

Green, efficient and low-impact: advances in sludge treatment technology

● There is an increasing focus for utilities on improving energy use and achieving higher levels of sludge treatment, prompting the development of technologies to improve efficiency, green energy production and recovery of nutrients. **LIS STEDMAN** summarises some of the recent advances in sludge treatment and management.

Energy-efficient thermal hydrolysis

At German exhibition IFAT in September, Veolia Water Solutions & Technologies launched an energy-efficient thermal hydrolysis process, Exelys, which, says the company, generates 20 to 40% more biogas than conventional digestion of sludge. The result is increased energy and organics destruction, and therefore lower disposal costs, and at the same time the sludge pasteurization provides a wider range of disposal options.

VWS Municipal Marketing Corporate Director Arnaud de la Tour du Pin explains that there are now three reference sites for the new system, two in France at Versailles and Lille, and one in Denmark.

Marc Cantegril, who heads up VWS' energy and sludge work, and in particular the Exelys programme, says: 'Exelys is a process that allows thermal hydrolysis, first to enhance the production of biogas, then to reduce sludge production at the exit of the wastewater treatment plant.'

Exelys can generate as much as 40% more biogas than a conventional plant, and the sludge reduction is between 30 and 50%, says Veolia, so it has been designed for utilities seeking to reduce their plant energy bills and resolve their sludge disposal issues.

The Exelys process heats the sludge to 165°C for at least 30 minutes, at between nine and 12 bar pressure, Cantegril explains. 'This phenomenon allows solubilisation of the organic matter, which allows it to be digested better.'

The Exelys DLD (digestion, lysis, digestion) process uses a classical digester followed by another standard digester, and the total volume of digestion is equivalent to that of conventional digestion. 'The most efficient process consists of digestion, hydrolysis and a second digestion

process at the end,' Cantegril observes. 'This process provides the maximum efficiency, but we have other configurations that can be used on existing plants to improve the capacity of digestion. We can make considerable improvements within existing plants.'

Compared to standard thermal hydrolysis, Exelys is a continuous process. Batch to continuous is a normal evolution of a process giving a smaller footprint, simpler control and easier service and maintenance. 'Further, you can't compare Exelys to a batch process that has lower energy efficiency,' he adds.

In terms of the complexity of the equipment, the only factor that needs to be closely controlled is the temperature, he explains. 'You only have to manage the heating and cooling of the sludge very well.'

The project in Denmark is close to Copenhagen, a 60,000 population equivalent (PE) plant configured as a DLD, a digester followed by an Exelys reactor and a digester to treat the

hydrolysed sludge.

The heat for the process is provided by steam from a boiler, which runs on the biogas produced.

Mr de la Tour du Pin says: 'We think this new technology is interesting because it drastically reduces the amount of sludge produced and increases the biogas, and it is unlike other technologies in operation... It's a very interesting technology. We think it could be a technological breakthrough.'

He believes there is a market for all sizes of wastewater treatment plants. 'We think it is a key technology,' he adds. 'All companies are working on the idea of a neutral-energy plant. We think Exelys could be one part of the answer. By developing new technologies like Exelys and Annamox, we think it will be possible to reach this objective.'

Harnessing cavitation for advanced oxidation

Valve technology company Mitton Abuma's BioCav technology harnesses cavitation to improve flocculation. Originally invented as a simple replacement for complex automotive valve train systems, inventor Mike Mitton discovered that his creation was inducing cavitation without suffering from any of the characteristic damage normally associated with the

Veolia's Exelys prototype plant at Hillerød, Denmark. Credit: VWS Photo Library / Lars Bahl.



phenomenon, which is infamous for causing damage to equipment such as pumps.

Hydrodynamic cavitation generates micro-bubbles through pressure pulses within a liquid, which act as minute reactors, generating highly oxidant radicals that make the technique analogous to advanced oxidation processes (AOPs). The technology uses small amounts of energy to generate a powerful cavitation field consisting of collapsing microbubbles, which generate powerful shear forces.

Ultrasound-generated cavitation has proved a reliable and easy solution, but Mitton believes hydrodynamic cavitation can offer better performance at an industrial scale.

Cavitation offers two important potential advantages over conventional AOPs, the company says, in that it does not use reactants or UV light and has significantly lower operational costs than other AOPs. In addition, the byproducts are limited to those expected from oxidation of the contaminants, rather than potentially dangerous byproducts such as chlorine.

