Journal of Air Pollution and Health (Summer 2017); 2(3): 145-152

Original Article

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

CO DISPERSION SIMULATION OF HIGH BURNERS FROM PROCESSED UNITS AT THE NATIONAL IRANIAN SOUTH OILFIELDS COMPANY BY SCREEN 3

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ARTICLE INFORMATION

Article Chronology:
Received 24 July 2017
Revised 21 August 2017
Accepted 12 September 2017
Published 28 September 2017

Keywords:
Carbon monoxide; pollutant dispersion simulation; Screen 3; burners

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ABSTRACT:

Introduction: Dispersion of pollutants from burners and stacks has been always one of the most important environmental concerns in some industries such as oil due to the personnel exposure to pollutant sources. All combustible burners, release hazardous pollutants in environment. The target pollutant in this study is carbon monoxide derived from combustion, so the perpouse is finding the distance from burner which the risk for inhalation of this pollutant is high due to the highest concentration of this pollutant at this distance.
Materials and methods: In this study, 4 pollution sources at the National Iranian South Oilfields Company were selected, then the exhaust gases, temperature, wind velocity, and the other parameters were measured by measuring instruments in order to carry out by Screen 3 for dispersion of CO.
Results: The highest concentration of CO (27.04 µg / m^3) at difference of 226 m from station 3 were determined in the stability class C. The exhaust gas velocity of burner was assumed as the most critical mode, 10 m / s, considering the exhaust gas temperature from burner was 1000 ° C.
Conclusions: Results showed that the burners of this unit are safe and in compliance with the standards in terms of CO emission.

INTRODUCTION

Preservation of the environment is one of the important concerns of the human society and also the observance of environmental criteria is one of the essential requirements for the survival of human beings [1]. The oil industry is one of the most important industries in Iran and is the first and most important sources of finance in the country, therefore it is of particular importance. On the other hand, oil as an industry with long and complex processes always has a lot of personnel who work continual alongside the various units, so it should be important to keep their health and prevent the occurrence of various short-term and long-term problems for this category.
Regarding the strategic position of Khuzestan province in the field of oil and gas in country and the continuous activities of the mentioned province, and also the wealth creation and various sources to overcome the needs for country, environmental damages caused by this industry is undeniable. The emission of pollutants releasing from stacks and burners is one of the most

Please cite this article as: Naghshe Javaheri M, Goudarzi Gh. CO dispersion simulation of high burners from processed units at the national Iranian south oilfields company by Screen 3. Journal of Air Pollution and Health. 2017; 2 (3): 145 - 152.

important risks which threatens all fields of oil industry. However exhaust emissions contaminate the air, the distribution of these pollutants should be determined in order to distinguish the territory of habitation for people or staff, considering their health.

The National Iranian South Oilfields Company has been operating the extensive activities in six provinces of southern Iran with a variety of stacks and burners. For this research, three burners are considered as samples. One of the issues in protecting people's health is to prevent the inhalation of pollutant gases released due to combustion in burners. All burners, due to the fact that they are combustible, release hazardous pollutants in environment, each of which has detrimental effects. The target pollutant in this study is carbon monoxide derived from combustion, and the purpose is to find the distance from the burner, in which the risk of inhalation of this pollutant is high, in other words, the concentration of pollutant is high. Once this area has been identified, it should be as much as possible avoided the presence of personnel in high-risk areas and built camps and communities in a safe distance from the burner.

The Gaussian model

The Gaussian model is used as the most common model for estimating the concentration of pollutants from point sources around the world and provides appropriate forecasts [2, 3]. The basic Gaussian equation for determining the concentration of pollutants in the downstream direction is as follow:

$$x = \frac{Q}{2\pi u_s \delta_y \delta_z}\left[exp\left[-0.5\left(\frac{z_r - h_e}{\delta_z^2}\right)^2\right] + exp\left[-0.5\left(\frac{z_i - h_e}{\delta_z^2}\right)^2\right]\right] \quad (1)$$

In which Q stands for emission rate (g / s), wind speed u_s at the stack height (m / s), δ_y and δ_z horizontal and vertical dispersion coefficients (m), h_e plum height (m), z_r height of the receiver from the surface (m), and z_i is the mixing height (m) [4].

