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Case Study

Improving the emission rates of CO, NO, NO_2 and SO_2, the gaseous contaminants, and suggesting executive solutions for accessing standard qualifications - A case study of Bandar Emam Khomeini

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ABSTRACT:

Among different industries, petrochemical industry is one of the main air pollutants which pollute the air by gaseous contaminants due to burning bulk of waste gases in flares. It is assumed that due to having different pollutant sources such as flue, metals, corrosive and chemical reactions, the economic zone of Bandar Emam Khomeini included these gaseous pollutants. Thus in this research Carbon monoxide (CO), Nitric oxide (NO), Nitrogen dioxide (NO_2) and Sulphur dioxide (SO_2), the gaseous pollutants of production process in the operational units of Shahid Tondgouyan port were measured and compared to the environmental standards. Therefore accomplishing basic studies, data collection regarding situation of exhaust emission in this selected area, investigation of production case and its management were investigated through different interviews and visits. Then the plan for providing and analysing the exhaust samples and preparing related tables and charts were carried out. By average calculation of exhaust gaseous contaminants from the selected flues and providing the factors of pollutant emission, their variance and standard deviation were evaluated and the situation of production and emission of air pollutants were studied. Also the plan for gaseous pollutants and their emissions were formulated. According to the results, regarding stabilizing the emission scale of CO, NO, NO_2 and SO_2 emitted from Shahid Tongouyan petrochemical output, only the amount of CO emission was excessive. This scale is modulated from 3922 ppm to 117 ppm. Other pollutants were emitted in a standard limit.

Keywords:

Air contaminant, Gaseous contaminant, Contaminant emission, Environmental standards, Shahid Tondgouyan petrochemical company.

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INTRODUCTION

Nowadays, air pollution is one of the serious problems among human being. It is important either environmentally or hygienically (Peavy *et al.*, 1985). Environmentally, air pollution causes risks such as climate change, acidic rain, destruction of ozone layer, and hygienically it brings irreparable damages to human beings (Bhatia, 2001). The petrochemical special economic zone in southwest Iran or the Persian gulf coast is, located in the city of Mahshahr and Bandar Imam Khomeini. Iran's National Petrochemical Company (NPC) proceeds to design and construct new petrochemical centers in an area close to petrochemical companies of Bandar Imam, Razi and Farabi. It takes 1700 hectares of the land as a special economic zone. This area is developed to 2600 hectares in the year 2006 in order to provide handicrafts from oil, gas and petrochemicals.

Due to advantages such as geographical, natural location, facilities of special zones, and also due to the substructures such as accessing to international water, national railroads, airports and different natural sources of energy, this zone has the appropriate chance for petrochemical construction, for the purpose of industry and business development specially petrochemical development and enhancement of economic, social and national interests, employment and technology absorption (Shi and He, 2012). Petrochemical centers such as Bouali Sina, Shahid Tongouyan, Khouzestan, Fajr and Amirkabir are located in the forth site of this zone. This area, because of the establishment of petrochemical parts and huge resources of oil, is considered as a main place in south.

Tondgouyan petrochemical company is established at 6 February 1998 with the approval of the board of national petrochemical industries for applying plans of producing Pure Terephthalic Acid (PTA) and Polyethylene terephthalate (PET). PET/PTA plans are carried out in northwest side of Persian Gulf at Khouzestan, in the special economic zone of Bandar Mahshahr in a land of 34 hectares.

Pure acid terephthalic is one of the main raw material for the production of polyethylene terephthalate resins which its production and consumption trends are impressive across the world. Polyethylene terephthalate is also one of the main raw materials of operative Polyester in production of synthetic and cotton fibers for textile, industry of plastic film manufacturing, production of soda bottles, jars and containers used in packaging of food, medical and hygienic material which is used dramatically (PSEZ, 2001).

Considering the management of pollutants including gaseous pollutant due to the different combinations of materials, aspects of compatibility and incompatibility in manufacturing operations and most importantly efficiency issue within the framework of environmental management of each certain area is of the most important.

In fact, environmental policy is an industrial unit representing goals and agenda regarding environmental protection in a certain period of time (Barrow, 2005). Because of the rich oil and gas resources in the country and government's economic policies, petrochemical industries received considerable attention as two special economic zones such as Mahshahr and Asalouyeh are considered beside the active petrochemical companies to stabilize such industries. These two special zones are located close to Persian Gulf. Their activities in the environment of this valuable ecosystem experienced some effects (Pourreza, *et al.,* 1993).

