Bellozanne STW

centralised sludge treatment facilities - phase 2

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An advanced anaerobic digestion plant has been constructed at Bellozanne STW, St Helier, Jersey to replace the existing sludge treatment plant. Bellozanne Sewage Treatment Works (STW) serves the Island of Jersey and is operated by the States of Jersey's Transport and Technical Services (TTS) Department. Doosan Enpure Ltd, DEL, secured the contract to design, procure, construct and commission the new sludge treatment works which replaces the existing sludge works as part of an ongoing capital maintenance programme. The project was won on a competitive basis with the final solution utilising DEL's pasteurisation process.

Boiler house and heating equipment - Courtesy of the States of Jersey

Background

Previously and in order to create an enhanced product for use on land, the digested and dewatered sludge was conditioned with imported lime to achieve pH of 12 or more thus maintaining a temperature of at least 55ºC for 4 hours or equivalent. The limed product was then applied on land around the island.

Following a competitive tendering process, an NPV analysis was carried out comparing the lime stabilisation process and the pre-pasteurisation technology offered by DEL. As a result of this study it was deemed that the long term cost of lime for sludge stabilisation did not offer the States of Jersey best value for achieving 6-log reduction in pathogens.

In addition as lime is an imported material to the States of Jersey, the cost per tonne does dramatically affect the operating cost of the process. A pasteurisation/ anaerobic digestion plant treating 10.6tDS/d was therefore selected as the preferred treatment process and offered the following benefits:

- Significant cost savings based on net present value (NPV).
- Fully guaranteed pathogen reduction.
- Reduced odour level.
- Small footprint technology that fitted well within the tight confines of the land area available.
- Better working environment.
- Proven and reliable technology by the process contractor.

Pasteurisation process

Thermal sludge pasteurisation is a composite item of plant which is utilised to thermally pasteurise sludge prior to sludge digestion. Its purpose is to eliminate pathogens harmful to health from the sludge and render it suitable for recycling to land. To this end the sludge is required by the contract to meet the following criteria:

- Faecal coliform of <1,000 most probable number (MPN)/g of total dry solids.
- Salmonellae sp - not detectable.
- Volatile solids reduction by a minimum of 40%.

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Pasteurisation & anaerobic digestion plant - Courtesy the States of Jersey


The early stages of base construction - Courtesy of Doosan Enpure


View from cake store prior to road completion Courtesy of Doosan Enpure


3 (No.) pasteurisation tanks with digesters in the background Courtesy of Doosan Enpure


Digesters and pasteurisation tanks - Courtesy of Doosan Enpure

The combination of the pasteurisation and digestion processes achieves the required level of treatment. The pasteurisation process achieves the required pathogen kill whilst the digestion process provides the volatile solids reduction.

The UK DoE *Code of Practice For Agricultural Use of Sewage Sludge* states examples of effective sludge treatment processes and for sludge pasteurisation it states that the process should achieve a minimum of 30 minutes at 70ºC or a minimum of 4 hours at 55ºC (or appropriate intermediate conditions) followed in all cases by primary mesophilic anaerobic digestion. Doosan Enpure Ltd's pasteurisation system is based upon 55ºC for 4 hours. This has been developed in preference to higher temperatures as it results in a better heat balance on the works and in addition minimises potential issues with vivianite deposition.

Pasteurisation/anaerobic digestion process

The new sludge treatment plant replaces the existing system and therefore ties into the existing STW with the interfaces having been managed to ensure that there was minimal interruption of the existing process. The main process stages of the new works are:

Sludge buffering: SAS is stored prior to being thickened by the existing sludge thickeners and then sent to the thickened sludge storage tank where it is blended with primary sludge. The resultant sludge blend has a dry solids of 6%DS under normal operation with a range of 3.8 to 6%DS. The design arrangement allows for primary sludge to be thickened along with SAS to 6%DS should this be required. A standby tank of 50m^3 capacity is supplied to allow drain down of the thickened sludge storage tank.

Sludge screening: Thickened Sludge is pumped through duty/standby Strainpresses. These provide efficient separation of screenings from the sludge with subsequent screenings compaction prior to discharge. Due to the high FOG content at Bellozanne, connections are provided to allow for a hot wash if required.

Pasteurisation - heat exchangers: The thickened and screened raw sludge is heated to approximately 57ºC prior to pasteurisation via a single stage concentric tube heat exchanger using hot water. Two heat exchangers are provided, operating on a duty/standby basis. The sludge outlet temperature is monitored and the hot water flow rate adjusted accordingly. Sludge baking is prevented via the control of the hot water system and a sludge run on facility that recirculates sludge back to the thickened sludge storage tank for a short period if required.

Pasteurisation

The pasteuriser plant operates as a semi-continuous batch process. This requires 3 (No.) pasteuriser tanks, each of 60m^3 capacity, that operate in sequence: as one tank fills, one of the two other tanks empties while the third tank is isolated and in 'pasteurising' mode.

Filling: Upon start-up, the temperature of the heated sludge is measured at the outlet of the heat exchanger and only passes forward to the pasteurisation process once it has achieved the required temperature. The selected pasteuriser is filled with a pre-determined volume of sludge. Once full, the individual inlet valve will close. By that time the next tank in sequence is ready to receive sludge.

Pasteurising: The tank that has just been filled is now isolated from the rest of the plant and is left standing for four hours in order to provide the required pathogen kill. A single duty recirculation pump is used to turn over the sludge and prevent the formation of a crust or raft within the tank.

Emptying: The emptying rate is based on the volume of sludge held in the tank. The discharge is spread over four hours to give a constant feed to the digesters.

Temperature and retention time is recorded for each batch and tagged for quality control purposes. Should any batch fail on low temperature or inadequate residence time, the discharge is diverted back to the thickened sludge storage tank thus retaining the heat energy within the sludge main process.

