Gaseous and particulate mercury in ambient air of the Upper Silesia, Poland

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Mercury is a persistent, toxic and bioaccumulative heavy metal. Atmospheric mercury exists mainly in three forms: gaseous mercury (Hg_g) including elemental (Hg^0) and divalent (Hg^{2+}) mercury and particulate mercury (Hg_p). These different forms have different characteristics in terms of transport, deposition and influence on ecosystems. Hg^0 is relatively inert and has a small deposition velocity and a long atmospheric lifetime (of about 1 year), thus it constitutes the majority of atmospheric mercury (over 95%) and can be transported globally. The particulate mercury residence time is much shorter (several days to a few weeks), thus it is likely to be deposited at intermediate distances from the sources. Hg^{2+} has the shortest atmospheric lifetime (hours to several days) resulting in low concentrations in the air even though it is emitted at a significant rate.

Coal combustion in coal-fired power plants and for residential heating is the biggest anthropogenic source of mercury in Europe, contributing 52% of total emission. In Poland, which emits 20 Mg of Hg per year, coal combustion constitutes over 60% of country emission. This share is much higher (about 80%) in the Upper Silesia, the most heavily urbanised and industrialised part of Poland, populated by over 3.5 million inhabitants. The study presents the results of mercury concentration measurements carried out in four Silesian cities from June 2008 to May 2009. The measurements were conducted periodically in 24h cycles. They comprised physical mercury speciation including total gaseous mercury (TGM) and PM10-bound mercury (and additionally particulate mercury associated with PM2.5 and TSP at the reference station in Zabrze). The gold traps were used for gaseous mercury sampling. The particulate matter was collected on the glass-fibre filters with the use of a low volume sampler. MA-2 analyser (Nippon Instr. Corp.) was used to determine gaseous and particulate mercury. The determination was based on thermal decomposition of samples with gold-amalgamation of mercury vapours and detection by technique of non-dispersieve double-beam cold-vapour atomic absorption spectrometry (CVAAS). The detection limit was 0.1 ng m^{-3} for TGM and 2.5 pg m^{-3} for Hg_p.

The average TGM concentration was 3.2 ng m^{-3} (2.4 ng m^{-3} - 3.9 ng m^{-3}) and was comparable to other industrialised areas in Europe and in the world. The lowest concentrations were observed in Tychy (residential district with central heating), the highest – in Dabrowa Gornicza (in the coking plant neighbourhood). Generally TGM concentration was higher in winter than in summer but its seasonal variability was different at the different sampling sites. The average PM10-bound mercury concentrations were from 117 pg m^{-3} in Tychy to 217 pg m^{-3} in Zabrze (sampling point by the main crossroads, high secondary emission of particulate matter). This is much higher than what is found in Europe and somewhat lower than Hg_p concentration in China. There was strong correlation between mercury and PM concentrations. Clear seasonal variations in Hg_p concentration illustrate the important contribution of mercury emission from coal burning in heating season. The highest mercury concentration was found in the finest PM2.5 fraction. It was also stated that Hg enrichment ratio for PM10 samples was similar for the sites of similar emission characteristics.