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Recovering and recycling phosphorus from incinerated waste

Phosphorus can be extracted in viable quantities from fly ash, a by-product created when municipal solid waste is burnt in incinerators, according to research conducted in Sweden. Sufficient phosphorus could be recovered from the country's incinerators to meet 30% of the Swedish annual demand for mineral fertilisers, say the researchers.

A substantial amount of municipal solid waste (MSW) is generated by people living in urban areas, and managing it in a sustainable way is a challenge. One option is to divert MSW from landfill sites and burn it to produce electricity or heat. This process produces fly ash, which is collected from the equipment used to clean the exhaust gases.

Fly ash contains valuable resources and is particularly rich in phosphorus. Phosphorus ore is mined, primarily to produce mineral fertilisers, and this finite resource is being steadily depleted. If phosphorus can be recovered from the fly ash and recycled, it will reduce the amount of phosphorus rock that needs to be extracted to meet growing demand.

For this study, the researchers used samples of filter ash taken from a municipal and industrial solid waste incinerator in Gothenburg, Sweden. They conducted a series of experiments to test two methods to extract phosphorus from the filter ash.

The first method was based on a two-step acid washing and precipitation process. Fly ash was first washed in hydrochloric acid to extract the phosphorus. The resulting solution was then treated twice with sodium hydroxide — an intermediate step to remove unwanted iron and aluminium metal contaminants. The remaining solution containing the phosphorous was then treated a second time with sodium hydroxide to create a solid phosphorus residue.

This method extracted 72% by weight of the phosphorus that was originally present in the fly ash. The final product contained 3% (dry weight) of phosphorus, which compares well with the 2.7% phosphorus found in commercial nitrogen/phosphorus/potassium fertilisers and also in sewage sludge from sewage treatment plants that is used as a fertiliser in some countries.

The final product still contained small amounts of metals at levels which made it unfit for immediate use as a fertiliser on agricultural fields in Sweden. However, it is possible to extract the phosphorus, the researchers suggest, and this could be used to produce phosphate fertilisers, which will also reduce the need to mine new phosphorus ore. In Sweden, for example, phosphorus recovered from fly ash could meet 30% of the annual demand for mineral fertilisers.

The second method was a two-step acid and alkali washing process, in which less than 1% of phosphorus was recovered. Nevertheless, the researchers are continuing to develop this method, as they think the recovered phosphorus would be purer than that obtained through the first method. The phosphorus product from this second method could then be used for agricultural purposes.

The researchers are also investigating how best to recover valuable metal contaminants, such as copper, magnesium and zinc, obtained as by-products from the first method of phosphorus extraction.

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