Removal of Mercury Vapour from Fluorescent Lamps Using Activated Carbonaceous Material from Waste Tyre Pyrolysis

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ABSTRACT

Elemental mercury, its vapours in the environment or in its bioaccumulated forms within seafood as well as plants destined for human consumption poses health challenges. In this study, removal of mercury vapours from end-of-life fluorescent lighting waste using adsorption technology was investigated. The objective was to establish if, carbon black from the pyrolysis of waste tyres could be exploited for use as mercury adsorbent during recycling of fluorescent lamps. Two portions of the pyrolytic carbon black were separately activated using sulphuric acid (H_2SO) and hydrogen peroxide (H_2O_2). These carbons' adsorptive potential was evaluated against that of commercially available activated carbon. The tyre pyrolytic carbon was characterised before activation, after activation and after adsorption trials to evaluate the adsorptive potentials. This characterisation included Fourier-Transform-Infra-Red spectroscopy, Scanning Electron-Microscopy coupled with Energy Dispersive X-ray, Brunauer-Emmet-Teller and powder X-ray Diffraction techniques. The adsorption testing trials involved thermal generation of mercury vapours which were then passed through an adsorbent packed column reactor while exiting through an outlet on the other end of that reactor. This vapour flow across the reactor proceeded for a fixed duration before the adsorbent was qualitatively checked for any mercury adsorption on its surfaces. Raw pyrolytic carbon black showed some adsorption promoting functional groups which quantitatively improved after both sulphuric acid and hydrogen peroxide activation. Morphology tests based on SEM technique revealed that the porosity of acid activated carbon and the peroxide activated carbon were both fourteen times more than that of the raw pyrolytic carbon black. Adsorption of mercury on activated pyrolytic carbon surfaces was observed although this was less intense when compared to that on the commercial activated carbon. The adsorptive performance of activated pyrolytic

carbon black was encouraging, demonstrating its technical potential in elemental mercury adsorption. The hydrogen peroxide activated carbon was superior compared to the sulphuric acid activated with mercury recoveries of 92% and 90% respectively. These recoveries are however lower than that of other previously studied corn based activated carbon which were above 98% in other cases according to literature. It is therefore recommended to carry out in-depth adsorption optimisation studies targeting tyre-based carbon improvements to match or exceed the performance of other activated carbon.