The future of microbial monitoring

The technology for monitoring water quality is fast changing as new technology is developed and employed. By **Alan Titchall**.

The monitoring of microbial quality of raw water, drinking water and recreational waters has long been deemed essential. But, despite monitoring technology advances, waterborne pathogens still pose a threat to public health and most of the disease-causing organisms originate from contaminated drinking water.

The majority of pathogens that travel through drinking water, or recreational waters, and cause disease in humans are faecal in origin. And the faeces that are most known to carry potentially pathogenic substances come from human beings, other mammals and birds. While different bacteria, viruses and parasites that can pose a health risk have long been identified, testing for all of them is still very time and cost consuming.

In consensus, the water industry has been testing for a few groups of bacteria that work as indicators of faecal pollution, which should be sufficient to 'raise the alarm'.

Coliforms, faecal coliforms and E.coli are all entero-bacteria that primarily colonise the colon and are found present in all faecal samples.

Additionally these organisms are relatively easy to test for and standard methods depend on sample filtering and subsequent growth on culture media. They also rely on a laboratory technician to examine the samples after a 24-hour incubation period, which makes the whole testing regime take between 24-48 hours to provide an answer.

The automated options

All water authorities require water utilities to maintain a certain frequency of testing, and while the testing of bacterial levels at the water treatment plant is already common, it is equally important to test the quality of the water on the distribution network, particularly where there is aging infrastructure and the possibility of leaking pipelines.

There is also the challenge that faecal pollution events can hit randomly, so not all incidents are recorded by the fixed testing scheme before the pathogens enter the distribution network. And any increase of testing frequency requires more manual labour with traditional systems. For drinking water safety, the time delay by manual sampling and analysis combined with the testing frequency can be crucial.

An alternative to this, and as a supplement to the testing already required by water authorities, is a fully automated online instrument monitoring system.

This involves a type of monitoring system that can be placed

at the water source to automatically take samples and analyse them in much less time than traditional methods.

"Basically there are two main approaches for automated bacteria detection that are commercially available at this stage," says Eike Breitbarth from REZO + Water Energy.

"These are fully recognised industrial systems, of which Colifast [from Norway] is the longest established company with installations for municipal water supplies since 2003.

The Colifast instruments incubate a water sample in a media and measure growth of specific target/indicator bacteria (eg, E. coli), he says.

"This is fully automated, with an alarm raised in the case of contamination after two hours and full results in clean water after 15 hours. The process produces results in CFM [Colony Forming Units] which is the standard unit for microbial water monitoring."

This technology is used widely in Europe to monitor raw water intake, says Eike, and is verified by the US EPA as well as the EU.

"Further, Vienna Water Monitoring [from Austria] developed its ColiMinder system a few years ago. It is important to understand that the Colifast and ColiMinder instruments work on very different principles."

Instead of bacterial growth, the VWM ColiMinder System measures target bacteria specific enzyme activity.

"This is also fully automated and yields results in 15 minutes. The unit is MFU [Modified Fishman Unit], which can be correlated to CFU taking some environmental factors into account. The power here is in the 'speed' of the process and the fact it measures the actual 'live activity', which makes this a great method for fast screening and process control.

"Both types of system offer various communication options for integration into networks/SCADA systems and can also can be used in remote locations – powered by solar, for example. The manufacturers offer a range of media and protocols for a wide range of applications in industry and environmental monitoring.

"The ColiMinder system is also available as a 'driving lab' for well screening etc or can be customised to demand, eg, for rugged field use or multiple intake points in the water industry."

Using tryptophan

The other option is to measure tryptophan, says Breitbarth, which is an amino acid. "It is not a specific marker for gut bacteria, but if present in water it indicates high biological activity that correlates well with bacterial contamination.

"We can measure tryptophan very well already with optical sensors such as the MatrixFlu by TriOS (Germany), but the calibration in the sense of a 'translation' of the tryptophan concentration to actual bacteria numbers requires further research," says Eike.

"There are companies that market these sensors for bacteria detection already, but this is still at the early stage and we are involved with method development here in New Zealand.

"This sensor measurement only takes seconds, does not require any consumables, and can already indicate a contamination when high tryptophan levels are detected.

"With their very low maintenance and relatively low cost, optical sensors could form a network that watches water sources and distribution networks, with robust/established methods such as the Colifast ALARM measuring at critical intake of distribution points."

Molecular mobile testing

Finally, bacteria can be identified and quantified using molecular methods. Biomeme (USA) is offering a mobile phone controlled miniature thermocycler (Biomeme two3) for real-time PCR or isothermal analysis, the gold standards in molecular diagnostic technology.

"This is a very smart device that allows field testing using the company's targeted primers to indicate bacteria and specific pathogens, such as Campylobacter, which was responsible for the Havelock-North contamination," says Eike.

Results can be achieved in one hour.

"Produced in cooperation with Smith-Root [a US-based world leader in fisheries conservation technology] a semi-automated sampling backpack that greatly simplifies its use in the field is also available."

While there are no fully automated industrial systems on the market yet, once available – online bacterial monitoring can be even more diagnostic in the future, says Eike. **WNZ**