

## **Continuous Thermal Hydrolysis without Steam or Chemicals**

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### **ABSTRACT**

Thermal Hydrolysis process (THP) is widely recognized as an effective mechanism for sludge pre-treatment to ensure higher Volatile Solids Reduction (VSR) leading to higher biogas production, while also helping increase the capacity of the digestion train. Conventional thermal hydrolysis systems have depended on the use of high quantities of steam for the provision of heat to “pressure cook” the sludge leading to quicker cell lysis. Alternate thermal hydrolysis treatments have required extensive use of chemicals such as caustic in conjunction with high temperature for achieving similar results. This paper looks at a different variation of THP, LysoTherm®, not requiring steam or a significant amount of chemicals.

The LysoTherm® process offered by Ovivo (the sister company of Eliquo), is a modular system that is capable of thermal hydrolysis without the use of steam or chemicals. The process employs a series of heat exchangers providing closed loops for thermal oil as well as water, ensuring optimum heat balance, while bringing about the temperature and pressure exposure to the sludge. This not only eliminates the need for a steam operator but also removes the need for pre-treatment chemicals. The process also does not require a pre-dewatering step, thereby helping reduce both capital expenditure on dewatering equipment as well as operational costs associated with polymer addition for the extra step. Since municipal wastewater treatment plant operators are typically familiar to heat exchangers, the LysoTherm® THP concept provides an operator friendly and a reliable Biosolids management option.

This paper discusses the implementation of the process full scale in Lingen (Germany) and provides data on the operational performance and process implementation. After installation of the LysoTherm® process higher biogas production and lower biosolids disposal cost have been achieved.

### **KEY WORDS**

Anaerobic Digestion, Thermal Hydrolysis Process, THP, disintegration, dewatering improvement, energy generation, gas, combined heat and power

### **INTRODUCTION**

Over the last decade Thermal Hydrolysis has gained significant traction to enhance the anaerobic digestion process. In simple terms, hydrolysis is the application of external energy, whether it is physical, chemical, or biological to make organic solids more readily biodegradable. Thermal Hydrolysis is the application of high heat and pressure to lysis or crack down the cell structures of organic solids. Typically, anaerobic digestion reduces the organic content (volatile solids) of primary sludge by 55 - 60% and for Waste Activated Sludge (WAS) by only about 20 - 30%. Biological hydrolysis is the limiting step for the digestion of WAS because the cell material is more difficult to lysis. A thermal hydrolysis process, such as

LysoTherm®, helps to overcome this limitation by improving the digestion process which increases the Volatile Solids Reduction (VSR) and gas yield, reduces the residual organic content in the digested sludge, and improves dewaterability. The improvements in VSR and dewaterability also result in a reduction of final disposal quantity of biosolids. Hence, a greater portion of anaerobic digestion plants around the world have implemented or are considering Thermal Hydrolysis as a way to generate more biogas (on-site production of green electricity) and to reduce operational expenses from biosolids handling.

Conventional Thermal Hydrolysis technologies in the market rely on a steam to provide the temperature and pressure needed for the lysis. The steam based systems apply pressure (120-130 psi) and temperature (330°F) for a set retention time of about 30 minutes to hydrolyze the solids prior to digestion. Cambi is one of the conventional steam THP technologies, which has had the most traction in the market, particularly with large treatment plants such as DC Water. However, at mid-size anaerobic-digestion plants, the concept of handling a steam system is not particularly attractive to operators given the complexity and cost. There are several drawbacks to steam-based THP systems, which include:

1. Special and expensive maintenance requirements:
  - a. Special maintenance plan is required, including additional health and safety requirements for the operator.
  - b. Plant shut-down (between one to two weeks) is required every year for inspection and maintenance.
  - c. A full-time steam engineer needs to be present on site to operate the system.
2. Odor issues are more likely with a steam-based THP because of the gas headspace.
3. High heat demand – the waste heat from the CHP is not sufficient to operate the system.

