Application of passive sampling technique in monitoring research on quality of atmospheric air on the Tri-City area, Poland

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INTRODUCTION

Because of carcinogenic properties (experts from identified as human carcinogens by International Agency for Research on Cancer) [1], special attention is paid to determination of benzene concentration in the atmospheric air. The compound as the only one from the group of BTEX compounds is subject to legal regulations defined in EU Directive (EU directive 2009/30/EC for 2010), in accordance with which the average yearly benzene concentration in the atmospheric air shall not exceed 5 μg/m³ [2].

Tri-city agglomeration area (Gdansk, Gdynia and Sopot) and surrounding, is one of the most industrialized regions in northern Poland. It is mostly shipbuilding industry, that is located there, as well as many big industrial enterprises, the activity of which has essential impact on the atmospheric air quality (Gdansk Oil Refinery - Grupa Lotos S. A., Phosphorus Fertilizer Manufacturing Plant - Gdanskie Zakłady Nawozów Fosforowych, S.A., sulphur-processing plants - Siarkopol Gdansk S.A., Heat and Power Generating Station - Elektrociepłownia Wybrowe). Furthermore increasing vehicle traffic, as well as the number of petrol stations can be a significant source of wide range of hazardous compounds (e.g. benzene) in the air and do affect its quality.

This study presents the application of the passive sampling technique (Radiello® diffusive passive sampler) for the long-term characterization of time-weighted average concentration of benzene. The results of benzene concentration obtained during monitoring campaign in years 2008-2012 in Tri-City area, were compared to the concentration values of NO₃ and O₃ measured in atmospheric air using automated analyzers, which are a standard equipment of the ARMAAG Foundation monitoring stations. Based on the relationship between benzene concentrations and NO₃ concentration, the influence of the aforementioned chemicals on O₃ concentration was estimated. The analysis of the measured values of benzene, NO₃ and O₃ concentration ratio allows to identify the potential emission sources of these air pollutants.

SAMPLING AREA

Research connected to the air quality monitoring was conducted in the shipyard cities that belong to the so called Tricity Agglomeration, i.e. in Gdansk (surface area of 261.96 km² and population density of 1717 persons/km²) and Gdynia (surface area of 135.14 km² and population density of 1830 persons/km²) and Sopot (surface area of 17.31 km² and population density of 2229 persons/km²). In order to determine the air pollutants, two monitoring stations, owned and administered by Agency of Regional Air Quality Monitoring Foundation in the Gdansk Metropolitan Area (ARMAAG Foundation), were used. The selection of monitoring stations was based on the results of long-term studies, and the locations of the stations were determined by such factors as weather conditions (temperature, pressure, relative humidity, wind speed and direction), human population density, and existing databases on pollutant emissions from point and surface sources.

During the monitoring campaign from 2008-2012, in every year 48 14-days exposure were carried out. Each time, two Radiello® diffusive passive samplers were exposed simultaneously at the sampling site for 14 days. This gave a total of 240 samples during the monitoring campaign.

RESULTS

CONCLUSIONS

Increase in atmospheric air temperature resulted in the decreased use of heating systems in residential areas which is reflected by the drop in benzene emission and lower benzene concentration in atmospheric air.

The relationship between benzene concentration and nitrogen oxides concentration in atmospheric air proved the hypothesis that these compounds originate from the same emission sources such as, mechanical vehicles equipped with combustion engines.

The research results presented in the paper showed, that the passive sampling technique may be successfully applied as the tool in atmospheric air quality monitoring in urbanized areas.

2) DIRECTIVE 2009/30/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

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ANALYTICAL PROCEDURE