How To Use Biological Filtration To Meet Today's Clean Water Challenges

Utilities and industries need reliable and cost-effective treatment methods to protect critical water resources. Water professionals want proven technology to remove contaminants from drinking water, wastewater, and process water. These technologies must also be able to operate under a variety of flows and conditions.

SUEZ in North America provides water and wastewater recycling services to 7.5 million people in the United States and Canada, as well as provides a broad range of technologies to help meet today's water challenges. Water Online spoke with Amit Kaldate, Biological Product Director at SUEZ, to find out how biological filtration systems can help utilities and industries produce clean water.

In general, how do biological filtration systems work?

Biological filtration is a combination of two processes. A biological reactor and a separation unit are combined into a single biofiltration unit. Biofiltration systems provide excellent treatment in a small footprint. They require a much shorter residence time compared to other biological systems. In the biological reactor, a biofilm grows on filter media. This media houses various types of bacteria. Biological oxygen demand (BOD), nitrogen, and ammonia removal reactions take place on this media. After the system is operated, interstitial spaces in the media retain incoming total suspended solids (TSS) as well as solids produced. Therefore, the system must be backwashed at a defined frequency.

In which type of treatment processes can biological filtration be used successfully?

Biological filtration systems have wide applicability. They are used for municipal drinking water and wastewater as well as industrial process water and wastewater. Because of their small footprint, these systems work especially well at industrial sites with restricted space for water treatment.

What are the various types of biological filtration treatment solutions available?

Biological filtration systems can be categorized based on the direction of water flow, either upflow or downflow. Each design has certain advantages and works better for specific applications. For upflow applications, a process like Biofor®, a wastewater treatment biofilter, has been very successful and is widely used. It's a biologically active filtration system for carbon removal, nitrification, and denitrification. Downflow applications include various processes, such as Ferazur® and Mangazur® to remove iron and manganese, and Nitrazur™ to remove ammonia and nitrate in drinking water. The Denifor® removes nitrate from wastewater.

Another way to categorize biofilters is based on aerobic or anoxic applications. For example, anoxic systems provide denitrification for removal of nitrates. Aerobic applications are basically oxidation processes to remove BOD and ammonia. In addition, there are many biofilters designed for specific uses, such as removal of metals including selenium.

Which contaminants can be removed using biological filtration when treating municipal drinking water?
Biofiltration can remove carbon, solids, and consequently turbidity from drinking water. In addition, some waters, especially groundwater, contain iron, manganese, and arsenic. SUEZ offers Ferazur®/Mangazur® biofilters to remove these contaminants. In some cases, water systems must remove nitrogen compounds, ammonia, and nitrate. The Nitrazur™ biofilter is specifically designed to remove ammonia and nitrate from drinking water.

How can biological filtration help industries treat their effluent for industrial reuse?
Biological filtration is an excellent application for industry, especially considering the recent emphasis and need for resource reuse and recovery. Biofilters can produce excellent water quality, with TSS of less than 5 to 10 parts per million (ppm) and total nitrogen less than 3 ppm. This is great quality for any downstream reuse application and, in some cases, further treatment such as ultrafiltration or reverse osmosis is not needed. At industrial sites, space is often very limited. A biofiltration system's reduced footprint is advantageous for many industrial processes. These two major advantages, high-quality water and a small footprint, make biological filtration an excellent choice for many industries.

How does biological filtration compare with typical activated sludge treatment in municipal wastewater systems?
From a technical viewpoint, biological treatment is combined in a single reactor to treat the same flow and levels of BOD and total nitrogen. So there is no need for clarifiers. Also, with an upflow filter, treated water is located on top of the filter, which reduces the likelihood of odor formation. Many of our Biofor® treatment plants are in the middle of a city and have never received odor complaints.

With biofiltration, active microorganisms are attached growth on the media. Biofilm in the reactor is more resistant to changes in flow and temperature. Active biomass remains steady during flow variations and is never lost during high flows. There's no waiting for biomass to recover. This ability to handle flow, load and temperature changes gives high-level of comfort to operators. The modular design ensures that one or more cells are always available for additional capacity.

Can the use of biological filtration systems for water and wastewater treatment result in cost savings and, if so, how?
Biofilters are very energy efficient due to their high level of oxygen transfer. Because electricity is a major expenditure as part of the water and wastewater treatment, reduction in operating costs is a major advantage. Also, if an anoxic system is used, no mixers will be required, reducing maintenance costs.

Capital costs for biological filters are competitive, due to combining biological reactors and separation systems. While the capital cost may be slightly higher, the smaller footprint, which includes the backwash system, and lower Opex may result in overall cost savings.

What are the key factors in controlling biological filtration system performance, and how difficult are these systems to operate?
Depending on the specific system, there are different control strategies. Controls include pollutant loading, such as pounds of BOD removed per cubic feet of active media per day. Hydraulic loading is also a factor. Biofilters used to remove BOD, nitrogen, iron, or manganese have specific hydraulic loading ranges for each application. Hydraulic and pollutant loading determine the number of cells online. Another strategy is to continually rotate cells by backwashing and then using a different cell. Some systems, which are operated based on pH or oxidation-reduction potential (ORP) for biological effect, must be operated in a certain range to function properly. Anoxic fixed biofilm is easier to operate compared to activated sludge because the fixed film maintains a low oxygen level.

Can existing treatment systems be retrofitted or upgraded to use biological filtration?
Yes, absolutely. We can appraise existing facilities for upgrades. If biofilters are already in place, it will be easy to upgrade the system. One thing to keep in mind is to ensure the use of specific media for which the system is designed because a specific depth of media may be required. In some instances, tank height may need to be increased. However, in many cases, existing facilities can be easily transformed to biological filtration.

What is the most practical way to optimize the physical-chemical-biological process design and get assurance of system reliability before committing to a biofiltration system?
Optimization starts with primary treatment. It's important to remove pollutants adequately, but avoid removing too many macronutrients, such as phosphorus. Also, the design must make provisions to ensure sufficient alkalinity for nitrifying systems. Desktop studies and modeling may be used during initial and conceptual designs. If needed, pilot studies can confirm the range of the system operation and how well it will perform under a variety of conditions.

During the design process, organic loading and flow variation should be checked. Is equalization needed? In addition, check for temperature range, as all biological systems' performance are temperature dependent. For tertiary treatment, such as nitrogen and phosphorus removal, biofiltration may be combined with physical/chemical processes.

By system reliability, we mean the ability of a treatment process to meet permit limits while maintaining requisite system availability. Biofiltration is advantageous in this respect. Biological filtration systems have a modular design, where certain cells can be brought online or taken offline without compromising performance. ■