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Air pollution

ATMOSPHERIC AIR POLLUTION DYNAMICS IN THE REGION OF THE TOWN OF PLOVDIV DURING THE PERIOD 1995-2000

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Abstract. The protection of the nature is of exceptional importance for humanity, for its survival and at the same time depends on it. The atmospheric pollution of the city of Plovdiv poses a serious environmental problem, scince the joint consequences of vehicle emissions and traffic noise affect dramatically the physical and mental health of the citizens, the quality of life and services. The concentration levels of primary and secondary pollutants in the atmosphere of the city of Plovdiv during the period 1996-2000 are examined. The air pollutants concentrations resulted from permanent monitoring stations for the city. The stations were located in the urban areas of the above mentioned city. The examined air pollutants are: CO (carbon monoxide), SO_2 (sulphur dioxide), TSP (total suspended particulates), NO_2 (nitrogen dioxide). The pollution levels are evaluated using the European Union (EU), Bulgarian Law and the World Health Organisation (WHO) standards for the air quality.

Keywords: atmospheric air pollution, dynamics, primary and secondary pollutants.

AIMS AND BACKGROUND

The problem with the environment condition and preservation is one of the most debated in the world as well as in Bulgaria during the last decade of the 20th century.

Nature's preservation is of exceptional importance for man, for his survival, and at the same time, it depends most strongly on him.

In the society's values scale health has always been one of the priorities and it is reasonably considered as a basic component of the national wealth and decisive for the headway of each nation. Health depends on a variety of factors – biological, social, psychological, internal and external, natural and anthropological.

Air pollution is a phenomenon, directly connected with economic and social factors. It is, to a great extent, a result of the human activities and the consequences are directed back to man and the ecosystems.

The atmosphere is one of the most mobile components of the environment. Under the influence of the air flows the pollution crosses the boundaries of countries and continents, thus turning the problem with the anthropological pollution of the environment from local (regional) to a global (world) problem.

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The effects can be of global (the industrial emissions of CO_2, methane) and regional (trans-boundary pollution) character, as well as short-term (summer and winter smog) and long-term (greenhouse effect).

As a result of the negative influence of the industrial activities on the environment, all its components – air, water and soil are affected.

The industrial pollution engages the attention and the activity not only of the specialised institutions and the public, but of the very enterprises, causing the pollution themselves.

The main centers of the accumulation of pollution in the atmosphere are in the impact zones in the ground layer, connected with the main sources of pollution – industrial agglomerations, towns, highways.

The most serious problems in the region of the town of Plovdiv, caused by the pollution of the atmospheric air, are concentrated in separate air basins, where the sources of pollution (single or a group) release emissions of considerable quantities of noxious substances and seriously threaten the population's health and the environment.

Considerable are the air emissions from the industrial production, which affect the atmosphere in the regions of the enterprises, the major contaminants being SO_2, CO_x, NO_x, dust. The sources of emission of noxious substances in the atmosphere may be organised and unorganised, caused by:

- badly maintained platforms;
- faulty sealing of the processing line;
- lack of ineffective operation of the ventilation equipment.

The main anthropological contaminants of the atmosphere come from the industrial complexes, the fuel-power complex, the construction and the building industry, the motor transport, the agriculture, the towns, the aviation. As a result of their activity, enormous quantities of chemical substances are emitted in the atmosphere, many of them being toxic. The main atmosphere contaminants are CO, CO_2, SO_2, NO_x (nitric oxides), hydrocarbon, heavy metals, dust. Other contaminants also get into the atmosphere, even though they are not typical for it or are synthesised by man, like the freons.

The atmosphere, compared to the other components of the environment, is comparatively most strongly burdened with different liquid, gaseous and solid chemical toxic substances. The anthropological changes in the atmosphere's chemical profile go beyond the bounds of a separate region and country and gained all-planet universal character.

The large-scale atmospheric circulation can disseminate these contaminants to great distances away from their sources, i.e. to carry out a trans-boundary transfer.

