

Evaluation of Environmental and Respirable Dust in Air of Tile Industry in South Khorasan

Elham Derakhshani^a, Ali Naghizadeh^{b*}, Habibeh Shahabi^c, Motahareh Nazinejad^d

^a Department of Environmental Health Engineering, School of Health, Shahid Beheshti university of medical sciences, Tehran, Iran.
^b Assistant professor, Department of Environmental Health Engineering, School of Health, Birjand University of Medical Sciences, Birjand, Iran.

^c Department of Environmental Health Engineering, School of Health, Birjand university of medical sciences, Tehran, Iran.

^d Department of Health, safety and Environment (HSE), Niloofar tile industries, Birjand, and Department of Environmental Health Engineering, School of Health, Kerman University of medical sciences, Kerman, Iran.

*Correspondence should be addressed to Dr. Ali Naghizadeh; Email: al.naghizadeh@yahoo.com

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Background & Aims of the Study: Dust is one of the detrimental factors in workplace of tile industry. Exposure to excessive amount of dust can create various hazards to the workers. Therefore, the present study aimed to measure the concentration of environmental and respirable dust in air of Birjand Niloofar tile Industry.

Materials & Methods: In the present study, using personal and environmental sampling method, the concentration of total and respirable dust was measured. The concentration of dust determined with gravimetric method.

Results: Measurement of dust in Niloofar tile No. 1, 2 and 3 showed the highest level of total dust was in Niloofar tile No.2 in tile crusher station (120.71 mg/m³). The maximum amount of respirable dust found in the mentioned station in Niloofar tile No.2 (370.35 mg/m³).

Conclusions: The results showed among the three factories, Niloofar tile factory No. 3 had the lowest dust concentration and Niloofar tile factory No. 2 especially crusher station had the highest dust concentration. Therefore, prevention strategies should be considered in stations with higher dust concentration regarding to reducing of exposure to high level of dust.

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Background

Non-metallic mineral industries such as ceramic and tile factory are one of the major causes of air pollution. Air pollution is one of the phenomena that have important effect on human life and health (1-3). Air pollution from various aspects including maintaining product safety and environmental protection equipment and economic perspective have been discussed. In a study in the United States, the relationship between bronchitis and air pollution has been proven. In this study, the treatment costs and the total costs of treating respiratory diseases

caused by occupational pollutant were estimated at \$930 million \$4887 million, respectively. It has been found that if 50 percent of air pollution reduced in the workplace, about 4.5 of the total cost in healthcare will decrease (4). In another study that was conducted in California on health effect of ozone and particulate matter with aerodynamic diameter of 10 micron, it was shown that each person per year show the symptoms of exposure with above material and experiences risk of death in one in thousands (in comparison with death risk of one in million related to normal people) (5). One of the primary materials for building of tile and

ceramic is silica. Dust from the erosion of this material as well as dust from tile soil (granules) in factories is harmful and deadly. From the health perspective, one of the health effects of silica and dust is lung diseases such as silicosis. Silicosis is a lung disease and decreases the ability of the lungs in oxygen up taking. Overexposure to crystalline silica in either respirable or irrespirable forms can cause adverse health effects. In case of respirable silica health effects, silicosis is one of the most important reported diseases. As a result, more than 250 workers die each year in United States of America because of silicosis, and more than hundreds of workers are disabled because of silicosis and bronchitis. Unfortunately, silicosis is not curable, but it can be prevented by reduction and control of exposure to silica compounds (6-9). In a study that conducted by Naghizadeh et al in complex of Sangan Iron ore mines, the concentration of dust was a few times higher than standard level (10).

Niloofar tile industry is located in Industrial town of Birjand in South Khorasan. The products of these industries included floor ceramic and wall tile. Regarding to operation type, the workers of these industries are exposure to dust and particles as well as exposure to lung disease. Thus, this survey conducted in order to evaluate the dust in respirable air of Niloofar tile industry.