Since the measurement of pollutants is not possible everywhere, it can be predicted the distribution of pollutants and the air condition at different points through the models [5].

The use of air emission models provides useful information for air pollution control strategies. [6]. These models are based on calculations made by computers and used to predict the effects of air pollution . Although various measurements of the industries, refineries and power plants exhaust have been carried out by environmental experts or environmental private companies, the accurate amount of pollutant emission regarding the production amount is not available to use as the primary data for air pollution modeling and management decisions [7].

Background

In a study on assessment of air pollution in oil refineries and identifying the critical area, the distribution model of pollutants has been analyzed for a refinery and the information collected has been analyzed using SCREEN 3. The diffusion of airborne pollutants from the operating stacks No. 01 in distillation unit and vacuum furnaces in the refinery and the surrounding environment has been analyzed and the results are acceptable [7].

According to a study entitled environmental management of air pollution at Bandar Abbas oil refining company by SCREEN 3 model and identifying its critical areas by GIS, field studies were conducted, then the required data was collected to be modeled by SCREEN 3. Therefore the concentrations of SO_x and NO_x were measured for 24 stacks and boilers in the Bandar Abbas Oil Refinery company to the distance of 25 km (according to the prevailing wind) [9].

In a study on distribution and emission factor of pollutants releasing from Ramin Power Plant's stacks, exhaust gases emitting from stacks of unit 3 and 4 were measured by TESTO 350 XL for 9 months weekly (December 2011- August 2012). Then the emission factor of SO_2, NO_X, CO, and CO_2 was calculated for modeling of pollutants dispersion by SCREEN3 [10].

MATERIALS AND METHODS

In this research, two mesurment systems were applied; 1) Lancom 3 manufactured by Land Instrumental International company in English, for measuring the pollutants in combustion sources, 2) Street Box manufactured by Signal Group in England,for measuring the ambient air. Exhaust gases of stack were measured for 6 months by portable Lancom 3 through the electrochemical sensors for determination of CO ،O_2 ،NO ،NO_2، SO_2 و H_2S ; infrared sensors to determine CO_2 ; and Pellistor sensor to determine hydrocarbons. In order to measure the environmental pollutants in downstream from pollution sources and burners, CO, SO_2, and NO_2 were measured by portable Street Box through electrochemical sensors with the accuracy of ppb. The air sample is pumped into the device and after measurement by electrochemical sensors, the result is recorded in the device memory. The device is capable for providing a 15-minute average concentration of pollutants in the long term.

Since the device measured parameters in ppm, some equations were used to convert ppm into mass flow rate in seconds considering that the input of Screen 3 should be in mass flow rate in seconds.

The Screen 3 has been designed based on normal distribution or Gaussian model. This model gives the acceptable results to estimate the maximum concentration at ground level; and the distance of this maximum value to pollution source ; and also the concentration of pollutant in every number of points with the differences which were defined by operator in the directions perpendicular to the pollution source or in line with it.

In this model, if the user identifies the stability class for analysis, all computations will be based on the same class of stability, otherwise, at each point, the most critical sustainability class is considered and the results will be determined in the output.

The parameters needed to enter the Screen 3 are different for the four type of pollutants. In this model, it is possible to analyze point sources, burners, volumes, and large-scale contaminants. In this study, it has been tried to simulate the pollution sources to the point sources in order to survey the effects of all pollution sources. Considering the overlap of the pollution sources, all these sources can be assumed as a pollution source with the overall mass flow of each stations individually.

