MARKET MAP

New aeration techniques bubbling up for energy efficiency

The inexorable drive towards energy efficiency has opened up more and more opportunities to optimise the aeration process. Control systems look set to contribute more than equipment innovation.

Aeration systems are critical to the operation of the vast majority of wastewater treatment plants across the globe, feeding oxygen to bacteria in the liquor to degrade organic matter so it can more easily settle to create a clean effluent. The problem is that aeration systems are huge consumers of energy, which in a climate of rising energy prices and low water tariffs creates significant cost pressures for utilities. Though energy efficiency is a top priority, ever tighter nutrient discharge regulations are also driving better aeration processes so that utilities and industrial end-users can effectively remove ammonia and phosphorus to ensure discharge compliance.

Some innovations are being realised with respect to aeration systems – such as improving how bubbles are delivered into wastewater or delivering high purity oxygen instead of air – but it is generally accepted that only so many innovations to the equipment can be made that result in meaningful improvements in efficiency. Control and monitoring-based solutions offer a more obvious path to improving efficiency, at least in the short term, signalling once again the overarching impact the digital revolution is set to have on the water sector as a whole.

In aeration, several industry participants told GWI that the sector has a good understanding of how to deliver air and oxygen to water, but the key factor is determining how well the oxygen is doing its job. "You need to get the oxygen to the microbes that are doing the work, understand how it is being delivered and understand how and where it is really being measured to make sure that it's doing the job it supposed to," explained Jim Lauria, vice president of sales and marketing at Venturi aerator supplier Mazzei. The industry is beginning to grasp the benefits a better understanding may present.

ASSESSING THE AERATION OPTIONS

There has been a long-term trend to replace surface aerators with diffused aeration. The advantages of the latter are clear, though surface aerators are still well suited for lagoons and oxidation ditches.

Characteristic	Diffused aeration	Mechanical surface aerators
Standard aeration efficiency	Potentially as high as 7-8 kg O2/kWh.	Limited to approximately 2 kg O2/kWh.
Installation	Diffuser system with piping and blowers. Submersible mixers to generate horizontal flow.	Single unit installation. May require additional stand-alone mixers and/ or supplemental aeration.
Flexibility in engineering design and capacity	Stand-alone units enable tailor-made solutions which meet oxygen transfer demands.	Limited oxygen transfer variability. Number and size of units are the main flexibility factors.
Installation cost	Depends to a large extent on diffuser density and number of blowers and mixers required. Cost highly related to efficiency.	Relatively low-cost with few additional components. May require additional concrete reinforcements.
Process control capacity	Highly flexible with independent blower air flow and/or valve control.	Very limited.
Maintenance	Few mechanical parts which need maintenance.	Frequent maintenance of rotating aerating parts.
Application	Aeration basin, SBR, swing zones, MBR, oxidation ditch.	Lagoon, oxidation ditch.

Source: Xylem; GWI

Technology landscape and innovations

The aeration process introduces air to wastewater to provide bacteria with oxygen for breaking down organic matter and is usually combined with mixing in order to keep the mixed liquors in suspension. Air is delivered either by a mechanical agitation system which delivers air from the atmosphere, or a subsurface system in which air is delivered by blowers and diffusers. There are different types of surface aerators, usually using impellers or paddles, while submerged systems include coarse or fine bubble diffusers (FBD), jet aerators and Venturi injectors (*see terminology, p49*). The industry is well versed in the respective merits and demerits of each configuration (*see table, below left*), and neither are likely to change dramatically for the foreseeable future. Surface aerators are more suited to large lagoons in regions with good land availability, while FBD systems are usually configured in a grid system below a concrete tank to provide more uniform aeration. There has been a general trend in replacing surface aerators with FBDs because the latter are often more energy efficient – surface aerators simply splash water into the air before droplets fall back into the wastewater tank, mixing in the oxygen.