Given that in the special economic zone of Mahshahr, petrochemical companies produce dangerous chemical materials, and monitoring these pollutants are environmentally important, field monitoring of pollutants could be effective in the improvement of pollutant emission.

RESULTS

After investigating the geographical location of Tondgooyan petrochemical center, production performance, examining operative units of the center, identifying the resources of gaseous pollutant emission and the environmental standard limit of gaseous pollutant are discussed.

The results of pollutant emission are recorded based on the particular unit of measurement. Then according to the measurement of the concentration of exhaust gases from the flues, average amount of pollutant emission is measured to identify and evaluate

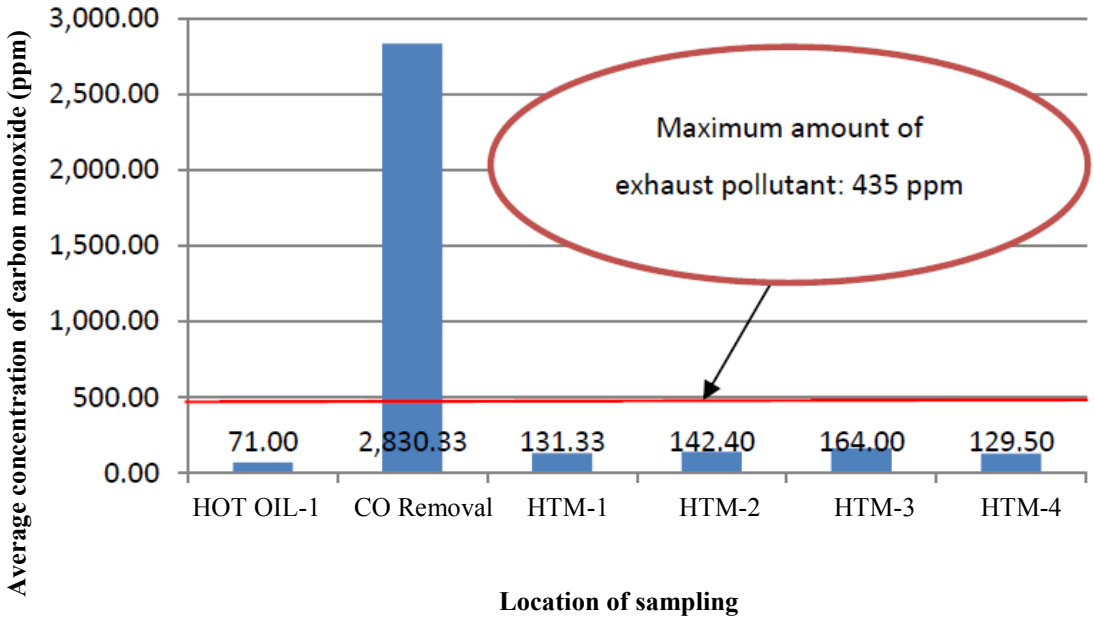

Figure 1. Comparison of the average concentration of with maximum amount of exhaust pollutant (during the last three months of the year 1992)