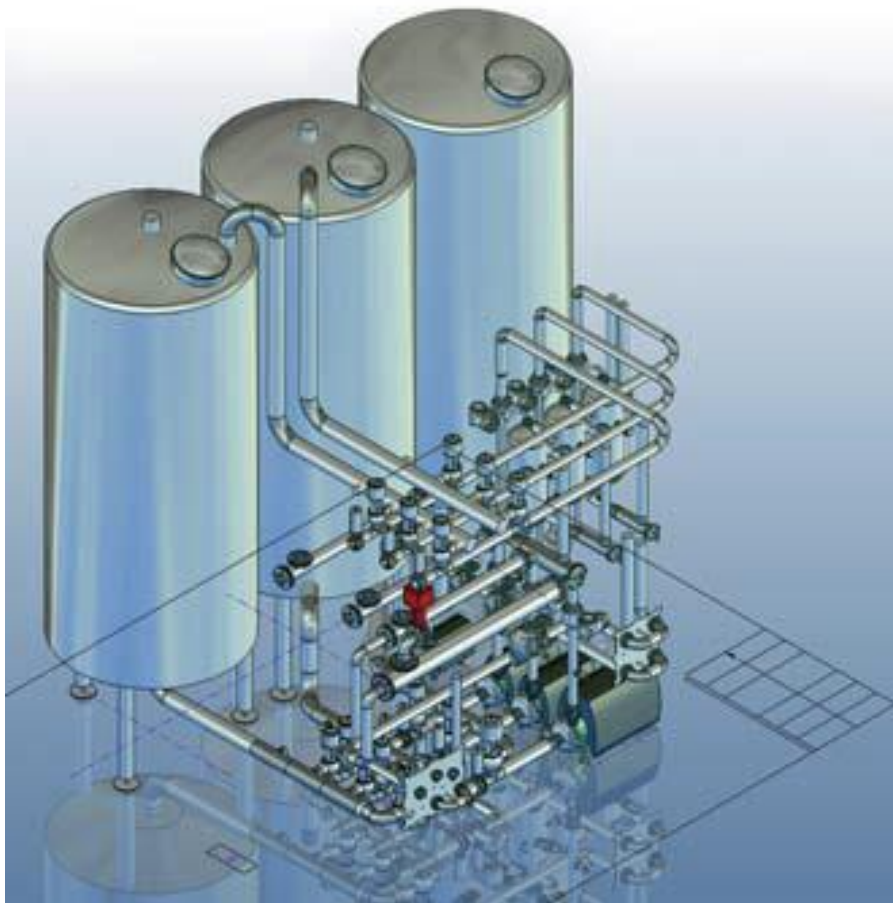
Over the last few years, an alternative to steam-based hydrolysis systems has emerged, which uses low temperature heat (<100° C) and chemicals to hydrolyze the sludge (known as Thermo-Chemical Hydrolysis, or TCHP). This method is more applicable to small and mid-size treatment plants, nonetheless, this process has not been proven as effective as steam-based systems with regards to biogas production and total reduction of disposal costs (Kopp, 2013). Moreover, the addition of chemicals to the sludge presents other issues, including health & safety requirements to handle the chemicals and environmental concerns.

In contrast to traditional steam-based THP and TCHP systems, LysoTherm® is a unique Hydrolysis technology that uses tubular heat exchangers and thermal oil (figure 2). LysoTherm® can operate as an energy positive system and no surplus heat energy is necessary for the hydrolysis process. Moreover, avoiding the need for steam generation and chemicals has a positive impact on economic viability, safety requirements, plant availability and operability.

## **METHODOLOGY**

The idea for LysoTherm® to use tubular heat exchanger for sludge hydrolysis was originally conceived from Eliquo's experience in the food and milk industry. Eliquo Protec specializes in the thermal processing of food liquids such as milk, cream and fruit juice. One of the technologies employed by Eliquo Protec uses a tubular heat exchanger, where the pre-treated milk is heated to 125°C. To eradicate microorganisms, the milk is maintained at this temperature for a specified time and is then subsequently cooled using a water regenerative circuit and cooling water. One of the key feature of this technology in the milk industry to prevent the fouling and scaling of the heat exchangers is a Clean-In-Place (CIP) system. In

general CIP systems provide an automatic rinsing, cleaning and disinfection of process equipment. The CIP is an integrated process in the course of the production process. Hence, in most cases, the CIP is conducted after a production shift or after a certain throughput has been achieved. The following figure 1 shows a typical scheme of a CIP process. The multi-stage process starts with a pre-rinse of the plant, which is conducted with cold water. The next step is a water rinse, where the equipment is cleaned from any residual particles from the process. After this step, the chemical cleaning using caustic and acidic cleaning agents is conducted. The final step of a CIP process is the disinfection. Each of these steps is followed by a water rinse to remove the pollution and the chemicals from the process equipment. Used chemicals are stored in tanks and re-used multiple times for further CIP cleanings.



