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## AIR POLLUTION BY AIRBORNE PARTICLES IN BOR CITY, SERBIA: PROBLEM OF CADMIUM

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### Abstract

The problem of airborne particles pollution is typical for urban areas, but despite the threat to human health, to this problem in Serbia has not been devoted enough attention. In this paper is exposed analysis of the results obtained by average annual concentration measuring of airborne particles at 8 measuring points in period of two successive years in the Bor region, Serbia. The content of cadmium was analyzed by atomic absorption spectrophotometry (AAS) and inductively coupled plasma (ICP). The results showed that the concentration of Cd in airborne particles is usually near or above the legal emission limit values.

**Keywords:** pollution, Bor region, air, airborne particles, cadmium.

### INTRODUCTION

Air purity affects human health and functioning of the ecosystem as a whole, whence is of great importance to detect sources of air pollution and take appropriate measures to reduce pollution. Air pollutants are objects or processes which emit pollutants in atmosphere. Sources of pollutants, by the broadcast origin, are divided into natural and man-made (anthropogenic), which also represent the largest source of air pollution and result from human activities [1].

The serious consequences of air pollution, which have emerged in the twentieth century, created the need for regular monitoring of the presence of pollutants in the air. The program of monitoring air quality of urban environment is covered by a standard measurement of emissions of pollutants: CO, SO<sub>2</sub>, nitrogen oxides, photochemical oxidants and particulate matter (soot and aero sediment) [2-4]. The pollution particles, which are specific to urban areas, have not yet drawn sufficient attention of researchers.

The particles are substances dispersed in air that may be in solid or liquid physical condition and having a diameter of the order of 0.001 microns to 1000 microns. Based on the size, the particles are classified into two groups: sediment particles and suspended particles. A group of sedimentary particles is characterized by a larger diameter of the order of 10 microns, while suspended particles (aerosols) in diameter on the order of less than 10 microns. Separation of particles over 10 microns in diameter from the air is performed by deposition under the influence of gravitational forces.

Suspended particles have a low speed of deposition, which is also caused by the influence of gravitational forces. Since the suspended particles follow the main flows of air they remain dispersed in the air for a long time and are transmitted over long distances. Suspended particles are also known as airborne particles and they are removed from air through rainfall. In urban areas, while monitoring the aero sediment, it is determined the total sediment matter, undiluted particles (such as ash and total), dissolved particles (as total and in particles\_solution is determined separately

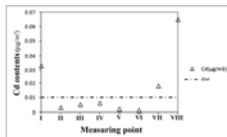


Figure 1 - Average content of cadmium in suspended particulate matter ( $\mu\text{g}/\text{m}^3$ ) for the first year of study

Of the eight sampling locations, in three were observed exceeding of Cd legal limit and a maximum overdraft (up to 6 times) is characteristic for measuring point VIII located in rural area around the city. Cadmium as a heavy metal that is hazardous to human health should not exceed the upper value of the emission (GVI), and therefore the excess is present in rural areas where people grow crops and livestock, cadmium easily enters the food chain. On figure 2 is given average content of cadmium in airborne particles for the second year examination compared with GVI. In second year, there is no exceeding of a legal limit for Cd content.

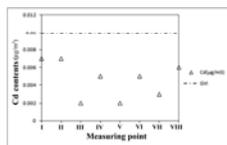


Figure 2 - Average content of cadmium in suspended particulate matter ( $\mu\text{g}/\text{m}^3$ ) for the second year of study

SO<sub>4</sub>, Cl and Ca). From aero sediment is determined the presence of heavy metals Cd, Pb, Fe, Cr, Mn, Ni and others as

necessary for their toxic effects [5].

Cadmium belongs to a group of metals which are toxic for the most living organisms on the Earth. Even very small concentrations of these elements (expressed in ppm) have serious toxic effects. Cadmium is an accumulative toxin that adversely affects the important enzymes; causes bone disease and kidney damage. Inhalation of dust and gases, with content of cadmium, leads to the lung failure due to the water accumulation in them [6-8].

### EXPERIMENTAL

In Mining and Metallurgy Institute Bor, Department for Chemical and Technical Control, there is a group for measuring of meteorology parameters and air quality control over 30 years. By UNEP (United Nations Environment Protection) donation, two fixed stations for SO<sub>2</sub> monitoring (Environment SA), mobile station for ambient particulate matter concentration monitoring (PM<sub>10</sub>—particles less than 10 µm in diameter), and dust sampler for heavy metal concentration analyses in deposited matter had been arrived in Bor during summer 2003.

Sampling instrument for the determination of airborne particles consists of a sample inlet, photometer, collection medium and a flow regulated pump. Photometer uses a light scattering technique to determine the concentration of particulates in the size range from about 0.4 µm to about 20 µm in diameter. The particulate is retained by the filter which can be removed for subsequent analysis of quantities of heavy and volatile metals by ICP-AAS (Spectro Ciros Vision) and GFAAS (PerkinElmer) techniques [9].

### RESULTS AND DISCUSSION

Bor is a typical representative of cities with intense urbanization, developed infrastructure and a strong (but obsolete) industry, which is a big polluter of environment. One century of mining and copper metallurgy in Bor have had a major impact on the process of environmental degradation, both in urban and in rural areas. As the development of technological processes are not been followed with appropriate actions to prevent and reduce exhaust emissions from these plants, the city of Bor and its surroundings today casts a dark shadow on the ecological map of our country [9,10].

Measuring the concentration of particulate matter is carried out periodically, at several locations, using a portable station [3]. The choice of interim monitoring points is dictated by the planned activity of production facilities and weather forecasts (the prevailing wind direction), and depends on season and state of vegetation. Regular measurements of airborne particles are of great importance for understanding the degree of air pollution in urban areas.

The content of heavy metals in suspended particulate matter is increased in measuring points that are located in the wind direction and are closer to the industrial zone. Particulate matter (particle size below 10µm) was detected using apparatus with 24-hour samples from the ten-day measurements by location. By chemical analysis of airborne particles was determined content of Cd.

In Figure 1 is represented the average value of the Cd content in airborne particles for the first year of testing, where it is necessary to emphasize that the I-IV measuring points are located in the city, while the V-VIII measuring points are in the surrounding rural areas. From the analysis of the data we can see that the content of Cd is increased in the city and in suburban areas.

### CONCLUSION

This paper was prepared In this paper was analyzed problem of air pollution by airborne particles in region of Bor from the aspect of Cd content. Average annual concentration of Cd in airborne particulate matter in the first year of investigation significantly exceeded the legally permissible limit (GVI), while in the second year of investigation was below the allowable limit. Large variations in the obtained results indicates the complexity of the problem of urban environment pollution, but worryingly high content of Cd in the first year of investigation indicates the need for constant monitoring of the problem, and the necessity of modernization of technology that is now used for the production of copper in Bor.

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