Wired for water

Technologies available to cut the cost of treating waste water, by improving efficiency and obviating practical problems, are many and various. Dr Tom Shelley explains

Water treatment at a plant near Helsinki, under modern ABB monitoring and control systems

All municipal and many industrial water treatment centres harness bacteria to break down unwanted organics, and supply oxygen to help them do so. The trick is to maximise the efficiency of the process, for example, by improving closed-loop plant control – or by using nature, in the form of reed beds, to do the work. Reed bed advocates make the point that plants are powered by sunlight, so require no additional energy source – just, possibly, pumps to deliver waste water and remove processed water, if gravity is not enough. They also point to reed beds' longevity.

"I have evidence that reeds can continue to work effectively after more than 120 years," states Melvyn Rutter of Yes Reedbeds in Yorkshire. And he explains: "My reed beds create aerobic conditions for bacteria to break down the biological and mineral pollutants in waste water. The living environment has done this kind of work for more than 400 million years. In a sewage works, you expect to see the clinker beds; reed beds use the same principle, but with less concrete and computers."

In fact, Yes's reed beds have been built to filter domestic sewage, ochre mine waters, brewery wastes, vegetable waste waters, carbohydrates starches and colloidal hydrocarbons, ammonia, nitrates, phosphates and other pollutants. And they can also cut the costs of treatment. "One recent system was built at a cost of £18,000, but this saved the company £30,000 per year over other methods," says Rutter. "There is a serious future for reed beds and other ecological solutions to human pollution. Ecological solutions allow human development, in balance with the natural world."

The only downside is the amount of space they require, which makes them fine for rural or semi-rural environments, but not urban sites, which will continue to require conventional aerated tanks.

Energy and maintenance

Moving on to conventional treatment plant, the big deals remain cutting energy and reducing maintenance. Faster response, and more accurate instrumentation and controls allow aeration energy to be reduced per dissolved oxygen requirement. However, until a few years ago, one barrier was the electrochemical dissolved oxygen sensors, which tended to require frequent recalibration.

One solution was Hach Lange's robust LDO (luminescent dissolved oxygen) sensors – patented technology unveiled back in 2002 that has since become fairly standard. Its probe tips are coated with a luminophore – a luminescent material excited by blue light from an internal LED. The material emits red light in relation to dissolved oxygen, with an internal red LED providing a reference. Importantly, it

Above: Conventional water treatment plant can conceal modern ideas and instrumentation
Below: Hache Lange technology is turning the tide of control

also only requires cleaning once every six months.

But the latest real time sensing and control systems from Hach Lange not only measure DO_2, but also ammonium and nitrate. Test results on two identical activated sludge process lines at a 250,000 population equivalent works in the UK are said to have shown that real time controls, aimed at cutting ammonium, reduced methanol consumption by 50% and air flow by 20%.

Phosphate payback

Incidentally, the company also offers real time technology for removing phosphates. These have to be extracted by chemical precipitation to avoid algae growth and low oxygen in the effluent. Several processes are being used, based on various chemistries, but systems using Hach Lange kit have greatly reduced chemical consumption. Payback times are also short: Hach Lange cites an unnamed UK works as having saved 37% of ferric sulphate and 57% of caustic chemical costs. The firm also claims that a plant in Italy achieved 50% cost savings and a payback of just seven months.

Meanwhile, sensing and managing toxic and flammable gases, such as methane, in waste water treatments plants have also improved. Most methane is now collected to provide fuel for generators to power plant equipment, but it's not always that simple. At the Dokhaven treatment plant in Rotterdam, for example, which is underground, a ventilated system maintains air pressure in the chambers below that in the tunnels.

This prevents any escape of contaminated air, which is instead fed back after passing through filter systems. All well and good, but ensuring safety during the first treatment stage (when oxygen is added to the waste water) meant installing 12 explosion-protected LEL (lower explosion limit) gas detectors.

These have 24V dc, 3.5W three-pole connection, as well as 4–20mA signal outputs, and maintenance engineers would normally require hot work permits for servicing. In this case, plant engineers solved that problem by using eXLink plug-in connectors, supplied by Cooper Crouse-Hinds. These allow connection and disconnection in explosive atmospheres, without tools and without having to isolate the apparatus from the mains or disconnect the terminals. That's important, because, if the detectors fail, the plant now shuts down.

But different challenges can be found on plant used for treating industrial waste water streams. In the food and drink industry, for instance, Siltbuster Process Solutions solved the problem of removing solids, fats, oil and grease, using what it terms 'packaged lamella dissolved air flotation' units. With this process, air is dissolved in the water under pressure and is then released as very fine bubbles as pressure reduces. Organic particulates then attach to the air bubbles as they rise to the surface, where they are collected, thickened and removed by a motorised scraper.

Users include Premier Foods' Ambrosia Creamery in Lifton, Devon, where a unit with a lamella plate area of $100m^2$ reduced the chemical oxygen demand loading on the biological treatment stage by an impressive 30%.

Interestingly, the idea of floating particles attached to air bubbles comes from minerals processing, where effluent tailings can pose even greater problems than those experienced in the food sector. Apart from the waste from gold extraction, using cyanides, one of the most challenging effluent treatment problems in the world is that associated with the Berkeley Pit in Butte, Montana, in the USA.

The more than 150 billion litres of water from this former copper mine are so toxic that birds landing on the lake are soon fatally poisoned. The water level is rising and, in order to prevent contamination of local sources, a treatment plant has been built that can process up to 27 million litres every day.

The mine waters are acid and the treatment consists of a two-stage lime (calcium hydroxide) precipitation process in combination with a high density solids phase. Lime, aeration and polymer addition remove the metals from the waters and these are then cast back into the pit. PE