*Figure 1: 3D drawing of a three circuit CIP plant (caustic, acid, disinfection) (Steinbacher, 2012)*

Similarly to the process used in the milk industry, LysoTherm<sup>®</sup> uses tubular heat exchangers to ‘pasteurize’ sludge. Heat is transferred in a two-stage process and a regenerative water circuit provides approximately 90% of the heat demand. The additional high-grade heat is supplied in the second step via thermal oil heat exchangers. Exhaust gas from the Combined Heat and Power (CHP) engines can provide the energy necessary to heat up the thermal oil, which means that LysoTherm<sup>®</sup> can operate as an energy positive system and no surplus heat energy is necessary for the hydrolysis process.

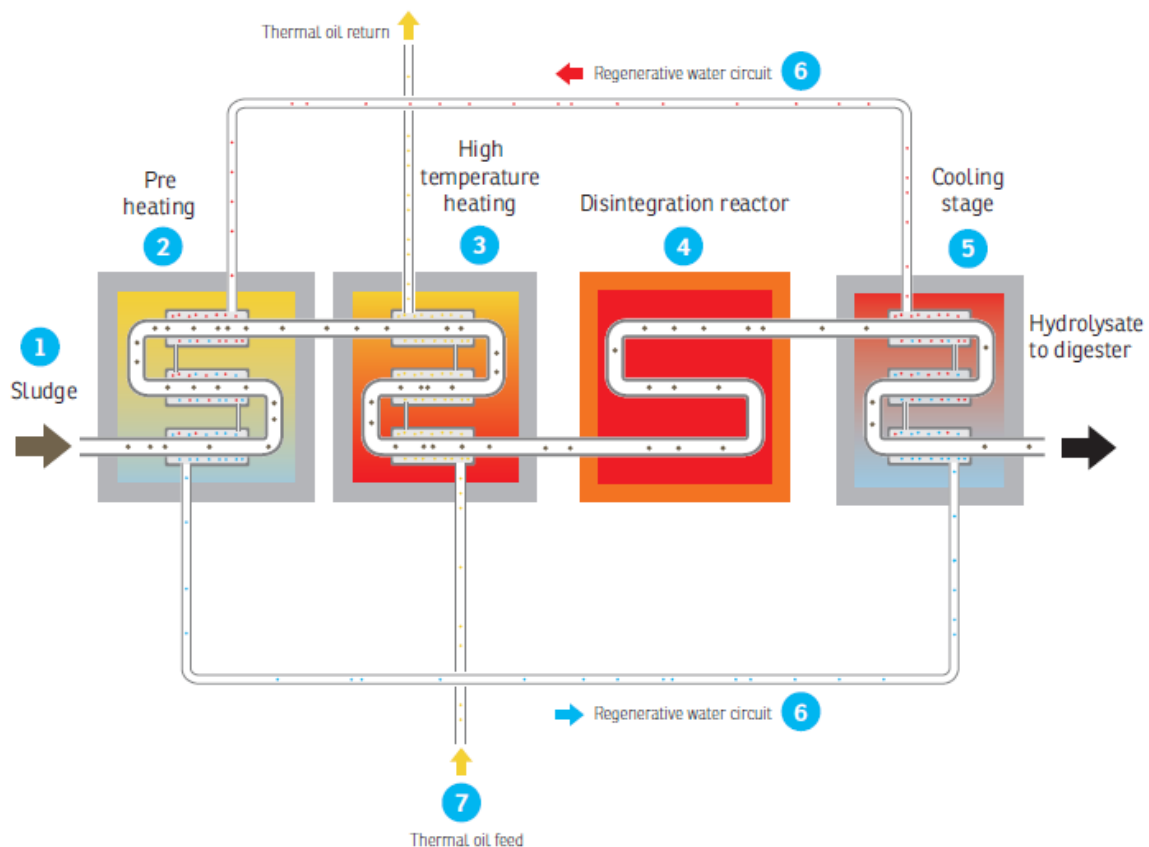


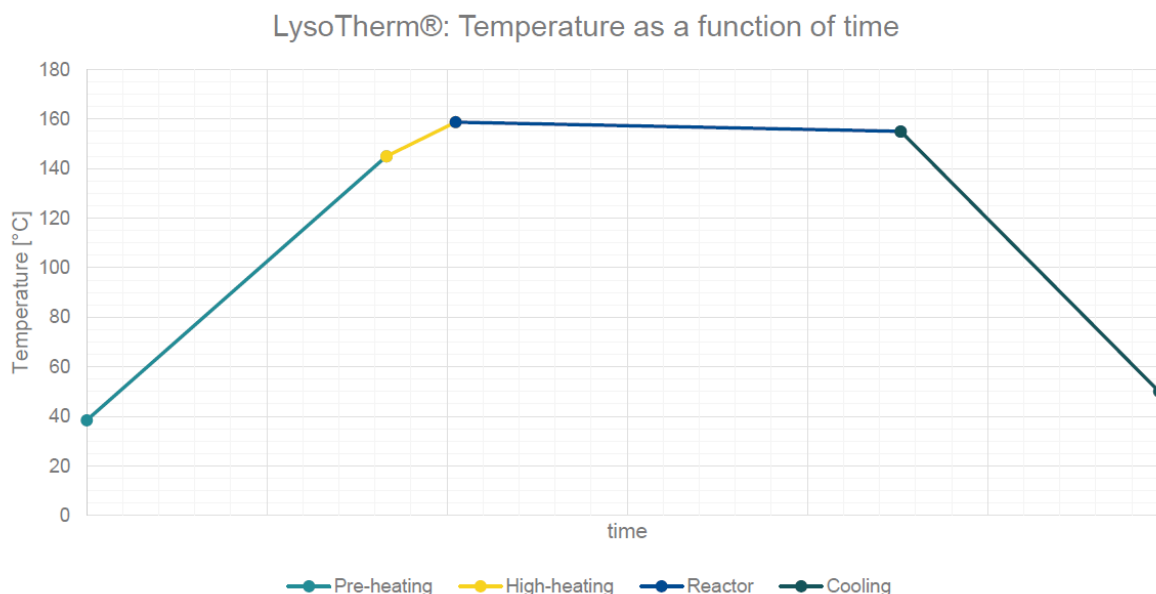
Figure 2: LysoTherm® Process Flow

The sludge passes through the sludge pump into a multi-stage heat exchanger system. It is pumped in continuously:

- 1) Pre-heating takes place in the first stage of the heat exchanger system.
- 2) The tubular reactor heats the sludge to the selected reaction temperature. The actual thermal disintegration takes place at the specified reaction temperature without further heat input into the disintegration reactor.
- 3) The disintegration process takes place in the reactor at the pre-determined reaction temperature (158 °C) where the sludge usually remains for 30 - 60 minutes.
- 4) After the disintegration is completed, the sludge moves to the cooling stage to the temperature required for entering the digester; alternatively, the sludge can be mixed with cold primary sludge to be cooled down to digestion temperature.

The system is heated via two heating circuits:

- 5) The regenerative circuit, in which water is used as the heat transfer medium. This system recovers heat from the hydrolyzed sludge, which is then used to provide the heat for pre-heating. This heat recovery mechanism provides 90% of the heat needed for LysoTherm®.
- 6) The thermal oil circuit provides the necessary process heat in the pipe reactor. The process heat is typically recovered from the exhaust gas heat of the combined heat and power units (CHP). This recovery allows the plant to utilize a source of heat that would otherwise be released into the atmosphere.