This ensures that all sludge exiting the pasteuriser system has received the required time at temperature. Two automatic valves are positioned on the pasteuriser outlet to ensure surety of the product passing forward.

The sludge discharged from the pasteurisers is at 55°C and therefore may need cooling prior to entering the anaerobic digesters. A single cooler is provided that can cool the sludge down to 35°C if required.

Anaerobic digesters

Three sludge digesters are provided to stabilise the sludge. The digesters are sized such that two digesters achieve a retention time of 12 days at 3.8% dry solids thus enabling one to be taken out of service. This results in 3 (No.) digesters each at 1,650m^3.

The pasteurised sludge is pumped to each of the anaerobic digesters in sequence such that the feed is semi continuous and is fed into the sludge recirculation line to ensure good mixing of the influent and dispersion of the heated sludge.

Additional mixing is provided via a combination of sludge recirculation and gas injection. A single duty chopper pump draws sludge from the bottom of the tank and pumps it through the venturi for a set time period every hour. Biogas is drawn from the top of the digester, mixed with the sludge and injected into the tank for a set period of time within the mixing cycle.

Due to filamentous issues on the sewage treatment works, foaming within the existing digesters has been an issue. An automatic foam suppression system is therefore supplied that incorporates spray nozzles mounted on the inside of the digester roof.

The digested sludge out of the digester flows by gravity to a new digested sludge storage tank with a capacity of 1,000m^3. An overflow from this tank to existing sludge storage tanks is provided.

Sludge dewatering: The digested sludge is pumped to two existing centrifuges. New sludge conveyors are installed to transfer dewatered sludge from each of the centrifuges to a new cake storage area. Both conveyors will discharge dewatered cake onto a single conveyor and then finally into the cake storage area. The centrate from the dewatering process is transferred into the existing liquors handling system.

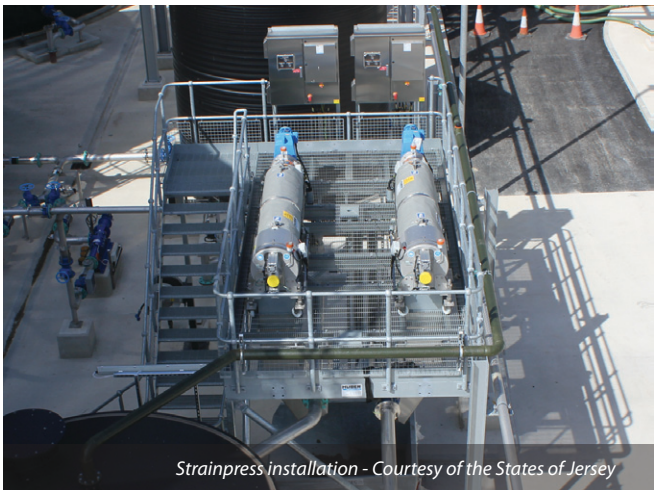
Gas production: Biogas produced from the anaerobic digestion process is used as fuel for the CHP and boiler. The biogas produced in each digester passes through a dedicated flowmeter and combines upstream of a double membrane type gas holder.

The gas holder has a capacity of 540m^3 and provides approximately 3 to 3.5 hours retention.

The biogas exiting the gas holder is fed to the boiler/CHP system via duty/standby gas boosters. These boost the gas flow to a sufficient pressure to allow the biogas to pass through the gas cleaning unit (H_2S scrubber) and future siloxane removal units prior to entering the CHP. A single waste gas burner is utilised, rated at 330Nm^3/h (twice the maximum gas production).

Heating system: The biogas produced by the digesting sludge is used as fuel for the CHP and the hot water boiler. The hot water produced by the CHP is pumped through a sludge/water heat exchanger so as to heat the raw sludge feed to the required pasteurisation temperature. Should the heat output from the CHP

Roles	Sub-contractor
Civil & building works	Geomarine Jersey
CHP	Edina
Mechanical & electrical installation	Field Systems Design
MCCs	CEMA Ltd
Steelwork	Keda Construction Services
Boiler	Comtherm Ltd
Heat exchangers	UK Heat Exchangers Ltd
Gas holder	Utile Engineering Co Ltd
Sludge conveyors	CTM Systems Ltd
Fabricated tanks	Allied Tanks
Tank mixing	Landia UK Ltd



Strainpress installation - Courtesy of the States of Jersey

be insufficient, the boiler is used to top up the heat required. The boiler is capable of operating on biogas or fuel oil.

A 500kW capacity engine is provided to fully utilise the biogas produced from the new works. At a sludge feed of 6%DS the heat energy from the CHP is sufficient to heat the raw sludge up to the required temperature for pasteurisation thus minimising the use of the boiler and any potential fuel oil usage.

Odour Control: All the raw sludge tanks, the pasteurisers and the digested sludge storage tank are covered and odour controlled to ensure that the concentration of the discharge at the stack of the odour control unit does not exceed 0.3ppm H_2S.

Contract & programme

The contract works commenced on 6th January 2014 with an overall duration of 74 weeks. The site was mobilised in February 2014 with the civil works and tank construction sub contracts running in parallel. The bulk of this work was completed by August 2014.

The main M&E installation phase commenced in September 2014 and ran through into March 2015. Significant package plant deliveries were scheduled in to suit access constraints and the M&E installation programme. As part of the new sludge treatment facility significant interfaces were required to the existing sewage treatment works, this work was incorporated into the M&E phase.

At the time of writing (May 2015) dry commissioning has been completed and the process commissioning is well underway.

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Pasteurisation and CHP
Courtesy of Doosan Enpure

Sludge storage tank
Courtesy of the States of Jersey