Input data

The minimum inputs required for analysis in the Screen 3 are:

Emission rate (g / s)
Stack height (m)
Stack inside diameter (m)
Stack gas exit velocity (m / s)
Stack gas temperature (°K)
Ambient temperature (°K)
Receptor height above ground (m)
Urban/ rural option (U= urban, R= rural)

Measurement

According to the obtained data on high burners, CO concentration is as follow:

According to the information obtained, the specifications of high pressure burners are as follows: The burner diameter: 30 cm; height above ground: 40 m; exhaust gas temperature: 1000 ºC; average discharge of each burner in a day: 0.2 million ft^3/ day, equivalent to 5664 m^3/ day.

Regarding that the acceptable input discharge for

Table 1. CO measurement specifications at stations

Turn	Station	CO (ppm)	Wind velocity	Temperature ºK	(Degree) Wind direction
First	St 2	1431	3.20	312	43
Second	St 3	8737	3.34	312	69
Third	St 3	3228	2.59	293	209
Forth	St 0	188	4.19	290	134

Screen 3 should be in mass flow rate, ppm values should be converted to g/ s.

Mathematic calculations

Through chemical equations and considering the molecular weight of carbon and oxygen, it was found that 1 ppm of CO is equal to 1.25 mg / m ^{3} in term of 273 ºK. So in other temperatures the following equation is considered.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

And assuming that the pressure is the same at both temperatures**:**

$$V_2 = \frac{T_2}{273 P_2}$$

For example, based on the above equation at station St 2, V_2 is 1.14. The value of 1.25 mg / m^3 should be divided into 1.14 m^3. Therefore the result is 1.1 mg / m ^{3}. Thus the value of 14, 1, 1.07, and 1.06 will be resulted for station 3 (the second turm, the third turm) and station 0, respectively for all the pollution sources.

Now, with the acquisition of new volumes, we calculate ppm conversions to mass flow rate:

For St 2:

$$1.14 \times 10^{-3} \times 1431 = 1632 \frac{g}{m^3}$$

$$5446 \frac{m^3}{day} \times 1632 \frac{g}{m^3} = 9244 \frac{g}{day}$$

$$9244 \frac{g}{day} \times \frac{1}{86400} = 0.1 \ \frac{g}{s}$$

And also for stations St 3 in the second and third turns, 0.66 and 0.23 and for Station 0, 0.01 g / s will be achieved.

In this way, the mass flow rate of different stations for the Screen 3 was obtained. Then the following analyzes were performed by entering raw data in the Screen 3.

RESULTS AND DISCUSSION

Station 0

The Screen 3 analysis chart for the station 0 is shown in Fig. 1

Fig. 1 indicated that at a distance of 226 m from the pollution source, there is the highest concentration of CO in the amount of 0.41 µg / m ^{3}, which will be present in the stability class C. After this point, the pollutant concentration chart will follow a downward trend.