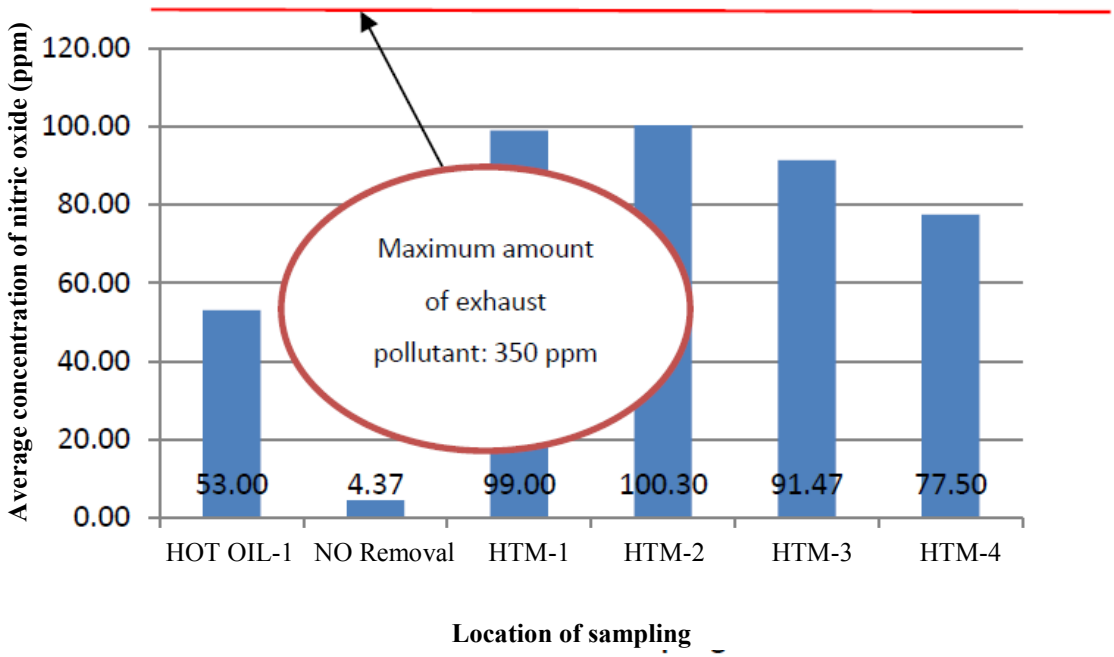

Figure 2. Comparison of the average concentration of NO with maximum amount of exhaust pollutant (during the last three months of the year 1992)

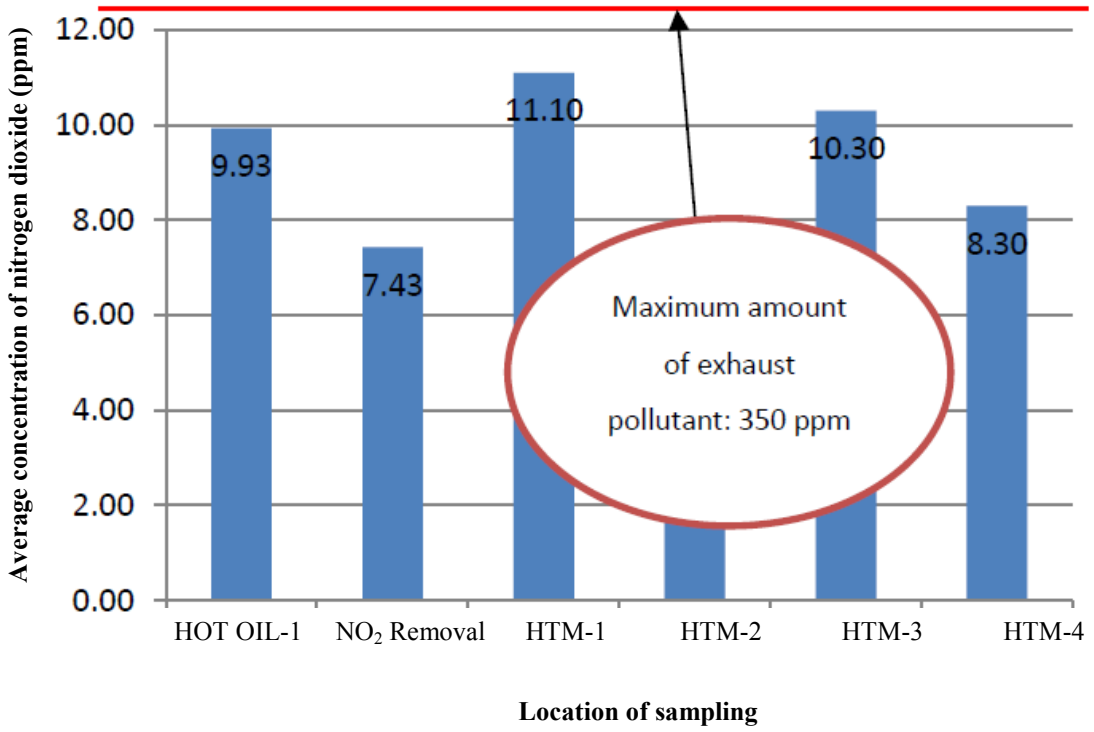

Figure 3. Comparison of the average concentration of nitrogen dioxide with maximum amount of exhaust pollutant (during the last three months of the year 1992)

