Mersey Valley Processing Centre [MVPC] Shell Green Extension, Widnes

Digested Sludge Recovery Centre

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The Mersey Valley Processing Centre (Shell Green), a strategic digested sludge incineration scheme, is an existing United Utilities facility situated in Widnes, in the shadow of the Fiddler's Ferry Power Station on the north bank of the Mersey. Built in the 1990's, the existing facility is critical to the safe and efficient disposal of waste water sludge from the Manchester/Liverpool region. Waste water sludge that has been digested at various treatment plants along the Mersey valley corridor, including Davyhulme (Manchester) and Sandon Dock (Liverpool) and is pumped through the Mersey Valley Pipeline to the processing centre. After mixing and various chemical treatments, the sludge is mechanically dewatered before being sent to either the two existing incinerator streams or removed off-site for agricultural use as a fertiliser.

Incinerator construction (January 2009) *Courtesy of S3JV*

The objective of the new 'Stage 2' design and build project is to treat more sludge by improving the existing plant's efficiency; improving the treatment of residual dewatered sludge centrate and expanding the capability of the existing facility by constructing a 3rd incinerator.

A key element of the planned work will be improvement to the dewatering process achieved through the replacement of the existing plate press technology with modern high performance centrifuges. The new process will also increase both sludge de-watering by a third and doubling of the fluidised bed incineration capacity by the addition of a new stream 3 incinerator. The new incinerator's auto-thermal combustion capability will be achieved by the inclusion of thin film sludge dryers whilst the gas clean-up technology will surpass the current legislative requirements of the site. The work will also involve a new centrate treatment plant to deal with the high ammonia loads arising from the dewatering liquors. Furthermore significant civil and structural engineering work is required to enable installation of the whole process.

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Total sludge reception capacity of circa 44.0 million PE.

This design and build project is a joint venture between Veolia Water Solutions & Technologies (UK) Ltd and Costain Ltd, titled S3JV, undertaken on behalf of United Utilities plc which utilises the Design and MEICA expertise of VWS and the construction capability of Costain for the site's infrastructure, for such a major and unique capital delivery scheme.

In September 2007 S3JV were awarded the Shell Green Extension Contract by United Utilities valued at over £91 million. The project has involved over 120 people from VWS & Costain and handover is scheduled during first quarter of 2010.

Overview of the project

The project involves two distinct processes, the first being solid separation from thin (liquid) digested sludge followed by a second process that turns the remaining volatile matter, in the dewatered digested sludge, into combustion products with the resultant release of exothermal energy and its recovery and utilisation as waste heat for green power generation using a steam driven turbine.

All the liquids removed by the sludge centrifugation is then further treated to reduce their solids content by flotation, these solids are reprocessed at the site.

A proportion of the liquors are then further treated for nitrogen reduction which is removed by biological treatment utilising low grade waste heat from the new incineration stream to maintain the correct conditions for the biology of the reactions employed. The treated effluents are then passed into the Liverpool sewer system or to the local Widnes facility according to the inventory defined by UU.

Before release to atmosphere at the consented discharge point (a new 85.0 m stack), the flue gas is processed to remove impurities such as fly ash; hydrochloric, trace hydrofluoric and sulphur dioxide (sulphurous) acids; mercury; nitrous oxides and water plume in the designed flue gas cleaning units.