*Figure 3: Temperature as a function of time in the LysoTherm® process*

As shown in Figure 3, LysoTherm® the energy recovery process is one of the innovative features of this technology. The only external energy required to operate the system during the high heating phase comes from thermal oil, which is a simple process known to operators. In contrast with Steam-based systems, the thermal oil system is a pressure-less system. The thermal oil has a very low steam pressure even at the required process temperature, which prevents boiling of the thermal oil even at atmospheric pressure. Thus, no overpressure in the system is necessary. The pumps which provide the thermal oil to the consumers have just to overcome the pressure drop in the pipes and the heat exchangers.

The heat recovery in steam-based systems is conducted by a pressure drop (“steam explosion”) after the hydrolysis reactor. The steam pressure of a liquid is a function of the temperature. The higher the temperature, the higher the steam pressure. If the steam pressure is higher than the pressure in the headspace, the liquid begins to boil. The pressure drop after the hydrolysis reactor causes boiling of the hydrolysate and the release of steam alongside. In parallel the temperature of the hydrolysate drops to the boiling point at the related pressure. The released steam is provided back to the preheating stage and injected to the liquid. Due to the pressure drop in the steam pipes and the hydrostatic pressure at the steam injection point in the preheating tank (pulper) the temperature of the hydrolysate after the pressure drop can be estimated to approximately 105 °C (221 °F). If mesophilic digestion is applied downstream the THP, the hydrolysate has to be cooled down to about 40 °C (104 °F). This further cooling of the hydrolysate can be conducted by heat exchangers using cooling water, dilution with tap water and/or mixing with primary sludge (figure 4).

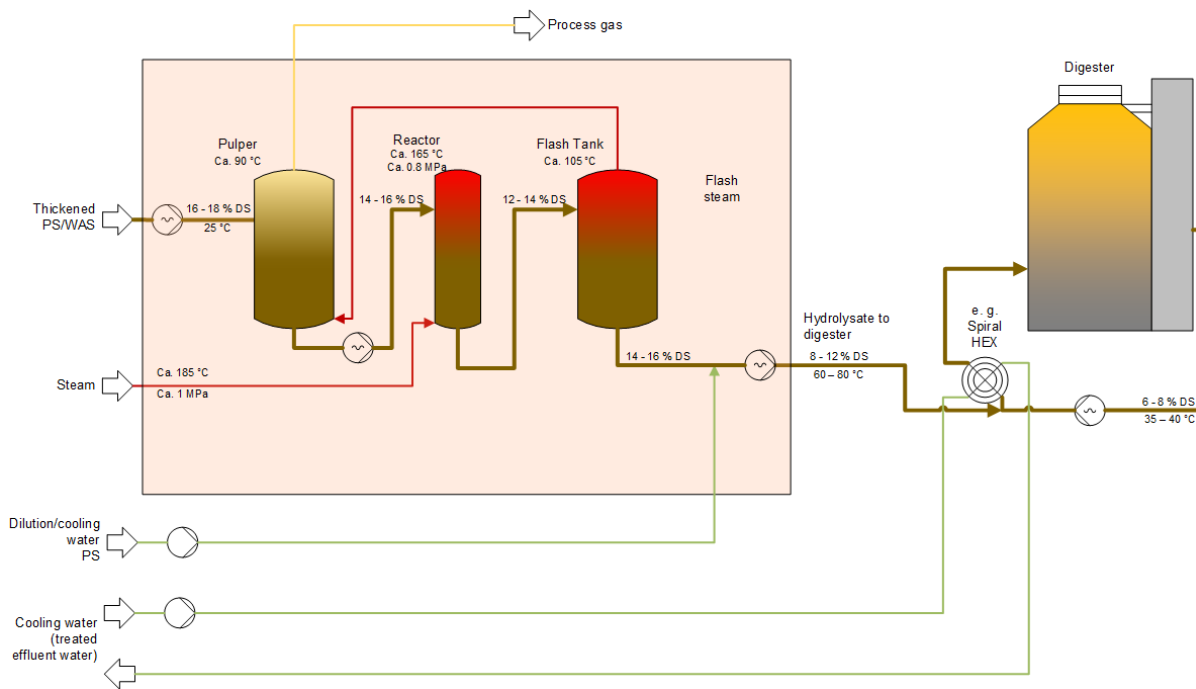


Figure 4: Process principle of a typical steam-based THP

In contrast to steam-based THPs, the LysoTherm<sup>®</sup> overcomes these limits caused by the thermodynamics in terms of heat recovery. The heat recovery in that case is just limited by the sizing of the heat exchangers. Furthermore steam-based systems are “open” systems. The flash steam conducted from the flash tank to the pulper contains process gases, which are produced during the thermal pressure hydrolysis process. These gases contain odorous components and thus the process gases need a special treatment step. This is one of the advantages of a heat exchanger based system: all process gases stay in the liquid and provided to the digester with the hydrolysate, where a re-solubilization takes place and no further gas treatment is required.