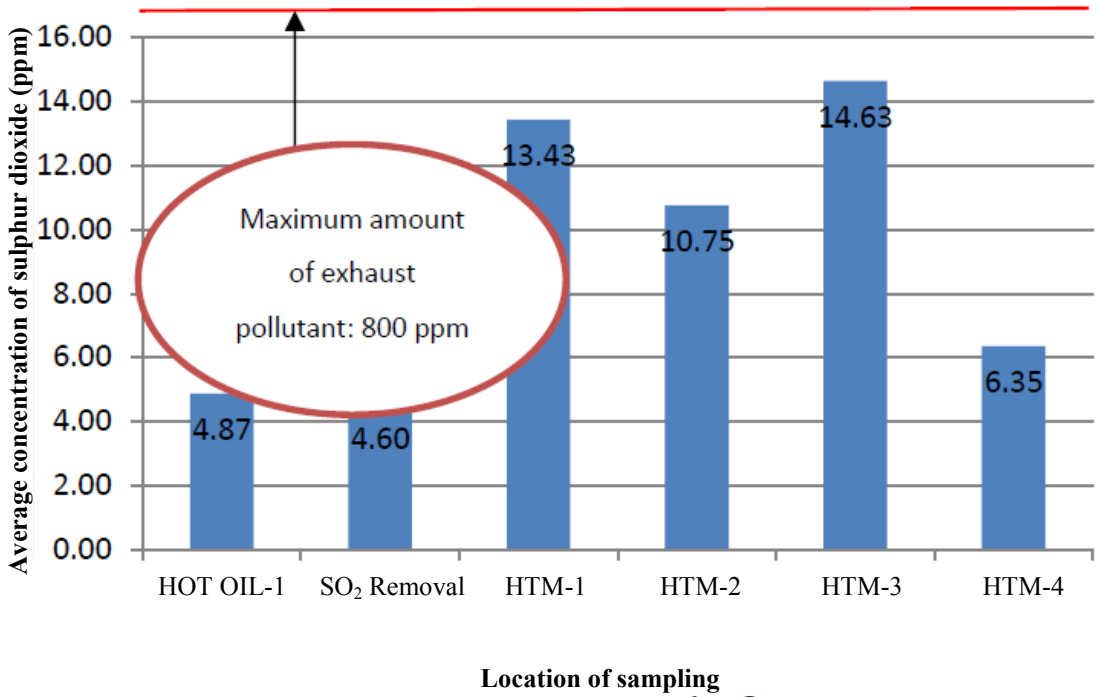

Figure 4. Comparison of the average concentration of SO_2 with maximum amount of exhaust pollutant (during the last three months of the year 1992)

the emission factor.

According to the measurement of exhaust gases emission from flues and evaluation of the tonnage of released pollutants, emission factor is evaluated and then the variance and deviation, data dispersion and its distance from the average scale is measured (Table 1-8).

The Figure 1, 2, 3 and 4 compares the average concentration of CO, NO, NO_2, SO_2 with maximum amount

Table 1. Variance and standard deviation of carbon monoxide (during the last three months of the year 1992)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	193.55	13.91
2	HTM-2	950.72	30.83
3	HTM-3	16.57	274.66
4	HTM-4	1.5	2.25
5	Carbon monoxide removal	2,589,982	1609.34
6	HOT OIL	48.66	6.97

Table 2. Variance and standard deviation of nitric oxide (during the last three months of the year 1992)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	304.66	17.45
2	HTM-2	21.88	4.67
3	HTM-3	53.14	7.28
4	HTM-4	12.25	3.5
5	Nitric oxide removal	0.04	0.2
6	HOT OIL	224	14.96

Table 3. Variance and standard deviation of nitrogen dioxide (during the last three months of the year 1992)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	0.48	0.69
2	HTM-2	2.58	1.60
3	HTM-3	24.9	4.98
4	HTM-4	7.84	2.8
5	Nitrogen dioxide removal	0.77	0.87
6	HOT OIL	21.47	4.63

Table 4. Variance and standard deviation of sulphur dioxide (during the last three months of the year 1992)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	3.40	1.84
2	HTM-2	0.29	0.53
3	HTM-3	1.05	1.02
4	HTM-4	0.02	0.14
5	Sulphur dioxide removal	0.08	0.28
6	HOT OIL	1.05	1.02

of exhaust pollutant (during the last three months of the year 1992).

The emission assessment of CO, NO, NO_2, SO_2 in the winter of the year 1992 are given in Tables 1-4. Figures 1, 2, 3 and 4 compares the average concentration of CO, NO, NO_2, SO_2 integrated flues with maximum amount of exhaust pollutant as well as the standard deviation in emission assessment tables in the winter of the year 1992, the amount of carbon monoxide in the exhaust gas unit, in carbon monoxide removal unit with deviation of 1609.34 is higher than the environmental standard limit during the last three months of the year 1992 (435 ppm), but emission of all gases include NO, NO_2 and SO_2 which is lower than the environmental standard and the amounts that are acceptable.

