Journal of Air Pollution and Health (Summer 2017); 2(3): 137-144

Original Article

Available online at http://japh.tums.ac.ir

ESTIMATION OF POLLUTANTS EMISSION RATE FROM ACTIVITY OF ISFAHAN CITY TAXIES

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ARTICLE INFORMATION

Article Chronology:

Received 24 July 2017
Revised 21 August 2017
Accepted 6 September 2017
Published 28 September 2017

Keywords:

Emission factor; taxis pollutants; air pollution; Isfahan

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ABSTRACT:

Introduction: Determining the sources of air pollutants and the emission rate from each one is the most important bases for the air pollution control policy in cities. The aim of this study was to determine the amount of different pollutants emission caused by urban taxies in Isfahan.

Materials and methods: In the first step, information was gathered about the number of active taxies, type of vehicle, manufactured year and the type of fuel consumed in Isfahan from taxi management and supervision organization. In the next step, by referring to the vehicle's manual, the used technology to design and build their engines was collected. Finally, the gathered information was introduced to International Vehicle Emission (IVE) model to analyze.

Results: Based on the results, the total emitted pollutants into Isfahan atmosphere was estimated as 16,276 tons of carbon dioxide, 78 tons of methane, 153 tons of carbon monoxide, 8.67 tons of volatile organic compounds, 25.69 tons of nitrogen oxides and 0.036 tons of sulfur oxides per year. This study confirmed that thousands of tons of volatile organic compounds, carbon dioxide, nitrogen oxides and sulfur oxides are introduced into the atmosphere by Isfahan taxies.

Conclusions: Although, the values of pollutants emission were very high, the number of passenger-to-car ratio in taxis is too much higher than that of single- person private cars.

INTRODUCTION

Air pollution is a phenomenon of today's modern life which is mainly the result of industrialization [1]. Cardiovascular and respiratory diseases, decreasing health index and adverse economic effects are some results of air pollution in large cities such as Isfahan [2]. Therefore, considering the environmental and health effects of air pollutants is needed to find the best possible solution to reduce this phenomenon. For this purpose, first of all, the main sources of pollutants should be identified and their emission rate should be determined [3].

Nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), volatile organic compounds (VOCs), carbon dioxide (CO_2), meth-

Please cite this article as: Eskandari Z, Talaiekhozani A, Makipoor G, Jafari S, Rezania Sh. Estimation of pollutants emission rate from activity of Isfahan city taxies. Journal of Air Pollution and Health. 2017; 2 (3): 137 - 144.

ane (CH_4) and particulate matters (PM) are the most important air pollutants [4]. Greenhouse effect, ozone depletion and acid rain are some of the atmospheric effects of these air pollutants [5]. For instance, carbon monoxide threatens the life of patients with cardiovascular and pulmonary diseases. Also, carbon monoxide leads to headaches, dizziness, high fatigue, and nervous stimulation even to healthy people [6]. Nitrogen oxides stimulate the eyes and deep parts of lungs which cause excessive fatigue and increase the incidence of disease [7]. In addition, plants can also be damaged by nitrogen oxides [8]. Sulfur oxides stimulate the respiratory tract, especially pharynx, nose and larynx, and cause chronic bronchitis, asthma and emphysema [9]. Sulfur dioxide is converted into acid when it is combined with steam in the air. Its precipitation in the form of acid rain causes the corrosion of metals, stones and fabrics [10]. This gas, like nitrogen dioxide, affects plants and causes them to disappear [11]. VOCs can be emitted from vehicles to the atmosphere meanwhile several types of VOCs have a potential role in damaging the human's health [12].

Various methods have been proposed to estimate the amount of pollutant emissions from vehicles. Among the various methods, International Vehicle Emission (IVE) model is one of the most reliable methods. The IVE model was designed in 2007 with the support of the US Environmental Protection Agency. The main purpose of this software is to provide a suitable model for estimating the emission of pollutants in the developing countries [13]. IVE has many advantages over similar software such as COPERT and MOBILE. This software has more characteristics of vehicles than similar software. Also, the calculation of emission factors in this software is based on instantaneous speed not average speed which is one of the best advantages of this software [14].