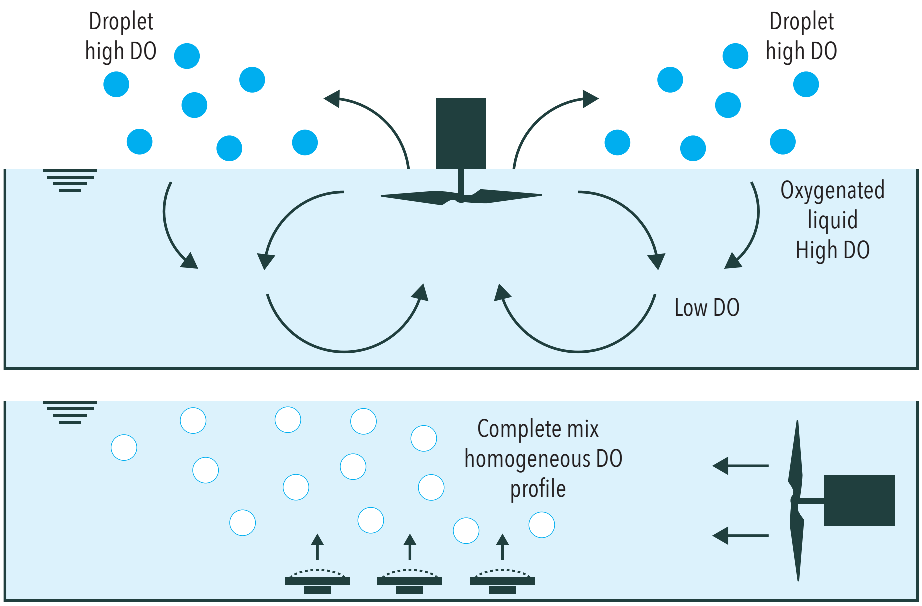
Diffusers meanwhile come in different shapes – tube, plate or disc – and the membrane in the diffusers is usually made of ethylene propylene diene monomer (EPDM) rubber, silicone or polyurethane, with EPDM being the most widespread. Marcus Höfken, CEO of aeration and mixing specialist Invent Environmental Technologies, argued that different materials are suited to certain kinds of wastewater or aeration basins, suggesting that "nobody wins" in a debate about materials.

"The improvements have been made in the way the people did the perforation [of the materials]," he said. Perforation of the material will determine how the bubble is delivered into the system, and how fast a diffuser will potentially clog.

Blowers provide the airflow to the diffusers deployed at the bottom or the side of a tank. The emergence of high speed ▶

DELIVERING THE AIR

Surface aerators oxygenate the mixed liquor by splashing water into the air before the droplets return to the water with high levels of dissolved oxygen (DO). However, surface aerators struggle to aerate the wastewater effectively at depths of 2 metres or more. The lower image demonstrates diffusers combined with mixers to enhance oxygenation of the wastewater.



Source: Xylem

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>
> Randy Chann, Environmental Dynamics International

turbo blowers over the last decade has significantly improved their contribution to greater energy efficiency. Blower manufacturers are investing in condition-based monitoring to monitor the health of these expensive assets.

Investigations into other kinds of equipment innovation are underway among the majority of manufacturers. "Everybody out there is trying to refine their mechanical systems for deployment of oxygen in the water. We want small bubbles but the right quantity," said Mario Coviello, principal engineer at Fluence. Aeration equipment and control specialist Environmental Dynamics International (EDI) meanwhile is favouring particular diffusers.

"We've been promoting panel-type diffusers for quite some time," EDI chief innovation officer Randy Chann told GWI. "They definitely offer higher transfer efficiency capabilities but definitionally they are higher stress type devices, meaning that the pressure loss is higher. We're trying to make a really small bubble so there have been a lot of mechanical failures of these devices."

However, there are limited improvements that can be made, with head pressure generally remaining the same due to a proliferation of aeration basins around the world possessing a tank depth of between 5 to 7 metres, as well as the constant of an alpha factor, which represents the ratio of the oxygen transfer efficiency in wastewater compared to clean water. Nevertheless, developments in material science have caught the interest of many.