In 2010, the Environmental Innovation Program of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety in Germany awarded the city of Lingen with funding to conduct a project under the priority ‘Energy-efficient wastewater facilities’. The goal of this project was to convert the wastewater treatment plant of the city of Lingen (Ems) in northwest Germany to an energy autonomous wastewater treatment plant. The primary drivers to convert Lingen (Ems) into an energy autonomous or ‘zero-energy waste water treatment plant’ were to increase biogas production during sludge digestion and optimize the energy recovery from biogas. In addition, an additional requirement from the funded project was to recover 30% of the phosphorous content of the influent wastewater. The optimization of the biogas production was achieved by implementing LysoTherm<sup>®</sup> for sludge hydrolysis, in addition to mechanical primary sludge thickening. In addition, EloPhos<sup>®</sup>, a technology for phosphate precipitation and recovery from digested sludge, was also implemented to achieve the phosphorus recovery goal. New CHPs with higher electrical efficiency and a new centrifuge for the dewatering of digested sludge were also implemented to achieve the goals of this project. The funded project concluded in September of 2018 with a third-party evaluation, which will be discussed in results section in more detail.

The funded project in Lingen aimed to improve of the anaerobic stabilization (digestion) of organic sludge to achieve increase of gas yield, improvement of sludge dewatering, and increase in digestion capacity. Lingen (Ems) collects and cleans approximately 14,000 cubic meters per day of wastewater from the city and from a neighboring municipality. The treatment

plant has an expansion capacity of 195,000 Population Equivalent (PE). However, the actual load in relation to the COD load is only around 140,000 PE (2011), of which, approximately 65,000 PE corresponds to municipal wastewater and 75,000 PE to industrial discharge. The biggest industrial discharger is a manufacturer of acrylic fibers whose wastewater contains a high proportion of COD, which is slowly degradable and even partly non-degradable. Because of the high percentage of industrial wastewater, the COD concentration in the inflow is higher than usual. Therefore, the sludge produced in the course of the treatment process behaved in an atypical manner during digestion, including lower anaerobic degradation of the volatile solids, poor dewatering and high polymer consumption for the dewatering. Therefore, the funded project in Lingen aimed to improve the anaerobic stabilization (digestion) of organic sludge to achieve increase of gas yield, improvement of sludge dewatering, and increase in digestion capacity. Moreover, other benefits of thermal sludge hydrolysis are lower viscosity, less foaming in the digester, higher increase in phosphorous recovery potential, and elimination of pathogenic bacteria.

The funded project in Lingen (Ems) provided the perfect opportunity for a full scale pilot of LysoTherm® in different configurations to validate the performance and return on investment of this unique and simple Hydrolysis technology for mid-size treatment plants. The project started with the installation of the LysoTherm® plant in 2012. In parallel all other process modification were planned. The selection of the most appropriate technologies was supported by pilot tests for sludge dewatering and Phosphorous precipitation and extraction, which were conducted in the years 2013 and 2014. Subsequently the measures were implemented in the years 2014 - 2016. The final measure was the refurbishment of the digesters.

After the planning and installation phase of all new components, the results of the project were assessed in the three phases:

1. R0: Reference state (2011 and before, re-assessed in October 2016)
2. R1: Thermal disintegration of waste activated sludge with separated digestion and with MAP precipitation (November 2016 – May 2017), and
3. R2: Thermal disintegration of digested sludge with mixed digestion and with MAP precipitation (June 2017 – February 2018).

