PROTECTION OF THE ATMOSPHERE IN THE RUSSIAN FEDERATION

I.K. Larin
Institute of Energy Problems of Chemical Physics RAS, Moscow, Russia

Keywords: atmosphere, acid rains, ecology, emission, environment, industry, pollutants, pollution, transport

Contents

Summary

This paper considers the present quality of atmospheric air and the level of its pollution by various pollutants in cities and regions of Russia. In addition, the influence of the main branches of economy (including industry and transport) on the quality of atmospheric air as well as the ecological consequences of the pollution of atmospheric air (including local and global effects) and some methods of atmospheric protection used in Russia have been described.

1. Introduction

The protection of atmospheric air is a key problem in the preservation of the environment. Atmospheric air is one of the most important components of the biosphere needed for the existence of life on Earth. It carries out a protective ecological function, guarding the Earth from biologically dangerous space radiations and meteorites. In the atmosphere the global meteorological processes proceed, forming the contemporary climate and weather.

Until recently man had practically no influence on atmospheric properties, and their change was wholly defined by natural processes. However, under modern conditions, when the scales of human activity are approaching those of natural processes, the

properties of atmospheric air have begun to deteriorate, threatening human health and life, and all living things.

As a result, at a global level the problems of ozone depletion and global warming have appeared: at a regional level, the problem of acid rain; and at a local level, the problem of air pollution by various substances, harmful to man and the environment.

We shall consider the problems of atmospheric pollution in Russia at all levels with the accent on the local one, the development of the situation during the last few years, and some methods of atmospheric air protection applied in Russia.

2. Quality of Atmospheric Air and the Level of Local Pollution

The main pollutants of anthropogenic origin which determine the quality of the atmosphere are sulfur dioxide (SO2), nitrogen oxides (NOx), carbon monoxide (CO) and solid particles. The total world emission of these pollutants in 1990 was 401 million tons, and in Russia in 1991, 26.2 million tons (see Table 1).

Pollutants, million tons	Sulfur dioxide	Nitrogen oxides	Carbon oxide	Solid particles	Total
Total world annual emission	99	68	177	57	401
Russia (only stationary sources)	9.2	3	7.6	6.4	26.2
%	9.2	4.4	4.3	11.2	6.5
Russia (all sources) %	12	5.8	5.6	12.2	13.2

Table 1: Emission of the main atmospheric pollutants in the world and Russia in 1990-1991, in million tons

In addition, many other harmful toxic substances are emitted into the atmosphere, such, as lead, mercury, cadmium and other heavy metals (sources: automobiles, melting factories etc.); carbohydrates, among which benzopyrene is most dangerous because of its carcinogenic action (sources: exhaust gases, boilers etc.); aldehydes, especially formaldehyde; hydrogen sulphide, and toxic volatile solvents (petrol, spirits, ethers) etc.

According to data collected through regular monitoring at the stations of Roshydromet, over the last 10 years (1990-1999) the average annual concentration of such pollutants as the suspended substances, sulfur dioxide, ammonia, phenol, hydrogen fluoride, soot and carbon bisulfide has decreased by 5 to 49% (Table 2); this is explained by the reduction of industrial emissions as a result of the recession in manufacturing industries. At the same time, the concentration of carbon monoxide and nitrogen dioxide has increased by 13 to 15 %; this is caused by the continuous growth in ownership of automobiles and the unsatisfactory technical condition of their exhaust systems.

Polluting substance	Change in average annual concentration of polluting	Change of the maximal concentration of polluting

	substance, %	substance, %
The suspended substances	-18,2	-14,8
Sulfur dioxide	-49,1	-45,6
Nitrogen dioxide	13,1	13,1
Nitric oxide	-4,5	-9,6
Carbon oxide	14,9	14,7
Benzopyrene	-55,3	-67,6
Ammonia	-34,3	-40,2
Hydrogen fluoride	-5,1	-28,8
Soot	-17,0	-21,5
Hydrogen sulphide	- 5,3	-10,5
Carbon bisulfide	-45,0	-25,0
Phenol	-6,9	-13,8
Formaldehyde	1,2	0

Table 2: The tendency of air pollution changes in cities of Russia for the 10-year period

For this period, the number of cities in which the average annual concentration of one or several pollutants exceeded the maximum allowable concentration (MAC), was reduced in the 13 substances considered. Nevertheless, in 1999 there were 195 cities which did exhibit this kind of pollution – that is, three quarters of the monitored cities, with a total population of 64.5 million people. In the republics of Bashkortostan and Buryatiya, the Krasnoyarsk territory, Leningrad, Murmansk, Nizhniy Novgorod, Orenburg, Rostov, Samara and Sakhalin areas there are at least five or six cities in which the average annual concentration of one or several pollutants exceeded the MAC. In Primorye Territory there are seven cities in this category: in Moscow area, nine: in Irkutsk area, fourteen. The problem of atmospheric pollution in cities is defined mainly by the high concentration of benzopyrene, suspended substances, nitrogen dioxide, carbon bisulfide and formaldehyde.

