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CTO OUTLOOK

How to boost the benefits of biofilm

With its anaerobic and anoxic MBBR offering, Headworks International has cemented its position at the forefront of biological treatment innovation. Now the company is setting its sights on providing resilient solutions with circular economy credentials.

SOMNATH BASU

VP of Process Engineering and Chief Technology Officer, Headworks International

Prior to joining Headworks International in 2016, Somnath Basu worked at several consulting engineers including CDM and AECOM, serving in roles including industrial wastewater treatment discipline leader and process design lead on many WWTPs, including the Deer Island Treatment Plant in Boston. In 2012 he joined the Shell Oil Co. Technology Centre as a technology lead in its water division. Basu has a master's degree in chemical engineering from IIT, Kharagpur, India and a PhD in environmental engineering from Northeastern University in Boston.

What market drivers have been most important in shaping the direction of your technology strategy?

In the municipal sector, the main market drivers are nutrient control – which is driving greater interest in the anaerobic ammonium oxidation (anammox) process – and the growing need for water reuse. In the industrial sector, it is the need for improved treatment practices on food and beverage wastewater. Another important driver is energy conservation and reduction of carbon footprint to mitigate its impacts on climate change. From this viewpoint anaerobic treatment of high strength wastes holds a huge potential as it produces biogas, which is a source of green energy.

What are the key technology areas you are looking at in your R&D activity and why?

The first major area is our anaerobic moving bed bioreactor (MBBR). There is an opportunity in high strength wastewater applications to recover energy and reduce the carbon footprint. Headworks has commercialised its anaerobic MBBR by extensive piloting and using proprietary designed media for the fixed film process. This offers several benefits over a conventional process by protecting the biomass from wash out, resulting in improved performance and stable operation.

We have also developed our MBBR for specific applications. For example, for the treatment of difficult wastewater streams from power plants, mining and petroleum refineries containing selenium, Headworks developed a process based on a multistage anoxic MBBR. Furthermore, Headworks has developed small footprint solutions to provide tertiary nitrification MBBR using its proprietary high surface area media ideal for achieving tight ammonia limits, even under low temperatures. For reuse applications, especially for industrial end-users, Headworks developed an MBBR process combined with UF to produce high quality effluent in a small footprint.

Lastly, Headworks sees the opportunity to apply anammox MBBR on the mainstream and is currently planning early-stage piloting to prove the benefits of reducing the overall energy demand and carbon footprint reduction at low strength ammonia concentrations in mainstream wastewater treatment.

What gaps do you see in the Headworks portfolio that could be strengthened?

Headworks specialises in biofilm based biological treatment but we see an increased demand from industrial end-users for turnkey solutions. Therefore, Headworks is strengthening its capability to offer a complete system which includes primary, secondary and advanced treatment steps.

What are the key markets for your anoxic and anaerobic MBBR options, and how much demand have you seen for these products?

When we were developing our anoxic MBBR process the main goal was to target energy utilities to fulfill the need for selenium control in the flue gas desulphurisation (FGD) water. However, this market is very much regulatory driven and in the last several years the regulations in the US were relaxed, leading to a slowdown in the demand for that technology. The new US administration, however, plans to reestablish tighter standards, which we believe will result in an upsurge in the market.

Our anaerobic MBBR is aimed towards the food and beverage market. There is certainly interest in anaerobic treatment in the F&B industry but in terms of new technology we see anaerobic membrane bioreactors (MBRs) have been making inroads into that market, which have a few years' head start on anaerobic MBBRs. However, we are actively marketing the MBBR technology, and when the clients see the benefit of fixed film processes, we are certain we can develop a good market for it.

How is your project for demonstrating wastewater treatment resiliency with Rice University and Black & Veatch in the city of Houston progressing and what have you discovered from that so far?