Directly after the phases R0 and R1 the process modifications for the next phase were carried out. The phases R1 and R2 were split into ramp-up phases to achieve a steady-state (R1a, R2a). In the measuring phases (R1b, R2b) a robust analytical program was conducted for the assessment of the process modifications. In the following table the project phases are summarized:

*Table 1: Overview of the project phases*

Phases	R0: Baseline	R1	R2
<b>Configuration</b>	Anaerobic Digestion	WAS only Pre	WAS+PS Loop
<b>Ratio of PS/Total (PS+WAS)*</b>	46%	46%	40%
<b>Operational Ramp-up</b>	N/A	Nov-Mar 2017	Jun-Dec 2017
<b>Data Collection</b>	October 2016	Apr-May 2017	Jan-Feb 2018

## R0 - Original State

The figure below shows a process flow diagram of the plant in the original state R0. Primary Sludge was thickened with a static thickener. Thickening of the Waste Activated Sludge (WAS) was conducted with a Belt Thickener. The thickened sludges were provided together with the Co-Substrate to the two digesters, which were operated in parallel. The digested sludge afterwards was stored intermediately in a Sludge Storage Tank prior Sludge Dewatering, which was carried out with hose filter presses.

The produced gas was utilized in CHPs to generate heat and energy.

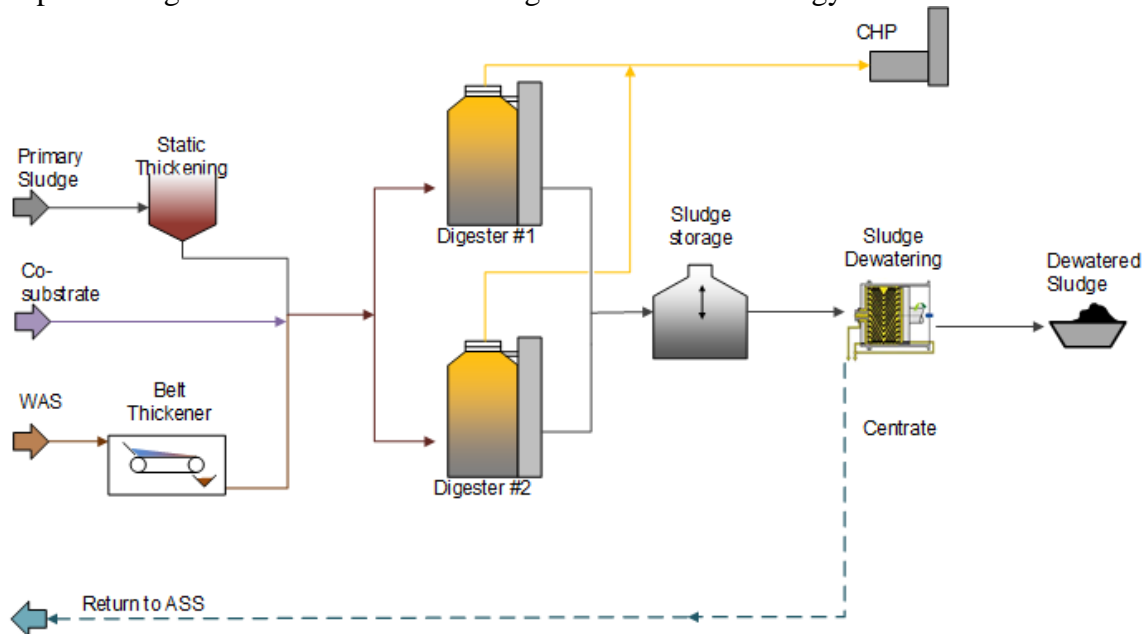


Figure 5: Process Flow Diagram of the original state R0

## R1 – LysoTherm® WAS THP + LysoGest®

In phase R1 the following process modifications were implemented:

- Mechanical thickening of the Primary Sludge with a Belt Thickener
- Installation of a LysoTherm® plant treating the thickened Waste Activated Sludge
- Conducting the sludge digestion in LysoGest® mode. LysoGest® is a patented process where the two existing digesters were separated from each other. Digester #1 was fed with primary sludge, Digester #2 with hydrolyzed Waste Activated Sludge.
- Vacuum degassing of digested sludge with EloVac® with subsequent Phosphate Precipitation and Extraction (EloPhos®).
- Replacement of one of the existing hose filter presses by a centrifuge.
- Installation of a Biological Desulphurisation Plant for the removal of Hydrogen Sulfide (H<sub>2</sub>S) from the biogas. This measure was necessary since the co-substrate contains high amounts of Sulphur which is converted to Hydrogen Sulfide during the anaerobic digestion process. Hydrogen Sulfide causes corrosion in the gas motors and results in Sulphur Dioxide emissions in the exhaust gases of gas motors. Hence, it has to be removed from the gas.