Comparison of the average concentration of CO, NO, NO_2, SO_2 with maximum amount of exhaust pollutant during the first three months of the year 1993 were given in Figures 5-8.

The emission assessment CO, NO, NO_2, SO_2 in the spring of 1993 are given in Tables 5-8. Figure 5, 6, 7 and 8 compares the average concentration of NO_2, NO, CO, SO_2 integrated flues with maximum amount of exhaust pollutant as well the standard deviation in emission assessment tables in the spring, emission of all gases include NO_2, NO, CO, SO_2 is improved lower than the environmental standard.

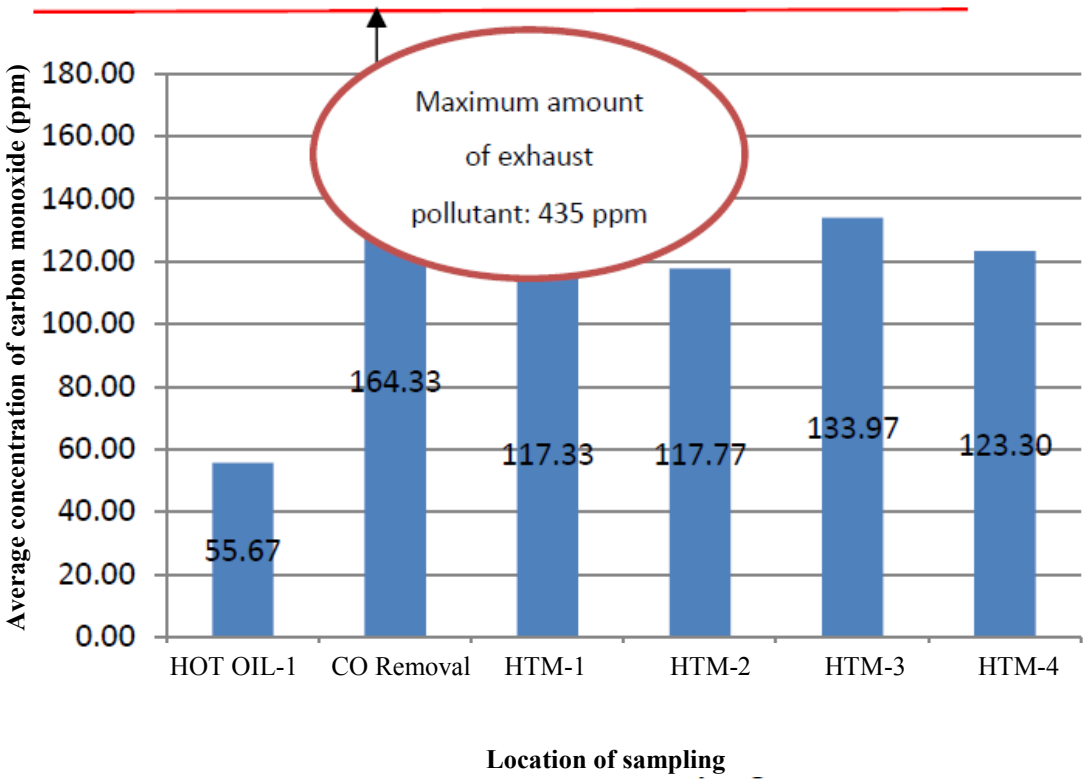

Figure 5. Comparison of the average concentration of CO with maximum amount of exhaust pollutant (during the first three months of the year 1993)

