DISCOVER — ENGAGE — IMPACT

SAVE OUR SEWERS

UQ sewer corrosion and odour research has revolutionised sewer management practice in Australia and will have an enduring effect on the worldwide water industry – its impact is mammoth, with documented savings to date already amounting to $400 million.

Sewers are one of modern society's unsung heroes, whisking away our wastewater and saving millions of lives by preventing the spread of diseases such as cholera and typhoid. Now researchers from UQ's Advanced Water Management Centre (AWMC) are playing a vital role in preventing sewer corrosion, saving millions of dollars in infrastructure costs in the process.

Every day, sewer pipes carry domestic and industrial wastewater to treatment plants, where pollutants and pathogens can be safely removed. Around the world, however, these pipelines are in crisis.

As wastewater is transported through sewers, bacteria on the sewer wall react with sulfates in the water to form hydrogen sulfide. This not only causes odour problems, but also provides sewer bacteria with a substrate for forming corrosive sulfuric acid, which then chemically eats away at the pipes.

Governments around the world spend billions of dollars repairing these corroded pipes, with corrosion presenting an estimated annual asset loss of around $14 billion in the US alone.

Researchers from the AWMC's Sewer Research Group, led by AWMC Director Professor Zhiguo Yuan, have spent over a decade working closely with the Australian water industry to investigate innovative methods for tackling the problem.

The research was spurred by the City of Gold Coast approaching Professor Yuan to investigate corrosion problems in its sewer pipes.

One of the key initiatives has been the SeweX model, which is the world's most advanced mathematical model for predicting where hydrogen sulfide will occur, and therefore where both preventative methods and remediation will have the most impact.

Researchers worked with industry partners across Australia to gather extensive field measurements of physical, chemical and biological processes within sewers.

This data was used to create a sophisticated mathematical model that predicts localised variations in sulfide, methane and other parameters such as pH within sewers.

"Thanks to SeweX we have saved $30 million in capital costs," says Bill Capati, Manager, Sustainability Services, City of Gold Coast, who originally approached Professor Yuan seeking a remedy for the Gold Coast's sewer network problems.

"We have also saved several hundreds of thousands of dollars annually on operating costs, and odour complaints from the public have stopped."

SeweX has been highly awarded, receiving the Australian Engineering Excellence Award (Innovation Research and Development Category, Queensland Division) and the International Water Association Project Innovation Award (Applied Research Category, East Asia and Pacific).

As a result of the SeweX research in close collaboration with industry partners, in 2008 the AWMC received the second highest Linkage grant ever awarded from the Australian Research Council to establish the Sewer Corrosion and Odour Research (SCORe) project, the world's largest ever sewer research project.

Receiving $21 million in funding from the Australian government and major Australian water utilities, the project involved five research and 11 industry partners, who collectively provide wastewater services to approximately 60 per cent of the country's population.

One of the technologies to emerge from this project was an affordable, environmentally friendly method of decreasing hydrogen sulfide production in sewers.

"Existing management techniques focus on using continual dosing of chemicals to remove the sulfide after its formation, which not only costs almost as much as asset loss, but also causes problems in the sewage treatment and reclamation process," says Professor Yuan.

"Our challenge was to find an affordable chemical that didn't harm the environment."

The team developed an affordable technology that produces environmentally friendly, free nitrous acid (FNA) from the sewage itself.

"The FNA targets and kills the organisms that create the odour and corrosion, and is then removed itself by the microbial community living within the sewage pipes."

Field trials in Australia showed that it could achieve a 75 per cent reduction in operating costs compared to the existing continual dosing techniques.

The FNA technology was developed into the commercial venture Cloevis Pty Ltd, led by UQ's commercialisation company UniQuest. Cloevis has since partnered with USP Technologies to take the technology to the US market where, after undergoing field trials, is now in full commercial mode.

A third business to spin out of AWMC's research is Lodomat, which uses FNA to reduce costs in wastewater treatment plants.

One of the main costs of treatment plants is the disposal of sludge, a by-product of the treatment process. Lodomat technology uses FNA to reduce the amount of sludge by up to 10 per cent. It is easy to install and retrofit, and can pay for itself in just two years. A parallel benefit is that Lodomat also increases biogas production from anaerobic digestion of sludge by 20 to 30 per cent.

Taking a holistic approach to the problem, the researchers have also investigated whether it is possible to reduce the amount of sulfates in wastewater in the first place.

Professor Yuan's team performed a two-year sampling campaign across South-East Queensland from 2009–2010, as well as conducting an extensive water industry survey across Australia, and producing comprehensive computer modelling of sulfate sources.

They found that aluminium sulfate added as a coagulant during the production of drinking water was a large contributor to the amount of sulfate in wastewater, and was indirectly the largest source of hydrogen sulfide in sewers.

A report published in *Science* in May 2015 recommended that simply by switching to sulfate-free coagulants, at little or no extra cost, water utilities could save large amounts of money in sewer corrosion.

In 2015, Professor Yuan's research was recognised by the Australian Academy of Technological Sciences and Engineering (ATSE), which awarded him a Clunies Ross Award, one of Australia's top technological sciences awards. He was also named one of Engineer Australia's Top 100 Most Influential Engineers for 2015.

Professor Yuan is quick to emphasise that none of this work would have been achieved without the commitment from AWMC's industry partners, who not only provided funding, but also provided avenues for implementing the research. Their advice and insight based on practical experience has been essential in developing innovative solutions to on-the-ground problems.

"We have committed partners who are looking for innovation," says Professor Yuan.

"Without their support and collaboration we wouldn't have been able to do what we have done."

In turn, water industry figures are appreciative of how applicable the research is to their needs.

According to Mr Capati, the most valuable feature of Professor Yuan's research work is how directly relevant the findings and solutions are for water industry practitioners, which has led to rapid industry uptake and substantial monetary benefits.

But it's been a group effort.

"The combination of world-class industry and academic engineers, microbiologists, materials scientists, analytical chemists and mathematical modellers have worked together to develop sustainable solutions to support the cost-effective management of complex sewer corrosion and odour problems," says Professor Yuan.

"The outcomes of their research will have an enduring impact on the global water industry."

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Timeline:

2003–2008: SeweX model in development

2008: Sewer Corrosion and Odour Research (SCORe) project commences

2009: SeweX start-up company is developed in conjunction with UniQuest

2010: AWMC team achieves breakthrough discovery that FNA inactivates the bacteria that produce hydrogen sulphide in sewers

2011: UniQuest develops Cloevis as a commercial venture, partnering with USP Technologies in the US

2014: Lodomat start-up is developed to bring novel technology to wastewater treatment plants

2015: Professor Yuan's research leads to documented $400 million in savings to the Australian water industry to date and continues to deliver cost-savings with increased, widespread uptake

2016: Lodomat trial in pilot phase with Queensland Urban Utilities at Luggage Point Innovation Centre, with funding from five utility partners along with The University of Queensland

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