In the present research work, our team set itself as a purpose to follow the dynamics in the concentrations of some toxic substances, that exerted influence on the quality of life.

The main task that we set in order to fulfil this purpose was the observation of the concentrations of the following contaminants – SO_2 and dust for the period 1995-2000.

EXPERIMENTAL

The national network for air quality control consists of stations with manual sample-taking and automatic stations. By means of the built up network, observations on the quality of the atmospheric air are carried out.

A network of control measurement stations is built up in the region of the town of Plovdiv, in order to keep under observation the quality of the atmospheric air and to give an idea of the influence of the transport, industrial and background pollution. The network includes an automatic measurement station of the air, situated in the garden near the store "Evmolpia", 4 stations of the Regional Inspection on Environment and Waters – Plovdiv with manual sample-taking and a supervening analysis, situated in the town of Assenovgrad, the village of Dolno Voden, the village of Kuklen and on the crossing near the block "Gigant" in Plovdiv, as well as two stations of the Hygienic-Epidemic Institute and the National Institute on Hydrology and Meteorology.

The automatic station is equipped with automatic analysers for reading the pollution with nitric oxides, sulphur dioxide, ammonia, hydrogen sulphide, ozone, carbonic oxide, non-methane and total hydrocarbons, dust (respiratory minimum 10 μm per m size of the particles) and observation of the meteorological parameters. The manual stations are equipped with precise modern installations, reading the pollution of the atmospheric air pollution with dust, sulphur dioxide, nitric dioxide, and giving the possibility for a supervening analysis of the heavy metals' contents.

The air emission control is also carried out with a mobile laboratory for atmospheric air control, which is taking measurements each season in the stations for mobile monitoring as follows: three in the town of Plovdiv and one in each of the settlements – near the village of Striama, near the village of Markovo, the town of Stamboulijski, the town of Pazardjik, the town of Smolyan and the town of Roudozem. The mobile laboratory is equipped with automatic analysers for determining the concentrations of carbonic oxide, sulphur dioxide, nitric oxides, dust (respiratory minimum 10 μm) and meteorological parameters.

RESULTS AND DISCUSSION

The condition of the atmospheric air in the country is an objective consequence of the way of life. The preservation of the air cleanliness is a prime task of the society, securing normal living conditions for the population.

The problems with the environment condition and preservation are one of the most debated in the world and in Bulgaria during the last decade of the 20th century. In the years of central planned economy, when the most important was to produce, the environment protection was within the framework of formalism and the fulfilment of measures and actions which did not lead to the desired result. After the social-political events that set in, the society got a real notion of the ecological price of our economic growth.

In the first research on the environment strategy (1991-1992) was found that most of the serious ecological problems were localised in particular regions, the so-called "hot spots", where the contaminants (mainly from the heavy industry enterprises) endangered the health of the people, who lived there – about 12% of the population of Bulgaria.

A serious problem was the high concentrations of dust particles, heavy metals, volative organic compounds, sulphur dioxide, released from the electric power stations, the industrial enterprises, the motor transport, the households.

A positive tendency towards atmospheric air quality improvement was observed in the last few years. In spite of these positive tendencies a large part of the Bulgarian population lived in regions, determined as ecological "hot spots", situated in the most strongly affected air basins. The atmospheric contaminants' concentration there in the period 1990-1995 had decreased and did not threaten the population's health.

In 1995 the annual levels of sulphur dioxide were relatively high, especially in the regions with high concentration of objects of the power generation and the industry, such as the ones concentrated in the region of the town of Plovdiv.

The level of non-toxic dust in the air was also maintained relatively high, around and above the average annual Maximum Permissible Concentrations – MPC. The condition in the region Assenovgrad – Plovdiv in the beginning of 1991 was disturbing, due to the high concentrations of dust and SO_x, the population there was exposed to their synergetic effect (Fig. 1).