Isfahan is one of the big cities in Iran that has many problems with air pollution [15]. Estimating the amount of emission of pollutants is the first step in managing and solving the problems in this city. One of the most important ways to reduce air pollution is encouraging people to use public transportation systems such as taxi rather than private vehicles. Governments encourage people to use public transportation by the expansion of these systems. A taxi is usually a licensed vehicle for people transportation with a distinctive color (usually orange-yellow in Iran) or a special sign on the top. Although pollutant emissions by cars in different cities of Iran have been estimation in few cities of Iran, it has not yet been specifically addressed to the Isfahan taxies emission inventory. Therefore, the main objective of this study is to provide the rate of pollutant emissions from taxis in the Isfahan. It should be noted that in Iran, along with official taxis under the umbrella of Isfahan taxi management and supervision organization, there are also illegal taxis, which are not considered in the study because of lack of statistics and information on their number.

MATERIALS AND METHODS

Gathering of input IVE data

In this study, the IVE model version 2.0.2 was used to calculate the emission rate of Isfahan taxies. The use of IVE model requires six categories of information includes (1) determining the driving pattern; (2) vehicle speed, acceleration and mileage; (3) the number of vehicles, year of vehicle manufacturing and annual operation; (4) vehicle's technology like fuel type, engine size, etc.; (5) environmental conditions such as temperature, humidity and etc; (6) characteristics and quality of fuel.

One of the most important input data of the IVE model is the type of vehicles that are moving in the city. In this study, number, type and year of manufacturing of Isfahan taxies were obtained from the Isfahan taxi management and supervision organization. In addition to the above information, the ambient temperature, humidity, elevation of Isfahan from the sea level were collected for year 2016. The height of the city of Isfahan was considered as much as 1602 m. Also, according to the Islamic Republic of Iran Meteorological Organization, the average temperature and humidity of Isfahan was 17.87 °C and 33.5%, respectively. In addition, the fuel type, fuel composition, the percentage of vehicles that used cooler on the temperature more than 27˚C, the number of start-

ups, the average distance traveled per day and the type of consumed fuel were collected through the distribution of 1,000 questionnaires among taxi drivers in Isfahan.

Driving Pattern

The driving pattern is one of the important parameters in IVE model. Therefore, the driving pattern should be evaluated accurately. Driving patterns means the speed of each car from the start time to reach to destination. In the study of a city, different streets must be analyzed, with the data representing the entire streets of the city.

The streets are often divided into three categories. The first category consists of connecting streets that can connect an urban area to another urban area. One of the most important characteristics of these streets is that they have the highest speed of the cars and the least traffic caused by red lights. This category is commonly known as highway or freeway. The second group of streets is the ones that connect different parts of a metropolitan area together. These streets are usually called arterial streets. The third category represents the streets that people use to go to their homes or small businesses in a metropolitan area. These streets can be one-way or two-way, with low speed. The third category of streets also has many crossroads. These streets are usually called residential streets.

In this study, a car was equipped with a Global Positioning System (GPS) and at different times of the day, it was moved on the main streets of Isfahan. The car was moved at the highest possible speed, but below the maximum permitted speed. Information was collected for selected city streets at different times of the day specifically 9 am, 15 pm, 16 pm and 18 pm. Also, to determine the Isfahan driving pattern following streets were selected. Sajjad street, Bozorgmehr street, Valiasr street, Neshat street, Palestine street, Ferdowsi street, Ayenekhane street, Chaharbagh Bala street, Hezar Jereyb street, Azadegan street, Sheikh Sadough street, Keshavarz-Artesh street, Western Nazar street, Middle Nazar street, Eastern Nazar street, The first Apadana street, the second Abshar street, the third Abshar street, Shahid Ayatollah Motahari street, Ali Khani street, the Garden of Golestesh street, Darvazeh Dolat street, Abdul Razaq street, Neshat street, Shamsabadi street, Kamal Ismail street, Khayyam street, Mirfandarsaki street, Northern Towhid street, Melat street, Hakim street, Mohtasham Kashani street, Roodaki street, Suhrawardi street, Keshavarz street, Baghe Daryache street, Imam Khomeini highway, Shahid Kharrazi highway, Safe highway, Shahid Agharebparast highway and Zob Ahan highway were considered.