"There is potential for better material science around the membranes used on aeration grids," said Oliver Grievson, flow compliance & regulatory efficiency manager at Anglian Water. "I'm pretty sure most of the aeration membrane suppliers are working on that. That is their differential."

While recognising that material science could contribute to solving the efficiency problem, others see a more holistic solution. Invent is advocating much more scrutiny over how aeration is combined with mixing. Höfken told GWI how many treatment plants are either aeration limited or mixing limited – either there are plentiful bubbles in the system and mixing is not an issue (though aeration efficiency is), or the aeration system is on turndown because of a low loaded phase or a plant not operating at full capacity, and there are too few bubbles to properly mix the fluid.

"If you cannot turn down your aeration system because otherwise the sludge will settle, you're wasting a lot of energy," he said. "If I ask a client why the oxygen concentration is 4 or 5mg/L in an aeration tank, they respond that they cannot turn down the aeration because the sludge will settle. The biggest innovation for them would be a mixer combined with an aerator to mix the sludge rather than just aerate it."

This approach is echoed by Chann. "We are trying to get the market to think about how diffusers, blowers and mixers are evaluated in total so that we can deliver best value to the project. We do not see that happening today," he told GWI.

Bubble size matters?

The idea behind moving towards smaller bubbles (*see chart, next page*) is that the surface area is greatly increased, increasing the contact time of oxygen with bacteria in a bioreactor, while also creating a healthier environment in the reactor. Though microbubbles are proving their worth in some applications, nanobubbles have also surged onto the scene. One system that has gained rapid uptake over the last 12 months is supplied by Los Angeles-based Moleaer, which possesses a generator system that delivers nanobubbles of size as low as 100nm at concentrations of up to 300 million bubbles per millilitre into a wastewater treatment system. Because the nanobubbles are not buoyant, oxygen transfer efficiency is significantly enhanced because the bubbles stay in solution much longer. Moleaer is looking to enhance or retrofit facilities with underperforming aeration systems.

"We don't consider ourselves as a competitor to conventional aeration," CEO Nick Dyner told GWI. "Where we focus are treatment plants that have a shortfall in terms of aeration capacity, poor delivery of the aeration itself, or dissolved oxygen (DO). Ultimately what we do is look to enhance treatment systems by solving a specific problem. Additionally, nanobubbles have an alpha factor greater than 1, so their transfer efficiency in wastewater is superior to conventional aeration."

Even though the science of nano- ▶

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> Oliver Grievson, Anglian Water

bubbles is not new, they have not had wide uptake in the water industry, largely because it has not been cost-effective to generate the nanobubbles on an industrial scale until Moleaer devised a patent-protected method. Moleaer has managed to secure a rapid uptake of the technology because it is fixed externally to the tank, relieving the need to remove or alter existing aeration systems and reducing technical risk. Since its start-up in 2016, the company has already secured around 60 commercial references.

Dyner also explained to GWI how the nanobubble system is agnostic to the depth of a tank, where head pressure can often affect how a bubble performs. Because nanobubbles are so small, they have a large surface tension with an internal pressure of up to 225 psi. Nanobubbles also exhibit a strong negative surface charge, which repel each other rather than coalescing.

"The depth of a tank doesn't matter for us but from a commercial perspective, we actually create more value for clients with shallow tanks because unlike nanobubbles, all other bubbles rise and therefore the shallower the tank, the less opportunity there is for those bubbles to dissolve their oxygen [before hitting the surface], leading to poor oxygen transfer rates," explained Dyner.

Oxfiniti, based in Cambridge, UK, has developed a system involving an oxygen generator, cavitating carburettor, mixing device and high shear injection nozzles to deliver high purity oxygen in molecular form (up to 55%) and nanobubble form (up to 20%) rather than in fine bubbles, dramatically increasing the relative surface area per equivalent unit of volume and enabling more efficient oxygen transfer to microbes.

So far, Oxfiniti's technology has been deployed at underperforming plants or plants that are subject to peaks in load, but its system can be used as the main source of oxygen. "We're quoting on a couple [of projects] at the moment which are quite large, but often at the moment, the utilities use us when they need to solve their particular problem," Oxfiniti business director John Williams told GWI.

