

Colchester Advanced Digestion Project

advancing the frontiers of enhanced digestion treatment

by Kubeshnee Chetty

The water industry has seen an emerging trend for energy self-sufficient wastewater treatment enabled through a process known as advanced digestion. Anglian Water's AMP5 Biosolids Programme applies shared learning and best practice to further advance the efficiency of energy recovery from sewage treatment. Aptly named "Special Projects," the programme comprises a new generation of enhanced hydrolysis plants using Anglian Water's proprietary Heating, Pasteurisation and Hydrolysis (HpH) process. The programme progresses an Ofwat obligation to provide enhanced digestion for 80% of Anglian Water's raw sludge production and to increase total renewable electricity output from biogas to 86.8GWh/year by 2015. The Colchester Advanced Digestion Project, the focus of this article, plays a key role in supporting target outputs for renewable energy production from biosolids. The upgrade offers a sustainable and long-term solution to sludge processing capabilities.



The new HpH facility with Heating, Pasteurisation and Hydrolysis tanks from left – Courtesy of Black & Veatch

Framework partners

Anglian Water chose to continue with its Special Projects framework partners from AMP4; seeing this as an opportunity to build on the proven ability of the partners to collaborate, challenge, innovate and deliver lessons learnt. Anglian Water's AMP5 Biosolids Programme has seen four existing wastewater recycling centres (WRC) upgraded with advanced digestion treatment: Colchester, Pyewipe, Basildon and Cliff Quay. The upgrades are being delivered by projects partners Black & Veatch (for Colchester and Pyewipe) and GTM (for Basildon and Cliff Quay).

Colchester WRC

Owned and maintained by Anglian Water, Colchester WRC treats 135,000 homes and businesses in and around Colchester, Essex. The WRC is sited on the edge of an industrial area. The existing works comprised a conventional digestion process with limited power generation, and served as a sludge reception facility for

liquid and cake imports from other Anglian Water satellite sites in the locality.

The Colchester facility has now been upgraded as an enhanced digestion treatment centre with capacity for 14,526 tonnes dry solids (TDS) per annum. The facility's increased capacity provides for all indigenous sludges from the works itself, expanded liquid sludge imports and a new cake import processing capability.

The various sludges are blended, pasteurised, digested and finally dewatered to cake, ready for transportation off-site for use as an enhanced quality agricultural product.

Scope of work

As principal contractor, Black & Veatch was selected to design and manage construction of the new treatment process. The works comprised:



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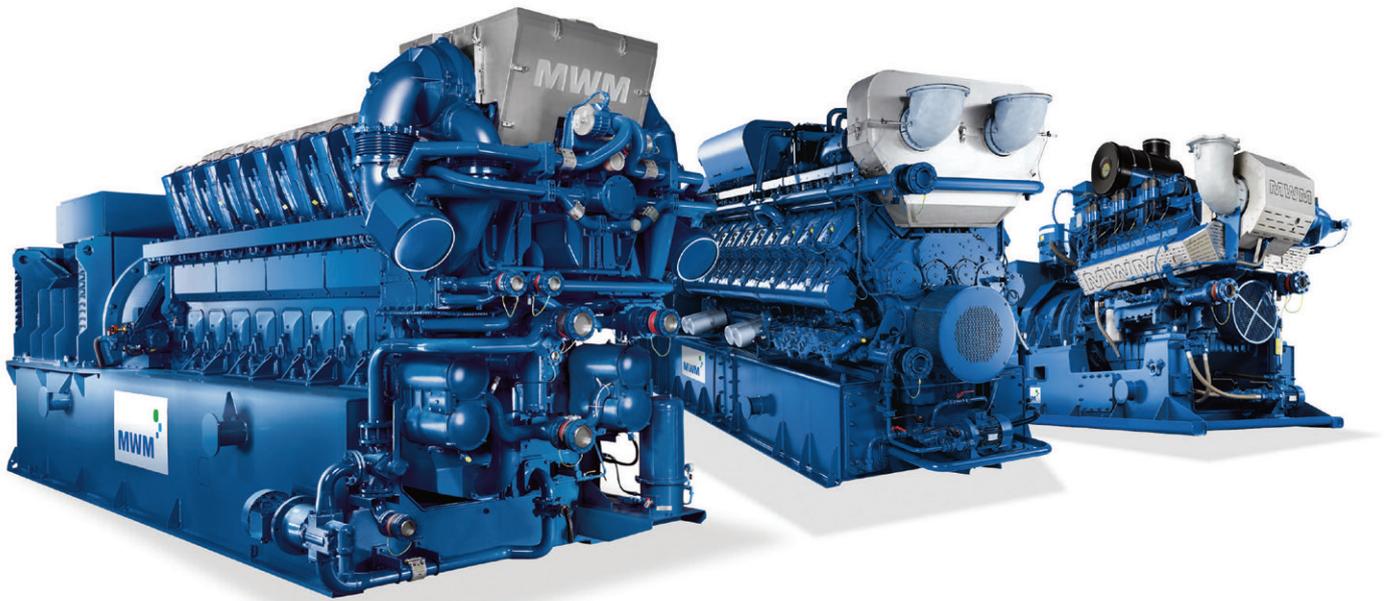
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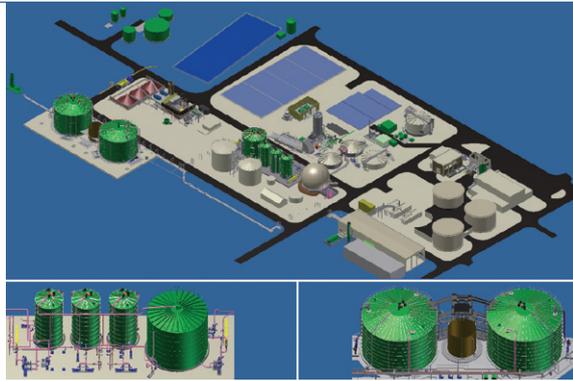
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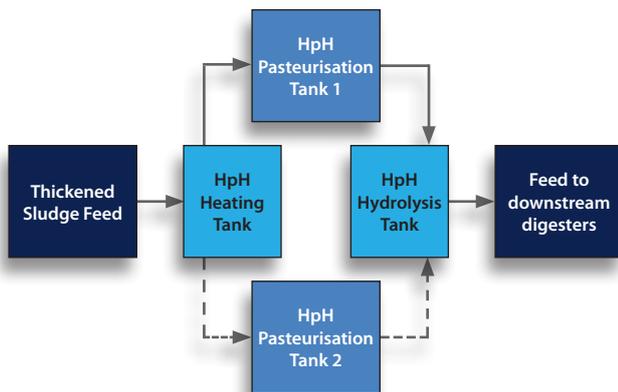


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3D CAD modelling was used extensively during the design process: Colchester site layout (top), HpH skid (bottom left), new digesters (bottom right) - Courtesy of Black & Veatch



HpH Process Flow diagram - Courtesy of Anglian Water



New GBT building (left), cake silo (centre) and cake reception facility (right) - Courtesy of Black & Veatch



The final dewatered cake is transported off-site for use as an enhanced quality agricultural product - Courtesy of Black & Veatch

- Modifications to the existing primary and imported sludge plant.
- Enhanced tanker imports facility.
- New surface activated sludge (SAS) treatment.
- New cake reception facility.
- HpH process.
- New digesters and associated biogas holder.
- Post digestion dewatering and return liquors treatment facility.

These elements are explored further within this case study.

Emphasis was placed on retaining and modifying elements of the existing works wherever possible, integrating the new and existing facilities as required whilst maintaining the existing plant process capacity. Three-dimensional engineering modelling was used extensively during the design process of this project to produce a realistic model of the site. This virtual model enabled any construction issues to be found and corrected in the virtual site thus saving time and money during the project's construction stage on site. All the construction 2D deliverables were taken directly from the 3D model thus ensuring the data was fit for purpose and without error.