In 1999 the concentration of benzopyrene exceeded MAC in 107 cities; of formaldehyde, in 102; of nitrogen dioxide, 99; of suspended substances, in 76. In 11 of the 15 cities in which the enterprise-sources of carbon bisulfide emission are located, the average annual concentration of this impurity was above MAC. In 62 cities the average annual concentration of three or more pollutants has exceeded MAC. The highest average annual concentration of the majority of pollutants has been 3-4 MAC; for carbon bisulfide, 7 MAC (Bratsk); for formaldehyde, 7-9 MAC (the cities of Biisk, Lipetsk, Magadan and Petrozavodsk); for benzopyrene, 9 MAC (Magnitogorsk). In Kurgan the average monthly concentration of benzopyrene was 60 MAC; in Magnitogorsk, 42 MAC. The maximal concentration of pollutants has exceeded 10 MAC in 31 cities with a population of 17.5 million people (Table 3); the greatest concentrations were in Omsk (acetaldehyde - 72 MAC, ethylbenzene - 55 MAC, hydrogen chloride - 34 MAC). In 79 cities the level of air pollution was high (Index of Air Pollution (IAP) = 7-13) and very high (IAP > 14).

The priority list, according to Roshydromet registers of cities with high levels of air

pollution (index of pollution of the atmosphere > 14) in 1999, included 22 cities with a total population of 13 million (Table 4). Probably there are more such cities, such as Angarsk, Blagoveshchensk, Kyzyl, Stavropol, Saratov, Archangelsk, Syzran, Nizhni Tagil, which are usually characterized by high concentrations of impurities and were included in a similar list of 1998, although the observations were interrupted between January and March, 1999.

City	Polluting substance	Q/MAC	City	Polluting substance	Q/MAC
Arkhangelsk	Methyl mercaptan Nitrogen dioxide	1421 μg m^{-3} 14.0	Novomoskovsk	Ammonia Nitrogen dioxide	13.2 18.8
Barnaul	Nitrogen dioxide Soot	28.8 12.7	Norilsk	Nitrogen dioxide	14.2
Beloretsk	Ethylbenzene	45.0	Omsk	Hydrogen chloride Nitrogen dioxide Ethylbenzene Acetaldehyde	34.4 15.3 55.0 72.3
Biisk	Suspended matter Nitrogen dioxide	11.4 11.4	Pervouralsk	Hydrogen fluoride Nitrogen dioxide Benzopyrene	13.7 11.1 12.1
Voljskii	Methyl mercaptan	1700 μg m^{-3}	Perm	Hydrogen chloride	14.5
Kazan	Nitrogen dioxide	11.6	Saint-Petersburg	Nitrogen dioxide	10.6
Kemerovo	Carbon bisulfide Soot Hydrogen chloride Ammonia	10.6 10.7 12.5 10.9	Slantsy	Hydrogen sulphide	23.8
Krasnodar	Suspended matter	18.2	Solikamsk	Hydrogen sulphide	12.6
Krasnoyarsk	Formaldehyde Hydrogen sulphide	10.5 27.2	Taganrog	Hydrogen chloride	13.6
Kurgan	Soot Benzopyrene	17.9 60.0	Tomsk	Formaldehyde	10.1

Luga	Nitrogen dioxide	14.1	Tumen	Carbon oxide	12.2
Magadan	Suspended matter Nitrogen dioxide	12.4 13.6	Ulan-Ude	Benzopyrene	18.9
Magnitogorsk	Suspended matter Nitrogen dioxide Benzopyrene	12.0 22.5 42.5	Tchelyabinsk	Benzopyrene	11.4
Krasnoyarsk	Benzopyrene	21.8	Tchita	Suspended matter Benzopyrene	15.2 13.5
Novodvinsk	Methyl mercaptan	3716 μg m^{-3}	Ujno-Sakhalinsk	Soot Carbon oxide Nitrogen dioxide	15.8 11.6 10.1
Novokuznetsk	Nitrogen dioxide Soot Formaldehyde	11.1 12.3 14.1			

Note: Q - average annual concentration of any substance; for methyl mercaptan Q is given in μg m^{-3}.