Some of the reasons, which led to the pollution of the atmospheric air, were:

1. The outdated technologies and the lack of purification works from a number of major contaminants SO_x, NO_x from:

– power generation and building industry;

– dust from metallurgy;

– NO_x from motor transport.

2. Use of fuels with high sulphur concentration (2.5 and more percent sulphur) and ash content, low caloricity – the local lignite and brown coal.

3. Non-observance of the technological regime.

4. Lack of automatic installations for self-control over the emissions above the sources.

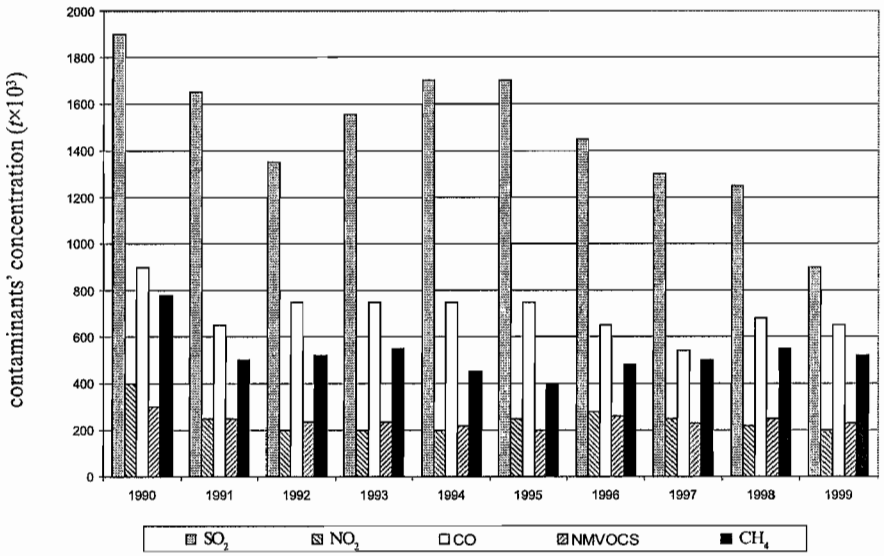

Fig. 1. Pollutants level

In our country the power generation was the largest source of sulphur dioxide and dust. The data from the inventory of the emissions of noxious substances showed the structure of the emissions' distribution between the separate groups of sources, compared to the previous years, keeping the burning processe a main source of dust, SO_2 and NO_2 (Figs 1A, 1B, Figs 2-14).

