The Full-Scale Implementation of an Innovative Biological Ammonia Treatment Process

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Many regions in the United States have excessive levels of ammonia in their drinking water sources as a result of naturally occurring processes, agricultural and urban runoff, concentrated animal feeding operations, municipal wastewater treatment plants, and other sources. Although ammonia does not pose a direct health concern at levels expected in drinking water, it may pose a concern when nitrification occurs in the drinking water distribution system. Nitrification, which is the conversion of ammonia to nitrite and nitrate by bacteria, can lead to water quality issues such as accelerated corrosion, oxidant demand, taste and odor complaints, and elevated nitrite levels. The US Environmental Protection Agency's (USEPA's) regulatory limits for nitrite and nitrate (at the entry point to the distribution system) are 1.0 and 10 mg N/L, respectively.

The study community of Palo, Iowa, is a small community located 7 mi (11.3 km) west of Cedar Rapids. Before 2008, the community did not have centralized water treatment or a drinking water distribution system. Following extensive flooding to the region in 2008, plans were made to build the necessary infrastructure to supply the community with potable drinking water and sufficient fire protection.

The city of Palo developed and constructed its entire drinking water treatment plant and distribution system over a period of approximately 3.5 years (August 2010 to January 2014). The water treatment plant incorporated an innovative biological treatment system developed by USEPA to treat elevated ammonia (>3 mg N/L) and iron in the groundwater supplies. The biological treatment process was successfully demonstrated through a pilot-scale study during a year-long evaluation period. Subsequently, the process was elevated to a full-scale level with the construction of a new well, water main, water tower, and treatment plant, the performance of which was evaluated over the first 406 days of operation.

FULL-SCALE TREATMENT PLANT DESIGN AND OPERATION

The primary processing units in the treatment train are the "aeration contactors," blowers, and dual-media filters. Also included in the treatment train are a phosphate feed, chlorine (sodium hypochlorite) feed, and sodium hydroxide (caustic) feed. The system was designed to serve a population of 1,139 people with an average daily demand of 0.115 mgd (0.44 million L/d), and a peak daily demand of 0.23 mgd (0.87 million L/d).

Using a system design flow rate of 300 gpm (1,136 L/min), the treatment plant operates an average of approximately 6.4 h/d and as much as 12.8 h/d during peak demand. Following the two contactors are two finished water pumps with variable frequency drives to help control the level in the contactors, which feed into a common header that dosed the three dual-media pressure filters sized for 100 gpm each. The pressure filters are designed to remove any iron that is oxidized and passed through the contactors and provide additional biological nitrification capacity. The finished water then passes through a monitoring station and into the 200,000-gal water tower before entering the distribution system.

CONCLUSION

Conclusions of this research can be found in the full version of this article. The authors believe this work is an important example of how local, state, and federal governments can collaborate with small communities to resolve pressing water needs by providing innovative, cost-effective, and environmentally friendly options for treatment. It is the authors' hope that other water suppliers can take this case study and apply it to their own communities, given that this biological ammonia treatment plant proved to be robust, reliable, and relatively simple to operate.

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