The quality of taxis fuel

The quality of fuel is a main requirement to use IVE for pollutant emissions prediction. This information was requested through the National Iranian Oil Refining & Distribution Company. The amount of sulfur in the fuel consumed by taxies was considered as 600 ppm. Also, the amount of lead in gasoline was considered as zero. The amount of benzene in gasoline consumed by vehicles was up to 3% while the amount of oxygen in the fuel was considered as 2%.

Determining emission of particles from the movement of taxis in the streets

Cars, in addition to producing suspended pollutants through the engine, can also produce particles into the atmosphere by moving on the road. Moving tires on the road can cause tire and road surface wear that produce dust particles. Eq. (1) can be used to calculate the amount of these particles.

In the above equation, TE is emission of suspended particulate matters (TSP, PM_{10}, $PM_{2.5}$) in grams, is the number of vehicles from each category, is the average mileage per car in each category in Kilometer, and is the emission factor for pollutant i and vehicle category J. The emission factors for passenger cars are TSP of 0.0182, PM_{10} of 0.0138 and $PM_{2.5}$ of 0.0074 g/km for each car [16].

RESULTS AND DISCUSSION

Type and number of Taxis in Isfahan

Isfahan has latitude of 51 degrees, 39 min and 40 sec east and 32 degrees latitude, 38 min and 30 sec north. According to the population and hous-

ing census of 2016, Isfahan has population of 2243249 people. This city is one of the large, industrialized cities of Iran, with hundreds of thousands of inland city trips every day. Necessary information related to taxies in the city of Isfahan such as the number of city taxis per type of vehicle and the year of manufacturing was collected from Isfahan taxi organization (Table 1). According to the latest statistics from the taxi organization in Isfahan, 9868 taxi vehicles was moving in this city in 2016. Nearly one hundred percent of these taxis are hybrid (CNG and gasoline). By collecting the results of the questionnaires, each taxi will run an average of 150 km a day and its gasoline will be 30 L/week for gasoline.