To complement the Colchester development, Black & Veatch has also carried out modifications to four satellite WRCs (Clacton, Jaywick, Haverhill and Harwich and Dovercourt) to enable them to export screened sludge to the Colchester facility as thickened cake.

Primary and imported sludge

At Colchester, all influent flows are primary settled and then treated by a nitrifying activated sludge plant. These indigenous primary sludges are removed via an existing auto-desludge system to a reutilised and re-equipped existing storage tank and screening. Modifications to the tank also include a new liquid import tanker facility.

The mixed and screened primary and imported sludge is then transferred to another re-equipped existing sludge tank. This feeds new duty/standby gravity belt thickeners (GBTs) delivering 6% dry solids (DS) product ready for blending with the other sludge streams prior to treatment. The GBTs are housed within a new dedicated building incorporating ancillary services for polymer make-up, dosing and washwater boosting.

Surplus activated sludge (SAS)

SAS is auto-desludged via existing site infrastructure, where it is transferred via new duty/standby variable flow strainpress systems and stored in a new SAS buffer tank. Here, it is fed forward for thickening via a new GBT with an existing drum thickener retained and re-equipped to provide standby capacity. New polymer and ancillary facilities are also provided. The thickened SAS product (5.5% DS) is then blended with other sludge streams prior to treatment.

Cake import facility

A new cake reception arrangement has been built to facilitate cake imports at which trucks and skips may offload. The fully automated facility incorporates intake screw conveyers, odour capture, surfactant spraying, automatic traffic barrier and door control systems using truck positioning and sensing devices to control the sequences involved.

The system automatically allows for differing cake qualities from the various import sites. The raw cake (at 26-28% DS w/w) is transported to a new (220m³) cake storage silo via a train of screw conveyers and pumps. The silo allows buffering capacity to cater for intermittent deliveries. Further pumping is provided to transfer cake from the silo to be blended with the other sludge streams within the blending tank. As it is transferred, dilution pumps

increase the volume by adding final effluent in a high pressure line to achieve an 8-9% DS consistency.

The blending facility involves another refurbished and re-equipped existing tank. In this tank various feed sludges from the silo and the GBTs are mixed and blended to achieve an overall consistency of 8% DS, ready to be fed forward to the HpH system for treatment.

Heating, pasteurisation & hydrolysis (HpH)

HpH is a unique process, developed, trialled, and up-scaled to full operational capacity by Anglian Water's own experts. The three-stage system performs the following functions:

- Pre-heats the blended feed sludges prior to pasteurisation.
- Pasteurises the sludge and achieves an 'enhanced' sludge product and rapid pathogen kill.
- Pre-conditions (hydrolyses) the digester feedstock for optimum biogas production.

Having already installed equivalent processes at its Cliff Quay and Basildon sites, HpH is now in full operation at Colchester where it is on target to treat 14,526 TDS/annum. This unique system comprises four reactors – 1 (No.) for pre-heating, followed by 2 (No.) for pasteurisation and 1 (No.) for hydrolysis.

The system operates an automated batching arrangement centring on the two (280m³ each) pasteurisation tanks. Whilst one pasteurisation tank is filling and heating, the other is holding at temperature and pasteurising its batch for at least five hours. After its holding period the batch is fed forward to the (1,115m³) hydrolysis tank and the cycle is repeated.

The initial pre-heating stage utilises a circulating hot water loop (80°C) fed from the heat recovery systems of 2 (No.) combined heat and power (CHP) engines. Additional heat is added as required

from 2 (No.) steam boilers which also utilise heat recovery from the CHPs' flue gases to create steam used by the process.

By these means, the pre-heating process raises the sludge temperature to 42°C at which time it is ready to feed the pasteurisation stage. This stage utilises direct steam injection to raise its temperature to 57°C.

