O 38. INDOOR AMBIENT PARTICLE MATTER MEASUREMENT AND MODELING IN FOUNDRIES

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ABSTRACT: Rapidly increasing world population causes air pollution in urbanization and safety of raw materials. Air pollutants impress human and environmental health. With the development of our country, the industrial sector has progressed. Foundries have an important share in the development of industrial sector. The increase in industrialization in the world has brought together raw materials and together. It contains very high amounts of dust and particulate matter. This situation has a negative impact on worker health and work efficiency. The contaminated foundry was produced during the working hours and at different points. It is aimed to protect the indoor air quality and to be the worker health.

Keywords: *foundry, indoor air quality, particle measurement, air pollution*

1. INTRODUCTION

Air pollution is a really important environmental problem not only in developed countries but also in developing countries (Bulgurcu, 2015). Approximately 3 million people are affected by air pollution each year (Altın, 2015; Babaroğlu, 2015). Air pollutants are present in various forms in the atmosphere, adversely affecting both human health and environmental health. Examples of air pollutants include carbon monoxide (CO), heavy metals, sulphur compounds, nitrogen compounds, organic substances and particles. Air pollutants are found not only outside but also indoors scale affected life quality. In both working and daily life, people had to spend time in closed environments for a long-time indoor place. In indoor environments, there are quite a lot of pollutants could be detected. They vary even in their environment including living in these environments. Some of the pollutants originate from the external environment enters aeration, while others are found produced direct in the indoor environment. High levels of pollutants reduce indoor air quality. The concentration of pollutants in the environment and the type of pollutants are effective. Decreasing indoor air quality poses short- or long-term problems on the health of the people in the environment. The deterioration of indoor air quality both affects workers' health negatively and decreases the work efficiency. Density of pollutant gases, dust, number of particles, temperature and humidity of the environment are also effective in poor indoor air quality (Bulgurcu et al., 2014). The gaseous pollutants are generally present in CO, NH_3, NOx, SO_2, H_2S forms. Particulate contaminants ($PM_{2.5}$ and PM_{10}) are present in solid and liquid form. Particulate matter sizes that are important for indoor air quality and human health are in the range of 0.1-10 µm. Particulate matter smaller than 0.1 µm is partially exhaled. Particulate matters larger than 10 µm are retained in the upper respiratory tract (Alptekin & Çelebi, 2015. Health Canada, 1995; Soysal & Demiral, 2007 Ünver Alçay & Yalçın , 2015). Internal health effects of particulate matter have been reported as eye, nose and respiratory tract irritation, asthma, bronchitis, lung damage, cancer, heavy metal poisoning, cardiovascular effects (Yurtseven, 2007; USEPA, 2012; Yurdakul, 2018). Dust particles can seriously affect human health in areas where ventilation is not working well. In this study, measurements were made in order to determine the amount of particulate matter in a foundry plant. As a result of the measurements, the effects of ambient air pollutants on the workers were evaluated.

2. MATERIAL AND METHOD

The measurements were performed in a private foundry factory at two time periods by continuous sampling method on 26/03/2019 and 28/03/2019. Indoor particle measurements are carried out in the moulding section of the foundry, in the melting furnace, in the blasting section, in the core shop, in the grinding section and so on was made in parts such as dust. PCE - PC01 Particle Counter was used for measurements. The device is capable of measuring and recording solid and liquid substances suspended in air in atmospheric environment and breathable by human. The device can measure existing particles in the air without the need for an air pump. The device could save the data obtained from the measurement points to its own memory. The device's memory can store 5000 data. It gives the measurement results in ppm. The instrument has a green, yellow and red colour scale (Figure 1).

Figure 1. PCE – PC01 Particle Counter instrument for measurement of Particle matter

3. RESULTS

Particle matter measurements were performed at designated points of a foundry operating in Konya industry region on Tuesday, 26.03.2019 and on Thursday, 28.03.2019 at 09:00, 11:00, 14:00, 16:00 and the data was mapped according to the measurement points geographic coordinate (Figures 2-16). It was found that the lowest value was found to be 1.728 mg/m³, the highest value was 26.850 mg / m³ and the average value was 12.414 mg/m³ for $PM_{2.5}$ measurements at 10 different points on 26.03.2019.