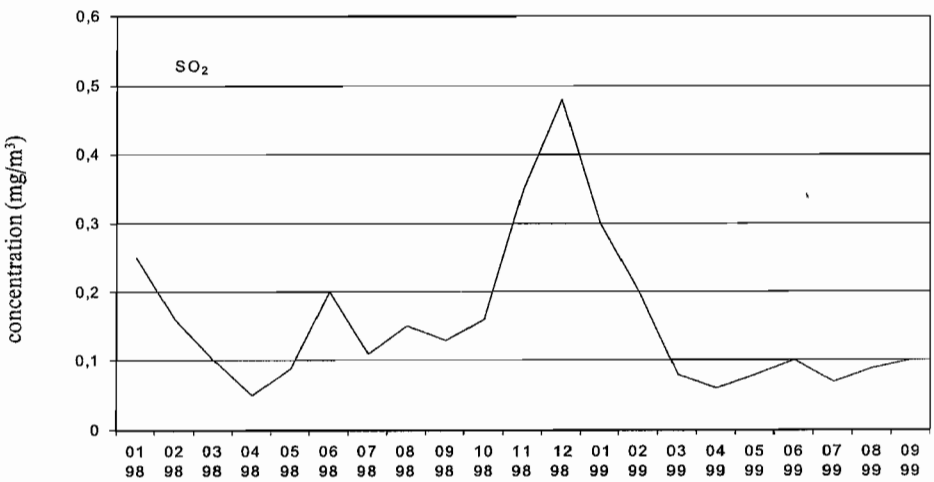

Fig. 1A. SO_2 distribution pattern

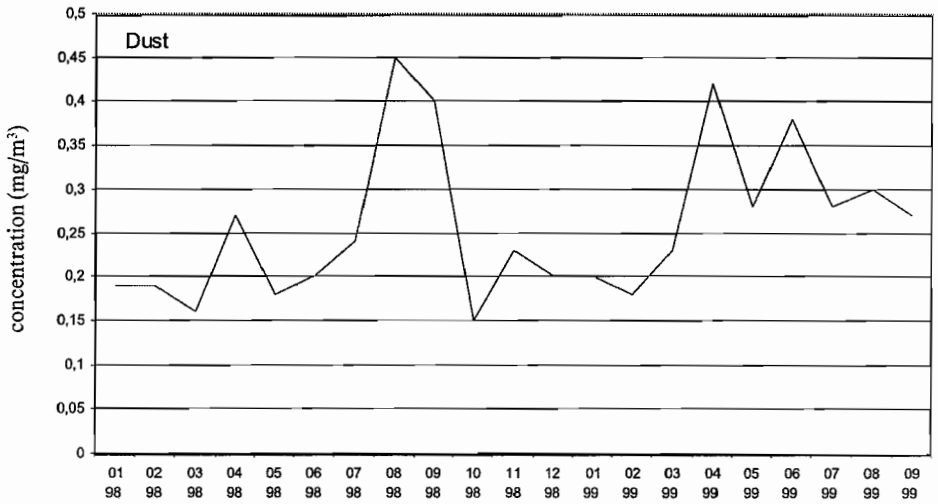

Fig. 1B. Dust distribution pattern

The main source of dust emissions was the combustion of solid fuels in the thermo-electric power stations, everyday life and industry. The burning of fuels in the sector of everyday life released 69% of the total quantity of polyaromatic hydrocarbons – PAH, followed by the quantity of emissions from the road transport (11%) and the thermo-electric power stations (10%).

The burning of low-calorific solid fuels in the sector of everyday life continued to be a source of local air pollution. The low quality lignite was the only significant in quantity domestic source of fossil fuels. In order to improve the ecological situation it would be necessary to provide fuels, causing less pollution to the environment, like charcoal with low sulphur contents. The thermo-electric power stations were the main source of pollution in terms of the emitted SO_2 and dust (49% of its quantity for the whole country), compared to the other sources, releasing this toxic substance, like the burning in the everyday life, the industrial combustion processes (including also the production of power) and the non-combustion production processes.

In some of the towns and villages of the country were measured concentrations, exceeding the annual rate, which once again confirmed that this source of pollution was the main one for most of the towns and villages. Unfortunately the station "Bania Starinna" in Plovdiv belonged to this group.

This source emitted more than 85% of SO_2 emissions for the country, which was a sad conclusion that pointed the priority direction for future work. The sources that added to the picture with this pollution source were the combustion processes from the industry (7%), followed by the burning in the everyday life (5%), other transport (Figs 8, 9).

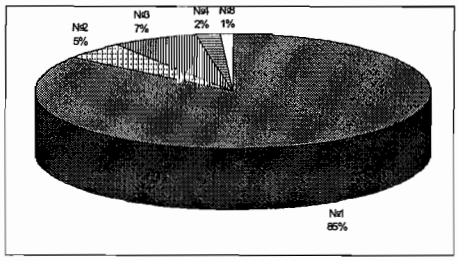

Fig. 2. SO_2 for 1996
1 – thermo-electric power stations; 2 – burning in houses; 3 – industry; 4 – non burning process; 5 – production of mineral resources; 6 – use of dissolving agents; 7 – auto transport; 8 – other transport; 9 – waste; 10 – agriculture; 11 – natural sources