This pilot project is to test the resilience of fixed film wastewater treatment processes like MBBR and membrane aerated biofilm reactors (MABR) against peak storm events and hurricanes, which are quite common occurrences on the US Gulf Coast, including Houston. The pilot at Northeast ▶

WWTP has started up this summer after an inordinate delay due to the pandemic. The data collection has been started at a low flow of ~20 lpm (5 gpm). Under the test program feed rate will be ramped up in a very short time to simulate shock hydraulic load, up to peak flow of three to 15 times to base flow, and the effluent quality and biofilm integrity will be monitored and modelled to investigate the impact of hydraulic shock loads on fixed film treatment processes.

What key trends are you seeing in the wider biological treatment market?

The trends are in several areas. Firstly, distributed treatment systems, especially in small and rural communities, and new housing and commercial developments. Secondly, existing plant upgrades to achieve tighter ammonia and/or nitrogen consents, including the use of biological nutrient removal. Thirdly, by removing the organic contaminants and nutrients biological treatment is a prerequisite for the final membrane treatment to achieve high quality effluent needed for reuse. Also, for a circular economy the biological treatment is key for valuable resource recovery.

What is the next big innovation in the headworks and screens market?

Increased demand for finer screening requires the development of suitable systems. We specifically further developed the MS Multi-Rake-Screen family with a version which offers 2mm slot openings. This system allows still for a robust screening system and does not require spray systems or brushes, which are commonly used by other technologies.

Which are your most active end-user markets, and in your experience, which industrial markets are in the most need for innovative technologies?

The most active end-user markets are oil & gas, pulp & paper, mining and poultry. We feel there is a dire need for adoption of new technologies for wastewater treatment in the food & beverage industry. We notice that there is sometimes reluctance, even among large industry houses, to move away from old lagoon-based treatment. Due to the non-removal of settled solids for decades, the active volumes shrink and effluent quality suffers, yet there is often hesitation to adopt new technologies.

How are digital technologies changing the treatment space and what are Headworks' activities here?

Primarily the digital technologies are increasingly being used for automation of wastewater treatment plants. Hands free operation and control is very important for small communities which may share one single operator with other such small plants in the area. Real time monitoring and control of key operating parameters is very important to achieve that goal. Headworks supplies compact, decentralised systems suitable for small communities completely equipped with on-line instruments and control systems.

Where are you looking for new ideas for innovation outside of Headworks?

Primarily we collaborate with universities. We are currently collaborating with Rice University on the MBBR pilot project as described above. We have also been heavily involved with University of Manitoba where Headworks sponsored the research leading to the developments of anaerobic MBBR and sidestream anammox process using real wastewater streams, as opposed to synthetic wastewaters.

What do you think will be the game changing technologies in the water sector in the next ten years? What is ripe for disruption?

Water is intricately tied with energy. As the energy production process is very quickly moving to renewable and green energy, concurrently the demand for innovation in the field water is also increasing rapidly. For example, green hydrogen is going to occupy a significant place in energy production. The feed material for the hydrogen production electrolysers is water. As the freshwater resources are fast depleting the main source of feedwater for hydrogen production will be advanced treated wastewater. Thus, reuse is expected to become a dominant technological and business sector in water industry, and also an integral part of future hydrogen economy.

Recovery of plastics from wastewater will become another business sector in the circular economy. The recovered plastics can be processed and fed to the crackers to synthesise recycled plastics, which will significantly reduce environmental impact of plastic wastes.

Finally, another disruptive technology in the area of circular economy is the recovery of ammonia from human and animal wastes. Ammonia is essential as a starting chemical for producing various types of fertiliser for agriculture. Industrial production of ammonia requires aggressive temperature and pressure conditions, in addition to extensive health and safety measures. The capital and operating costs of ammonia production plants are also very high. If a large part of ammonia demand from the agricultural sector can be fulfilled by capturing it from wastewater, that will significantly reduce the cost of industrial production of ammonia. ■

NEVER TOO COLD TO NITRIFY

In 2003, Headworks International installed the first large MBBR in North America at a municipal WWTP in Moorhead, Minnesota. The nitrification process goes on unabated even at sub-zero ambient temperatures.

Source: Headworks International