Naturally, greater efficiencies will be realised if oxygen is delivered in much purer form. Air is only 21% oxygen, meaning that much of the air input into the process is wasted and not taken up by the microbes. However, challenges present themselves when generating and storing the oxygen and the process is costlier. Currently their application is limited to industrial applications, where players such as US firms Praxair and Mazzei have numerous references.

"What we found is that in heavy industrial wastes, like in textile mills or some pulp & paper [mills] where it's 3-5% solids, then you have no choice but to inject high purity oxygen. You'll never get enough air in there to effectively treat those high strength industrial wastes," observed Lauria.

Some are much less sold on the idea of delivering high purity oxygen despite much better energy efficiency. "A couple of years ago we partnered with a major oxygen supplier to run analyses and pilots to determine the economics. It really doesn't pay out. What we look at is not just oxygenation and maintaining good biology, but also the mixing function," said Coviello.

New treatment technologies

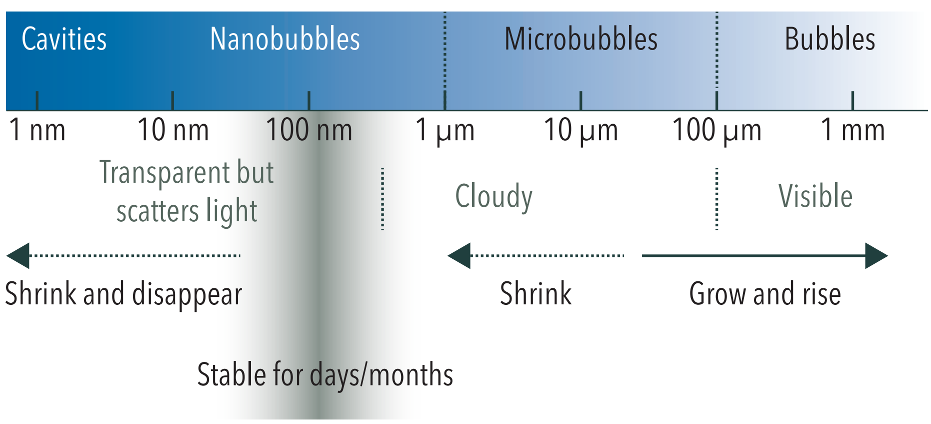
The market for wastewater aeration in the future will be affected by the proliferation of new biological treatment methods such as Royal HaskoningDHV's Nereda process, the anaerobic ammonium oxidation (anammox) process and membrane aerated biofilm reactors (MABR). All of these systems on paper promise much greater oxygen transfer efficiency with similar aeration requirements: Nereda because only the outer layer of the sludge granules is aerobic, while the core is anoxic; in the anammox process, anammox bacteria convert ammonium and nitrite directly to nitrogen gas anaerobically, though air is still needed to oxidise ammonium to nitrite; and MABRs involve nitrifying biofilm being fed air (or higher purity oxygen) through a gas-permeable membrane. This is a whole new take on delivering air to wastewater, removing the need for bubbles altogether. Levels as low as 10% energy consumption compared to more conventional aerobic processes have been claimed for the MABR technology.

Nereda now has roughly 40 reference sites across the globe, making an impact in dozens of countries, with the technology poised to be introduced next to the US market. Adoption of MABRs has begun to gather pace too, where Fluence, Suez Water Technologies and Oxymem are leading the charge, while anammox has been widely deployed on nitrogen- and phosphorus-rich sidestreams (i.e. filtrate from sludge dewatering) and looks set to play a role in mainstream wastewater treatment within the next couple of years. Though they offer greater aeration efficiency, these systems are more complex than their predecessors, demanding more complex instrumentation and control systems. ▶

SIZING UP THE BUBBLES

The virtues of microbubbles and nanobubbles seem clear, given their much lower buoyancy than visible bubbles and reduced tendency to coalesce. However, some in the industry argue that their smaller oxygen-carrying capacity means they will be redundant after a short period in a tank, with no more oxygen to transfer.

