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European Commission

Science for Environment Policy

New magnetised carbon nanotubes more effectively remove mercury from water

Water pollution by toxic elements is a major economic and environmental concern, and mercury is one of the most poisonous of the elements to be released into the environment by industry. Mercury exposure can cause severe ill health. Efficient, simple and convenient methods to remove mercury from industrial and other waste streams and drinking water are essential. This study successfully trialled a new technique, using magnetised multi-walled carbon nanotubes (MWCNTs), to remove mercury from waste water.

Mercury can contaminate air, water and land thousands of kilometres from where it's emitted, and measures to control its emission therefore need to be on a global scale. Mercury exposure can cause poisoning of wildlife and multiple ill-health effects in people. Mercury discharges into water are restricted in the EU[1], and there is an environmental quality standard for mercury in surface waters under the Water Framework Directive.

The EU signed up to the Minamata Convention[2] on Mercury in 2013 and the EU Regulation on mercury was amended in 2017, with a commitment to adopt best available techniques to reduce emissions of mercury from industry. The development of techniques that efficiently remove mercury from industrial waste, using recyclable materials, is therefore required.

This study used magnetised MWCNTs to remove mercury from waste water. They were magnetised by treating them with a solution of iron chlorides to create iron(III)oxide (Fe_2O_3) clusters on the tubes. The tubes were "functionalised" by treating them with thiosemicarbazide to make their large surface areas attract mercury. The research team investigated the conditions that affect the removal of mercury using the nanotubes, including: temperature (25–55^{0}C), pH (1–4), contact time (2–150 min) and concentration of mercury (50–2 000 mg/L) in the waste water.

Under the optimum conditions of pH 3 and 25°C — under which most mercury was adsorbed — the MWCNTs removed 172.83 micrograms (µg) of mercury per gram (g) of adsorbent material, much higher than reported in previous studies. The adsorption process, of mercury adhering to the surface of the MWCNTs, was fast, with most of the mercury (69.5%) being adsorbed within 10 minutes. The MWCNTs were effective in attracting mercury even in the presence of lead and cadmium ions. The magnetisation of the tubes meant they could easily be separated from the water by applying a magnetic field once they'd adsorbed the required amount of mercury. The recycled MWCNTs retained 92% and 88% of their adsorption capacity after one and four regeneration cycles, respectively.

Magnetised MWCNTs, are an effective novel technique for removing mercury from water in the laboratory. If successfully scaled up, this novel technology could contribute to meeting the EU's long-term objective under the seventh Environment Action Programme of a non-toxic environment[3].

1. See Science for Environment Policy's In-Depth report 15: Tackling mercury pollution in the EU and worldwide

2. See: http://www.mercuryconvention.org/

3. Decision No 1386/2013/EU on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet': http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN