Biological Drinking Water Treatment: Challenges and Potential

By Fiona Webber, WRc (WaterOnLine.com - December 2014)

The continuous struggle to remediate contaminated natural waters, and to reduce the impact of emerging challenges on the supply of safe potable water are key drivers for research and development in the global water industry today. WRc, the innovation consultancy, have investigated the potential of biological processes in drinking water treatment for meeting those emerging challenges. The conclusion is that biology has significant potential in addressing a variety of key water quality, sustainability, and supply integrity issues.

So what can biological treatment of potable water offer that conventional processes cannot?

Biological treatment of potable water is not a new concept. However, over recent years these processes have become the focus of renewed attention, particularly in mainland Europe and the United States. Skeptics may claim that biological processes are too difficult to control, are limited to low hydraulic loads, and that performance is variable and highly site-dependent. Nonetheless, some of these traits are not necessarily limiting factors, if acknowledged and managed correctly, particularly where alternative chemical or energy intensive processes have failed to deal with highly challenging emerging problems. Actually, the "quirkiness" of biological processes offer a fantastic opportunity to rethink how we can approach water treatment with a new and unique perspective. Innovation in this arena will be achieved through non-conformity.

Operators may be uncomfortable if intervention options are limited. Conversely, if this is factored into the design, it becomes an advantageous feature of biological systems: a reduced number of interventions translates into fewer man-hours required to operate these processes. Slow treatment processes may require investment for additional assets to provide capacity for low hydraulic loads; however, the associated whole-life costs particularly for energy consumption and usage of treatment chemicals could very likely tip the balance in favor of biotreatment. Regarding site-specificity, if better understood, this could provide water companies with an adaptive and versatile asset capable of removing specific contaminants almost while they emerge.

This versatility arises from the microbial ecosystems that underpin biodegradation — the basic concept of biological water treatment. The wide array of microorganisms and the inherent ability of microbial ecosystems to evolve and adapt when confronted with changes in their environment means that biological drinking water treatment has extensive application potential.
Metaldehyde is a good example of one of the many emerging concerns for water companies that is driving research and innovation in the field of biological treatment of potable water in the UK. This compound is a widely used molluscicide to control slugs and snails in agriculture, horticulture, and domestic gardening. Metaldehyde is highly stable in the environment due to its unique molecular structure, and although it has low toxicity to humans and other complex organisms, it is regulated as any other pesticide. Metaldehyde is neither efficiently nor consistently removed by commonly practiced water treatment process, including granular activated carbon (GAC) filtration and ozonation, posing a difficult challenge for the industry seeking a cost effective and sustainable solution.

Although recalcitrant, metaldehyde removal was observed in the UK, in a small number of slow sand filters that utilize biodegradation. This observation has prompted collaborative research between WRc, Cranfield University, and UK water companies to investigate the potential to better exploit biological treatment to deal with metaldehyde. A four-year STREAM project (UK Industrial Doctoral Centre for the Water Sector) has already achieved bench-scale biodegradation of metaldehyde in a fluidized bed bioreactor. WRc recognizes the potential of this process and support extending this research to develop an effective full-scale process.

**Pilot-scale fluidized bed bioreactor (FBBR)**

Significant knowledge gaps surrounding biotreatment remain, including the identification of microorganisms crucial for the degradation of specific contaminants and optimization of biodegradation through process design and operation. The water industry recognizes that only through further investment and investigation will significant ground be gained in harnessing the potential of biological treatment. With a clear conviction that biotreatment can become an enabler for addressing both imminent and emerging needs, WRc will continue to advance this field, driving research and development in the coming years to provide intelligent and tangible solutions to those difficult challenges.