

The composition of fine airborne particles – traffic indicator

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The composition of airborne particulate matter (PM) is highly heterogeneous and varies greatly in size, composition, and concentration, depending on the sources generating the particles and such factors as location, season, day, and time of the day.

Road transport contributes significantly to the production of PM emissions mainly from fuel combustion but also from mechanical abrasion processes from tyres, brakes, clutches and road surfaces. Particles with an aerodynamic diameter of less than 10 µm are inhaled by humans and very fine PMs penetrate deeply into the lungs. Epidemiological studies over last decade have reported associations between the long-term increases in exposure to PM and the increase in morbidity and mortality, particularly in people with respiratory or cardiovascular diseases. It is expected that health problems resulting from traffic emission are largest in cities. Traffic emissions do not contribute only to outdoor PM levels, but also to the indoor levels.

The major components of PM are metals, organic compounds, materials of biological origin, ions, reactive gases and the particle core, (frequently composed of elemental carbon). With such a heterogeneous composition, systemic identification of toxicity due to individual components is a very difficult task and represents a major challenge. Several reports suggest that much of PM toxicity is related to the trace metals content of the particles. The group of transition metals may be important. These catalyse the production of reactive oxygen species (ROS). Ultrafine particles collected through autopsy from human lungs were shown to consist mainly of metals. According to toxicological studies, the metals present in urban aerosol contribute significantly to two biological mechanisms that cause damage in the alveoli. These two mechanisms are production of ROS and interaction with macrophages (cytokine production).

There are still a few data on the contents of trace metals in fine fraction PMs (PM_{2.5} and PM₁). Because of small amounts of sampled particulates PM_{2.5} and PM₁ deposited on the filter and due to the low concentrations of some relevant elements, combined analytical methods consisting of high performance sample decomposition in combination with highly sensitive instrumental methods are a prerequisite for getting accurate data.

In the contribution we will present results of particulate matters concentrations and metal contents in the air of localities impacted by the transport. The attention has been also paid to influences of the vertical level measurement on their concentration and chemical composition.

Sampling of PM_{2.5}, PM₁ was performed during 24 hours (from morning to morning of the following day) on streets at two with different traffic intensity and character:

“Kotlarska” – a relatively narrow street with high vehicle flows (more than 20 000 vehicles / 24 hours)

“Kroftova”- a calm street in a residential district with lower traffic intensity (less than 4000 vehicles / 24 hours).

Samples were taken on pre-weighted mixed cellulose filters (Millipore, diameter 47 mm, Typ: RAWP) using medium volume samplers LECKEL MVS 6 (standard flow rate 2,3 Nm³h⁻¹).

The samplers operate in accordance with Directive 1999/30/EC and European reference method CEN EN 12341 for sampling of particulate matter for heavy metals analyses. The filters were weighted after 48 hours-conditioning with microbalance Mettler-Toledo MX5/A, equipped with antistatic ionizing unit Haug, in an air-conditioned room at $22\pm 1^{\circ}\text{C}$ and $50\pm 2\%$ RH. The filters were digested with the mixture of 2 ml H_2O_2 + 3 ml HNO_3 + 1 ml HCl by means of microwave digestion device with quartz glass vessels (working pressure of 75 bar) Multiwave (Anton Paar), equipped with a combined pressure-temperature sensor accessory for reaction control. The determination of elements Ba, Cd, Co, Cr, Cu, Ni, Mn, Mo, Pb, Pd, Pt, Sb, Sn, Sr, Ti, Zn, Zr and platin group (Pt, Pd, Rh) was carried out by inductively coupled plasma quadrupole mass spectrometry ICP-QMS (ELAN DRC plus, Perkin-Elmer).