The hot water and steam systems are designed to harvest all heating needs from the CHP power generation process. If the CHP is out of service the boilers may be fuelled by burning surplus biogas, or if necessary, by diesel oil from the new storage tank.

Following the pasteurisation stage the batch is discharged to the hydrolysis tank where it is held for a period of time. The sludge is then transferred via a heat exchanger where final effluent is used to cool the flow to less than 38°C ahead of being slowly pumped forward to the digesters.

Digestion

Due to progressive decrepitude, the site's existing 5 (No.) digesters have gradually been set aside from everyday operation. Two new larger mesophilic anaerobic digesters with a working volume of 3,802m³ each have been built in their place. These receive the HpH treated sludge and hold it for a minimum period of 14 days.

Biogas evolved from the digestion process is passed from the digesters to an existing (1,500m³) gas holder which feeds the site's CHP engines. A siloxane filter scrubs this gas en-route, to reduce corrosive elements that can affect the engine condition.

CHP

The basic principle of the CHP installation is to provide power generated by biogas from the enhanced digestion process. Two new Edina CHP units rated at 1.2MW each, provide sufficient power



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and heat to run the treatment process, but also allow the site to export surplus power to the grid.

All power generated by this process is subject to Renewable Obligation Certificate (ROC) accreditation which generates an additional source of revenue. Total output from both engines is 2.4MW/h; of this approximately 1.3MW/h is consumed on site with the remainder taken up by the grid.

Operational preference is given to maximise power production through the CHP engines and hence on-line time is a key feature of the 24/7 operation. If CHP demand should be less than optimum, then surplus gas is burned to support the steam boilers and if necessary, can be burned-off by a new flare-off system.

Siloxane treatment

Siloxane treatment has been incorporated as part of the AMP5 scope of works as a result of lessons learned from AMP4. Under its appointment to Anglian Water's Special Projects Programme, Black & Veatch identified a build-up of furans and siloxane deposits had led to recurring engine breakdowns within the CHP plant at both Cotton Valley and Whittingham sites. The solution of a gas pre-conditioning (siloxane treatment) system removes the potential for siloxane build-up, reduces the maintenance frequency of the CHP engines, and thereby improves overall resilience of sludge treatment operations.

Post digestion dewatering

Post digestion sludge is dewatered to cake by means of an expanded centrifuge arrangement comprising two new units and a reformed existing unit (duty/duty/standby). A new polymer preparation and dosing system has also been installed to serve the expanded facility. The dewatered cake is discharged via screw conveyors onto a new 5-day storage pad from where it is collected by HGV trucks for removal off-site.

Return liquors treatment

The digested sludge centrate is collected in a new tank and transferred by new variable flow pumps to a new liquor treatment facility. Here, the ammonia-laden centrate is fed through a new liquor treatment (AMTREAT) process within which ammonia in the range of 1,400 to 1,600mg/l is reduced to around 25mg/l and sent back to the head of works, thus reducing a substantial load on the main sewage treatment stream.

Summary

The new Colchester WRC advanced digestion scheme is the third (of four) to be brought on line under Anglian Water's AMP5 biosolids programme. Through extensive planning and effective teamwork, Black & Veatch and Anglian Water have together managed its successful integration to the existing facilities.

This complex construction and commissioning programme successfully met the inherent challenges whilst maintaining excellent treatment performance across all key operational parameters.

The completed upgrade represents a state-of-the-art treatment centre that brings Anglian Water ever closer toward its targets for enhanced sludge treatment capacity and renewable energy production.

As well as meeting population growth requirements, the work at the plant will help further enhance final effluent quality, improving local waters and providing a diverse and important regional amenity, and helping safeguard biosolids recycling to agriculture for the foreseeable future.

The Editor & Publishers would like to thank Kubeshnee Chetty, Project Manager with Black & Veatch, for providing the above article for publication.



Boiler house and associated equipment - Courtesy of Black & Veatch



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