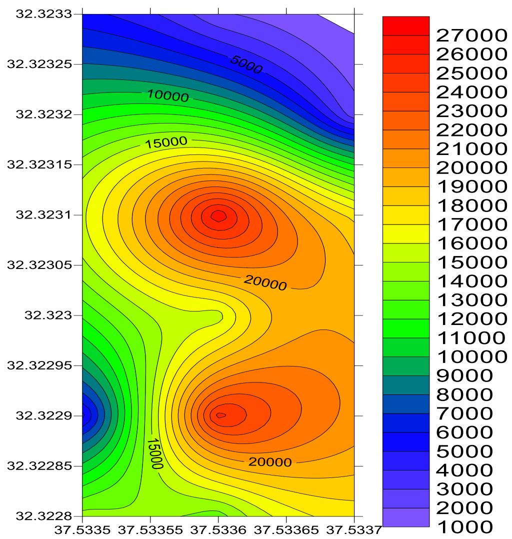

Figure 2. Distribution of 2.5µm size particle at 09:00 on 26/03/2019

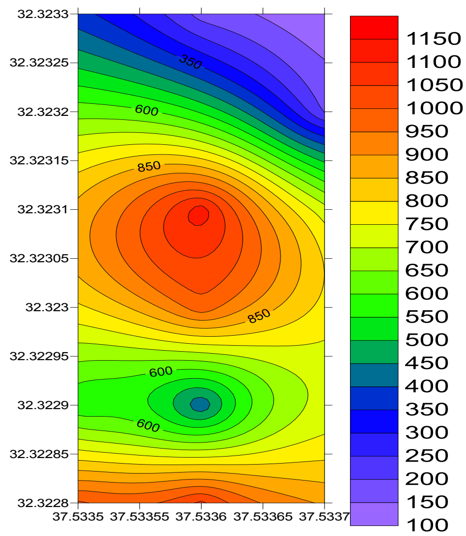

Figure 3. Distribution of 10 µm size particle at 09:00 on 26/03/2019

Distribution of the measurements at 10 different points on 26/03/2019 at 09.00 showed that the lowest value for 10µm was 0.105 mg / m³, the highest value was 1.126 mg / m³ and the average value was 0.635 mg / m³. It was found that the lowest value was found to be 1.229 mg / m³, the highest value was 36.191 mg / m³ and the average value was 10.304 mg / m³ for 2.5µm measurements at 10 different points on 26.03.2019.

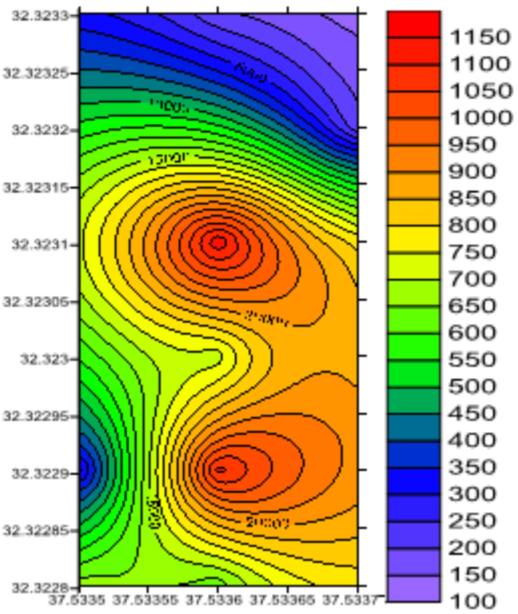

Figure 2. Distribution of 2.5µm size particle at 11:00 on 26.03.2019

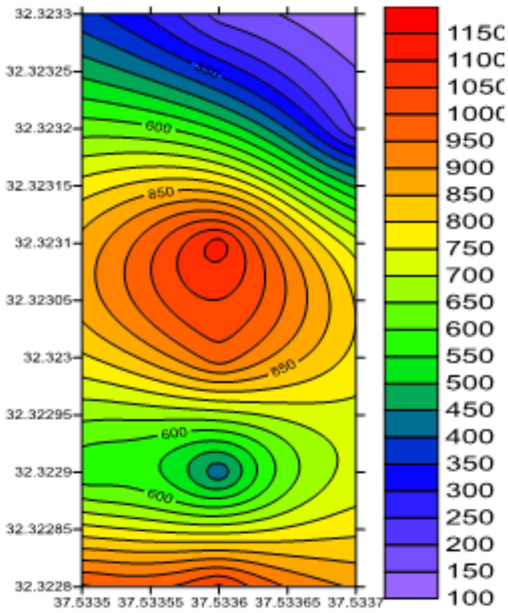

Figure 3. Distribution of 10 µm size particle at 11:00 on 26.03.2019

Distribution of the measurements at 10 different points on 26/03/2019 at 11.00 showed that the minimum value for 10µm was 0.152 mg/m³, the highest value was 1.216 mg/m³, and the average value was 0,608mg / m³. The measurements at 10 different points dated 26/03/2019 at 14.00 showed that the lowest value for 2.532 was 3.329 mg / m³, the highest value was 40.721 mg / m³ and the average value were 14.297 mg/m³.

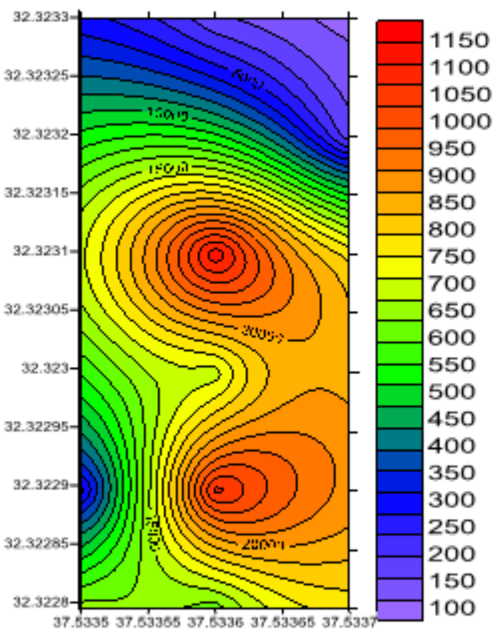

Figure **6**. Distribution of 2.5µm size particle at 14:00 on 26.03.2019

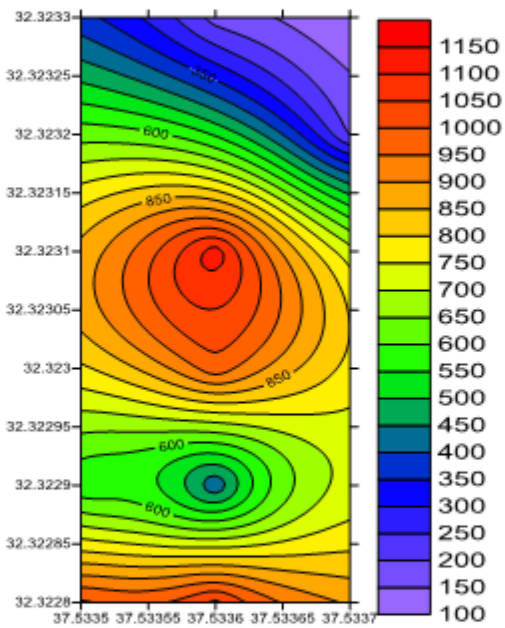

Figure **7**. Distribution of 10µm size particle at 14:00 on 26.03.2019

It was found that the lowest value was 0.063 mg / m³, the highest value was 0,762 mg / m³ and the average value was 0,487mg / m³ for 10µ at 10 different points on 26/03/2019. It was found that the lowest value was 2.586 mg / m³, the highest value was 154,776 mg / m³ and the average value was 22,621 mg / m³ for 2.5µ measurements at 10 different points on 26/03/2019.