Table 1. The type, year of manufacturing and number of taxis in Isfahan

Type of vehicle	The year of manufacturing	Number of vehicle	Type of vehicle	The year of manufacturing	Number of vehicle	Type of vehicle	The year of manufacturing	Number of vehicle
Samand-4EF	2014	175	Peugeot 405	2011	1565	ROA	2006	6
Samand-4EF	2015	11	Peugeot 405	2012	142	ROA	2007	620
Samand-4EF	2016	44	Peugeot 405	2016	423	ROA	2008	296
Samand-4EF	2017	56	Peugeot 405	2017	163	ROA	2009	561
Tondar	2009	433	Peugeot RD	2000	3	ROA	2010	171
ARIO IT	2015	1	Peugeot RD	2002	3	ROA	2011	225
ARIO IT	2016	172	Peugeot RD	2003	4	Samand-X7	2003	6
ARIO IT	2017	10	Peugeot RD	2004	10	Samand-X7	2004	304
KIA pride	2001	1	Peugeot RD	2005	39	Samand-X7	2005	221
KIA pride	2002	8	Peugeot RD	2006	20	Samand-X7	2006	95
KIA pride	2003	9	Peugeot RD	2007	1	Samand-X7	2007	106
KIA pride	2004	12	Peykan	1982	1	Samand-X7	2008	6
KIA pride	2005	19	Peykan	1983	1	Samand-X7	2009	22
KIA pride	2006	281	Peykan	1984	6	Samand-X7	2010	1
KIA pride	2007	142	Peykan	1985	4	Classic Samand	2004	1
KIA pride	2008	117	Peykan	1991	1	Classic Samand	2006	91
KIA pride	2009	994	Peykan	1992	2	Classic Samand	2007	203
KIA pride	2010	227	Peykan	1993	4	Classic Samand	2008	108
KIA pride 141	2003	2	Peykan	1994	1	Classic Samand	2009	117
KIA pride 141	2006	1	Peykan	1995	4	Classic Samand	2010	47
KIA pride 141	2007	174	Peykan	1996	10	Classic Samand	2011	273
KIA pride 141	2008	24	Peykan	1997	5	Classic Samand	2012	9
KIA pride 141	2009	5	Peykan	1998	10	Ghazal	2007	3
Peugeot 405	1992	1	Peykan	1999	35	Ghazal	2008	1
Peugeot 405	2003	36	Peykan	2000	49	FAW	2008	1
Peugeot 405	2004	32	Peykan	2001	9	Volkswagen caddy	2007	6
Peugeot 405	2005	3	Peykan	2002	33	Volkswagen caddy	2008	18
Peugeot 405	2006	1	Peykan	2003	34	Narvan	2007	34
Peugeot 405	2007	191	Peykan	2004	60	Narvan	2008	19
Peugeot 405	2008	49	Delica	2006	2	Delica	2008	85
Peugeot 405	2009	75	Delica	2007	211	Delica	2009	14
Peugeot 405	2010	37	-	-	-	-	-	-

Driving pattern

Determining the driving pattern in each city is one of the most important required data to use the IVE model for the estimation of pollutant's emission in the atmosphere by vehicles. As indicated in the methodology section, a vehicle equipped with a GPS was used to determine the driving pattern in the main streets of Isfahan and its speed recorded for every second of the journey. Since the pattern of driving in the city varies over the time, this study was carried out at four different hours specifically 9 am, 15 pm, 16 pm and 18 pm. Then, the average speed of each vehicle in the streets of Isfahan was determined with the help of collected data as shown in Fig. 1. The driving pattern of Isfahan has an 800 sec period, which is constantly repeated for each taxi driver. Fig. 2 shows the time distribution of BIN model.