Materials & Methods

This study was aimed to measure the total and respirable dust of Birjand Niloofar tile industry and compared these values with standards. The numbers of staff working in these industries were 300 members that working in three working shift. The total and respirable sampling were accomplished based on 7500 NIOSH method. In order to remove humidity from filters, before weighing, they were maintained and dried for at least 24 h in desiccators, before sampling. Filter weighing was performed by digital balance with precision

of 0.001 g. Selected membrane filters had 25 mm diameter and were provided from Sartorius Company (Germany). Sampling pump was provided from SKC Company (United States). As calibration is required for sampling train, we calibrated the pump using a flow meter before sampling and after each repair or abuse in the field. For calibration of the sampling pump, the suction tube of sampling pump was connected to the inlet of the flow meter. Then, by adjusting the flow rate of the pump on a specific rate, the flow rate was read on the flow meter and was considered as true flow rate of the sampling pump. Sampling was based on environmental and personal sampling methods. In environmental sampling method, sampling apparatus including filter and filter holder, environmental sampling pump, and flexible pipe were prepared and fixed in sampling stations. In personal sampling method, the flow rate of the personal samplers was 1.7 L/min and the pumps stopped automatically at 4 h. Finally the following equation was used for determination of dust concentration at milligrams per cubic meter (mg/m^3):

$$C = \frac{(C_1 - C_0)}{Q \cdot t} \times 10^3$$

Where C is dust concentration of air in workplace; C_0 =filter weigh before sampling, mg; C_1 =filter weigh after sampling, mg; t=sampling period, min; Q=sampling pump flow rate, L/min (with correction of sampled air volume to volume in standard condition).

Results

To determination of dust in tile industries, 61 environmental and respirable samples were taken. The results of environmental dust measurements in Niloofar tile No. 1 were shown in figure 1.

As shown in Fig.1 the maximum concentration of environmental dust was

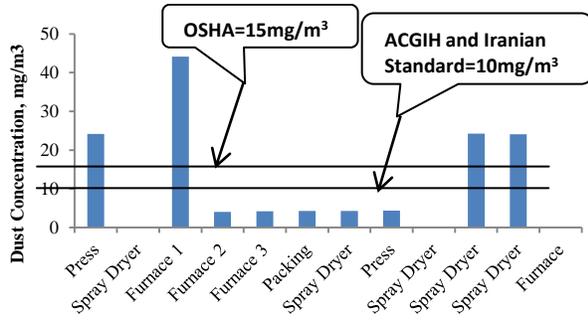


Fig. 1: Concentration mean of Environmental dust of sampled stations in Niloofar tile No.1

measured in furnace 1 station at 44.11 mg/m^3 and its minimum was measured in furnace 2 station at 4.02 mg/m^3 .

The results of respirable dust measurements in Niloofar No.1 were shown in figure 2.

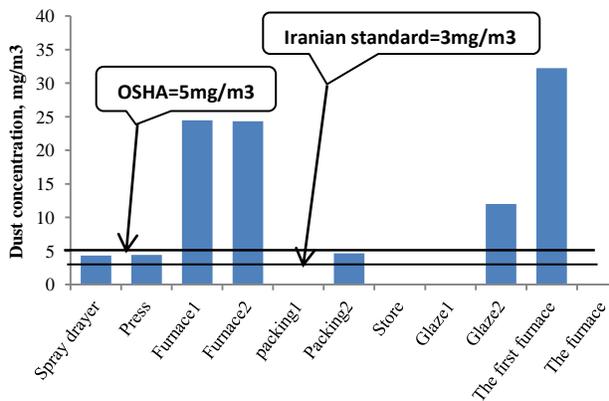


Fig. 2: Concentration mean of Respirable dust of sampled stations in Niloofar tile No.1

Regarding to Fig.2 the maximum concentration of respirable dust was measured in the first furnace station at 32.26 mg/m^3 and its minimum was measured in spray dryer station at 4.35 mg/m^3 .

Fig. 3 Show the environmental dust measurements in Niloofar tile 3. Regarding to this figure crusher station with dust concentration of 120.71 mg/m^3 had the higher level of dust comparing other stations.