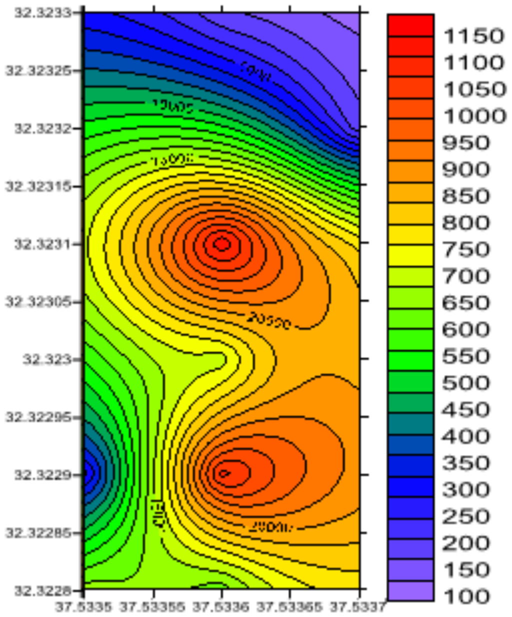

Figure 8. Distribution of 2.5µm size particle at 16:00 on 26.03.2019

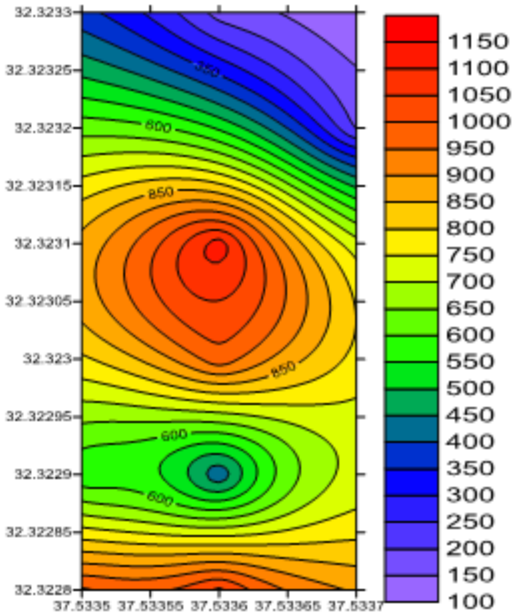

Figure 9. Distribution of 10µm size particle at 16:00 on 26.03.2019

Distribution of the measurements at 10 different points on 28.03.2019 at 16.00 showed that the lowest value for 10µm was 0.105 mg / m³, the highest value was 1.126 mg / m³ and the average value was 0.601 mg / m³. It was found that the lowest value was 0.617 mg / m³, the highest value was 13,702 mg/m³ and the average value was 6.411 mg / m³ for 2.5µ measurements at 10 different points on 28.03.2019.

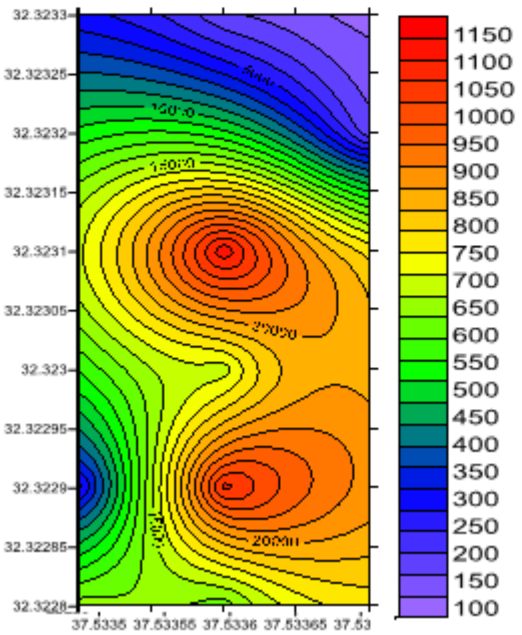

Figure 10. Distribution of 2.5µm size particle at 09:00 on 28.03.2019

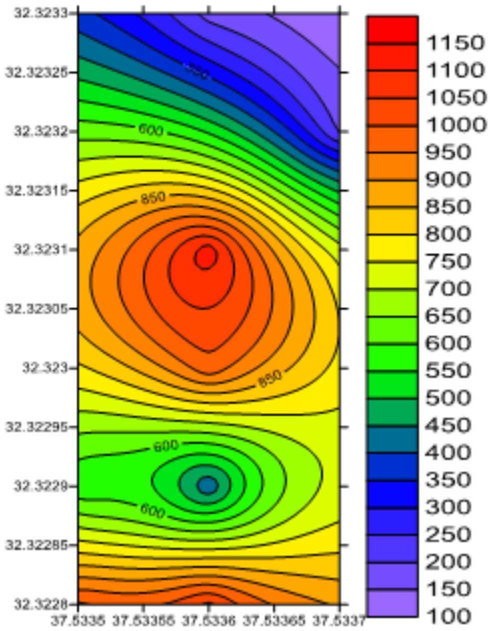

Figure 11. Distribution of 10µm size particle at 09:00 on 28.03.2019

The measurements at 10 different points on 28.03.2019 at 09.00 showed that the lowest value was 0.053 mg / m³, the highest value was 0.922 mg/m³ and the average value was 0.441 mg/m³ for 10 m. The measurements at 10 different points dated 28.03.2019 at 11.00 showed that the lowest value for 2.580 was 2.580 mg / m³, the highest value was 19.555 mg / m³ and the average value were 6,629 mg / m³.