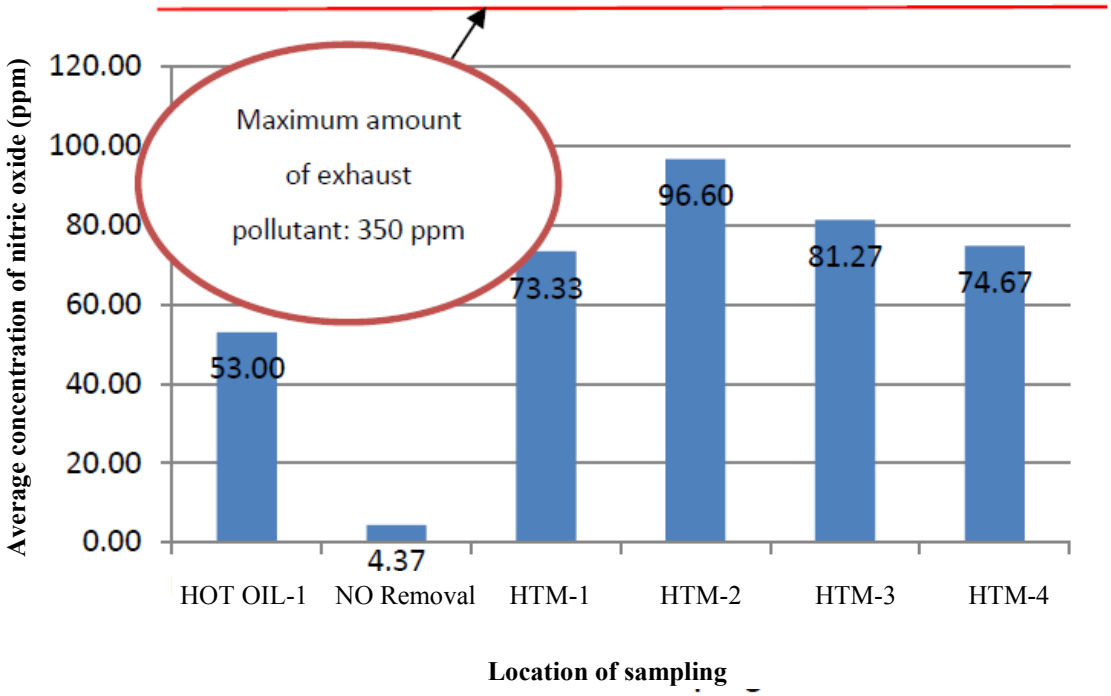

Figure 6. Comparison of the average concentration of NO with maximum amount of exhaust pollutant (during the first three months of the year 1993)

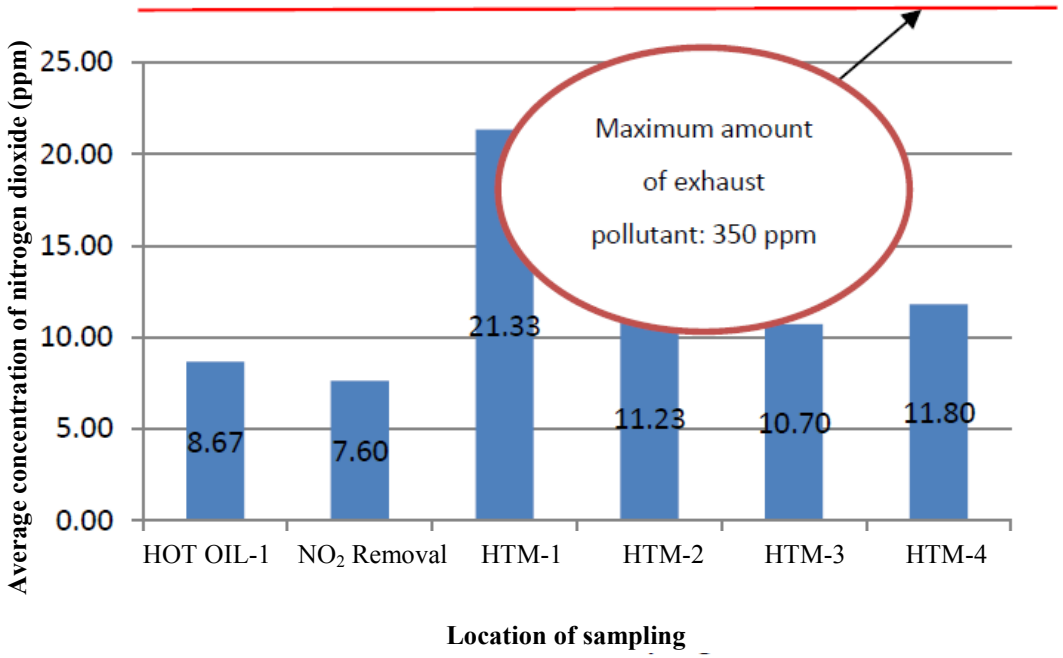

Figure 7. Comparison of the average concentration of NO_2 with maximum amount of exhaust pollutant (during the first three months of the year 1993)

