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# Air Pollution Control in Iran with Special References to Iranian Oil Industry

**A.R. Dahaghin, H. Kazemi and S.Tasharrofi**

Department of Environmental Research Pollution  
N.I.O.C. Research Institute of Petroleum Industry of Iran  
✉ deaghinar@ripi.ir

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**Abstract:** In this paper reference has been given to the national bodies involved in environmental pollution, with especial emphasis on air problems. The scope of work of some of these organizations and the governing Acts are also explored. Specific attention has been paid to the previous and current activities of Iranian Oil Industry with respect to safeguarding the environment.

The annual means of some of the measured pollutants in the vicinity of Tehran Refinery for the period of 1993 to 1998 are given. Even though the sulfur dioxide, nitrogen dioxide and oxidants do not exceed the standards, the soiling index, suspended particulate matter, dust fall and hydrocarbons do.

## Introduction

During the last four decades, Islamic Republic of Iran has experienced a rapid technological development. The population grew beyond the conventional figures, as will be discussed in the text. Industrial and population growth could face the country with devastating environmental problems. However, in order to protect the environment and well-being of present and future generations, anti-pollution measures have been adopted. Bearing in mind the problems that have been experienced by highly industrialized countries, the main objective was to maintain adequately the quality of the environment in parallel with the industrial growth.

## Acting Bodies

To protect the environment a number of national organizations started to carry out studies and research on environmental pollution problems. Some of the main bodies involved are as follows:

1. Department of the Environment
2. Ministry of Petroleum
3. Bureau of Environmental Health (Ministry of Health and Medical Education)

4. Air Quality Control Company, Municipality of Tehran
5. The Iranian Meteorological Organization
6. Geophysics Institute (Tehran University)
7. School of Public Health (Tehran University)
8. Atomic Energy Organization Center
9. Materials and Energy Research Center

## Department of the Environment

Prior to 1956, there was not a single Act of legislation to protect the plant and animal species of Iran. In 1956, the Center for Hunting was established to protect the game species. In 1963, the center was expanded and renamed as the Organization for Control of Hunting and Fishing. After the 1972 Stockholm Conference, the organization was restructured and became the Department of the Environment of Iran (Report to UN, 1992).

The Director of the Department is Vice-President of the Islamic Republic of Iran. The main objectives of the Department of the Environment are as follows:

- (a) Conducting Environmental Research.
- (b) Issuance of Regulations and Environmental Standards.

- (c) Promotion of Environmental Education and Awareness.
- (d) Supervision, Control and Law Enforcement.

Generally speaking, the Department of the Environment, by law, is empowered to practice and supervise the protection and conservation of the country's environment. Furthermore it is authorized to limit or totally stop the activities of industrial plants polluting the environment beyond the standards.

The enacted legislations to empower the Department for enforcing the air pollution control measures are:

- The Environmental Protection and Enhancement Act of 1974.
- The Clean Air Act, 1975.
- Standards and Regulations for Air and Noise Control.

The Department of the Environment has been monitoring major atmospheric pollutants in Tehran, Isfahan, Shiraz and Tabriz since 1977. Currently, there are seven monitoring stations installed in Tehran, which continuously measure and record carbon monoxide, sulphur dioxide, oxides of nitrogen, total hydrocarbons, particulate matter and meteorological parameters.

### Ministry of Petroleum

The Ministry of Petroleum, being aware of the problems corresponding to environmental pollution from use of fossil fuels as well as oil and gas refining activities and petrochemical plants operations, had been relatively active in environmental measures since mid fifties. Measurement of some air pollutants in oil fields and industrial sites, and conducting full detailed studies for implementation of preventive measures before the erection of Tehran and Shiraz Refineries, can be mentioned. The Tehran Refinery pollution studies were performed by international consultants in 1963 (Faith, 1963), while similar studies for Shiraz Refinery were carried out by the experts from the National Iranian Oil Company in 1967 (Fallah & Badakshan, 1968; Fallah et al., 1969).

However, since the rate of consumption of fossil fuels was increasing rapidly, more refineries and petrochemical plants were to be built, and existing ones were expanding, the need for a stringent control of pollutants was recognized.

So, to study and carry out research in matters related to environmental pollution caused by oil, gas and petrochemical industries, the Environmental Pollution Research Department (E.P.R.D) was established in the Research Institute of Petroleum Industry in early 1969 (Oifar, 1978). The ultimate goal then was to find proper

solutions for prevention and combating such pollutions. Since then, the E.P.R.D. has been actively involved in controlling the environmental problems.

Some of the measures taken to control air pollution, in order to improve the quality of the environment, are mentioned below:

*Petroleum Act:* Some articles of the Petroleum Act of 1987 has designated the Ministry of Petroleum to carry out duties for the protection of the environment.

According to article I of the Act, the industry will create proper conditions in its operations such that safety, occupational health and environmental protection against pollution be achieved.

Article 7 of the Act states that:

“In order to ensure preservation of petroleum resources, natural endowment and industrial facilities, the Ministry of Petroleum, through the cooperation and coordination with other concerned organizations, must develop proper plans such that, during oil industry operations, the environmental pollution prevention principles (for air, water and soil) be observed.”