Gas bubble diameter



Source: OxyDoser

Becoming more controlling

For all the advances that could be made in blowers or diffusers, it can be hard to look beyond control systems and techniques as the go-to choice for maximising the chances of fully optimising an aeration process. The odds are stacked in control systems' favour as they preclude the need to replace or tamper with an existing aeration system (unless it is coming to the end of its useful life). Utilities and industrial end-users have implemented control measures in the past, but it is widely accepted in the industry that further measures to enhance energy efficiency could in theory be taken.

Implementing better control systems involves closer monitoring of particular parameters (*see table, below and diagram, right*) to get an idea of the health of the biology in the system and ensure compliance. The potential for greater use of control systems is apparent, with many WWTPs underprepared for both varying incoming loads and tighter regulations concerning nutrients in the discharge.

The increasingly stringent regulatory environment around ammonia and phosphorus levels is likely to drive the shift towards advanced control systems, opening up the business case further, according to Grievson. However, better understanding of these types of systems is paramount. "There are lots of control systems out there but as an industry we're probably not using those potential savings to the full benefit," he suggested.

Many of these systems go beyond simple dissolved oxygen control using a fixed setpoint (i.e. just one value of DO – often 2.5 mg/L – is monitored that when reached determines a change in operation of the aeration system), which has been the default option in the past, and employ more dynamic setpoints to frequently adjust the levels of DO required in response to the wellbeing of the biology in the reactor.

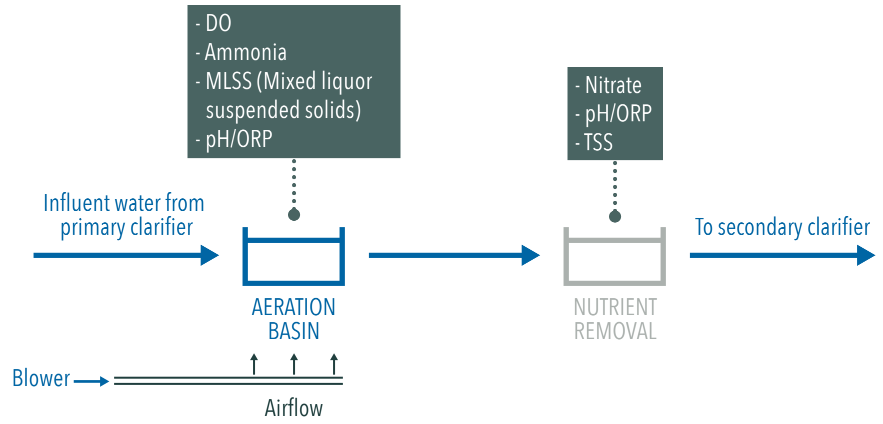
"People are mainly controlling to rules of thumb and historical factors," explained Michael Dooley, CEO at instrument provider and consultancy Strathkelvin Instruments. "They control the plant to a DO level of 2.5mg/L, and that's almost regardless of the load coming in or what [effluent quality] you're achieving, or what you want to achieve. That tends to give you good compliance performance, so most [operators] are purely reactive." The concept is that if the DO level drops below a setpoint then a control system will increase the blower speed or open another valve to increase air supply to the system.

A departure from this approach is beginning to emerge, with numerous companies offering alternative – and potentially more sophisticated – solutions that aim to help utilities improve their aeration efficiency without jeopardising discharge compliance. Suez employs a technique using the CREA advanced aeration control product (in collaboration with intelligent control solutions firm Createch 360°) to take advantage of certain synergies by enhancing the link between air production and distribution control (including most open valve control) and air demand control through effluent quality (e.g. ammonia levels). For example, with air pressure being monitored, traditionally if it fell below a minimum setpoint, another blower would start up to ensure required air delivery to the treatment process was maintained. This system also engages ammonia monitoring, meaning that when pressure does fall below the minimum setpoint, it queries the ammonia levels, determining whether more aeration is required. If the ammonia levels are not at the maximum setpoint, there is a delay in switching on an additional blower, thereby reducing excess energy usage.