The range of applications is extremely diverse – Mitton's system is being used to eliminate wastewater sludge from food processing operations, to explode open algae and plant cells to optimise biodiesel production and maximise methane yield for power generation, and the company is working with the oil and gas sector to explore the technology's potential to remediate oil sands tailings in Alberta.

Compact floc formation improves sludge dewatering

Germany's Aquen Aqua-Engineering managing director Dr Christian Schroeder explains that his company has developed a novel floc-forming reactor in cooperation with Cutec to counter the variability often found in sludge flocs.

'Achieving the floc form is a two step process,' Dr Schroeder explains. 'The first step disperses the flocculant to get a homogenous floc and a very simple floc structure. Our system has four degrees of variation – normally the floc can only be adjusted by consumption or dosage, but our system allows it to be varied by size and density as well.'

The advantage of the FlocFormer is that it is possible to obtain very compact flocs that are very suitable for dewatering. 'It's a kind of pelleting of flocs,' Dr Schroeder notes. The second step involves passing the homogenous floc through a narrow gap in a device with an inner cone in an outer cone



The FlocFormer from Aquen Aqua-Engineering

shell, which creates vortices that roll the flocs on each other.

'If the flocs touch, the density increases,' Dr Schroeder explains. 'This gives better separation and dewatering. Municipal wastewater treatment plants can optimise dewatering, leachate treatment, and COD (chemical oxygen demand) reduction.'

Thermal hydrolysis for advanced digestion

Cambi is another specialist in the advanced sludge treatment market and has a significant installed base of its thermal hydrolysis (THP) process. Cambi THP is a high-pressure steam pre-treatment for the anaerobic digestion of both municipal and industrial sludge and bio-waste, and the company says that using the system can double digester loading, increase biogas production and give a pathogen-free, stabilised biosolids product with increased cake dewaterability.

The Cambi THP biogas plants are usually combined with cogeneration plants to produce green electricity and provide hot steam for the THP process, which fits very well with utilities' increasing focus on energy saving.

Cambi's Biosolids Business Development Manager, Harald Kleiven, says that there is a huge drive for wastewater utilities in Europe, due to various directives, to push for higher degrees of wastewater treatment. As a result, the sludge produced tends to be a more difficult, biological type. 'It tends to be very difficult to break down and to dewater mechanically,' he says. 'Also as utilities move towards nitrogen and phosphorus removal, this tends to need a carbon source, so many plants in Europe are moving from primary sedimentation to extended aeration, so they have only biological sludge.'

The city of Brisbane in Australia similarly converted to extended

aeration, to utilise the primary sludge as a carbon source. However, Kleiven explains, the resultant sludge proved impossible to digest. 'For these types of plants in the developed world, which are producing more and more difficult sludges, there is an increasing need for advanced digestion.'

In such circumstances, the Cambi system can make a huge difference, he notes. 'One site in Denmark doubled its biogas production and reduced sludge cake by 50% after dewatering.' In the developing world, particularly India and China, he sees a lack of sludge treatment and tendency towards landfill leaping towards incineration.

Kleiven asks: 'Should they create a cycle with nature? Should they just put the sludge in a hole in the ground, and not use the phosphorus, which is valuable and in limited supply, or should they adopt systems that take back the sludge as biosolids fertilizer to agriculture or other type of land bank? As long as anaerobic digestion is planned or wanted, our system makes sense, whatever the use of the final product.'

In terms of comparing performance, the figures suggest most UK plants consistently achieve less than 25% dry solids dewatering, compared to the Cambi system, which produces 32% dry solids. The attractions of the system are such that it was recently chosen for United Utilities' massive Davyhulme site in Manchester and, in the US, for Washington DC's four million PE Blue Plains wastewater treatment works, with estimated \$50 million annual operating savings compared to its old system. Furthermore, the savings in digester tanks were such that they paid for the entire pre-treatment system.

'Davyhulme has an incinerator and they were going to build another one,' Mr Kleiven explains. 'Now they have two and a half times the sludge throughput through the existing biogas plant, using Cambi, and they don't need another incinerator.'

Although the wastewater treatment market is inherently conservative, Cambi's system is enjoying considerable success, having managed to get across its message about reduced digester size, better dewaterability and increased, improved quality biogas.

Kleiven says that the company is approaching sites around the world where digestion is being considered and suggesting that they install Cambi's system. The solution is normally used to treat sludge from wastewater treatment plants with populations of 150,000 upwards, or approximately 4000 dry tonnes per year of sludge. For smaller digestion plants the company has developed a down-scaled THP plant. ●