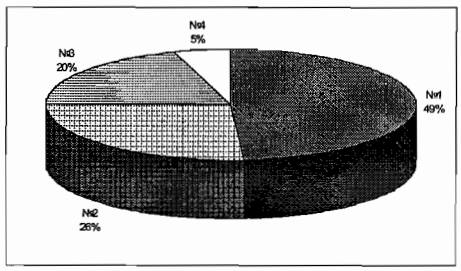

Fig. 3. Dust for 1996
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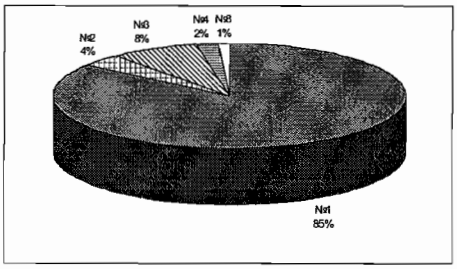

Fig. 4. SO_2 for 1997
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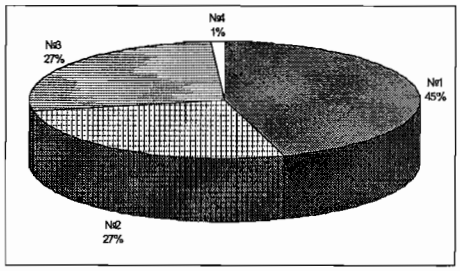

Fig. 5. Dust for 1997
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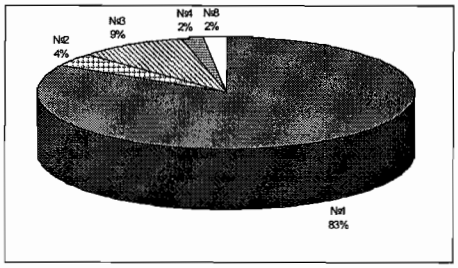

Fig. 6. SO_2 for 1998
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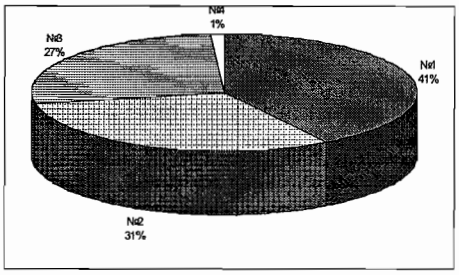

Fig. 7. Dust for 1998
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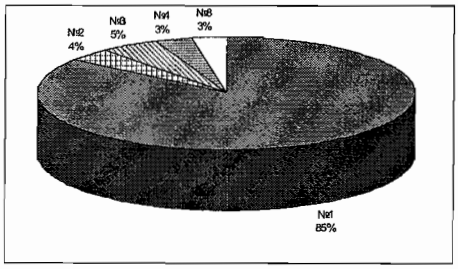

Fig. 8. SO_2 for 1999
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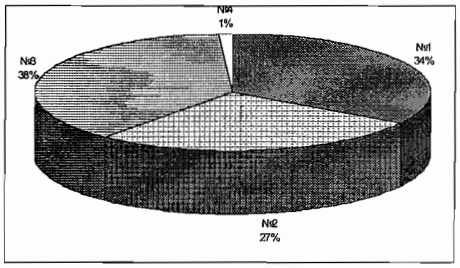

Fig. 9. Dust for 1999
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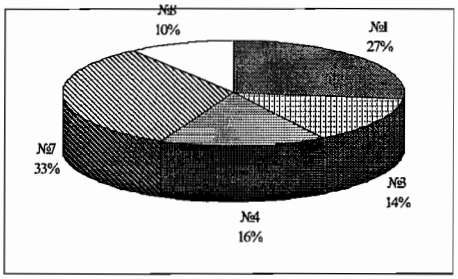

Fig. 10. NO_2 for 1996
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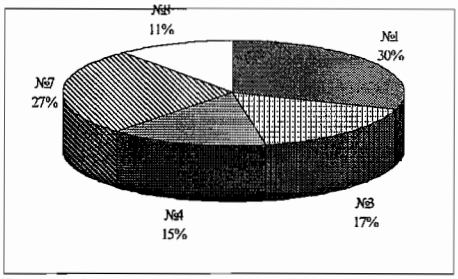