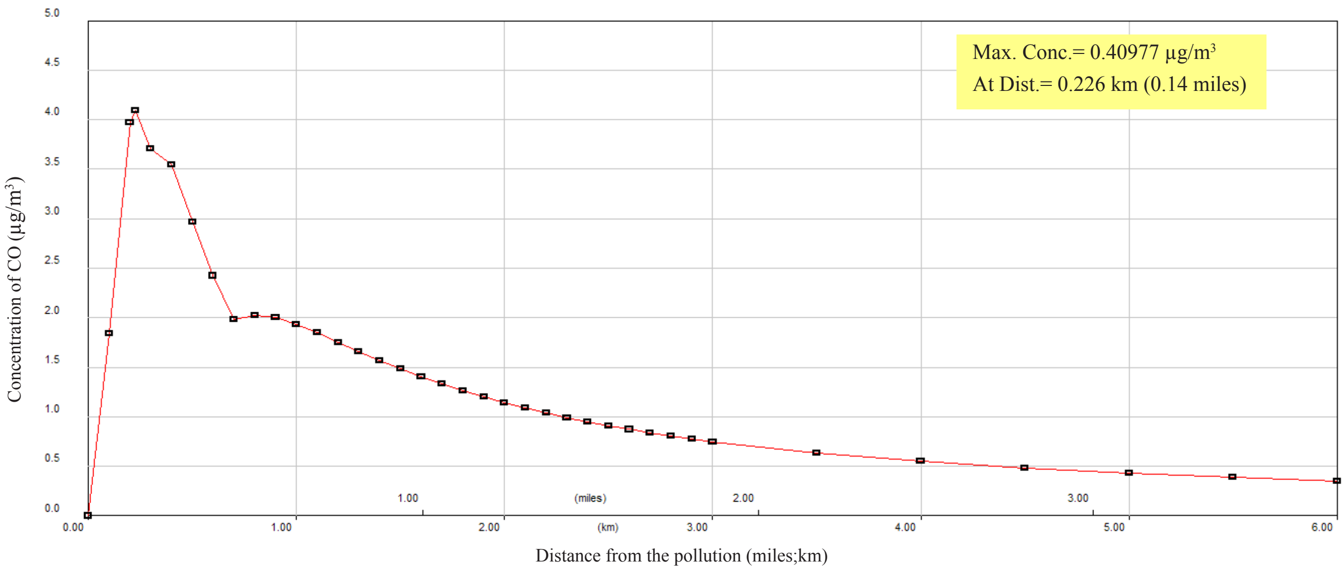

Fig. 1. Three Screen analysis chart for St 0

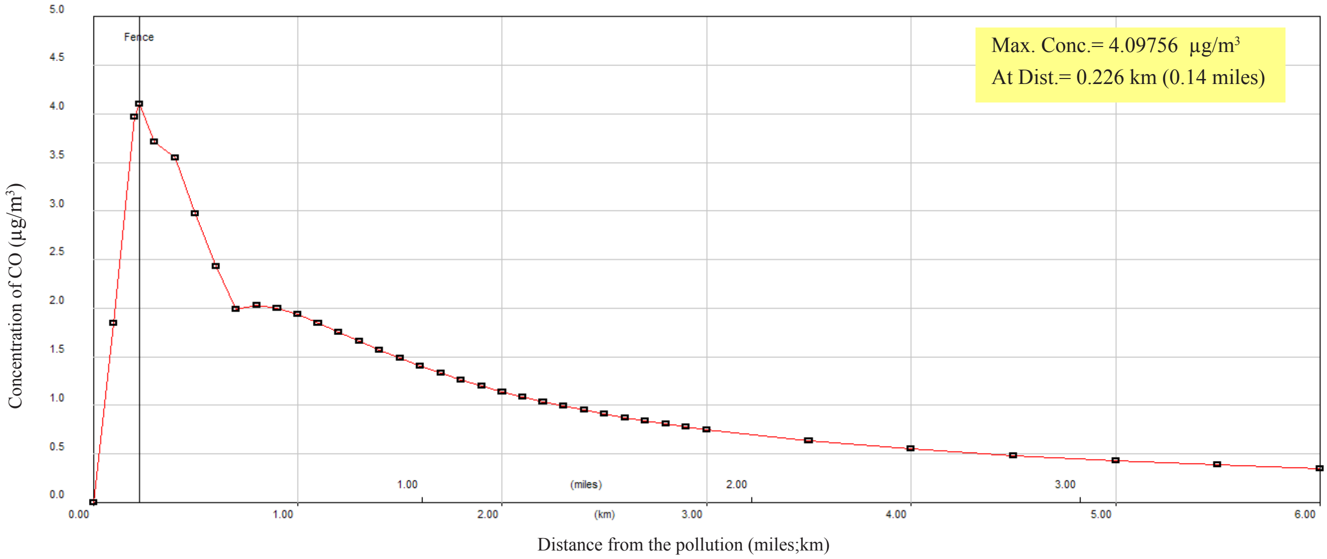

Fig. 2. The Screen 3 analysis chart for St 2

Station 2

The Screen 3 analysis chart for this station is as follow:

At this station, there is a maximum pollutant amount of 4.10 µg / m^3, at a distance of 226 m from the pollution source, which happened again in the stability class C.

