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New low-cost wastewater treatment system pioneered in Ireland

A pilot scheme in Ireland is treating agricultural wastewater using waste alum sludge from water-treatment works. **Akin Babatunde** and **Yaqian Zhao** from University College Dublin report on what could become the world's low-cost wastewater-treatment system of choice, particularly in remote areas.

Alum sludge is the main residual by-product from drinking-water-treatment processes including coagulation, flocculation, clarification and filtration, followed by dewatering in plants using aluminium salt as a coagulant. It is the most widely generated water-treatment residual worldwide – and is mostly sent to landfill being perceived as a waste of little known reuse value.

In Ireland, an annual total of 18 000 t dry solids of alum sludge is generated from the largest water-treatment plant alone, with landfill disposal costs of about £2·6 million. In the UK, about 182 000 t dry solids of waterworks sludge is generated each year, with disposal to landfill as the predominant disposal route.

However, due to increasing environmental awareness, escalating costs, dwindling landfill space and the need for sustainability, efforts have been geared towards either minimising the generation of the sludge or finding alternative reuse options. The latter appears to be more feasible, with several studies being conducted to develop alternative end-uses.

The pilot-scale alum-sludge-based engineered wetland wastewater treatment system at an animal farm in Ireland has cut soluble reactive phosphorus by up to 99·8% and BOD_5 by up to 90%

Engineered wetland

At the centre for water resources research at University College Dublin, Ireland, a multi-dimensional research project aimed at reusing alum sludge in wastewater treatment engineering has been ongoing since 2004. One of the significant outcomes of the research to date is reuse of alum sludge to develop a novel engineered wetland system.

The development represents a novel technological innovation to the constructive management of sludge derived from drinking water treatment. The new system is capable of enhanced and simultaneous removal of phosphorus and organic matter, particularly from high-strength wastewaters, while at the same time it offers a beneficial reuse alternative to alum sludge disposal.

Operational performance hinges on the abundant aluminium ions in the alum sludge, which enhance its phosphorus removal capacity. The enhanced oxygen transfer efficiency of the tidal flow operation in the engineered wetland system also greatly improves the microbial degradation of organic compounds.

Demonstration project

After extensive laboratory studies, a pilot-scale demonstration of an alum-sludge-based engineered wetland system is currently being carried out to treat agricultural wastewater at an animal farm in Newcastle, County Dublin, Ireland. The pilot builds on previous work carried out on development and field deployment of the system.[1,2]

The system consists of four identical wetland cells in series, with a total treatment surface area of 3·42 m^2. Dewatered alum sludge is used as the main substrate and total substrate depth in each cell is around 0·75 m. Loadings up to 0·29 m^3/m^2d (hydraulic) and 150·8 g-BOD_5/m^2d (organic) have been applied across the entire system (BOD_5 is biochemical oxygen demand over 5 days).

Preliminary results obtained showed that removal efficiencies up to 99·8% for soluble reactive phosphorus and 90% for BOD_5 were achieved in the system.

Great promise

The system holds great promise as a low-cost wastewater-treatment system of choice, particularly in cases such as isolated or scattered settlements, agricultural and industrial effluents, private dwellings, hotels, parks, and rural areas. At the same time, it offers a novel reuse alternative for the alum sludge as opposed to landfill.

The project has attracted funding from a variety of sources including the University College Dublin seed-funding programme, Urban Institute Ireland and the Irish Environmental Protection Agency.

Enterprise Ireland is now funding a field-scale validation of the system with emphasis on industrial adoption, while the Irish government's Department of Agriculture, Fisheries and Food is funding integration of the design and operation into a coupled catchment-model decision-support system aimed at predicting, identifying and mitigating nitrate and phosphorus losses from agricultural catchments in Ireland.

References

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