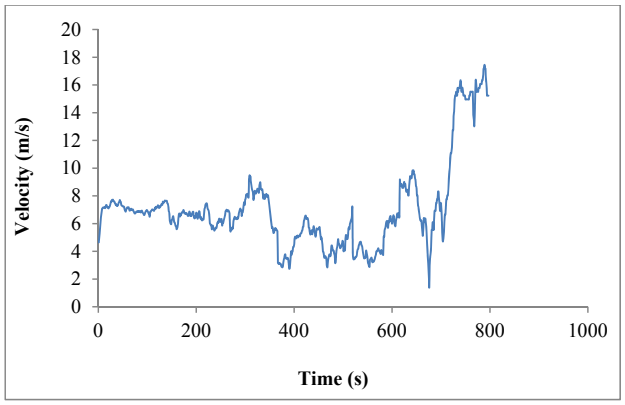

Fig. 1. Driving pattern of Isfahan Taxis

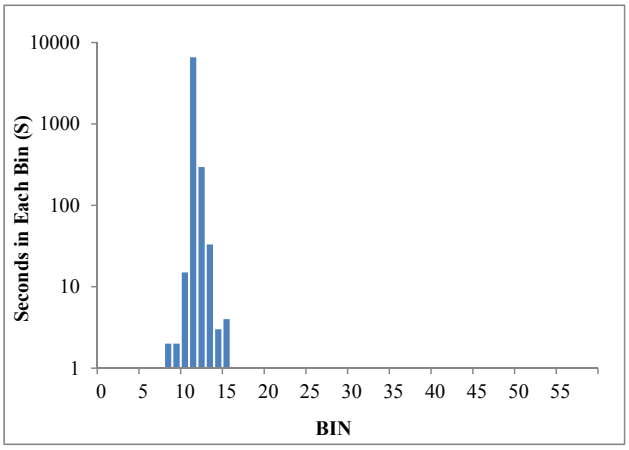

Fig. 2. Time distribution of driving pattern (BIN) in Isfahan

The rate of gaseous pollutants emission

Various pollutants are generated and released into the air during start-up and running of the vehicle. These pollutants can be divided into three categories as (a) typical air pollutants, (b) greenhouse gases and (c) toxic contaminants. The main air pollutants are suspended particles, sulfur oxides, nitrogen oxides, volatile organic compounds, and carbon monoxide that known as air pollution indicators [10]. Also, toxic contaminants that are usually released from vehicles are formaldehyde, lead, ammonia, butadiene, acetaldehyde and benzene. In this study, greenhouse gas emissions are carbon dioxide and methane. The amount of emission of each of the mentioned pollutants in the form of annual and daily for year 2016 are shown in Table 2.

Gasoline is a part of crude oil that is distilled between 70 and 175 ºC and contains hydrocarbons from C_5 to C_{11} and in some cases up to C_{12}. Normal gasoline is a mixture of hydrocarbons such as paraffins (alkanes), naphthenes (cycloalkanes), and olefins (alkenes), but octanes (C_8H_{18}) are also known as one of the specific compounds in gasoline. All of the above mentioned compounds can be considered as VOCs. VOCs can emitted to the air as a result of evaporation of fuel from different parts of the car. The evaporation rate depends on the air temperature. Therefore, the amount of evaporation in the warm months of the year is the maximum and in the cold months the evaporation is minimal. In some months that the weather is mild; the amount of evaporation is between the cold and hot months. Most of the compounds in gasoline are toxic or carcinogenic. Therefore, their emission into the atmosphere is of particular importance. The results of this study showed that in 2016, 2763 tons of fuel was evaporated from Isfahan city taxies. Assuming a density of 0.68 tons/m^3 for gasoline, this evaporation rate is equivalent to 4819 L of gasoline.

Meanwhile, by dividing the total emissions of organic compounds caused by evaporation of gasoline on the number of taxies in Isfahan (9868 units), the average emission factor of evaporating organic compounds based on its weather conditions is calculated. This study recommends the release of VOCs from the evaporation of gasoline

from the Isfahan taxies as much as 27.98 kg per taxi per year. The following points are relevant for the application of this emission factor in the coming years: (1) this emission factor is related only to taxies in Isfahan and maybe has a significant error if it be used in other cities with different weather conditions and traffic variations; (2) this emission factor does not include the evaporation of gasoline during re- fueling. To estimate the release of VOCs, during re-fueling vehicles, special emission factors introduced by international organizations such as the US Environmental Protection Agency or the European Environment Agency should be used; (3) although, this emission factor has been introduced to calculate the rate of VOCs evaporation from taxies, but it can also be used for an approximate estimation of pollutants emission rates in non-taxi vehicles in Isfahan.

Table 2.The rate of air pollutants emission released from taxis in Isfahan in 2015