*Measurement of Major Atmospheric Parameters:* Monitoring programmes have been carried out to measure major atmospheric pollutants in oil industry installations and adjacent residential areas. Such activities are conducted on a nation wide basis covering areas from Khangiran Gas Refinery in the north-east of Iran to Tehran and Isfahan Refineries in the centre, as well as some other installations in southern oil fields, Abadan area, Bidboland Gas Refinery, Razi Chemical Complex and Kharg Island.

Such parameters include sulfur dioxide, hydrogen sulfide, mercaptans, total sulfation activity in the atmosphere, oxides of nitrogen, hydrocarbons, polycyclic hydrocarbons, carbon monoxide, suspended particulate matter, dust fall and soiling index.

Meteorological parameters such as wind speed and direction, temperature, pressure, humidity and solar radiation have been also recorded in parallel.

However, it must be mentioned that air pollutants and meteorological parameters are measured selectively in different stations, based on the particular needs and available facilities.

A mobile lab is also provided for determination of down wind concentration of air pollutants and meteorological parameters in any remote area and adjacent to any plant.

The annual means of some of the measured pollutants in the vicinity of Tehran Refinery for the period of 1993 to 1998 are given in Table 1. Even though the sulfur

**Table 1: Air Pollutants Concentrations in the Vicinity of Tehran Refinery**

Year	$SO_2$	$NO_2$	$NO$	$O_3$ Max. hr. concent.	$HC$ Less $CH_4$	$CH_4$	$SPM$	Dustfall	Soiling index
	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	$\mu g/m^3$	$g/m^2$ per month	COH per 1000 LFT
1993	0.020	0.027	0.032	0.07	2.4	2.5	219	9.9	0.83
1994	0.019	0.022	0.017	0.06	2.3	2.3	198	10.2	0.71
1995	0.027	0.029	0.033	0.07	2.5	3.0	209	13.7	0.85
1996	0.28	0.034	0.033	0.06	2.6	2.7	212	10.2	0.84
1997	0.024	0.045	0.035	0.10	2.6	2.4	224	9.7	—
1998	0.028	0.041	0.039	0.10	2.9	1.9	215	14.3	0.97
Ave.	0.024	0.033	0.032	0.08	2.55	2.47	213	11.3	0.84
Max.	0.028	0.045	0.039	0.10	2.9	3.0	224	14.3	0.97

dioxide, nitrogen dioxide and oxidants do not exceed the standards that are 0.03, 0.05 and 0.12 ppm respectively, the soiling index, suspended particulate matter, dustfall and hydrocarbons do.

*Modernization:* The newly erected refineries in Iran use upgrading processes. As an example, isomax process in Tehran and Isfahan Refineries converts vacuum gas oil, with a high sulfur content, mainly to middle distillates, i.e. kerosene and gas oil, which are directly marketable. In addition to cracking of heavy fractions, the process desulfurizes the products. Produced hydrogen sulfide is then directed to gas treatment and sulfur recovery plants. Thereby, the sulfur, which could have produced sulfur dioxide, in combustion, will be converted to elemental sulfur.

During Iran-Iraq war all refineries in Iran were severely damaged. Abadan Refinery, with a refining capacity of 600,000 barrels per day, one of the biggest ones in the world, was fully ruined. Fortunately the damages are repaired and the present refining capacity of this refinery is about 450,000 barrels per day.

It is worth mentioning that rebuilding activities in Abadan and Kermanshah Refineries resulted in reducing the atmospheric pollutants in those areas.

Use of floating-roof tanks, especially for light oil products, is an effective means of reducing emission of gaseous pollutants from refineries and tank farms.

Installation of tall stacks in industrial sites has resulted in reduction of pollutants in adjacent residential areas.

Use of gas instead of fuel oil in some of the furnaces is another step taken to reduce pollution caused by oil industrial activities.

*Study of Dispersion of Gases:* Diffusion equations have been applied to study the vertical and horizontal

dispersion of pollutants emitted from stacks, in order to estimate the maximum ground-level concentrations, distance of maximum concentrations, as well as concentration of pollutants at any point down wind from stacks. These parameters are calculated for different weather conditions and stabilities.

The results are used in decision making for : size selection of new refineries and petrochemical complexes; expansion of existing plants; implementation of preventive measures before their erection or expansion; as well as fuel selection for industries.

*Gas Consumption:* The associated gas has been simply flared for many years in Iran. However, at the present time, gas flaring, in certain fields, is prevented to some extent using Trans-Iranian Gas Pipeline from the southern oil fields to the northern provinces to be used in major cities and industrial centres.

Use of gas, as a clean energy source, is progressing rapidly. Presently, gas is transported through 50,000 kilometres of pipeline distribution network, feeding over 340 cities. The number of gas extensions is well over 3000,000 and about 55% of energy supplied to the power plants is natural gas (National Iranian Gas Co. unpublished report, 1999).