Station 3 - the first turn

The Screening 3 analysis chart for this station is as follow:

In this graph, it is also observed that the maximum concentration (27.04 µg / m^3) is again at a distance of 226 m from the source in the stability class C.

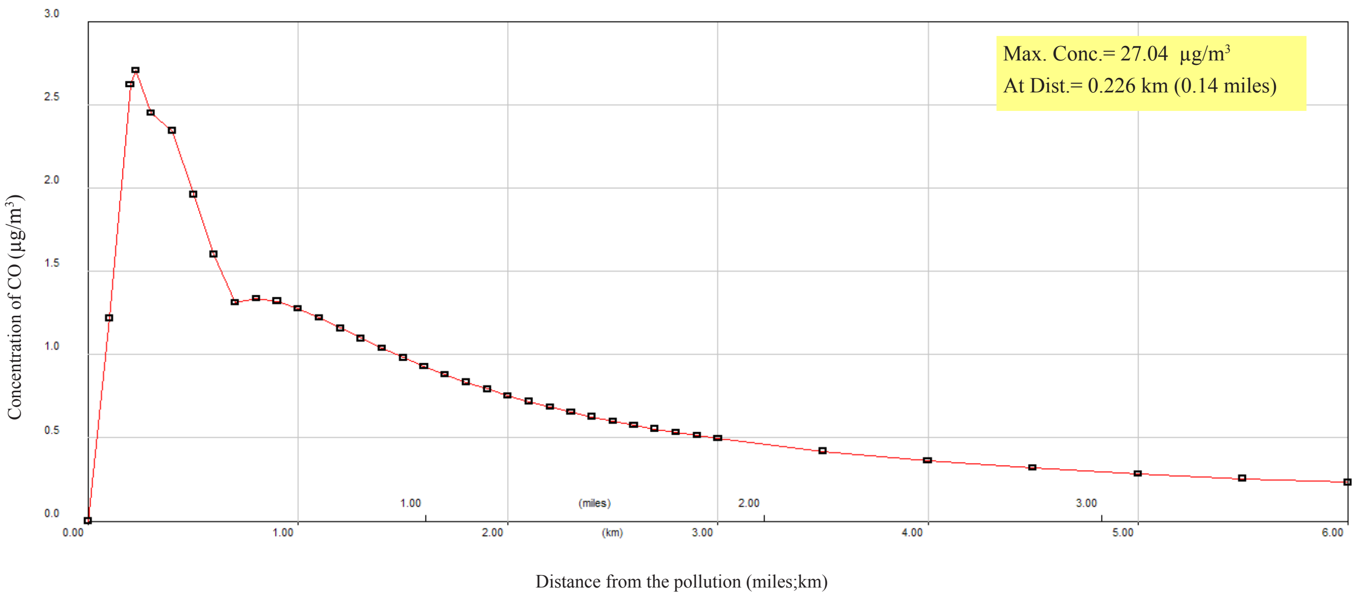

Fig. 3. The Screen 3 analysis chart for St 3 (fist turn)

Station 3 - second turn

The Screen 3 analysis chart for this station is as follow:

The maximum concentration (9.42 µg / m^3) at this station is at the distance of 226 m from the source and in the stability class C. After the maximum point, the chart trends a downside.

To consider all the stations as a centralized station with a cumulative mass flow, the chart will be as follow:

In this case, the highest concentration of pollutant will be 734.3 µg / m^3 at a distance of about 1.5 km from the centralized pollution sources in the stability class F. In this case, at first, the increasing in concentration will be seen to the distance of 400 m, then a decrease will be in the distance of 400 – 800 m. After that, the chart will shows the maximum point at the distance of 1.5 Km, then a downside trend will be seen.