Unit	Type of pollutant	Starting Up	Running
Ton/day	1.3 Butadiene	0	0.0000123
	Lead	0	0
	Acetaldehydes	0.00000002	0.00215
	Formaldehyde	0.00000031	0.028
	Ammonium	0.000000008	0.011
	Benzene	0	0.00009
	Carbon dioxide	0.000014	52
	Nitrous oxide (N_2O)	0	0
	Methane	0.00000325	0.249
	Carbon monoxide	0.000021	0.4895
	VOCs generated during combustion in the engine	0.00000036	0.027
	Evaporated VOCs from fuel	0.0000003	0.882
	Nitrogen oxides	0.00000147	0.82
	Sulfur oxides	0	0.00016
	Total suspended particles	0.00000001	0.00069
Ton/year	1.3 Butadiene	0	0.003
	Lead	0	0
	Acetaldehydes	0.00000262	0.6745
	Formaldehyde	0.000097	8.94
	Ammonium	0.00002504	3.55
	Benzene	0	0.028
	Carbon dioxide	0.0046	16276
	Nitrous oxide (N_2O)	0	0
	Methane	0.001	78.05
	Carbon monoxide	0.006	153.22
	VOCs generated during combustion in the engine	0.0001	8.67
	Evaporated VOCs from fuel	0.0000939	267.11
	Nitrogen oxides	0.0004	25.69
	Sulfur oxides	0	0.0364
	Total suspended particles	0.00000313	0.2165

The rate of suspended particles emission due to the movement of taxis tire on the street

Cars create different types of suspended particles on the road during their journey. The air suspended particles are initially below 1 µ and can be seen up to 100 µ. Particles larger than 50 µ cannot basically stay in the air for a long time. The researchers estimated that the particles need a minimum of terminal velocity equal of 7 cm/s to stay in the air as they are deposited at a lower velocities [17]. In most cases, gravity has little effect on sedimentation of dusts that are smaller than 1 µ in size. Particles smaller than 1 µ require only 0.03 mm/s of terminal velocity to stay in air. The amount of suspended particles released from the movement of Isfahan taxis on the streets is shown in Table 3. As can be seen in this table, 8.43 tons of total suspended particles are annually emitted by the Isfahan taxies. The amount of PM_{10} emitted per year was also estimated around 6.39 tons. The $PM_{2.5}$ value was also estimated at 3.42 tons/year. The results of this study showed that 0.21 tons of suspended particles are emitted to the Isfahan air through the activity of taxi engines, while 8.43 tons of these particles are emitted annually due to the movement of taxis on the street. In total, the release of suspended particles due to the activity of Isfahan taxis is 8.64 tons/year. The amount of suspended particles produced by the operation of taxi engines is only 2.5 % of the total suspended particles produced by these vehicles, and 97.5 % of the particles are due to the movement of their tires on the street.

CONCLUSIONS

One of the bases for determining the policy of controlling air pollution is to find the emission rate of each source of pollutant. Therefore, the study of each city's emission inventory of pollutants is one of the most important steps in controlling the air pollution of that city. This study found that thousands of tons of volatile organic compounds, carbon dioxide, nitrogen oxides, sulfur oxides, and many more are introduced into the atmosphere by Isfahan taxies. Although these values are very high, the passenger-to-vehicle ratio in taxies is far higher than that of single-person private cars. Additionally, the total number of taxies in the Isfahan released 16,276 tons of carbon dioxide, 78 tons of methane, 153 tons of carbon monoxide, 8.67 tons of volatile organic compounds, 25.69 tons of nitrogen oxides and 0.036 tons of sulfur oxides into the atmosphere in 2015. Also due to the movement of taxies on the streets, 8.43 tons of airborne particles were released. The amount of suspended particles produced by the operation of taxi engines was only 2.5 % of the total suspended particles produced by these vehicles, and 97.5 % of the particles were due to the movement of their tires on the street.

FINANCIAL SUPPORTS

Jami Institute of Technology financially supported this study (Vot. No. 000105).

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.

