	0.025
Entrance of the new warehouse of explosives	0.038	0.039
Extraction site	0.016	0.040
Bahabad Road before overpass	0.016	0.038
Bahabad Road after overpass	0.009	0.018
Agglomeration entrance	0.086	0.039
Between Buildings 1 and 3	0.016	0.049
Choghart Square	0.035	0.017
Steel Road	0.021	0.057

According to Table 6, the IPI values indicate that all the measured parameters belong to the low pollution group. Further, the results in Table 6 suggest that in terms of MC_d, all the measured parameters show a very low degree of pollution.

CONCLUSIONS

The results obtained from this research in determining the value of PI for CO, NO, NO_2, SO_2, and H_2S in September 2013, indicate that 100% of the samples lie within the low pollution group.

Finally, the findings of this study indicates that according to IPI, all the measured parameters including CO, NO, NO_2, SO_2, and H_2S indicate low pollution levels. Similarly, the MCd pollution degree index also shows that all the measured parameters have very low pollution degrees.

Therefore, overall, the parameters CO, NO, NO_2, SO_2, and H_2S are free from any effect in the central iron ore company air in Bafgh Region and the company's surrounding air was free from any kind of pollution previously mentioned in September 2013. Researchers such as Zakerian et al. (2002), Molashahi et al. (2012), Hashemi et al. (2012), and Delkhosh and Seifaghayi (2004) arrived at similar results. Rezaipoor Baghdar et al. (2015) also reached the same conclusion. However, it is suggested that variations in the concentration of the measured parameters are monitored and investigated in many years and across various seasons of the year, so that the effect of these parameters on air pollution in the desert region of Bafgh and surrounding the Iranian Central Iron Ore Company – Bafgh is fully determined.

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