Ammonia monitoring and control has become much more common in recent years as the industry faces tighter nutrient discharge consents. Water quality instrumentation giant Hach has been leading the way in this area and offers real-time control and monitoring of ammonia in conjunc- ▶

PROBING WASTEWATER SYSTEMS

Control and monitoring upgrades start in the aeration basin, which are usually monitored via numerous parameters and sometimes with multiple DO sensors. If nutrient removal is required, DO is not monitored in the denitrification process as this typically takes place in anoxic conditions.



Source: GWI

MEASURING THE WASTEWATER

There are several important parameters to be measured during the wastewater treatment process (not all are measured at every WWTP) for determining optimal levels of aeration.

Parameter	Reason for measurement	Monitoring technique
Oxidation reduction potential	To monitor the increase of strength of biological loading at the inlet	ORP electrodes
Dissolved oxygen	To control level of oxygen and manage the biological treatment process at the aeration basin.	Galvanic; optical sensors
BOD/COD	To control level of oxygen and manage the biological treatment process at the aeration basin.	Respirometer; Polarographic sensor
Ammonia	To precisely control ammonia levels at the aeration basin	Colorimetric; ion-selective electrodes; UV absorbance
Turbidity	Used as a surrogate of BOD and total suspended solids (TSS) levels	Absorbance; direct imaging

Source: GWI

tion with DO (*see diagram, right*). However, questions still remain around the reliability of ammonia sensors, which require frequent cleaning, driving costs up because of higher maintenance requirements. To avoid the need for an ammonia sensor, Spanish environmental monitoring and control & automation specialist Adasa Sistemas has developed OptimEDAR, which uses a virtual sensing technique by taking dissolved oxygen and oxidation reduction potential (ORP) measurements to calculate the equivalent organic load to determine how the organic load in a reactor is behaving.

The system was demonstrated during the European Union FP7 project R3 Water, where it performed similarly to a system based on ammonia control in terms of biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total nitrogen removal but saved on capex and opex, primarily due to the reliability of DO and ORP sensors versus their ammonia counterparts. The benefits are most realised on plants with varying wastewater loads coming into the plant. “One of the conditions we say for the system to get real optimisation is that you must not have a stable input into the plant,” said Jordi Cros, innovation manager at Adasa. Beyond reducing energy consumption, the company is also receiving interest in its OptimEDAR system to enhance effluent quality in countries such as the Philippines, where recent regulation changes have resulted in many operators falling out of compliance with the discharge standards.

In contrast to Adasa’s less instrument-heavy approach, Scotland-based Strathkelvin Instruments has a more complex method, determining an oxygen uptake rate (OUR) in order to determine how much biodegradable load is left. “Not only to do we measure the ammonia load, we also measure total load, so we know what’s BOD, what’s ammonia and what’s the endogenous rate of the bacteria,” explained Dooley. The endogenous rate of the bacteria is equivalent to their starving rate, the amount of oxygen required just to stay alive.

Strathkelvin even goes one step further by measuring at what dissolved oxygen level the maximum rate of BOD or ammonia removal is achieved, adjusting the DO setpoint on a supply and demand basis. “If you reduce a dissolved oxygen set point from 2.5mg/L to 2.2mg/L, you can actually generate up to 20% energy savings,” said Dooley. “By being able to only supply the oxygen that you need to a DO level you need and to keep that at a minimum, you have a much more efficient process and the bacteria are much happier. It doesn’t sound like a lot, but it is.”

Smarter aeration

As well as putting control systems on top of existing aeration systems, some firms are looking to incorporate intelligence in their own aeration systems. In late 2017 Fluence began marketing its SmartAerator, which is a system of controls, sensors and variable frequency drives to help reduce unnecessary aeration.

