Bacteria and nanofilters -- the future of clean water technology

Bacteria often get bad press, with those found in water often linked to illness and disease. But researchers at The University of Nottingham are using these tiny organisms alongside the very latest membrane filtration techniques to improve and refine water cleaning technology.

These one-celled organisms eat the contaminants present in water — whether it is being treated prior to industrial use or even for drinking — in a process called bioremediation.

The water is then filtered through porous membranes, which function like a sieve. However, the holes in these sieves are microscopic, and some are so small they can only be seen at the nanoscale. Pore size in these filters can range from ten microns — ten thousandths of a millimetre — to one nanometre — a millionth of a millimetre.

These technologies can be developed into processes which optimise the use of water — whether in an industrial system or to provide drinking water in areas where it is a scarce resource.

The research is led by Nidal Hilal, Professor of Chemical and Process Engineering in the Centre for Clean Water Technologies — a world-leading research centre developing advanced technologies in water treatment.

Current membrane technology used in water treatment processes can decrease in efficiency over time, as the membranes become fouled with contaminants. By using bioremediation the membranes can be cleaned within the closed system, without removing the membranes. Researchers at the centre have developed the technology in partnership with Cardev International, an oil filtration company based in Harrogate.

As well as being highly effective in the water treatment process, transforming industrial liquid waste contaminated with metals and oils into clean water, ultrafiltration and nanofiltration membranes have a useful side effect. The waste products have a very high calorific value, and can be used as fuel.

Nanofiltration and ultrafiltration membranes are also being used in work funded by the Middle East Desalination Research Centre, which looks at creating drinking water from seawater. By pre-treating the seawater and removing contaminants, the membranes reduce the fouling of machinery in the next stage of the process — whether through reverse osmosis or thermal desalination. This can prevent damage to the machinery, reducing the need for expensive repair and replacements.

And by measuring liquid properties at the nanoscale, using state-of-the-art atomic force microscope equipment at the University, researchers are exploring how liquids behave at an atomic level — how they flow and pull apart. These results could be used in mechanics and industry, for example, maximising the use of oil in an engine.

Liquids are also being tested at a range of temperatures, from the very low (-50C) to the very high (150C).

Professor Hilal said: “Examining the properties of liquids has never been done before at this scale.

“By using bioremediation and nanofiltration technology combined, the water cleaning process is integrated — using far less energy than current processes. Add to this the recycling of waste products as fuels and you have a greener technology.”

Source: University of Nottingham