Nanobubble transformation of water treatment

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Emily Warrender July 14, 2025

Professor Niall English discusses the challenges and advancements in water treatment, highlighting AquaB Nanobubble Innovations' breakthrough nanobubble-generation technology, which offers a more sustainable solution for water treatment across various sectors

The world is facing ever more challenging problems in water treatment, especially given the ongoing high cost of aeration for activated- sludge treatment – but also for Dissolved-Air Flotation and even more dramatically in the area of environmental water treatment (e.g., treatment of algal blooms in reservoirs and lakes, in view of UN record- breaking increasing temperatures in recent decades). In this increasingly urgent context of climate change, and given the quest for more sustainable solutions in water treatment across various disparate sectors – especially in those with already-large energy requirements (e.g., in the gas and oil industries), AquaB Nanobubble Innovations Ltd has made substantial techno-commercial strides in recent years with its breakthrough nanobubble-generation technology, aided by UCD's Prof. Niall English, who lead-invented and developed the underlying electric-field technology.

Enter nanobubbles:

Our friends Electric Nanobubbles (NBs) are tiny buoyancy- evading gas-filled communities outside of standard thermodynamic (Henry's Law) dissolution; in other words, rather than being solitary molecules surrounded by water or solvent molecules, they are present in larger bubbles on the nanoscale, with many thousands of gas molecules and are metastable for long periods. Because they do not rise quickly, as the demo video here shows, defying Stokes' Law, they are stable for potentially many weeks, unless there is a pressing biological or chemical gas demand, e.g., for activated-sludge cultures, wider water treatment, in fermentation or oil-gas operations – to name just a few important areas.

As previous work has shown

(April 24, October 24, August paper, January 25), the electric-field approach to NB generation used by Prof. English in his ERC and AquaB's EIC projects is superior to previous-generation mechanical approaches. This has led, inter alia, to significantly more competitive proof-of-concept work in microalgae cultivation, with increased biomass output for reduced input (January 25), which is very promising for NB-enhanced microalgae activities and ambitions, as Prof. English outlined in his plenary lecture at the first European Conference on Algae Biotechnology in April 2025. In a word, by avoiding membranes and classical mechanical NB-generation approaches, the energy cost for

electric-field NB generation, or ‘bubbles per buck,’ is significantly reduced, with more facile operation, including Off-Grid, e.g., by solar and backup batteries for round-the-clock operations. This is also discussed in the podcast.

Overhauling water treatment: Leaner, greener, smarter

AquaB’s and Prof. English’s most recent TRL-8 field trials at wastewater treatment plants (WWTPs) from the successful ERC and EIC projects have shown a notable scope for performance improvement in aeration operations, with lower energy costs and more energy-efficient operation. By leveraging intrinsically more efficient oxygenation, AquaB has demonstrated substantial aeration-energy savings in wastewater treatment plant (WWTP) operations, as well as significantly higher dissolved-oxygen levels that benefit activated-sludge cultures and improve Dissolved-Air Flotation (DAF) operations. There was potent oxidation of ammonia and nitrite, as well as wider beneficial redox reactions for odour control.

In addition, an overview has also been presented of AquaB’s important and new advanced monitoring and feedback-control systems, particularly with the development of governing AI models for optimising ongoing NB-generation productivity.

Gas and oil progress

In the gas industry, AquaB and UCD have also made significant progress with further biogas-plant trials, supported by Gas Networks Ireland, iForm Science Foundation Ireland, Enterprise Ireland and the European Innovation Council (EIC)/European Research Council (ERC). In the renewable-gas industry, numerous water-treatment needs exist. Most notably, NBs can be used to clean raw biogas directly. The water absorbs methane and hydrogen sulphide preferentially from the raw biogas, leaving much purer methane. A lower-energy and membrane-free ‘upgrade’ of biogas was achieved using only electric-field NB generation in NB-enhanced “water washing”. In contrast, air and CO2 NBs were used for similarly effective and low-energy digestate-water treatment, redox manipulation, odour neutralisation, and the production of residual organic fertiliser material.

Indeed, progress in pilot trials has also been strong in the fuel and oil sectors. Here, amongst other things, AquaB’s NB generators have also shown good promise, with well-performing core-flood tests, surface-tension shifts, and oil-water separations requiring significantly less surfactant, which is vital for midstream operations. In the case of upstream NB-based fracking for Enhanced Oil Recovery (EOR), there is, therefore, much greater and faster frac-water penetration into the rock-sediment matrix, which dislodges pore-intercalated hydrocarbons and releases more rapidly greater quantities of oil. It was also found that oil-well ‘produced water’ (with every barrel of oil producing perhaps ten to 15 barrels of wastewater) can be treated more easily by CO2 NBs for the mass formation of carbonates – and their crash-precipitation release – to afford its en-masse desalting.

For downstream operations, the combustion of NB-aerated petrol and diesel in internal combustion engines (ICEs) has proven to be more efficient, with improvements of 14% and 16%, respectively, in efficiency, along with reduced emissions.

Outlook: Electric Dreams

With the TRL-8 pilot trials and ERC- and EIC-project exploration of fundamental and technical/industrial progress, Prof. English and his colleagues have managed to realise robust industrial progress in the gas, oil, fuels and water-treatment sectors. Coupled with AquaB's latest AI-model progress and its millifluidic designs developed during the EIC AQUA-BUBBLES project, AquaB is now equipped with smarter and more efficient TRL-9 CE-marked and ISO-certified NB generators to span the full flowrate range from sub-litres to thousands of litres per minute.

With solar-battery capability for passive NB generation, either on a floating or shore-mounted basis, in large water bodies, AquaB looks forward to a strong future with a full product range, from the domestic to industrial scale, in its effort to address pressing global challenges of our day.

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