“This technology would be especially beneficial for a lower headcount facility. They can use the technology to bridge the gap between the amount of time the staff have in a day to go out and make their rounds, so they can multitask better,” explained Coviello. The system comes with an analytics platform and built-in artificial intelligence. “In the most clinical sense it’s not AI from out of the box, but it has machine learning capability to predict what the oxygen demand is a year from now on this particular day using historical data,” said Coviello. Fluence ran a pilot in 2017 which suggested up to 50% energy savings compared with conventional aeration and mixing.

Increasing uptake of control systems

The uptake of control systems – particularly those that are more advanced – can be a challenging process for vendors. Proving the anticipated savings to the client presents a stiff obstacle, but some have found a way around it. Suez proffers a questionnaire to a client to fill out their operating parameters, and the answers are then compared to past system references so that the anticipated savings are based on real data rather than theory. With around 150 references for the system, Suez and Createch 360° are well positioned to offer this service. The profile of Suez’s clients is usually embodied by those with a green agenda.

“The majority of the time it is energy efficiency – plants are hitting compliance but want to do so in a more environmentally friendly way,” said Lynne Bouchy of Suez’s Water Technologies and Solutions business unit. “10% of the time the driver is getting a better grip with process control in order to hit compliance.”

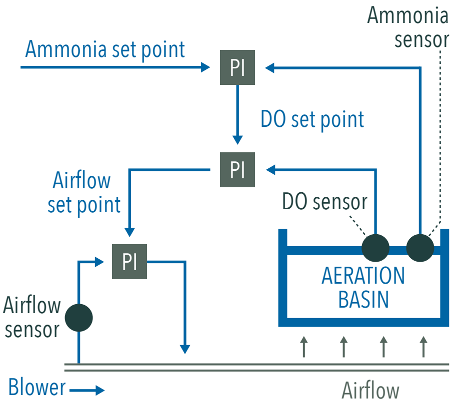
Logic also dictates that the greatest energy and cost savings can be obtained from the larger plants which have extensive aeration systems and high energy usage. However, while this is currently the case, advanced control systems could be a remedy to an expected dearth of qualified treatment plant operators in the future, and could be used to operate smaller plants. “There’s a niche for unmanned plants that are visited for an hour every couple of days, which is [currently] an inefficient process,” said Dooley.

Moves towards consideration within utilities of lifecycle costs – such as the totex-based guidelines in the England and Wales water sector which dominated the planning behind the latest asset management cycle – will also bring control systems front and centre to a utility’s decision process in enhancing its aeration efficiency. On larger plants, typical payback times for more advanced aeration control are less than three years, with periods as short as 12 months reported for the most inefficient of plants. The move to lifecycle cost consideration will help, but the industry believes that there is still more that could be done to increase uptake.

EDI has encountered challenges in the uptake of its Symphony product largely because potential clients are still coming to terms with the idea of more advanced ▸

COMPLEX CONTROL

A cascading control system where measured ammonia is compared with the ammonia setpoint, calculating the DO setpoint which informs the DO controller, which calculates required air flow.



Source: Olsson; IWA

> The majority of the time clients want more energy efficiency – plants are hitting compliance but want to do so in a more environmentally friendly way.
>
> Lynne Bouchy, Suez

Terminology

Aeration: the addition of air or oxygen to water or wastewater to increase dissolved oxygen levels and maintain aerobic conditions.

Blower: air conveying equipment that generates pressures up to 103 kPa (15 psi) commonly used for wastewater aeration systems.

Brush disc aeration: Mechanical aeration device most frequently used in oxidation ditches, consisting of a horizontal shaft with protruding paddles rotated at the water surface.

Coarse bubble aeration: an aeration system that utilises submerged diffusers to release relatively large bubbles e.g. greater than 1.5mm.

Diffused aeration: the introduction of compressed air into water by means of submerged diffusers or nozzles.

Diffuser: porous plate or tube through which air, or another gas, is forced and divided into bubbles for diffusion in liquids.

Dissolved oxygen (DO): the oxygen dissolved in a liquid.

Fine bubble aeration: method of diffused aeration using fine bubbles (which have diameter between 1-1.5mm) to take advantage of their high surface areas to increase oxygen transfer rates.