As indicated in the measurements, the results for the stations were:

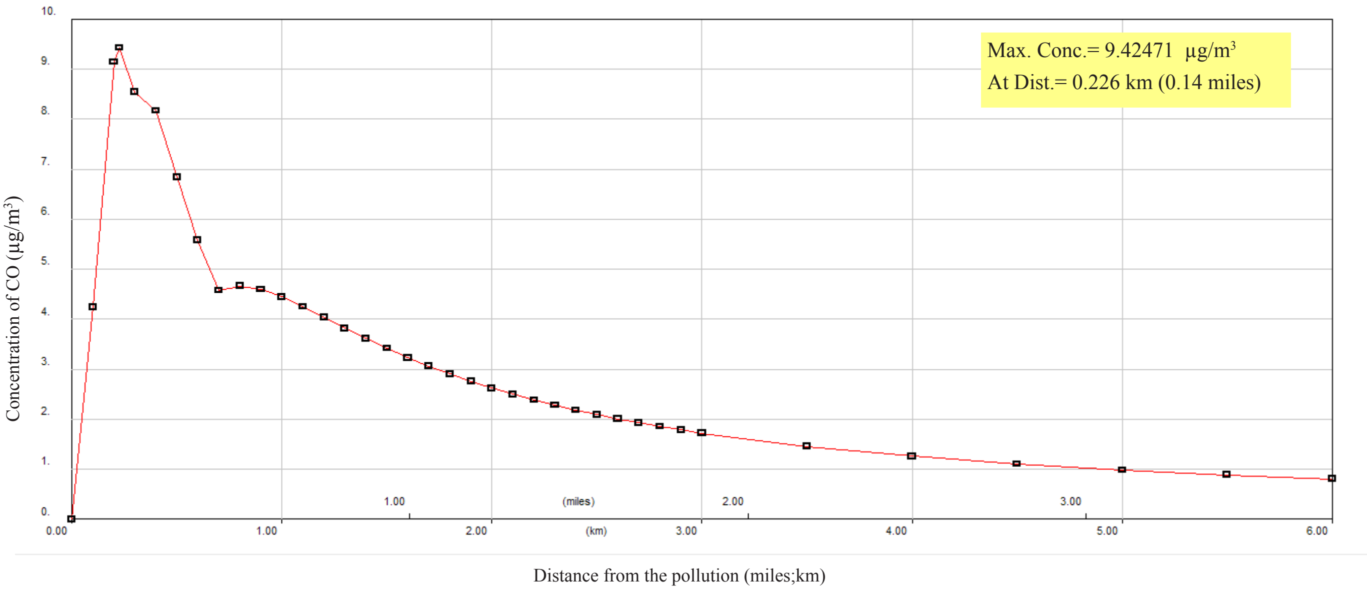

Fig. 4. The Screen analysis chart for St 3 (second turn)