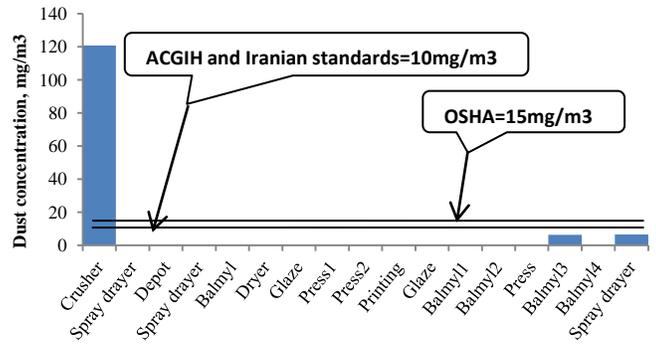


Fig. 3: Concentration mean of Environmental dust of sampled stations in Niloofar tile No.2

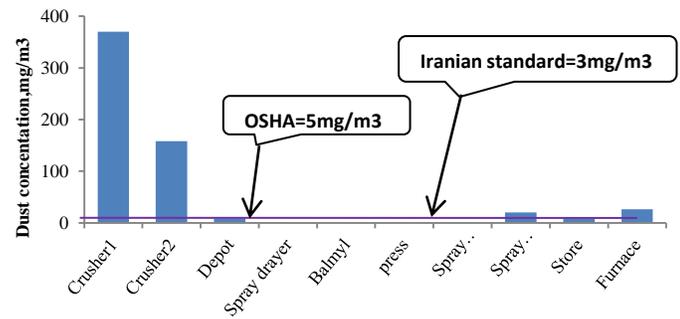


Fig. 4: Concentration mean of Respirable dust of sampled stations in Niloofar tile No.2

As shown in Fig.4 that present results of respirable dust measurements in Niloofar tile No. 2, the maximum concentration of respirable dust was measured in furnace 1 station at 44.11 mg/m^3 and its minimum was measured in furnace 2 station at 4.02 mg/m^3 .

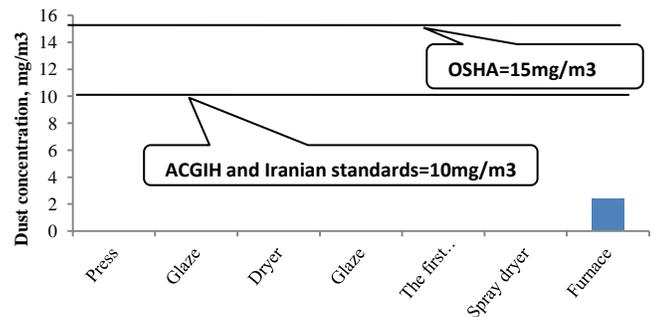


Fig. 5: Concentration mean of Environmental dust of sampled stations in Niloofar tile No.3

The results of environmental dust measurements in Niloofar No.3 were shown in figure 5. Regarding to this figure only furnace station had dust concentration and amount of dust in this station was lower than standards.

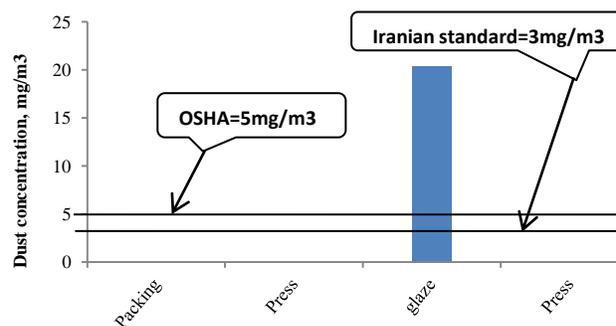


Fig. 6: Concentration mean of respirable dust of sampled stations in Niloofar tile No.3

Fig. 6 Show the respirable dust measurements in Niloofar Tile 3. Regarding to this only glaze station with dust concentration of 20.38 mg/m^3 had the higher level of dust concentration.