Fig. 11. NO_2 for 1997
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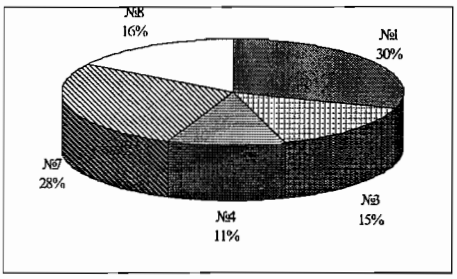

Fig. 12. NO_2 for 1998
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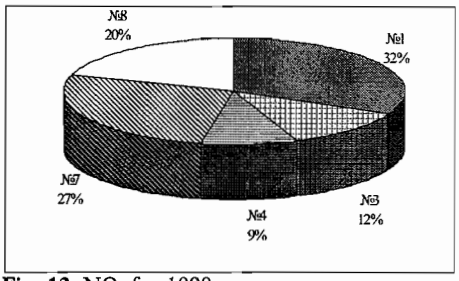

Fig. 13. NO_2 for 1999
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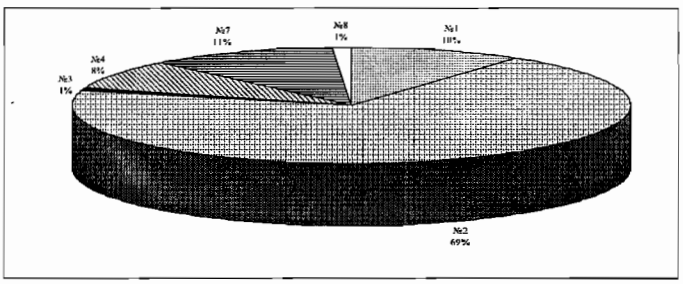

Fig. 14. Polyaromatic hydrocarbons for 1997
The designation is the same as in Fig. 2

The stations, in which were measured the maximum concentrations of sulphur dioxide in 1996, were situated mainly in settlements, in which there were enterprises of the non-ferrous metallurgy, the chemical industry and the power generation. Disturbing was the fact that the station "Assenovgrad" in the town of Assenovgrad was included in the stations, exceeding the MPC (Figs 2, 3).

Nitric dioxide – in a large town like Plovdiv, the highest concentrations were measured on busy road crossings. High concentrations, exceeding the average annual MPC, were measured in Plovdiv (Figs 10-12).

In 1997 there was a tendency towards reduction of the emissions, compared

to the one in 1996. This was due to the decreased emissions of sulphur dioxide from big thermo-electric power stations over 300 MW. In 1997 the existing tendency towards the highest percentage of emission of SO_2 from thermo-electric power stations was preserved (Figs 4, 5).

After the considerable decrease of the emissions, we regarded as positive the fact that the region of the town of Plovdiv was not included in the list of the stations with the highest average annual concentrations. In 1997 the highest concentrations of NO_2 were measured on busy road crossings – Plovdiv and in stations of the industrial activity, exerting influence on the air quality in the settlements. The station at "Bania Starinna" had values, exceeding the MPC in 1997.

The main sources of lead were the motor transport and the industry. Hopeful was the fact that due to a fall in the lead petrol consumption, a reduction of the emissions of this toxic substance was ascertained.

In general for the country, the tendency towards reduction of the annual concentrations of the lead aerosols was preserved. In the town of Plovdiv the station at "Bania Starinna" and the station at the Regional Inspection on Environment and Waters – Assenovgrad had values below the MPC. Typical for the whole country was that in the large towns like Plovdiv or near big enterprises the values of NO_2 exceeded the MPC.