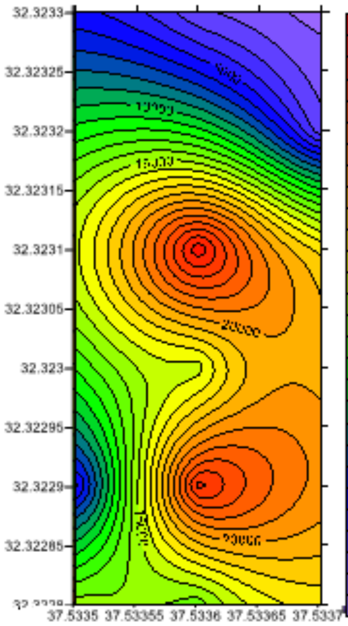

Figure 12. Distribution of 2.5µm size particle at 11:00 on 28.03.2019

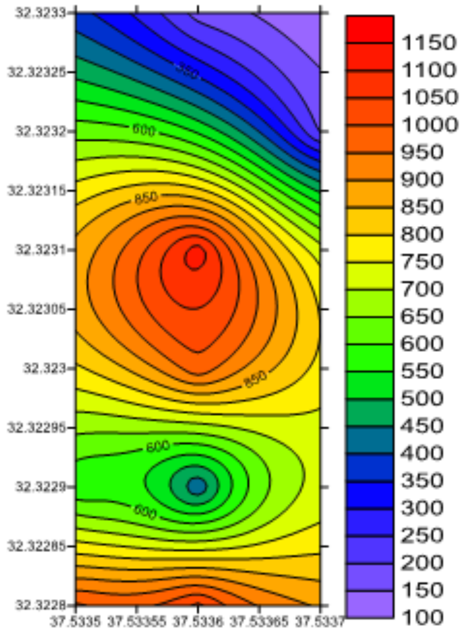

Figure 13. Illustration of a 10µm particle size made at 11.00 on 28.03.2019

Distribution of the measurements at 10 points on 28.03.2019 at 11:00 showed that the lowest value for 10µm was 0.340 mg/m³, the highest value was 0.849 mg/m³, and the average value was 0.510 mg / m³. The measurements at 10 different points on 28.03.2019 at 14.00 showed that the lowest value for 2.5µ was 1.197 mg / m³, the highest value was 31.229 mg / m³, and the average value was 10,235mg / m³.

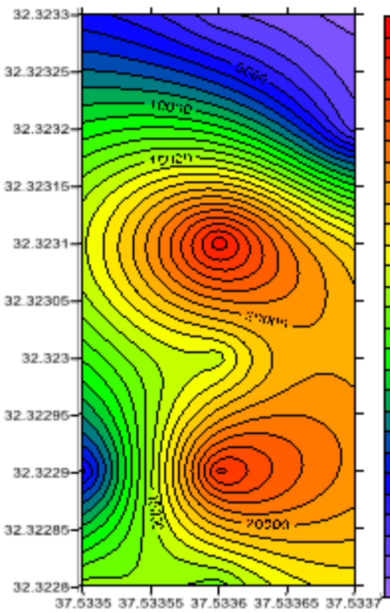

Figure 14. Distribution of 2.5µm size particle at 14:00 on 28.03.2019

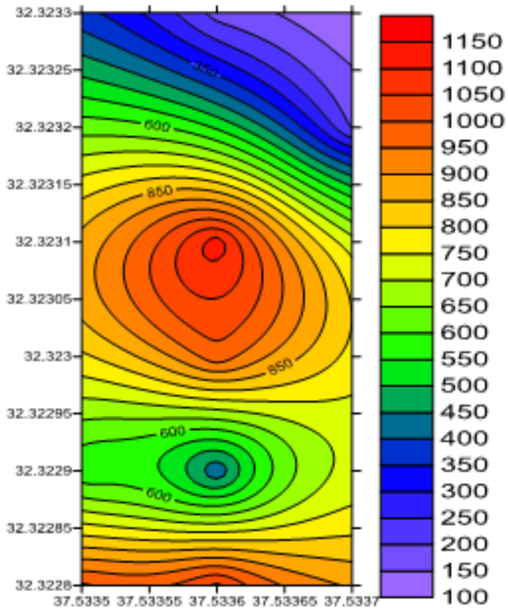

Figure 15. Illustration of a 10µ particle size made at 14.00 on 28.03.2019

The measurements at 10 different points on 28.03.2019 at 14.00 showed that the lowest value for 10µ was 0.098 mg / m³, the highest value was 0.582 mg / m³ and the average value was 0.369 mg / m³. The measurements at 10 different points on 28.03.2019 at 16.00 showed that the lowest value for 2.5µ was 0.772 mg / m³, the highest value was 23.496 mg / m³ and the average value was 11.816 mg / m³.

