United States Environmental Protection Agency

Research Project

National Risk Management Research Laboratory
Water Supply and Water Resources Division
Treatment Technology Evaluation Branch

The Role of Microbial Processes in the Oxidation and Removal of Ammonia from Drinking Water

Impact Statement

Ammonia in source waters can cause water treatment and distribution system problems, many of which are associated with biological nitrification. Therefore, in some cases, the removal of ammonia from water is desirable. Biological oxidation of ammonia to nitrite and nitrate (nitrification) is well understood and common in wastewater processes. The biological filtration to convert ammonia to nitrate in drinking water applications in full-scale systems is limited in the United States. This research further contributes to the U.S. Environmental Protection Agency's (EPA) ability to provide expertise and guidance to water utilities, engineers, the general public and other stakeholders on drinking water treatment.

Background:

Many regions in the United States have excessive levels of ammonia in their source waters. For example, farming and agricultural sources of ammonia in the Midwest contribute to relatively high levels of ammonia in many groundwaters. Although ammonia in water does not pose a direct health concern, nitrification of significant levels of excessive ammonia may. In addition, ammonia in arsenic bearing waters, for example, may negatively impact arsenic removal by creating a chlorine demand and reducing the chlorine's availability to oxidize arsenic. Clearly, the complete oxidation of excess source water ammonia during the treatment process reduces the potential negative impact (nitrification) on distribution system water quality. While physicochemical methods for ammonia removal are possible, such as ion exchange, biological methods appear to be more efficient and cost-effective.

Biologically-active filtration has been used successfully in Europe for years. Bouwer and Crowe (1988) documented the use of various biological methods throughout Great Britain, France, and Germany, including fluidized beds, rapid sand filters, biologically active granulated active carbon (GAC), and soil-aquifer treatment. However, the use of biologically active filtration to oxidize ammonia as a full-scale drinking water treatment process has not been thoroughly considered in the United States. A number of concerns with biological water treatment exist including the potential release of excessive numbers of bacteria into finished waters, sensitivity of bacteria to changes in water chemistry and operating conditions, and a lack of long term documentation of the effectiveness and reliability of biological water treatment processes.

Description:

The purpose of this study was two-fold: (1) to monitor and evaluate nitrification in a full-scale iron removal filtration plant with biologically active granular media filters located in Ohio, and (2) to determine how to most efficiently regain nitrification following filter rebedding with new filter media. Results showed that the biologically- active filters consistently oxidized all of the 1.2 milligrams/L NH_3-N to nitrate. Seasonal variations in ammonia oxidation effectiveness were not observed because yearly changes in water temperature and other water quality parameters were minimal. Pilot tests using dual anthracite/sand filters were used to determine the time required to achieve complete nitrification by three different seeding methods of new filters. The results of the pilot tests showed that all three methods took approximately seventy days. Biological oxidation of ammonia is a simple, robust and effective way to convert ammonia to nitrate in full-scale water treatment systems.

This project assesses the concentration of nitrogen-containing compounds in water systems with elevated ammonia levels. Water systems used for this project were suggested to the EPA project team by contacts outside the EPA. These sites have been visited by EPA and treatment train descriptions and general water-quality information has been obtained. The systems were asked to provide four to six water sampling locations in their distribution systems. Sites must be available for monthly access and sampling, and are distributed fairly evenly across the distance of the distribution system (close, mid-way, and far from the treatment plant). Plant sampling must be also performed by the operator on the same day as distribution system sampling. Given the nature of the study, EPA investigators have no say on the ultimate sites selected by the system, and must rely on the client's judgment and knowledge of the system to select the most appropriate locations.

EPA GOAL: Goal #2 - *Clean & Safe Water*; Objective 2.1.1- *Water Safe to Drink*
ORD MULTI YEAR PLAN: Drinking Water (DW), Long Term Goal - DW-2 *Control, Manage, and Mitigate Health Risks*

EXPECTED OUTCOMES AND IMPACTS:

Water utilities, states and engineers will better understand nitrification problems and approaches to reduce nitrification in distribution systems.

OUTPUTS:

Current and future outputs of the project will consist of published papers, peer-reviewed journal articles.

RESOURCES:

NRMRL Corrosion Research: http://www.epa.gov/nrmrl/wswrd/cr/index.html

NRMRL Drinking Water Research: http://www.epa.gov/ORD/NRMRL/wswrd/dw/index.html

NRMRL Treatment Technology Evaluation Branch: http://www.epa.gov/ORD/NRMRL/wswrd/tteb.htm

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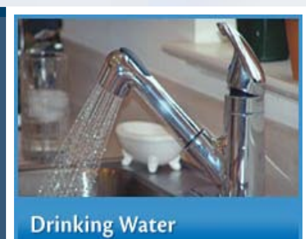

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