Power generation was the largest source of SO_2, and in 1998 its share from the total quantity had decreased, compared to the level in 1997 (from 85 to 83%). The values of dust also ranged in the same direction – from 45% to 41%. The increase of the quantity of a number of contaminants – carbonic dioxide, methane, non-methane hydrocarbons, heavy metals, was due to the rise of the quantity of the burnt petrol, as well as the extended consumption of firewood in the sector of everyday life (Figs 4-7).

In 1998 there were many forest fires, which increased the quantity of pollutants, emitted from natural sources.

The decrease of the general emissions of sulphur dioxide for the country was due to reduced emissions from the thermo-electric power stations. The consumption of lignite in the same year had dropped with 2%. The decreased contents of sulphur in the lignite also exerted a favourable influence for the reduction of the emissions.

The burnt fuels in the sector of everyday life provided the presence of the whole quantity of polyaromatic hydrocarbons – PAH. Their quantity was increased from 69% in 1997 to 72% in 1998, which led to an increase of their emissions. In 1998 there were many forest fires, which increased the quantity of pollutants, emitted from natural sources (Figs 4-7).

Hopeful were the results in a number of towns in the country, in which values below the MPC were read – a sign for improvement of the ecological

situation in many regions. Such stations were: the town of Plovdiv – station "Block Gigant". The tendencies in the air quality in the region of Assenovgrad – the Combine for Non-ferrous Metals were favourable and corresponded to the expected emissions' fall. The influence of the lead aerosols had decreased considerably since 1999, which was among the most serious ecological achievements in the country, and the improvement of the ecological situation there was due to the measures, undertaken by the leaders, as well as due to the introduced purification works and new technologies. The level of dust particles and sulphur dioxide in this region had fallen sharply, so this should be considered for the most hopeful example for ecological improvement in the last 5 years (in spite of the fact that the level of the two contaminants exceeded the advisable margins) (Figs 8, 9).

In respect of SO_2 emissions, a slight increase in their concentration from the thermo-electric power stations was observed in 1999, compared to the previous year. In the case of another contaminant – dust, examined in parallel with the sulphur dioxide, the opposite tendency was observed – a decrease of the contaminant's concentration from the thermo-electric power stations, the burning in everyday life and the combustion processes in industry.

Lead as a contaminant kept values, close to the ones from the previous year, which oriented us to the beginning of a period of stabilisation. The thermo-electric power stations released 85% of the total quantity of sulphur dioxide. In 1999 the emissions of all atmospheric contaminants were decreased, compared to the level in 1998. The most considerable was the drop of PAH– 25.5%, due to the strongly reduced consumption of coal bricks. An increase of the nitric dioxide concentrations was observed during the winter months.

The monthly distribution of the dust concentrations showed that unlike the sulphur dioxide, in the case of dust there was not a substantial connection between the increased values of the concentrations and the increased consumption of fuels during the winter months (Fig. 13).

In general for the country, a reduction of the annual concentrations of nitrogen dioxide was observed in 1999. An exceed above the MPC was not registered in the station of the Hygienic-Epidemic Institute – Plovdiv. In spite of the increase of the emissions from the motor park, the production of electric and thermal energy for daily wants and for industrial purposes was still exerting a stronger influence on the contents of nitric dioxide. The tendency towards decrease of the annual concentrations of the lead aerosols was also preserved as a whole for the country.

Despite that the 5-year period (1990-1995) was obviously not sufficient in order to determine a long-term tendency in the development of the industry, this period informed us on the occurred changes in the volume and composition of the industrial produce.

The follow up of the dynamics of some contaminants was of great importance, because it pointed us to the existing tendencies with regard to the environment protection. The improvement of the ecological situation could be a guarantee for a cleaner environment and a better life.

CONCLUSIONS

We could make the following conclusions:

1. A characteristic tendency for the period 1995-2000 was the considerable decrease of the emissions of the atmospheric contaminants. This tendency was mainly due to the fall of the industrial production and energy consumption and to a smaller extent to the undertaken specific ecological measures.

2. The condition of the air was improved as a result of the fall in the level of the economy, the production decrease and the investments in new capital equipment.

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