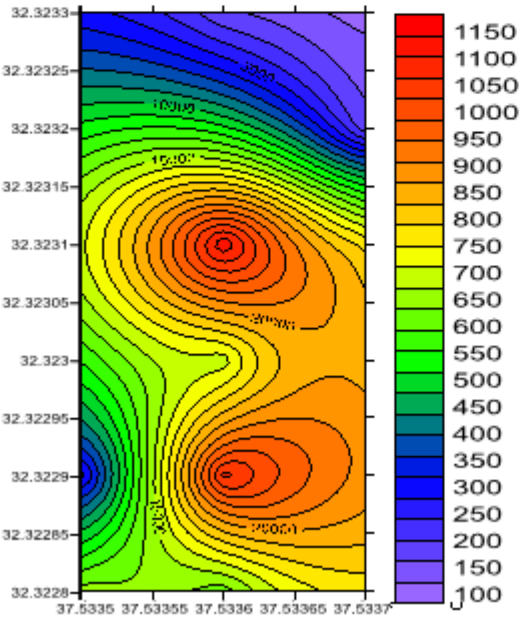

Figure 16. Distribution of 2.5µm size particle at 16:00 on 28.03.2019

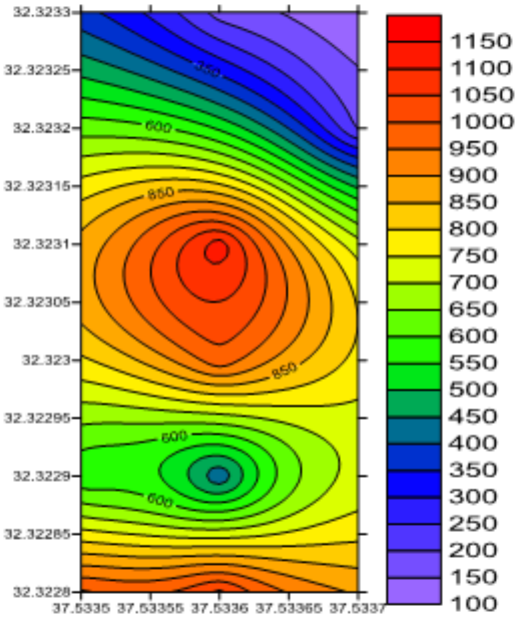

Figure 17. Illustration of a 10µ particle size made at 16.00 on 28.03.2019

In the measurements taken at 10 different points on 28.03.2019 at 16.00, the lowest value was found to be 0.095 mg/m³, the highest value was 0.746 mg / m³ and the average value was 0.409 mg/m³.

4. DISCUSSION

Foundries produce a lot of dust due to their production processes. The resulting dust adversely affects workers' health. As a result of the measurements, it was observed that the values found were above the limit values. The measured area of the foundry is 2000 m². The highest particulate matter level in the foundry was found to be the core shop, sandblasting section and melting furnace. Ventilation was found to be insufficient in the foundry. Although this does not affect the workers working in the foundry in a short time, it will have a serious impact on their health in the long term. Particulate matter in the air causes especially upper respiratory diseases. The short-term effects of the powder cause irritation, cough, emphysema and asthma. Cancer and heart diseases are examples of the long-term effects of the powder (Çobanoğlu, 1994; Motör, 2011; Öztürk & Düzovalı, 2011; Karakaş, 2015; Dindar, 2018).

In order to reduce the effects of this situation on workers' health, firstly, the ventilation of the environment should be very good. Dust collection system should be installed to reduce dust generated in the melting furnace and sand blasting section. Powder producing parts should be collected in a single section. All workers, not only those working in the quarry and in the sandblasting department, should be required to wear permanent masks. Ambient air quality should be monitored regularly. Workers should undergo regular health checks. Training should be provided to workers. Working hours and breaks should be set to expose to fresh air (Çalı, 2000; Gülen, 2013; Güllü, 2016; Işık E, Çibuk, 2015 Gönüllü et al, 2018).

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