LIFT Scholarship Exchange Experience for Innovation & Technology (SEE IT)
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TRIP REPORT, PART 2 – BIOSOLIDS HANDLING PROCESSES USING THERMAL HYDROLYSIS PROCESS (THP) WITH MESOPHILIC ANAEROBIC DIGESTION

SCHOLARSHIP UTILITY: *City of Raleigh Public Utilities Department (CORPUD), Raleigh, NC*

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ATTENDEES: *Erika L. Bailey, CORPUD (Scholarship Recipient)*

Accompanied by following representatives from design engineering firms for CORPUD's Bioenergy Recovery Project (each independently covered costs of own travels): Amy Hanna, Hazen and Sawyer; Matt Van Horne, Hazen and Sawyer; and Greg Knight, Black & Veatch

TRIP DATES: 4/29/2017 – 5/7/2017

UTILITIES/SITES VISITED

THP Sites visited:

- *Seafield WTW, Edinburgh, UK, Private Finance Initiative for Scottish Water, operated by Veolia*
- *Crawley STW, West Sussex, UK, owned and operated by Thames Water PLC*
- *Long Reach STW, Kent, London, UK, owned and operated by Thames Water PLC*

TECHNOLOGIES/INNOVATIONS SEEN:
Visited three different plants in the United Kingdom that have implemented thermal hydrolysis process with mesophilic anaerobic digestion. All three plants have CAMBI's newer modular THP reactors and are using the same size reactors (B6) proposed for CORPUD's THP process. Each plant has a slightly different solids handling process configuration but all three plants are utilizing digester gas for combined heat and power (CHP).

TRIP BACKGROUND and RATIONALE (250 WORDS): *What technology did you select to visit? What is the problem you are trying to address? How did you envision the LIFT SEE IT scholarship trip helping your utility?*

One of the primary objectives of the LIFT SEE IT site visits was to visit biosolids treatment processes utilizing Thermal Hydrolysis Process (THP) followed by mesophillic anaerobic digestion to gain valuable knowledge to assist with decision making during design and implementation of the City's Bioenergy Recovery Project. The site visits included three different treatment plants in the UK that have implemented THP for enhanced anaerobic digestion, are of similar size to the City of Raleigh's proposed THP process, and are using CAMBI's newest, modular B6 THP reactors.

The City is undergoing a biosolids upgrade design project, referred to as the Bioenergy Recovery Project, to transition to anaerobic digestion with thermal hydrolysis pre-treatment (THP) to produce all Class A biosolids while moving toward energy neutrality. In 2015, the City of Raleigh completed initial site visits during the Preliminary Engineering Phase of the Bioenergy Recovery Project that included site visits of different types of THP systems. One of the primary objectives of the 2017 LIFT SEE IT trip was to focus specifically on specific THP and biosolids handling technologies under consideration for final design of the City's Bioenergy Recovery Project.

As the City has progressed into the detailed design phase, additional technical considerations are being discussed and key design decisions need to be made. Valuable information was gained by this second round of site visits in learning about how other utilities have successfully implemented THP systems. It was also very valuable to review different THP installations and operational and maintenance practices that have worked well for other utilities.

TRIP SUMMARY (1 page max. Please include 10 photos and a 1-2 minute video montage from the trip. The video does not need to be professional, however if you have the means to create a professional video feel free to do so): *Why did you select the specific utility and technology for the visit? Based on your visit, do you think this technology/approach works for your utility? How useful was the trip in your decision making process? What were some of the trip highlights and takeaways?*

Seafield WTW, Edinburgh, UK, THP System

Seafield WTW was selected for a site visit because it is one of the newest THP installations utilizing CAMBI's modular B6 reactor configuration. Overall, the solids handling process is very similar to what is being proposed for the City of Raleigh. The site visit of the THP system was particularly helpful for visually observing the B6 reactor set up and operation and to see the solids configuration from pre-conditioning to feeding the THP system and digesters.

The Seafield WTW is designed to treat a population equivalent of 850,000. The biosolids handling facilities treat biosolids generated at the Seafield WTW and approximately 20 trucks per day (~30 m^3 each) imported from other Veolia treatment facilities. The anaerobic digestion process produces approximately 30,000 m^3 of biogas/day with a methane content of 60-65% which are treated for siloxanes and then used in three combined heat and power systems. The Seafield WTW is currently 90-95% energy self-sufficient.

