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Negative impact of landfill is reduced by choice of liner

A new study has shown that contamination of groundwater by hazardous substances contained in waste liquid from landfill sites – known as leachate - could be significantly reduced by choosing specific types of material to line the landfill reactors.

In Europe, **more than 200 kg of waste per person** is buried in landfill sites every year. A major environmental concern is that water can become contaminated with a large number of hazardous substances as it percolates through the solid waste. The toxic liquid – known as leachate – can then potentially infiltrate groundwater sources as it migrates into the surrounding landscape.

European law[1] requires that landfill reactors are lined to mitigate groundwater contamination. However, several different materials for the liners are available and research shows that transport of leachate into the surroundings may still be possible through these liners. The new research tested four types of liner within a simulated landfill scenario to assess whether contamination of groundwater is affected by the choice of material. The scientists looked specifically at contamination by organic phenol compounds and inorganic heavy metals (lead, copper, zinc, chromium, cadmium and nickel). Phenols are used heavily in the plastic and chemical industries and have been linked to endocrine (hormone) disruption in humans. Accumulation of heavy metals in the body can lead to cancer, disruption of the central nervous system, liver and kidneys.

The scientists assembled four test-scale landfill reactors (R1 to R4), each with a different liner: compacted clay (R1), compacted clay and geomembrane (R2), a lining with an extra bentonite layer (R3) and a lining with an extra zeolite layer (R4). Each reactor was filled with 150 kg of municipal solid waste from a real landfill site in Istanbul, Turkey.

The scientists filled a cavity at the bottom of each reactor with distilled water to represent groundwater. Leachate and 'model' groundwater samples were collected from each reactor at monthly intervals during the experimental period (540 days) and tested for contamination.

After 540 days, lead and chromium concentrations of 0.2 – 0.5 mg per litre were found in the leachate but were below the limit of detection in the groundwater samples. Zinc and copper in the groundwater also decreased by around 60% in R1 and R2 and up to 95% in R3 and R4, compared to maximum concentrations in the leachate. The groundwater concentration of nitrophenols – a particularly hazardous class of phenol - increased with time in all four reactors. However, the transport efficiency varied significantly. This was expressed by calculating the average groundwater concentration for the total experimental period as a percentage of the average leachate concentration, i.e. the proportion of nitrophenol in the leachate that leaked through to the groundwater.

The average transport efficiency for three different nitrophenols was significantly lower for R3 (26%) and R4 (23%) than for R1 (34%) and R2 (39%), which the scientists attributed to the absorption of nitrophenols by the bentonite and zeolite layers in the R3 and R4 liners. Other organic contaminants showed similar trends and overall, the scientists showed that using a bentonite or zeolite layer in the lining of a landfill reactor could reduce the migration of organic contaminants into groundwater by between 30 – 50%.

The scientists recommended more stringent regulations for landfill liners to allow better control over leachate contamination of groundwater. On-line monitoring systems integrated into landfill sites will also help to monitor groundwater quality.

1. EU Directive on the Landfill of Waste (Council Directive 99/31/EC). See: http://ec.europa.eu/environment/waste/landfill_index.htm

Source: Varank, G., Demir, A., Top, S. et al. 2011. Migration behaviour of landfill leachate contaminants through alternative composite liners. Science of the Total Environment. 409; 3183-3196.

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