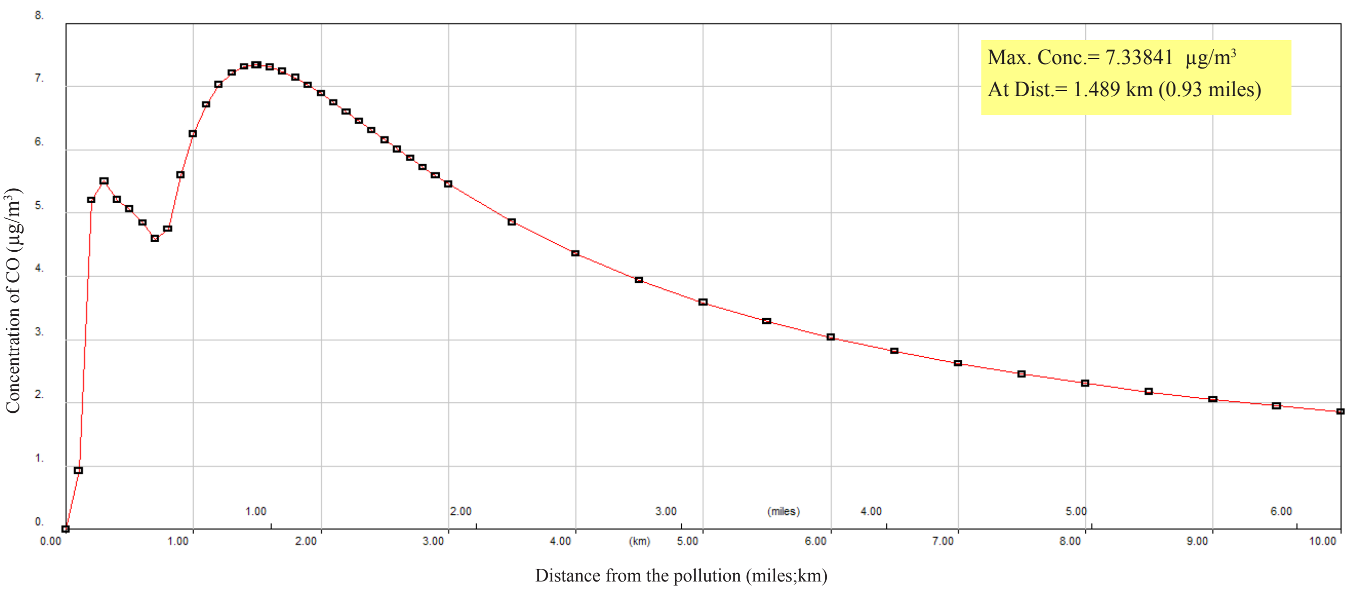

Fig. 5. The Screen 3 analysis chart for total stations

Table 2. Carbon monoxide discharge at stations

Turn	Station	CO ($\frac{\mu g}{m^3}$)
First	St 2	0.41
Second	St 3	4.10
Third	St 3	27.04
Forth	St 0	9.42

According to the standard level of NAAQS, which has determined the maximum CO (9 ppm) for 8 h measurement, the results shown in Table 2 were much less than this permitted level, so that all burners are in an environmental standard condition and are safe for downstream in long and short terms. Interestingly, the maximum concentration in all burners occurred at a distance of 226 m in the stability class C, which this is notfarfetched regarding the topographic position of that location.

Even if all the burners would be considered as a particular burner which the mass flow rate of this burner would be equal to sum of the total mass flow rate of all burners, the highest concentration would be equal to 734 µg / m^3, which is still much lower than the permitted limit without any environmental risk. Considering that the maximum concentration in this way occurs at the distance of 1.5 Km from all burners, the Karun river doesn't affected by environmental risk in term of the far distance of the burners from the river.

CONCLUSIONS

In a general conclusion, it can be said that the burners don't make environmental risk for the surrounding area, considering the environmental standards. In addition self- purification of the air surrounded of burners can be confronted with this amount of air pollution, while according to a study [8] , it was found that the amount of pollutants were higher that the permitted standards at the distance of 600- 1400 m from the Bandar Abbas Oil Refining company which caused to environmental risk.

The results of current study is consistent with the results of a study [10] on distribution and emission factor for the stacks at Ramin power plant.

It is recommended to measure the other pollutants releasing from high burners, boilers, etc., and comparing with the standards. In addition a survey on a new fuel and changes to combustion systems is recommended to decrease the concentration of pollutants in high risk area. Moreover optimizing and developing the current instruments may cause to optimal operation considering the environmental standards.

FINANCIAL SUPPORTS

The financial support of the study was done by author team.

COMPETING INTERESTS

The authors declare that they have no conflict of interest.

ACKNOWLEDGEMENTS

The authors thank the National Oil and Gas Organization of the South for their contribution to the preparation of this article.

ETHICAL CONSIDERATIONS

The authors state that they have no ethical consideration.

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