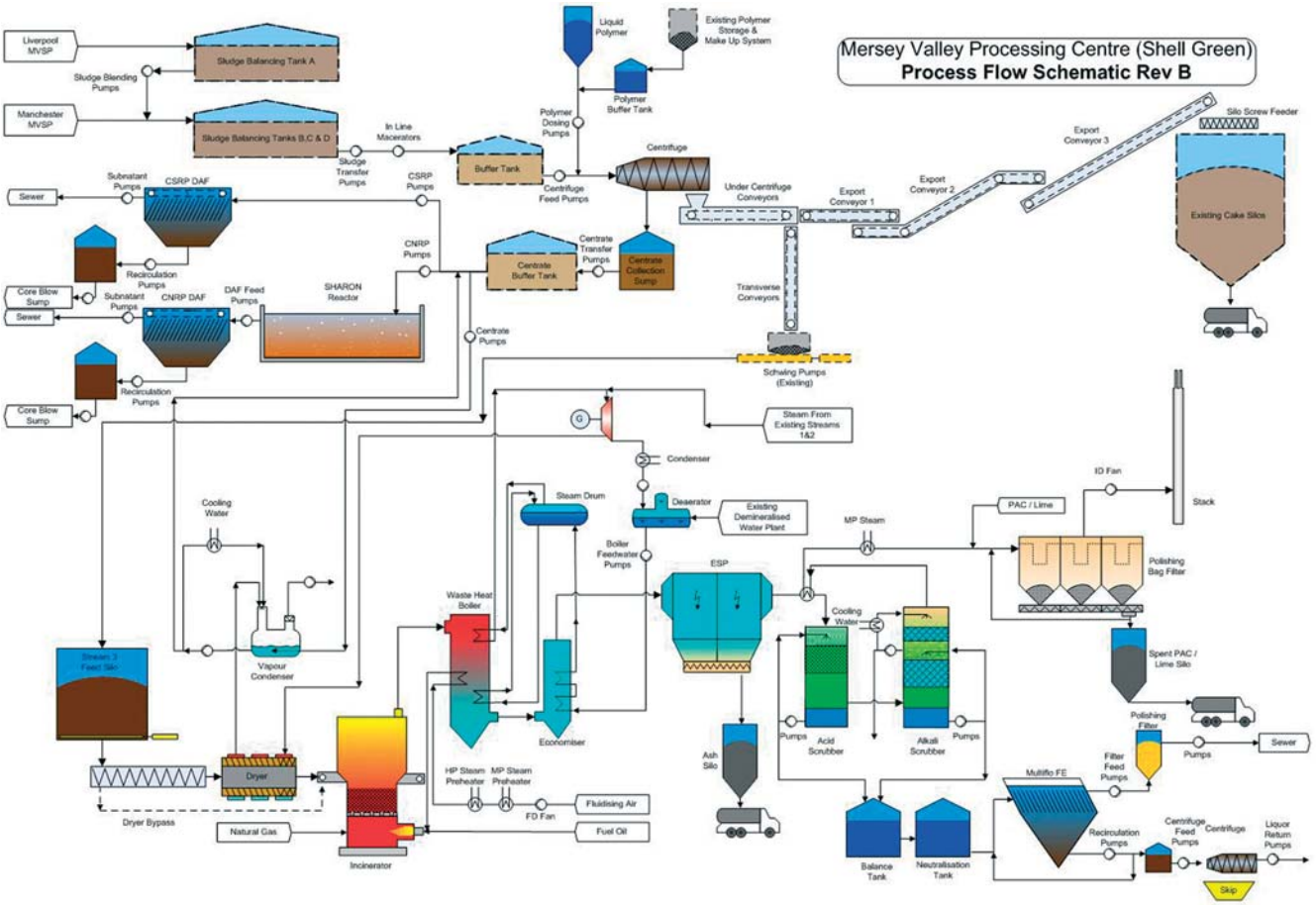
In addition the plant retains the flexibility to export dewatered digested centrifuge cake for land application and nutrient recovery but the scheme also includes new conveying facilities to feed this material into the existing sludge export silos. Also additional Ash, Fresh PAC/Lime and Spent PAC/Lime storage provision is being provided and a new scrubber effluent treatment (SET) plant for the liquors arising from the new incineration unit's flue gas treatment in being installed.

The extension to Shell Green will see the realisation of truly auto-thermal incineration with the resultant green power generation by waste heat recovery from the steam boiler(s). The original design utilised filter presses to dewater the sludge to a dryness which was auto-thermal, however, operational difficulties were encountered in both the mechanical handling of the dewatered filter cake and the operational burden of maintaining batch dewatering facilities. This problem was compounded by the operator being unable to realise the full potential of the filter presses cake dryness, incurring additional OPEX for the downstream incineration units.

From project conception two key criteria were identified; firstly to replace the batch dewatering facilities with a continuous system and secondly to extend the incineration capacity of the site with an auto-thermal stream.

The constraints imposed on the project are to maintain a strategic operational dewatering facility at sufficient capacity to process the sludge presented, whilst replacing the existing filter presses with centrifuges in the dewatering hall without the need to expand this existing asset whilst also retaining and integrating the existing assets and relevant auxiliary plant into the new completed scheme.

Mobile Temporary Dewatering Plant (Sept 2008) *Courtesy of S3JV*



Process Flow Schematic *Courtesy of S3JV*

The construction of a new incineration stream, in a dedicated building, is designed to supplement the plant's existing combustion capacity, whilst integrating the waste heat boilers into a common power circuit by replacing the existing steam turbine with a new drive end to provide the intermediate pressure [IP] steam required to ensure the auto-thermal operation of the new line. Also included in the project is planned improvement to the existing incineration streams gas cleaning process with the replacement of the existing primary bag filters with Electrostatic Precipitator [ESP] units to mirror the technology being utilised by the new third incineration stream.

Progress to date

Following the contract award September 07, the design process began and the business started to mobilise resources from January to March 08. In March 2008 Richard Lancaster was appointed Project Director for Shell Green and by late March the project office complex site at Shell Green Site Offices had been established.

