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Determination of the emission factor of carbon monoxide for jewelry making workshops

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ABSTRACT:

Introduction: Air pollution has become a problem in the city of Isfahan, Iran. Jewelry making workshops are one of the city's sources of pollutants. No studies had been yet conducted to determine the emission factor for Isfahan's jewelry making workshops. The purpose of this study was to determine the carbon monoxide emission factor obtained from the Isfahan emission factor.

Materials and methods: In the first step, jewelry making workshops were visited in Isfahan and it was found that the only source of carbon monoxide was the use of an oxy-fuel welding system for melting gold. In the second step, a pilot experiment determined the emission rate for carbon monoxide. Then, the gas consumption was measured for the oxy-fuel welding system. Next, the amount of carbon monoxide produced per cubic meter of consumed natural gas in an oxy-fuel welding system was calculated.

Results: The results of this study showed that the carbon monoxide emission factor for an oxy-fuel welding system is 0.0865 kg / kg of consumed natural gas. Interviews with the managers of some of the jewelry making workshops found that on average 22 kg of natural gas is used per month by each of Isfahan's jewelry making workshops. Each month, each jewelry making workshop produces about 1499 kg of carbon monoxide.

Conclusion: The emission factor introduced in this study can be used to calculate the air pollutants emissions of jewelry making workshops in Isfahan to find their share of Isfahan's air pollution.

Introduction

Nowadays, air pollution is one of the problems of living in big cities [1]. Technological development has led to the expansion of sources of air pollutants and has increased concentrations of various pollutants in urban areas' atmospheres [2]. Since many air pollutants are hazardous to human health, it is essential to control their release [3]. In order to control the emission of air pollutants, all sources of contamination must be identified and their emission rate of pollutants should be determined [4-6]. One of the most common ways of determining the rate of emission of pollutants from pollutant sources is the

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use of emission factors [7]. An emission factor is a coefficient that is linked to a particular pollutant and, if multiplied by the activity, the emission rate of pollutant is obtained [8]. The use of emission factors to estimate the rate of emissions of air the pollutants in the atmosphere is fast and reliable [9]. Among of thousands of airborne compounds, five compounds-carbon monoxide, nitrogen oxides, sulfur oxides, volatile organic compounds and suspended particles-have been selected as air pollutants indicators [8, 10]. Although many studies have been conducted by international organizations such as the US Environmental Protection Agency and the European Environment Organization to introduce air pollutants emission factors, it is important to determine the local emission factors due to the different technological levels used to process in factories in different countries [11].

Carbon monoxide, with the chemical formula of CO, molecular weight of 28.01, melting point of 207 °C and boiling point of 192 °C, is a colorless, odorless gas that results from incomplete combustion of coal and fossil fuels [8]. The natural concentration of carbon monoxide in ambient air is 0.01 to 0.2 ppm (volumetric). Concentration of carbon monoxide in the atmosphere of urban areas is usually less than 17 ppm, but the concentration of carbon monoxide during heavy traffic in some areas of Tehran, the capital of Iran, has been detected up to 50 ppm or even more for short-term periods [8]. The concentration of carbon monoxide in indoor environments of particular workshops has been reported up to 100 ppm. Carbon monoxide has many negative effects on human health, such as effects on the human cardiovascular system, neurological behaviors, fibrinolysis and fetuses [9]. Therefore, controlling its concentration in the air is very important [12].

The city of Isfahan is one of Iran's major cities that is exposed to air pollution [13]. The use of hundreds of thousands of cars in Isfahan has led to the production of a large amount of pollutants in the city [14]. Isfahan is also an industrial city with thousands of factories. These factories could emit pollutants in the atmosphere. In order to control the air pollution of this city, it is essential to produce an emission inventory of air pollutants [15]. Jewelry making workshops are one of the industries that have expanded rapidly in Isfahan. There are dozens of jewelry making workshops in Isfahan suspected of releasing air pollutants. Calculation of the emission rate of pollutants emitted by the workshops is the first step in calculating their share of Isfahan's air pollution. Unfortunately, to date no emission factor has been created for the Isfahan jewelry making workshops. Therefore, it is imperative to calculate the emission rate of these workshops. Although many studies have already been carried out on the introduction of emission factors for different air pollutant sources, there has not been any study on the emission factor of jewelry making workshops. The purpose of this study was to introduce a carbon monoxide emission factor for jewelry making workshops in Isfahan. This emission factor was determined by experiments on the technology used in these workshops.