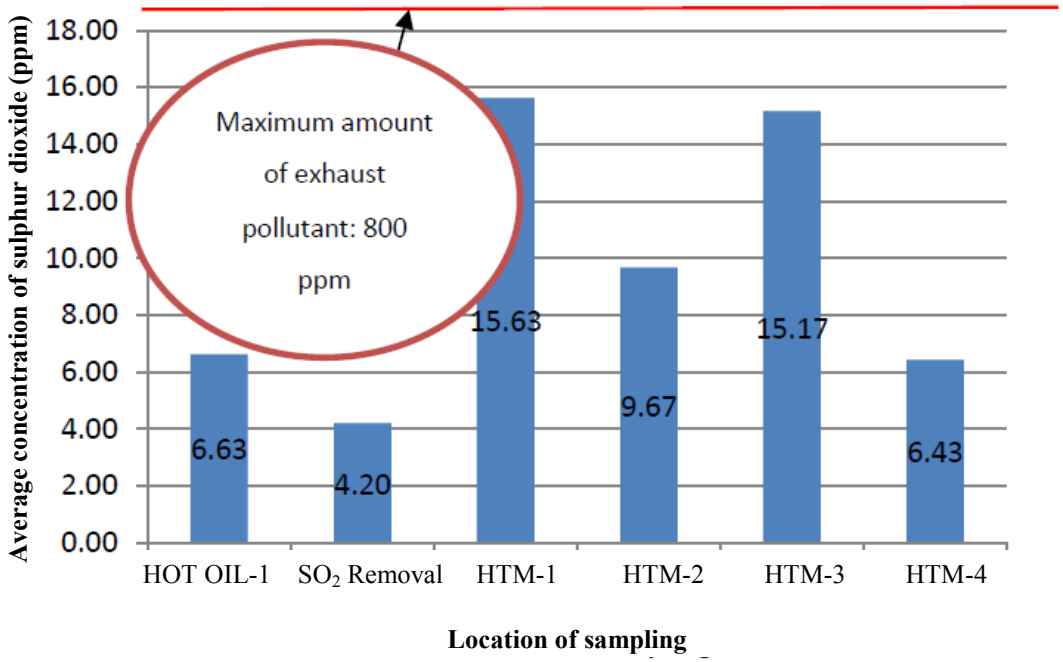

Figure 8. Comparison of the average concentration of SO_2 with maximum amount of exhaust pollutant (during the first three months of the year 1993)

DISCUSSION

According to the standard requirements there are two types of air monitoring: monitoring the ambient air quality which aims at collecting and evaluating samples of air pollutant for air condition assessment and comparison to clean air standards. And monitoring emission from stationary sources which aims at collecting and applying the measured data in stationary resources for investigating the performance of control instruments or applying control procedure and examining condition of standard emission (NAEI, 2007). Since Mahshahr petrochemical special economic

Table 5. Variance and standard deviation of carbon monoxide (during the first three months of the year 1993)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	9.55	3.09
2	HTM-2	2.51	1.58
3	HTM-3	2.06	1.43
4	HTM-4	0.38	0.61
5	Carbon monoxide removal	3682.88	60.68
6	HOT OIL	69.55	8.33

Table 6. Variance and standard deviation of nitric oxide (during the first three months of the year 1993)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	11.55	3.39
2	HTM-2	3.48	1.86
3	HTM-3	15.72	3.96
4	HTM-4	1.55	1.24
5	Nitric oxide removal	0.04	0.2
6	HOT OIL	224	14.96

Table 7. Variance and standard deviation of nitrogen dioxide (during the first three months of the year 1993)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	9.55	3.09
2	HTM-2	14.40	3.79
3	HTM-3	18.34	4.28
4	HTM-4	3.94	1.98
5	Nitrogen dioxide removal	14.82	3.84
6	HOT OIL	3.31	1.81

Table 8. Variance and standard deviation of sulphur dioxide (during the first three months of the year 1993)

S. No	Unit name	Variance	Standard deviation
1	HTM-1	1.26	1.12
2	HTM-2	0.88	0.93
3	HTM-3	0.08	0.28
4	HTM-4	0.05	0.22
5	Sulphur dioxide removal	0.006	0.07
6	HOT OIL	0.20	0.44

zone is one of the main engines of petrochemical industry in the country and the pollutant resources exist in this area, a research is done in Shahid Tondgooyan petrochemical company in the forth site of this special zone in order to evaluate the amount of produced pollutant gases.