Jet aeration: wastewater aeration system using floor-mounted nozzle aerators that combine liquid pumping with air diffusion.

Microbubbles: gas bubbles with a diameter between 100 µm and 1 µm.

Nanobubbles: gas bubbles with a diameter between 1 µm and 10 nm. Known for having little to no buoyancy.

Oxygen transfer rate (OTR): the mass of oxygen being transferred per unit time, normally expressed in kilograms of oxygen per hour.

Standard aeration efficiency (SAE): calculated by the amount of oxygen transferred by the amount of energy added, expressed in kilogram of oxygen per kilowatt hour for clean water conditions.

Standard oxygen transfer efficiency (SOTE): usually measured in clean water conditions as a percentage of the air put into the system, SOTE is calculated by measuring the amount of oxygen remaining in bubbles once they are at the surface divided by the amount that was originally injected via diffusers.

Surface aerator: mechanical aeration device consisting of a partially submerged impeller attached to a motor and mounted on floats or a fixed structure.

Venturi effect: the reduction in fluid pressure that accompanies an increase in the velocity of a fluid as it passes through a constriction in a pipe or channel.

Venturi injector: a device for adding gas to liquid by utilising the Venturi effect.

digital solutions. Symphony is a suite of advanced control technologies which constitute an operations management system for optimisation of the aeration process.

"We're really looking at digital solutions that capture and apply learned knowledge. Functionally, that's taking data and transforming it into operational actions, perhaps management insights," said Chann, noting that water utilities are not necessarily suitably equipped to get a handle on these kinds of solutions. "I've been involved in the front end of Symphony marketing for a couple of years, and we've resisted using that term artificial intelligence because it's so abstract to people," he added.

Looking forward

One issue that continues to stimulate debate in the industry is the technique for measuring oxygen transfer rate for aeration systems. Tests for the oxygen transfer rate are usually conducted in clean water in order to make an equal comparison between technologies, but then the alpha factor is applied for derating transfer in wastewater, which can then be a source of bad information. The off-gas method – where a hood is applied at the top of the aeration basin to collect gas and determine the residual oxygen – has emerged to improve accuracy in real-life conditions.

"If you look at overall aeration system and not on the diffuser level, I think this was one of the biggest innovations in the market in the last 10 years," enthused Höfken. "This system helps you to monitor the actual performance of the aeration system and also later on it can save up to 25% of the blower energy – a much smarter way of controlling the oxygen demand."

Through its own control methods to determine the OUR, Strathkelvin also sees key benefits for improved knowledge around transfer rates. "We can do live transfer efficiency studies and I think that is critical for aerator and diffuser design – looking at when you replace those assets to give you the energy optimisation," Dooley told GWI. However, other players see it as costly and impractical, indicating that further development needs to be applied to get a more cost-sensitive handle on aeration efficiencies in real-time.

Many see an even smarter future for aeration control systems in order to realise further energy efficiencies and cost savings. "The real effort here lies in the passive data analysis done by algorithms or AI to take what is currently running in a plant, give that feedback, and then determine [...] that there's some good kW savings if we turn down an aerator but still maintain the oxygen and mixing levels," commented Coviello.

For some, better implementation of control systems is imperative. "I don't think the full benefits of advanced control systems on treatment works have been seen. It's very difficult to see the benefit and you've really got to push the business case," noted Grievson, adding that clients that had taken the plunge with advanced control had been brave, but it was not the right solution for everybody, particularly for smaller plants. Grievson also told GWI that though incremental improvements in equipment are inevitable, it is integrating them with better control and monitoring systems that will be the clincher for significant energy efficiency gains going forward.

"I actually think that the opportunities in the market are on the operations front," suggested EDI's Chann. "Provided that we give them the right-sized equipment and the right tools, we're going to see more gains from that area than the development of some new widget or physical technology." Overall, the general belief is that it is up to end-users to move away from a mindset geared towards environmental compliance to creating value (e.g. moving towards energy neutrality or becoming energy positive) in their wastewater treatment processes. ■