Table 3: Cities with the maximal concentration of pollutants higher than 10 MAC

City	Substances, determining a high level of atmospheric pollution	City	Substances, determining a high level of atmospheric pollution
Balakovo	Carbon bisulfide, formaldehyde, nitrogen dioxide	Moscow	Ammonia, nitrogen dioxide, formaldehyde
Biisk	Formaldehyde, suspended substances, dioxide nitrogen	Novokuznetsk	Formaldehyde, suspended substances, hydrogen fluoride, nitrogen dioxide
Bratsk	Dioxide nitrogen, formaldehyde, hydrogen fluoride, carbon bisulfide	Novorosiisk	Nitrogen dioxide, benzopyrene, suspended substances

Ekaterinburg	Formaldehyde, benzopyrene, acrolein	Omsk	Formaldehyde, acetaldehyde, soot
Irkutsk	Formaldehyde, suspended substances, nitrogen dioxide	Rostov-na-Donu	Nitrogen dioxide, formaldehyde, suspended substances
Kemerovo	Carbon bisulfide, ammonia, formaldehyde, soot	Selenginsk	Formaldehyde, phenol, carbon bisulfide, methyl methacrylate
Krasnjyarsk	Benzopyrene, suspended substances, chlorine	Tjumen	Suspended substances, formaldehyde, lead
Krasnodar	Phenol, formaldehyde, suspended substances	Ulan-Ude	Suspended substances, formaldehyde, nitrogen dioxide
Lipetsk	Phenol, ammonia, formaldehyde, nitrogen dioxide	Khabarovsk	Benzopyrene, nitrogen dioxide, sulfur dioxide, formaldehyde, ammonia
Magadan	Phenol, formaldehyde, nitrogen dioxide	Chita	Benzopyrene, formaldehyde, suspended substances, nitrogen dioxide
Magnitogorsk	Benzopyrene, phenol, suspended substances	Ujno-Sakhalinsk	Soot, suspended substances, nitrogen dioxide

Table 4: Cities with the greatest level of air pollution in 1999

Thus, despite an essential reduction of industrial emissions in 1990-1998 and a reduction in the concentration of the monitored polluting substances in the atmospheric air of many cities, the level of pollution in 1999 remained inadmissibly high.

Taking into account the growth of manufacturing industries, which began in 1999, and the increase in emissions of pollutants by the gas and coal industries, black and color metallurgy, chemical and petrochemical industries, wood, woodworking and pulp and paper industries, industries of building materials and light industries, and also the imminent growth of emissions from heat-and-power engineering in connection with the planned transfer of several dozen large heat-power plants from ecologically pure fuel -- natural gas -- to coal and black oil, it is necessary to expect significant deterioration in the quality of atmospheric air, and growth in both the sickness rate and mortality caused by these factors.

In this connection it is obviously necessary to strengthen state regulation of the activities of such exclusive companies as "Gasprom", with the priorities of safeguarding the health of the population and the preservation of the natural environment. It is

necessary, furthermore, to develop state ecological monitoring and state ecological control of the enterprises, and also control of the quality of atmospheric air in cities and industrial centers.

-
-
-

Bibliography

State Committee of Russian Federation on protection of an environment. The state report on the condition of the natural environment of the Russian Federation in 1999. [This is a collection of statistic data on the quality of the atmosphere in the Russian Federation]

V.I.Korobkin, L.V.Peredel'skiy, Ecology, Rostov-na-Donu, (2001) Feniks. [This is a review of the state of the atmosphere in the Russian Federation]

Biographical Sketch

Larin I.K. was born in 1935, May 30, in Moscow Region, USSR. After graduation from secondary school he entered Moscow State University, Department of Physics, and graduated in 1959. Then he took a junior research post at the Institute of Chemical Physics, Russian Academy of Sciences (Semenov's Institute), Moscow. He received his Ph.D. in 1971 and D.Sc. in 1991. From 1979 until the present he has been head of Laboratory of Chemical Physics of the Atmosphere in the Institute of Energy Problems of Chemical Physics of the Russian Academy of Sciences Moscow.

Professional Activities:

- A member of International CODATA Task Group on Chemical Kinetics (1978-1982);
- Deputy Chairmen of National Council on Atmospheric Chemistry of the Russian (Soviet) Geophysical Committee (since 1987);
- A member of Commission on Chemistry of Ozone Friendly Freons of Russian Academy of Sciences (since 1991);
- A member of editorial board of the Journal of Ecological Chemistry (Russ. and Engl.), since 1992.

Larin is married,with one daughter.