Solids handling treats a blend of approximately 60% primary solids and 40% waste activated solids (WAS). WAS are thickened using gravity belt thickeners. Primary solids are screened upstream of dewatering. Imports are screened remotely. Indigenous WAS is not screened. Blended primary and thickened WAS solids are pre-dewatered using centrifuges to approximately 20% solids. Plant water is used to dilute pre-dewatered cake to meet % solids content required for CAMBI THP units. The diluted pre-dewatered solids are fed to two B6-3 modular CAMBI trains. Each train consists of a single pulper, three individual pressure reactors, and a flash tank. The thermally hydrolyzed solids (THS) are cooled in a single pass heat exchanger and then digested in one of six anaerobic digesters. The feed temperature to the digester is 42 °C. Final dewatering is achieved using centrifuges to approximately 32% solids. The dewatered cake is transported using screw conveyors to an enclosed loading area which provides about one week of storage. Some key observations / take aways from this site visit include:

- *Dilution water to the pre-THP dewatered cake is controlled based on pump pressure, which is used as a proxy for % cake solids and has been found to work well.*
- *Individual gas meters are installed on each digester; staff have found these to be particularly helpful for monitoring for early signs of process issues with a digester.*
- *VSR is calculated based on averages of weekly data. There are significant differences in VSR (as much as 10%) depending on if the downstream sample is collected at the digester, post-digestion holding tank, or after polymer addition for final dewatering.*
- *A technician is dedicated to process solids sampling and lab analysis required for monitoring solids handling system performance.*
- *Polymer usage is a key performance indicator closely monitored.*
- *The B6 modules are more space efficient compared to the previous custom-built trains. No odors were noted. The system was noted to vibrate during periods of the operating cycle.*
- *Plant staff noted that the screw conveyors for the final cake improves granularity of the final product. The final product appeared somewhat dusty which the plant staff noted that the farmers like as it works well with their existing spreading equipment.*
- *Some of the digesters were being cleaned out during the site visit. The digesters pre-date the installation of the THP in 2014 and had not been cleaned for 7 years. However, it was noted that grit does tend to pass through the THP system and accumulate in the digesters over time. Long radius elbows and orifice plates are noted to help prevent grit wear in the THP system.*

Crawley STW, West Sussex, UK, THP System

Crawley STW was selected for a site visit because it is one of the newer THP installations utilizing CAMBI's modular B6 reactor configuration and is of similar size to the City's Phase 1 THP system. Like Seafield WTW, the solids handling process is very similar to what is being proposed for the City of Raleigh's Bioenergy Recovery Project. Crawley STW utilizes belt filter presses for final dewatering, which is the primary final dewatering that will be used in the City's Bioenergy Recovery Project. Overall, it was very helpful to see different treatment facilities using different dewatering systems in the THP process for comparison on dewatering system performance and final product.

The Crawley STW treats approximately 15 mgd of indigenous primary / waste activated solids (WAS) biosolids with 15 mgd of imported biosolids. The main plant utilizes chemically enhanced primary treatment (CEPT) so it has a higher percentage of primary to WAS solids compared to plants not using CEPT. The plant has a 7 mg/L BOD limit, a 1 mg/L Total Phosphorus limit, and a 3 mg/L ammonia-N limit. This facility was the first THP system to install a modular B6 CAMBI reactor and has a single B6-3 THP train. Biogas from the digestion process is treated for siloxanes and utilized to produce heat and power using a 1 MW combined heat and power (CHP) system. The digester biogas generated exceeds the capacity of the CHP so not all biogas is utilized.

The Crawley STW utilizes belt filter presses for pre- and post-THP dewatering. WAS is not pre-thickened prior to pre-dewatering. A sludge screen was installed but not in use during the time of the site visit. The plant utilizes a two-step dilution process upstream of THP. Pre-THP dewatered cake is diluted with heated water from the CHP process and mixed with imported solids to achieve 20% total solids. The diluted dewatered cake is pumped to the single B6-3 THP train which consists of a single pulper, three pressure reactors, and a single flash tank. The pulper pump is constantly run in duty mode to keep it hot (either for feeding or recirculating) which is standard practice for Cambi THP systems The thermally hydrolyzed solids (THS) are cooled in a single pass heat exchanger and then digested. Final dewatering is achieved using belt filter presses. The solids are dewatered from 5.8-6% digested solids content to approximately 29-30% dewatered solids. The dewatered cake is transported using belt conveyors to a partially enclosed storage / truck loading area.

