Model filter system removes antibiotics from wastewater

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A model for an economical filter system that can remove antibiotics from wastewater has been designed by Agricultural Research Service (ARS) and University of California-Riverside (UCR) collaborators.

Microbiologist Mark Ibekwe with the ARS Agricultural Water Efficiency and Salinity Research Unit in Riverside, California, and UCR soil chemist Daniel Ashworth constructed the prototype system using four layers of natural materials: gravel, sand, soil, and biochar in a column 50-cm tall and 12-cm diameter.

They used the laboratory-scale model to remove four antibiotics: amoxicillin, cefalexin, sulfadiazine, and tetracycline at various levels of efficiency. These four antibiotics were selected for testing in the scale model because they are among the most common in wastewater treatment plant effluent. Conventional wastewater treatment plant systems are relatively effective at removing nutrients and bacteria but can be somewhat ineffective at removing antibiotics.

The effectiveness of the laboratory-scale system varied with the antibiotic being evaluated. It successfully removed 98 percent of the tetracycline, followed by 91 percent of cefalexin, 81 percent of amoxicillin and 51 percent of sulfadiazine. The antibiotics had initial concentrations of 10 ppb, comparable to levels that have been seen in municipal wastewater.

Amoxicillin and cefalexin removal were largely controlled by chemical degradation in the gravel layer, while sulfadiazine was largely removed by a combination of chemical and microbial degradation in the soil mixed with biochar layer. Tetracycline was primarily removed by chemical reactions with water (hydrolysis) in the gravel layer.

"These results show the importance of using layers of different materials to target different antibiotics rather than expecting one layer and material will be able to do the job." said Ibekwe.

Increasing the time it takes for the water stream to pass through the column also improved removal efficiency, especially for amoxicillin and cefalexin. In this design, the simulated wastewater enters at the bottom of the column to saturate the bottom layer and then is pumped up through the column to flow out through the top.

A "full-size" scale-upped version of the researchers' filter system—one that might serve a small-town wastewater treatment plant—would be about 2 meters tall and 50 cm in diameter, according to Ashworth. Of course, you could use multiples of the columns to serve a larger need and the footprint would still be relatively small, which is one of the powerful features of this system, Ashworth added.

There are some existing systems that can remove antibiotics from wastewater, but these tend to be very expensive or require much more space. This research was published in the *Journal of Environmental Chemical Engineering*.

More information: Daniel J. Ashworth et al. System of multi-layered environmental media for the removal of antibiotics from wastewater, *Journal of Environmental Chemical Engineering* (2020). DOI: 10.1016/j.jece.2020.104206

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