*Cleaner Fuels for Vehicles:* Certain plans and projects to use CNG or LPG in vehicles are under consideration and execution. Presently, a number of taxis in Tehran, Shiraz and Mashhad use them and some gas refueling stations are constructed (NIOC, 1991).

The effort is also made to produce non-leaded gasoline, or gasoline containing a very limited amount of lead in existing and future refineries. In Research Institute of Petroleum Industry a number of projects are being carried out with the aim of reducing lead content

of gasoline and using oxygenated compounds such as methyl alcohol or MTBE, mixed with gasoline, to reduce air pollution.

*Sand Stabilization:* The land pattern of Iran could be categorized as shown in Table 2 (Iran Almanac, 1977).

**Table 2: Land Categories in Iran**

<i>Land</i>	<i>Area (hectares)</i>
Total Area	164,000,000
Arid and semi-arid	100,000,000
Unsuitable for cultivations	40,000,000
Sandy	12,000,000

Half of the sandy lands which is about six million hectares is the source of moving sands. The blowing winds over the sandy lands create sand storms which cause detrimental effects on villages, railways, airports, agricultural lands and residential areas. On the other hand, because of a number of factors such as deforesting and improper grazing, the deserts are progressing.

Ministry of Petroleum, with cooperation of Ministry of Agriculture using certain petroleum mulches, have taken effective measures in sand stabilization and dedesertification. Due to the mulch utilization and its resulting moisture retention in soils, increase in vegetation has been achieved (Badakhshan, 1974).

Atmospheric and vacuum bottom residues obtained in crude oil distillation, having proper characteristics, as well as emulsified bitumen are used as petroleum mulches.

Depending on the type of the soil and sand dome, quality of mulches, and weather conditions, about 4-8 tons of petroleum mulches have been applied per hectare of land.

### Other Organizations

Sampling and measurement of sulfur dioxide, suspended particulate matter, smoke and lead is carried out regularly in several large cities of Iran by Ministry of Health and Medical Education. This organization is monitoring stations in Tehran. Air Quality Control Company has installed three monitoring stations for measurement of major atmospheric pollutants in Tehran.

The Iranian Meteorological Organization is involved in background air pollution monitoring. The first station is installed in Firoozkooh, a mountainous site close to Tehran. This site is developed recently, with the cooperation of World Meteorological Organization (WMO).

The University of Tehran, Atomic Energy Organization of Iran, Materials and Energy Research Center, Geophysics Institute, as well as School of Public Health have been also involved in determination of atmospheric pollutants in Tehran and some other cities of Iran.

### General Remarks

Even though particular attention has been and is being paid to air pollution control in Iran, the following points still need to be raised:

1. The capacity of the present nine refineries of Iran is over 1,600,000 bbl/day.
2. Gas and petrochemical industries are also expanding.
3. Rapid development in other industrial sectors is envisaged too.
4. The population, as well as the rate of increase and urban residency ratio in 20th century are shown in Table 3 (Ketabi, 1998).

**Table 3: Population Growth in 20th Century**

<i>Year</i>	<i>Population (thousand)</i>	<i>Annual rate of increase (%)</i>	<i>Urban residency ratio (%)</i>
1906	10,556*	—	—
1916	11,229*	0.495*	—
1926	12,063*	0.666*	—
1936	13,390*	0.895*	—
1946	15,549*	1.395*	—
1956	18,954	1.876	31.40
1966	25,788	3.127	39.97
1976	33,790	2.714	47.03
1986	49,445	3.91	54.29
1991	55,837	2.46	57.02
1996	60,055	1.47	61.31

\*Estimated

So, during the first thirty years of the table, the population has increased slowly. However, there has been a rapid increase afterwards. The maximum rate of increase with an annual average of 3.91% belongs to the period of 1976 to 1986, and since then the rate of increase has declined. On the other hand, the migration to the main cities has increased; the urban residency ratio has been 31.4% and 61.31% in 1956 respectively. At present, the population of Tehran is about seven millions.

5. Automobiles are the principal source of pollutants in big cities. The number of motor vehicles in Tehran is well over one million.

6. According to the measurements carried out by different organizations in Tehran, the concentration of some of the atmospheric pollutants such as HC, CO, SO<sub>2</sub>, NO<sub>2</sub>, smoke and suspended particulates usually exceed the ambient air quality standards.

Thus, it is of utmost importance to note that neglecting the air pollution problems can face the country with devastating environmental difficulties. Therefore proper steps are to be taken to overcome the issue.

### Conclusion

Oil industry should increase its efforts to control pollution in related industrial activities and provide the other industries, as well as cities, with cleaner fuels. However these activities will be effective if the other responsible bodies of the country do their best to overcome the pollution problems too. Fortunately the government is making especial efforts to cope with the matter and so it is anticipated that a better environmental condition will prevail in the future.

In the Islamic Republic, protection and conservation of the environment, in which present and future generations must enjoy enhancing social life, is a public obligation. Therefore, any economic or non-economic activity which could be irreparably destructive to nature or would necessitate environmental pollution is prohibited.

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