In this thesis, using the concentration of exhaust pollutants measured by TESTO, emission factor and evaluation of pollutant average concentration, their variance and standard deviation as well as comparative study of concentration of pollutant and environmental standards, it was concluded that the amount of carbon monoxide in the exhaust gas unit, in carbon monoxide removal unit with deviation of 1753.20 is higher than the environmental standard limit during the last three months of the year 92. Hence there were some measures taken to reduce the amount of exhaust gas from flues in the selected area. It will be discussed in detail in conclusion. For other gases the amounts are standard and acceptable.

CONCLUSION

In general, the emergence of environmental pollutants such as air pollution and other pollutants are resulted from human's behaviour in nature. Therefore focusing on environmental management projects could be effective in reducing pollution. One of the effective measures to control, monitor and stabilize the

preventive and precautionary actions in an inappropriate condition is identifying the real amount of pollutants and describing the quality of air, compared to the standard conditions (Ardakani, 2003).

According to the measurement conducted in December, January and February 2013 and comparison of pollutant concentration during several months, regarding the productive carbon monoxide in monoxide removal flue during the last three months of the year 1992 and first three months of the year 1993, in Shahid Tondgooyan petrochemical company, the amount of exhaust pollutant from flue was higher than the standard limit (435ppm). There was no change for other pollutants.

Then by some recommendations and corrective actions offered for reducing the pollutants in Tondgooyan company, the productive amount of carbon monoxide was reduced to a standard limit.

Corrective proceedings

After observing the flue of carbon monoxide removal, these steps were taken to solve the problem:

- De-coke operation in the removal of carbon monoxide.
- With regard to system capacity for reducing the amount of exhaust carbon monoxide and increasing the efficiency of carbon monoxide removal in the first step, the action of system de-coking was taken for rehabilitation by steam.
- Temperature monitoring was done in the flue of carbon monoxide removal.
- In order to avoid the disintegration and deformation of the place of exhaust emission, the temperature has been controlled system clearing.
- At the end, all paths and transfer lines were cleaned by cleaning vapour.
- Offering supplementary guidelines for reducing the amount of pollutant.
- Increasing the temperature of incoming feed stream, the agent of carbon monoxide removal by food pre-heater converter.
- In the system, the exhaust gas flow reactor is used to heat the incoming air stream. This action is done by employing carbon monoxide removal unit. By doing so the temperature of exhaust gas is reduced and the system efficiency is increased. For this purpose, by increasing the temperature in incoming feed stream interring to reactor, through increasing the flow of reacted exhaust gases of the reactor into carbon monoxide removal unit, the results would be hopeful.

SUGGESTIONS

Executive proposals to continue the process of improving the existing conditions (for managers and experts)

- Installing online analysers are used to stabilize the flue exhaust emissions, specially at monoxide removal unit carbon phase 1 to control better operating conditions and concentration of exhaust gas and online analysers to evaluate the scale of NO, NO_2, CO, SO_2.
- Regular calibration of installed analysers in selected systems for exact investigation in unit operation
- Using expert operators in Tondgooyan petrochemical company for data record related to pollutant emission and monthly and seasonal report.
- Environmental education courses include an introduction to principles of ecology, different types of environmental pollution in the special economic zone as well as the necessary training regarding calibration of analyser instrument and Tondgooyan portable petrochemical company by operators of the company.
- Consultation for the presence of vendor at the time of system launching due to having skill in operative plan.

- Adjusting the air-fuel ratio and continuous control at adjustment time can adjust Carbon monoxide to the standard amount. While it should be noted that by changing the air-fuel ratio all contaminants are subjected to change.
- Modifying flues technically reduce the amount of pollutants during the combustion process (repairmen is possible by increasing the amount of air or by reducing the amount of fuel).
- Providing standard elevator or safety stairs for emission evaluator platforms.
- Quantifying the statistics of pollution emission and providing reports for managers by Rial with the damages to equipment and environment, monthly and seasonally.
- Changes in priorities with special attention to purchases related to environmental equipments.

Suggestions along with research proceeding (for other researchers)

- Continuation of the project on the effectiveness and pollution contribution of Shahid Tongooyan petrochemical company in the special economic zone of Mahshahr.
- Continuation of the project to monitor the emission standards in enclosed spaces (workplaces, laboratories) the first phase of Shahid Tondgooyan.
- Petrochemical company and offering strategies regarding the elimination of potential problems.
- Continuation of the project trends regarding the studied gaseous pollutants in the second phase of Shahid Tondgooyan petrochemical company.
- Investigating the contribution of particles and heavy metal sin pollution of the studied area.

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