Table 3. The rate of suspended particles emission from movement of taxis tiers on the rod

The rate of $PM_{2.5}$ emission in ton/day	The rate of PM_{10} emission in ton/day	The rate of TSP emission in ton/day	The rate of $PM_{2.5}$ emission in ton/year	The rate of PM_{10} emission in ton/year	The rate of total suspended particles (TSP) emission in ton/year	Type of pollutants
0.010	0.020	0.026	3.42	6.39	8.43	The rate of emission

ACKNOWLEDGEMENTS

This study is the result of the Master's degree thesis by Golshan Makipoor, chemical engineering student in the Jami Institute of Technology (JIT), Isfahan, Iran. The authors of this study appreciate the financial and spiritual support provided by JIT and the Isfahan taxi management and supervision organization, which specified the requirements of this study. The permission of publication of this paper was enquired from Manager of Research and Planning of Isfahan Taxi Management and Supervision Organization on December 2017.

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. Authors adhere to publication requirements that the submitted work is original and has not been published elsewhere in any language.

REFERENCES

[1] 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).

[2] Di Q, Wang Y, Zanobetti A, Wang Y, Koutrakis P, Choirat C, et al. Air pollution and mortality in the Medicare population. New England Journal of Medicine. 2017;376(26):2513-22.

[3] Talaiekhozani A, Ghaffarpassand O, Talaei MR, Neshat N, Eydivandi B. Evaluation of emission inventory of air pollutants from railroad and air transportation in Isfahan metropolitan in 2016. Journal of Air Pollution and Health. 2017;2(1): 1-18.

[4] Talaiekhozani A, Moradi M, Darvar P. Evaluation of Carbon Dioxide, Methane and Non-Methane Organic Compounds Emission from Solid Waste Landfill of Bandar Abas City. The 6th National and 1th International Conference of Applications of Chemistry in Advanced Technologies, Isfahan, Iran. 2016.

[5] Talaiekhozani A, Masomi B, Hashemi SMJ. Evaluation of gaseous pollutants emission rate from Marvdasht landfills. Journal of Advanced Medical Sciences and Applied Technologies. 2016;2(1):162-75.

[6] Talaiekhozani A, Nematzadeh S, Eskandari Z, Aleebrahim Dehkordi A, Rezania S. Gaseous emissions of landfill and modeling of their dispersion in the atmosphere of Shahrekord, Iran. Urban Climate. 2017.

[7] Weaver GM, Gauderman WJ. Traffic-Related Pollutants: Exposure and Health Effects in Hispanic Children. Am J Epidemiol. 2017.

[8] Green ML, Foster K, Gough L. Urban development in the southern Great Plains: effects of atmospheric NOx on the long-lived post oak tree (Quercus stellata). Urban Ecosystems. 2017;20(3):651- 61.

[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; 29 (4): 305-15.

[10] Ghiaseddin M. Air Pollution, Sources, Impacts and Control. Tehran: Tehran University of Medical Sciences; 2015.

[11] 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).

[12] Dai H, Jing S, Wang H, Ma Y, Li L, Song W, et al. VOC characteristics and inhalation health risks in newly renovated residences in Shanghai, China. Science of Total Environment. 2017;577:73-83.

[13] Hao L, Chen W, Li L, Tan J, Wang X, Yin H, et al. Modeling and predicting low-speed vehicle emissions as a function of driving kinematics. Journal of Environmental Sciences. 2017;55:109-17.

[14] Mohammadi-Zadeh MJ, Karbassi A, Bidhendi GN, Abbaspour M, Padash A. An Analysis of Air Pollutants' Emission Coefficient in the Transport Sector of Tehran. Open Journal of Ecology. 2017;7(05):309.

[15] Arfaeinia H, Kermani M, Aghaei M, Asl FB, Karimzadeh S. Comparative investigation of health quality of air in Tehran, Isfahan and Shiraz metropolises in 2011-2012. Journal of Health in the Field. 2017;1(4).

[16] EEA. EMEP/Corinair Emission Inventory Guidebook. Version 4 (2006 edition) ed: European Environmental Agency; 2006.

[17] WHO. Hazard Prevention and Control in the Work Environment: Airborne Dust, Chapter 1 - Dust: Definitions and Concepts. In: 1999, editor. USA: World Health Organization.