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Mercury Behaviour in Waste Incineration Facilities: Gaseous Transformations and Retention by Carbon and Mineral-Based Sorbents.

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TP-195

AUNPS/TIO2NF: A PROMISING COMBINATION TOWARDS LOW COST AND EFFECTIVE SENSOR DEVICES FOR GEM MONITORING IN THE FRAMEWORK OF GMOS

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In the framework of ongoing research projects and programmes (i.e., GMOS, UNEP F&T) aiming to develop advanced sensors for major atmospheric pollutants, and having as overarching goal to assure a full operational capability of global observing systems for persistent pollutants such as mercury a novel sensors with promising sensing features for environmental applications have been designed and tested. The aim of this paper is to present novel kinds of sensors with promising sensing features for environmental applications, exploiting both the combination of gold affinity for mercury and nanosized frameworks of the sensing materials. Specifically, in the present study, conductive sensors working at room temperature and based on composite nanofibrous electrospun scaffolds of titania easily decorated with gold nanoparticles by photocatalysis under UV-light irradiation, have been developed to obtain nanostructured hybrid materials, capable of entrapping and detecting Gaseous Elemental Mercury (GEM) traces. The size and the shape of these nanostructures have been demonstrated to be key parameters in defining the properties of the resulting sensors, because of the strict relationship between the surface and the bulk of the sensing material which is extremely reduced in size. The increase in the number of binding sites has been confirmed to be a successful strategy to ensure sensitivity at trace level. SEM, AFM, TEM and HR-TEM analyses have been performed to characterise the morphology and the nano-sized structure of these composite materials. Different electrical and sensing features of the resulting chemosensors have been achieved by tuning fibres roughness and gold nanoparticle size. A suitable measuring chamber for mercury detection have been designed and developed in order to improve the sensing feature of the sensor. Thus few minutes of air sampling were sufficient to detect the concentration of mercury in the air without using traps (LOD ~ 1 ppb). Longer measurements allowed the sensor to detect lower concentrations of GEM (tens of ppt). A short thermal treatment (450°C, 3min) was necessary to completely desorb mercury from AuNPs. The resulting chemosensors are expected to be very stable over time, robust and resistant to the interference that may be caused by common solvents and by VOCs commonly present in ambient air.

TP-196

MERCURY BEHAVIOUR IN WASTE INCINERATION FACILITIES: GASEOUS TRANSFORMATIONS AND RETENTION BY CARBON AND MINERAL-BASED SORBENTS

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Waste incineration plants have been declared by the Minamata Convention as one of the major industrial sources of mercury (Hg) emissions. Elemental mercury (Hg0) is released from the incinerator (850-1200 °C) into the flue gas and, as the temperature goes down, Hg undergoes a large number of homogeneous and heterogeneous oxidation processes. Hg0 is converted either to oxidized mercury (Hg2+) compounds and/or Hg adsorbed compounds (Hgp) onto particles. Effective and efficient mercury control technologies are needed to meet the increasingly stricter mercury emission regulations. Dry flue gas cleaning methods, using solid sorbents based either on soda or calcium hydroxide, are used in municipal solid waste (MSW) incineration but their efficiency on mercury removal needs to be further studied. Injection of activated carbon is a potential method for capturing mercury which is removed downstream, in a particulate matter control device, such as electrostatic precipitators (ESP) or fabric filter (FF). The efficiency of mercury removal from the flue gas is substantially affected by its speciation, flue gas composition and process conditions (e.g. temperature, air pollution control units). Many studies are found in the literature related to mercury behaviour under conditions of coal combustion, however, there is a lack of studies connected with MSW conditions. This study discusses the effect of temperature and gas components, present in typical flue gas from MSW incineration, on both mercury oxidation and capture by mineral and carbon-based sorbents. The study was carried out by means of a laboratory scale device that simulates the gaseous mercury behaviour in flue gas at temperatures ranged between 150-300 °C. The results show the influence of HCl, SO2, NOx and H2O vapour in the gaseous transformation of mercury identifying the major reaction pathways. Under the simulated conditions, mercury (II) chloride (HgCl2), mercury (II) oxide (HgO) and elemental mercury (Hg0) are thermodynamically relevant species. In presence of CO2 and O2, the minor gas components NO, SO2, and HCl are involved in homogeneous oxidation of mercury and therefore, in the retention capacity. The higher temperature, the lower efficiency of Hg capture (i.e. higher emissions of Hg). SO2 is oxidized to SO3 at higher temperature. This effect, together with adsorption effects of CO2 and water vapour, inhibit mercury adsorption as there could be a competition for the same surface binding sites. The study provides a basis for the development of new strategies for mercury removal in the air pollution control devices of MSW incineration plants.