BIOLOGICAL DENITRIFICATION OF GROUNDWATER: DEMONSTRATIONS OF A NEW PROCESS FOR COST-EFFECTIVE TREATMENT OF RURAL DRINKING WATER

[1]J. Silverstein, [2]G. Carlson, and [3]J. Copeland

[1]Department of Civil, Environmental, and Architectural Engineering, Engineering Center, Room ECOT 441, University of Colorado, Boulder, CO 80309; Phone: (303)492-7211; Fax: (303)492-7317.

[2]BASX Systems, 3801 Automation Way, Fort Collins, CO 80525; Phone: (970)226-6360; Fax: (303)438-0211.

[3]Aqua International, 2463 S. Balsam St., Denver, CO 80227; Phone: (303)986-0044; Fax: (303)986-0545.

ABSTRACT

A novel attached-growth biological denitrification process for treating nitrate-contaminated groundwater in rural communities or other small systems has been demonstrated in Colorado, New York, and Israel. Demonstration plant capacity ranged from 55 to 165 cubic meters per day. The drinking water treatment process consists of an anoxic packed-tower bioreactor for denitrification, an aerobic biofilm prefilter, and a filter-polishing process. Two polishing processes were tested: slow sand filtration and microfiltration.

The purpose of the demonstrations was to verify the performance of the denitrification treatment system at full scale, under actual operating conditions, and for sufficient duration to demonstrate process stability. Carbon substrate was either food-grade corn syrup or acetate (vinegar). Vinegar was the superior substrate, resulting in higher rates of denitrification per unit biomass and lower numbers of coliform bacteria in the effluent. Nitrate removal was controlled between 50 to 100% by the carbon addition rate, depending on treatment goals. Microfiltration effectively removed bacteria filter effluent total coliform was below detection level, and heterotrophic plate count median value was 1 cfu/100 ml.

In December 1998, an operating biological denitrification plant was put in service in the town of Coyle, Oklahoma, providing drinking water to 290 residents and 400 school children. Plant design capacity is 150 cubic meters per day. Design denitrification capacity allowed for denitrification of influent well water with a concentration of 16 to achieve blended water concentration of < 8 mg/L NO3-N. A study of costs, capital and operating, between December 4, 1998, and February 24, 1999, indicated that total unit cost of water treated in the Coyle denitrification facility was $0.21/cubic meter ($0.79/1,000 gallons) distributed as $0.06/cubic meter ($0.23/1,000 gallons) capital costs and $0.15/cubic meter ($0.56/1,000 gallons) operations costs, power consumption and chemical additional.

Key words: denitrification, nitrate contamination, microfiltration, slow sand filtration