Some key observations / take aways from this site visit include:

- *Dilution water to the pre-THP dewatered cake is controlled based on pump pressure.*
- *Polymer usage is a key performance indicator monitored. Pre-dewatering polymer usage was* 4-6 lb/dry ton and post-THP dewatering polymer usage was 20-22 lb/dry ton.
- *No odors were noted at the THP system. Significant vibration was noted on the THP unit, particularly from the pulper.*
- *The final product was very inert (no odor noted) with almost a soil like texture. It was more malleable (less granulated) compared to final product at Seafield WTW.*

Long Reach STW, Kent, London, UK, THP System

Long Reach STW was selected for a site visit because it is one of the newer THP installations utilizing CAMBI's modular B6 reactor configuration of similar size to the City's Phase 1 THP system. Unlike Seafield and Crawley, the THP solids handling process at Long Reach WTW is slightly different from what is being proposed for the City of Raleigh's Bioenergy Recovery Project in that Long Reach STW only hydrolyzes a portion of its biosolids (all of its waste activated solids and a small portion of the primary solids). Long Reach STW was an interesting site to visit because of its unique application of THP and because it uses an innovative final dewatering system called the Bucher hydraulic press. However, of the three THP systems visited, this site visit had less direct applicability in comparison to the other site visits to the City or Raleigh's Bioenergy Recovery Project.

The THP system was designed to hydrolyze only the WAS. The general concept with a WAS only THP system is that thermal hydrolysis is more beneficial with making WAS more degradable, whereas primary solids are readily digestable without pretreatment. The sizing of the THP system is reduced since it is sized to treat only WAS solids. In addition, cooling upstream of the digester is not required because the thermally hydrolyzed solids are cooled via mixing of WAS with unheated primary solids. However, this process would not achieve a Class A biosolids, since only a portion of the solids are pasteurized. Meeting Class A biosolids was not a driver for the Long Reach STW.

The Long Reach STW is designed to treat a population equivalent of 900,000 or 80 mgd. A single B6-3 CAMBI reactor is used to thermally hydrolyze all the WAS (~ 30 dry tons/day). A small portion of the primary solids and liquid imported solids are mixed in a pre-dewatering blending tank with the WAS that has been pre-thickened using gravity belt thickeners. The solids are screened upstream of the THP reactor and pre-dewatered to 15 to 16% solids. The THP reactor includes one B6-3 train, which has a 50 dry ton/day capacity and includes a pulper, three pressure reactors, and a flash tank. The thermally hydrolyzed solids are mixed with the remaining primary solids and fed to the anaerobic digesters at 6-7% solids. The digester operates at a 12.5 day SRT and typically achieves 60% volatile solids reduction. The plant has five Bucher hydraulic presses for final dewatering. The Bucher presses were selected as they have been utilized in other applications to achieve very high dewatered solids content on the order of 35% solids. However, Long Reach STW was only achieving approximately 25% solids currently on the final dewatering process. The dewatered cake is discharged via chutes to an indoor storage and loading facility with odor control.

Some key observations / take aways from this site visit include:

- *The WAS only THP concept is an innovative strategy for enhanced digestion while reducing size of the THP process, pre-dewatering equipment, and eliminating cooling requirements. However, a Class A biosolids cannot be achieved in this concept.*
- *The Bucher hydraulic presses are innovative dewatering technology used in the process. The dewatering systems appeared to be relatively quiet and simple to operate, but do require chemical cleaning once per week and replacement of socks every six months. Since initial start-up at Long Reach STW, the units have not yet performed as expected, with lower than anticipated dewatered cake content and high polymer demand (40 lb/dry ton).*
- *The final product was very inert (no odor noted) with had a soil like texture. The final product was noted to be significantly wetter than the previous two THP plants visited, attributed to lower cake solids content.*