Materials and methods

In the first step of this study, one of the jewelry making workshops in Isfahan was visited. The visit revealed that the only source of carbon monoxide emission in jewelry making workshops is an oxy-fuel welding system used for melting gold. In the oxy-fuel welding system, the fuel, which is usually natural gas, burns with pure oxygen that produces intense heat. This high heat melts gold. Because there is sufficient oxygen in an oxy-fuel

welding system, the amount of pollutant emissions is lower than in other burning methods.

An experiment was carried out to determine the emission factor of carbon monoxide in the oxy-fuel welding system. In this system, a torch was placed in a chimney, which had a diameter of 0.15 m (Fig. 1). The carbon dioxide concentration was then measured using a digital detector (KIMO CO 110). Air velocity was determined in the chimney using a digital speedometer (PROVA AVM-07). In the next step (see Eq. (1)), the carbon monoxide emission rate was determined. Then, the oxygen gas of the oxy-fuel welding system was cut off so that only natural gas was burned this system. Next, the natural gas flow rate was measured. Finally, the emission factor was calculated using Eq. (2). With the aid of interviews conducted with managers of some of the jewelry making workshops, gas consumption per month was identified for 2018.

$$ER = \left[V \times \frac{\pi D^2}{4}\right] \times C \quad (1)$$

Where ER is emission rate of carbon monoxide in mg / m^3, V is gas velocity in chimney in m / s, D is diameter of chimney in m and C is the concentration of carbon monoxide in the chimney in mg / m^3.

$$EF = \frac{ER}{Q_{Natural\ gas}} \quad (2)$$

Where EF is the emission factor in mg / kg consumed natural gas and $Q_{Natural\ gas}$ is the mass flow rate of natural gas in kg / s.

Results and discussion

The results of the experiments showed that the mass flow rate of consumed natural gas was kg / s. The concentration of carbon monoxide in chimney was measured when the oxy-fuel welding system was turned on. The concentration of carbon monoxide measured in the chimney was 48.9 mg / m^3. The air velocity in the chimney was measured at 0.65 m / s. The calculations showed that the carbon monoxide emission rate was 0.5269 mg / s. It was also found that the carbon monoxide emission factor while operating the oxy-fuel welding system was 0.0852 kg / kg consumed natural gas. By conducting interviews with the managers of some of the jewelry making workshops, it was found that on average 22 kg of natural gas were used per month. The calculation showed that each jewelry workshop in Isfahan emitted about 1.87 kg of carbon monoxide per month in 2018. It is estimated that nearly 800 active jewelry workshop is in Isfahan in 2018. It means that 1499 kg carbon monoxide is emitted in Isfahan's atmosphere each month. The calculations revealed that approximately 17994 kg carbon monoxide is annually emitted into the atmosphere by Isfahan's jewelry making workshops.

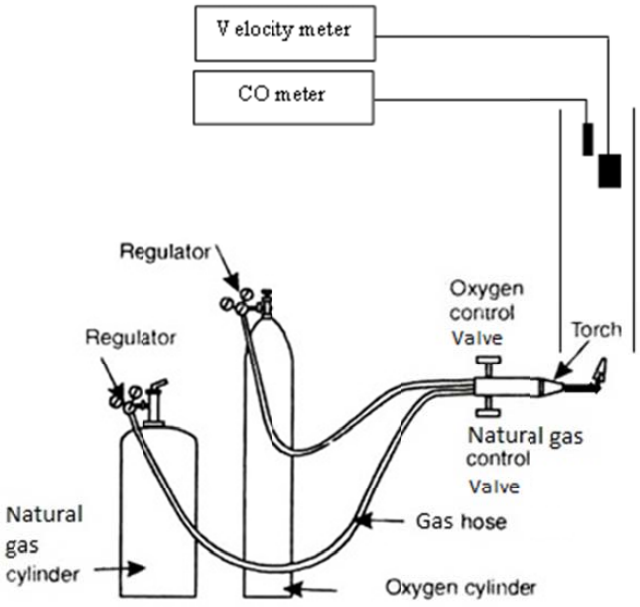

Fig. 1. Schematic of the experimental instrument used to determine carbon monoxide emitted from the oxy-fuel welding system.