Discussion

In the present study we measure the levels of dust in air of a tile industry in South Khorasan for distinguishing that the workplace is dangerous for workers or not. As shown in Fig. 1 the level of environmental dust in furnace station is about 2.5 times of OSHA standard (15 mg/m^3). This level is 4.4 times of ACGIH and Iranian standard (10 mg/m^3). Also, the concentration of dust in press and spray dryer stations were higher than mentioned standards (about 1.5 times of OSHA standard and 2.4 times of ACGIH and Iranian standard). Other stations had lower level of dust comparing the standard.

Considerate to Iranian standard for respirable dust (3 mg/m^3) and OSHA standard (5 mg/m^3), and regarding to Fig. 2, the concentration of dust in operation Hall and furnace stations were higher than these standard. The level of dust in beginning of furnace station was about 11 times of Iranian standard and about 6 times of OSHA standard.

The concentration of dust in packing, deport and glaze station were zero in sampling period.

Samadi et al survey the dust and free silica concentration in Emarat zinc and lead open mine and concluded that level of these material were higher than permissible level (14). In another study mohammadian et al assesses the worker exposure to crystalline silica particles in workshop of Mazandaran province and concluded that mean of exposure to respirable silica particles in air of respirable zone in workers of four industrial groups was too higher than permissible limits presented by American Conference of Governmental Industrial Hygienists (15).

Exposure rate to dust in some stations such as furnace was very broad. There are occupational exposures in similar works such as metallic mines, coal mines, and non metallic mineral, building stones, extraction of clay, sand extraction and non ferrous casting (16, 17).

Pulmonary diseases caused by dust are of the oldest occupational diseases. Pulmonary disease caused by free silica crystalline named silicosis. This pneumoconiosis occurs while digging or extraction of mines with stone crusher or in the other words while exposure with free silica. This disease is one of the most difficult and one of the most expensive occupational disease (18).

Regarding to figure 3, with the exception of stone crusher station in Niloofar tile No. 2, environmental dust concentrations in the other stations were lower than OSHA, ACGIH and Iranian standards. The level of dust concentration in this station (120 mg/m^3) was 12 times higher than OSHA and Iranian standards and 8 times higher than ACGIH standard.

Figure 4 present the results of respirable dust measurements in different parts of Niloofar tile No. 2. By considering OSHA and Iranian standard about respirable dust (3 and 5 mg/m^3 ,

respectively), it was found that in stone crusher stations the dust concentration (370 mg/m^3) was much higher than mentioned standards. The levels of dust respirable concentration in spray dryer, mileage and press stations were zero. In a study performed by Hazrati et al about evaluation of dust concentration in workplace of Ardabil Cement Company, the researchers concluded that cement dust was higher than permissible limits determined by Iranian technical committee of health professionals (19). Also in the other study conducted by Golbabaei et al about assessment of occupational exposure of cement company workers to respirable cement and silica dust, researchers concluded that exposure to respirable dust in overall operations was higher than permissible limits and in official unit was lower than these limits (20).

As shown in Fig. 5 only furnace station in Niloofar tile No. 3 had dust concentration and amount of dust in this station was lower than OSHA, ACGIH and Iranian standards. There was no dust in other stations. Regarding to Fig. 6 respirable dust concentration in furnace station (20.38 mg/m^3) was 4 times higher than OSHA standards (5 mg/m^3) and 6 times higher than Iranian standards (3 mg/m^3). There was no dust in other stations. In a study entitled exposure assessment to dust and free silica for workers of Sangan iron ore mine in khaf performed by Naghizadeh et al, it was conducted dust concentration only in official and safeguard stations was lower than Iranian standard and in other station the level of dust concentration was much higher than permissible limits (10). Strategies to prevent workers from exposure to dust including health monitoring of mixing materials, more using of wet refining methods, use local ventilation systems and use of personal protective equipments (21).

Conclusion

The results of the present showed among the three factories, Niloofar tile factory No. 3 had the lowest dust concentration and Niloofar tile factory No. 2 especially crusher station had the highest dust concentration. Therefore, prevention strategies should be considered in stations with higher dust concentration regarding to reducing of exposure to high level of dust.

Footnotes

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Conflict of Interest:

The authors declare no conflict of interest.

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