Mobile Temporary Dewatering Plant - Because the plant has to stay operational, the first stage of the project was to divert the existing buried services on site and install a mobile temporary dewatering plant to facilitate removal of filter presses 1 to 4. This stage was completed by the end of Aug 08.

Incineration Plant - The foundation work began soon after for the commencement of the first stage of the mobile temporary dewatering plant. The erection of the steel superstructure for the new incinerator building commenced in November 08, whilst major elements of the incineration shell delivery and erection commenced in December 08. The structural element of the scheme is involved with the building enclosure being constructed in a phased sequence around the incinerator process plant as both are erected.

The boiler is supported within its own support structure which is independent of the building superstructure but the design does include load bearing cross members and craneage which interact. Due to the requirement for auto-thermal operation of stream 3, there are two thin film sludge driers which raise the centrifuge cake dryness from circa 26% w/w to ~32% w/w. These units weigh in excess of 128 tonnes each (when operating) and are located on a concrete mezzanine floor over +11.0m above ground level together with a 220 tonne fed sludge silo. The requirement to provide sufficient space to maintain the internal rotors of the dryers at this concrete floor level and with the need to remove strategic components by 40 tonne cranes results in a complex structural design. These cranes are located either side of the ESP which is used for primary dust removal from the flue gas and located under the roof between the incineration building and gas cleaning house.

The gas cleaning house contains the remaining flue gas treatment train comprising secondary and tertiary purification processes; these comprise of wet scrubbing (two stage: acid & alkali) to capture the halogens and majority of the sulphur and mercury released by the sludge combustion.

The acid scrubber operates as a quench spray tower, whilst the alkali tower is a counter current packed column using caustic soda to correct pH, with a top section dedicated as a cooler for flue gas dehumidification. These are followed by final polishing with adsorption onto powdered PAC/Lime material, this is pre-coated onto the tertiary bag filters and recycled via a reactor/dispersion chamber, with a proportion wasted. The scrubber towers are now positioned on their foundations, whilst the superstructure of the gas cleaning house is currently being erected around the process plant. The elevated tertiary bag filter is now almost complete. Again the structural design is involved needing to account for the temporary situations before the building is closed with the various wind loading conditions etc.

Dewatering Plant - The initial phase1 decommissioning and dismantling of the existing presses in the dewatering hall commenced

after the successful commissioning and performance testing of the temporary mobile dewatering plant.

To treat the arising centrate design consideration has had to be given to the following:

- A greater volumetric flow than the filtrate from the filter presses due to the greater dewatering capacity of the designed centrifuges.
- Greater solid and ammonia loading than the filtrate due to the greater efficiency of the designed centrifuges.

Consequently measures are now included to reduce both the solids loading and nitrogen loading from this effluent stream. This has been achieved by providing a dissolved air flotation plant [DAF] to remove solids and a centrate nitrogen removal plant [CNRP] utilising the 'SHARON' process.

The site's Environment PPC consent requires all structure process wastewater effluent to be bunded or secondary contained to prevent contamination of the ground water aquifer. As a result the CNRP plant was subject to a thorough design risk assessment and the design incorporated fracture lines for monitoring leakage rates. This work permitted a reduced excavation for the process plant structure and associated building. This design is now finalised and an agreement with the consenting authority has been obtained enabling the main drainage works and foundation works to commence early than planned, with superstructure erection now well near completion.

Safety

The project has now undertaken over 1000 Safety inductions, which includes all site visitors and delivery personnel. In addition the site employs a face recognition system that acts not only as security device but also a messaging service. At present the project has successful achieved a RoSPA Gold and has won a Considerate Constructors Scheme (CCS) Gold award.

Technical data

- Dewatering plant capacity vol 500m³/h; solids 9.9 tDS/h; feed sludge 2.0%-4.0% w/w.
  Off eight centrifuge units, each rate ar circ 63 m³/h, with dedicated feed pump and polymer dosing.
- Incineration Capacity Stream 3 (new) 5.7 tDS/h, Stream 1&2 each 2.1 tDS/h.
  Pre-Dryers 2 off 3.33 t/h evaporation each, WHB capacity nominal 15.4 t/h max 20.7 t/h at ~40.0 bar(a) & 400° C.
- Flue Gas Treatment Stream 3 (new) Max Gas Flow 55,000 Nm³/h, new 85.0 m Stack.
- CSRP (DAF Units) 2 off each 250 m³/h.
- CNRP SHARON tank volume 3150 m³, Capacity 1.4 Ml/d, 1 DAF ~62.0 m³/h plus auxiliary plant pH correction, nutrient & carbon source (methanol) dosing.

Note: ***The Editor & Publishers thank Richard Lancaster, Project Director and Andrew B. Gilbert Lead Process Engineer both with S3JV (Veolia) for providing the above article.***■