Conclusion

In this study, the carbon monoxide emission factor was investigated in jewelry maker workshops. The carbon monoxide emission factor for these workshops was 0.0852 kg / kg consumed natural gas. The introduced emission factor in this study can be used to calculate the air pollutants emission inventory of jewelry making workshops in Isfahan to find their share Isfahan's air pollution. It is suggested that in future studies the exact position of Isfahan jewelry making workshops were determined. Then the distribution of this pollutant can be modeled to understand which areas in Isfahan are affected by emissions from these workshops.

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Competing interests

The authors declare that there is no conflict of interest that would prejudice the impartiality of this scientific work.

Author's contributions

It is certified that all of the authors have made the same contribution in the experiments and manuscript writing.

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Ethical considerations

Authors are aware of, and have complied with, best practices in ethics, specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests and compliance with policies on research ethics. The authors have adhered to the publication requirements that the submitted work is original and has not been published elsewhere in any language.

References

1. Sharma N, Agarwal AK, Eastwood P, Gupta T, Singh AP. Introduction to Air Pollution and Its Control. Air Pollution and Control: Springer; 2018. p. 3-7.
2. Seinfeld JH, Pandis SN. Atmospheric chemistry and physics: from air pollution to climate change: John Wiley & Sons; 2016.
3. Di Q, Wang Y, Zanobetti A, Wang Y, Koutrakis P, Choirat C, et al. Air pollution and mortality in the Medicare population. N Engl J Med. 2017;376(26):2513-22.
4. Talaiekhozani A, Eskandari Z. A Short Communication on Estimation of the Airborne Pollutants Emissions from Consumption of Gasoline and Diesel Fuel in Isfahan. Journal of Air Pollution and Health. 2018;2(3):123-8.
5. Al-Hasaan AA, Dann TF, Brunet PF. Air pollution monitoring in Amman, Jordan. J Air Waste Manage Assoc. 1992;42(6):814-6.
6. EPA. Technical Air Pollution Resources USA: United States Environmental Protection Agency; 1995 [Available from: https://www.epa.gov/technical-air-pollution-resources.
7. Talaiekhozani A, Eskandari Z, Yosefi M, Dehkordi AA, Talaei MR. Preparing the emission inventory of air pollutants from Isfahan's waste in 2016. Journal of Air Pollution and Health. 2017;2(1).
8. Ghiaseddin M. Air Pollution, Sources, Impacts and Control. Tehran: Tehran University Medical of Sciences; 2015.
9. Sharma HK, Dandotiya B, Jadon N. Exposure of Air Pollution and Its Health Effects in Traffic Police Persons of Gwalior City, India. Environmental Claims Journal. 2017:1-11.
10. Saxena N, Bhargava R. A Review on Air Pollution, Polluting Agents and its Possible Effects in 21 st Century. Advances in Bioresearch. 2017;8(2).
11. Adams M. EMEP EEA air pollutant emission inventory guidebook 2016 Introduction. Denmark: European Environment Agency; 2016.
12. Levy RJ. Carbon monoxide pollution and neurodevelopment: a public health concern. Neurotoxicology and Teratology. 2015;49:31-40.
13. Modarres R, Dehkordi AK. Daily air pollution time series analysis of Isfahan City. International Journal of Environmental Science and Technology (Tehran). 2005;2(3):259-67.
14. Eskandari Z, Talaiekhozani A, Makipoor G, Jafari S, Rezania S. Estimation of pollutants emission rate from activity of Isfahan city taxies. Journal of Air Pollution and Health. 2018;2(3):137-44.
15. Brunekreef B, Holgate ST. Air pollution and health. The lancet. 2002;360(9341):1233-42.