Bran Sands Advanced Anaerobic Digestion Facility

Northumbrian Water - from Sludge Drying to Digestion

by
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Following the implementation of the Urban Waste Water Treatment Directive and the subsequent ban on the disposal of sludge to the North Sea, Northumbrian Water (NWL) embarked on the construction of what was then the UK's largest thermal sludge drying facility. The phased construction of the Regional Sludge treatment Centre (RSTC) meant that by 2001 NWL had the capacity to treat up to 90,000 tonnes of Dry Solid per year at Bran Sands, producing a pelletised, enhanced treated product.

Advanced Digestion panoramic view of site *Courtesy of MWH*

Following eight years of plant operation it became apparent in 2005 that the sustained increase in utility prices, combined with high plant maintenance requirements, necessitated a review of the existing sludge strategy. After eighteen months of investigations and studies NWL again took the industry leading decision to construct a 40,000 dry tonne per year advanced anaerobic digestion facility, giving them both a drying and digestion capability at their Bran Sands site.

Background

Following a high level review of potential sludge treatment options, MWH carried out a feasibility study in early 2006 to determine the potential costs, saving and integration issues associated with the installation of a Thermal Hydrolysis Advanced Digestion Facility adjacent to the current thermal drying plant on site. The advanced digestion process, as well as offering significant operational cost savings, produced an enhanced treated biosolid. Whilst the thermal hydrolysis part of the process was relatively new, the digestion and CHP aspects were seen as well proven technology. Design calculations indicated that the new process would generate six figure annual cost savings and significantly reduce carbon emissions. Aker Solutions were awarded a design and construct contract to design, construct and commission the new facility based on a fixed price with performance guarantees.

Confidence Testing

Confidence tests were carried out, by Aqua Enviro Ltd, on representative mixtures of sludge to confirm digestibility, biogas production and digested cake dewaterability. There were concerns relating to the nature of the sludge fed to the RSTC as a significant portion originated from the adjacent Effluent Treatment Works (ETW) which treats a mixture of industrial effluents and domestic sewage. The confidence tests confirmed that the sludge was a "typical", digestible sludge, that 60% reduction on volatile solids was achievable and that the biogas contains the "normal" quantity of methane. The dewatering results indicated the potential for the generation of a digested cake with a dry solid content in excess of 35% w/w.

Current Project Status

Construction work started on site in October 2007. The plant is now fully constructed and entering the commissioning phase.

Plant Overview

Sludge Supply

The new process is supplied with indigenous and imported sludge cake, at approximately 25% w/w dry solids. Primary and thickened secondary sludge from the adjacent ETW, and a small quantity of imported liquid sludge, is dewatered in the existing RSTC by a number of existing dewatering lines (gravity tables and dewatering belts). The indigenous cake and cake imported from other sites is transferred and unloaded into above ground enclosed cake import facility. These conveyors transfer the cake into cake storage tanks from where it is extracted through live bottom screws, diluted to an initial target of 17% w/w dry solids via the use of liquid sludge and transferred to the Cambi buffer tanks.

Cambi feed pumps dilute the sludge from 17%w/w to 16% w/w, as required by the Cambi process. Dilution and rate of transfer to the pulper is carefully controlled to ensure optimum re-use of energy.

Thermal Hydrolysis system

The Cambi process on this site consists of 2 streams of 4 reactors with their associated pulper, flash tank and foul gas skid. After holding under the required conditions (165 degrees C at 6 Bar for 30

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minutes) raw water is injected into the hydrolysed sludge, reducing the dry solid concentration from14.3% w/w to 10%w/w.

Sludge from each Cambi stream is transferred sequentially to 3 mesophilic digesters, sludge is continuously recirculated from each digester at a rate corresponding to 3 times the net feed flow to minimise fouling of the air cooled heat exchangers, installed between the Cambi process and the digesters. The coolers reduce sludge temperature from 48 degrees C to the digester operating temperature of just below 40 degrees C.

Digestion

3 new concrete digesters have been constructed at Bran Sands for the digestion of sludge pre-treated in the CAMBI (or THP) process. Each digester has a working volume of 6700 m^3 and operates at up to 5.5 $kgVS/m^3$. Biogas is transferred, at a rate of 44,000 Nm^3/d, to membrane gas holders and digested sludge is pumped into existing onsite storage tanks, retrofitted with air mixing systems.

Digested Sludge Dewatering

Stored digested sludge is pumped to the RSTC's existing dewatering process from where it is dewatered to approximately 35% dry solids and it can be either transferred to the cake store (or, if required, further treated using the existing drying plant). The newly constructed cake store provides for the storage of dewatered cake for up to 7 days, maximising the potential for further liquid release.

CHP Plant

Biogas can be utilised in either the CHP plant, boiler plant or both (dependant upon availability and economic considerations). The CHP plant comprises of four Jenbacher gas engines with waste heat recovery modules, generating up to 4.7MWe of power. This provides flexibility while maintaining close to optimum generation efficiency over a wide biogas flow range. Approximately 40% of the steam required for the process is generated in the waste heat recovery modules, the remainder is produced from one of the two package boilers.

Power Integration

The ETW, adjacent to the RSTC, is a large combined industrial and domestic treatment complex. The benefit of locating the new process on the existing Bran Sands site not only provided the opportunity to re-use a large number of existing assets, but also the potential to use the power generated by the process to offset the power demand of the ETW. Integration of the new process into the existing site wide High Voltage system proved to be one of the most challenging aspects of the project. To ensure maintenance of ETW operation in the event of power failure, the existing ETW/RSTC operating philosophy included a system of load shedding, standby power and gas turbine operation. The integration of the new CHP plant into this system along with the requirement to operate in "black start" mode required the modification of the HV system and the existing operating philosophy.

The benefit of having Bran Sands advanced digestion online to Northumbrian Water is clear. The end point will see the adoption of an entirely new sludge management strategy for the entire Northumbrian region. That sludge management strategy will also be one that is entirely energy self-sufficient and may even provide additional energy to off-set much of the power used in sewage treatment.

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New cake reception facility ***Courtesy of MWH***