From Earth to Space: Application of Biological Treatment for the Removal of Ammonia from Water

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Managing ammonia is often a challenge in both drinking water and wastewater treatment facilities. Ammonia is unregulated in drinking water, but its presence may result in numerous water quality issues in the distribution system such as loss of residual disinfectant, nitrification, and corrosion. Ammonia concentrations need to be managed in wastewater effluent to sustain the health of receiving water bodies.

Biological treatment involves the microbiological oxidation of ammonia to nitrate through a two-step process. While nitrification is common in the environment, and nitrifying bacteria can grow rapidly on filtration media, appropriate conditions, such as the presence of dissolved oxygen and required nutrients, need to be established.

This presentation will highlight results from two ongoing research programs – one at NASA's Johnson Space Center, and the other at a drinking water facility in California. Both programs are designed to demonstrate nitrification through biological treatment.

The objective of NASA's research is to be able to recycle wastewater to potable water for spaceflight missions. To this end, a biological water processor (BWP) has been integrated with a forward osmosis secondary treatment system (FOST). Bacteria mineralize organic carbon to carbon dioxide as well as ammonia-nitrogen present in the wastewater to nitrogen gas, through a combination of nitrification and denitrification. The effluent from the BWP system is low in organic contaminants, but high in total dissolved solids. The FOST system, integrated downstream of the BWP, removes dissolved solids through a combination of concentration-driven forward osmosis and pressure driven reverse osmosis. The integrated system testing planned for this year is expected to produce water that requires only a polishing step to meet potable water requirements for spaceflight.

The pilot study in California is being conducted on Golden State Water Company's Yukon wells that have hydrogen sulfide odor, color, total organic carbon, bromide, iron and manganese in addition to ammonia. A treatment evaluation, conducted in 2011, recommended the testing of biological oxidation filtration for the removal of ammonia and production of biologically stable water. An 8-month pilot testing program was conducted to develop and optimize key design and operational variables. Steady-state operational data was collected to demonstrate long-term performance and inform California Department of Public Health permitting of the full-scale process.

As ammonia continues to present challenges to water and wastewater systems, innovative strategies such as biological treatment can be applied to successfully manage it. This presentation will discuss application of cutting-age research being conducted by NASA that will bridge existing information gaps, and benefit municipal utilities.