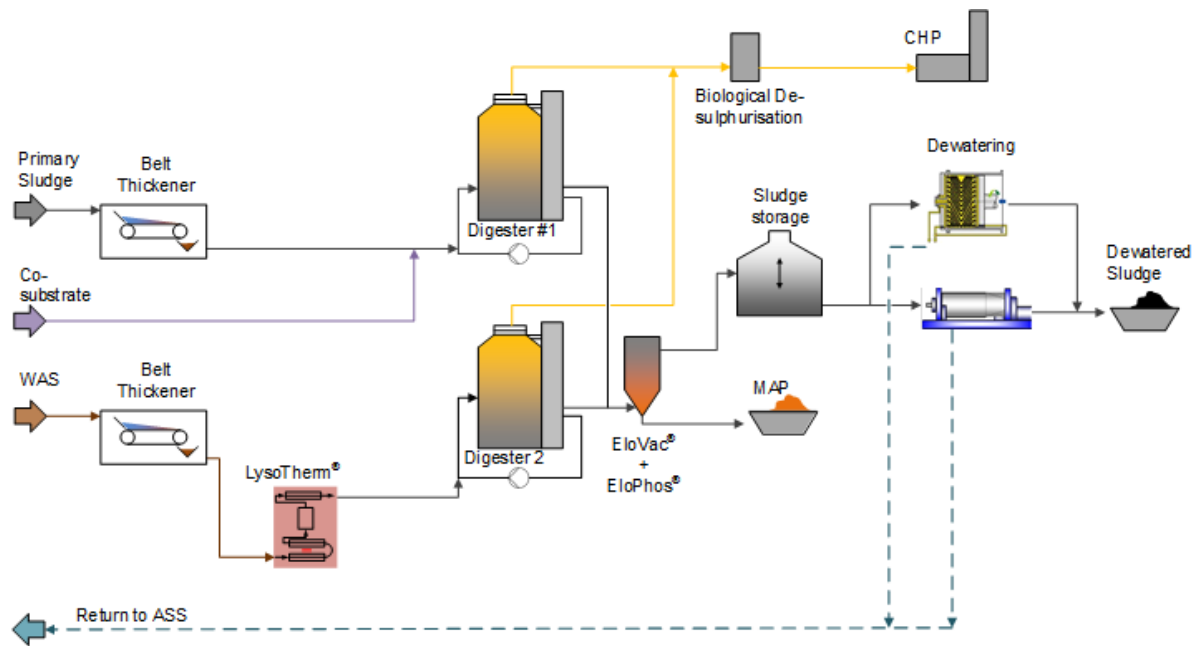


Figure 6: Process Flow Diagram phase R1

The LysoGest<sup>®</sup> process is where digestion of the Primary Sludge and hydrolyzed Waste Activated Sludge are separated. The goal of this configuration was to achieve an enhanced digestion process with a high volatile solids removal in the digesters.

Full scale pilot tests carried out previously showed a much better dewatering performance of a centrifuge compared to the existing hose filter presses in terms of dry matter content of the dewatered sludge as well as polymer consumption. Thus, it was decided to exchange the existing hose filter press by a centrifuge.

### R2 – LysoTherm<sup>®</sup> Loop Configuration

In phase R2 the digestion process was switched back from separated digestion (LysoGest<sup>®</sup>) to the parallel operation of the two digesters. Like in the original state, Primary Sludge, Waste Activated Sludge and Co-Substrate were provided to the digesters in parallel. The LysoTherm<sup>®</sup> was operated in loop mode. That means, digested sludge is extracted from the effluent of the digesters, thermally treated in LysoTherm<sup>®</sup> and fed back to the digesters.

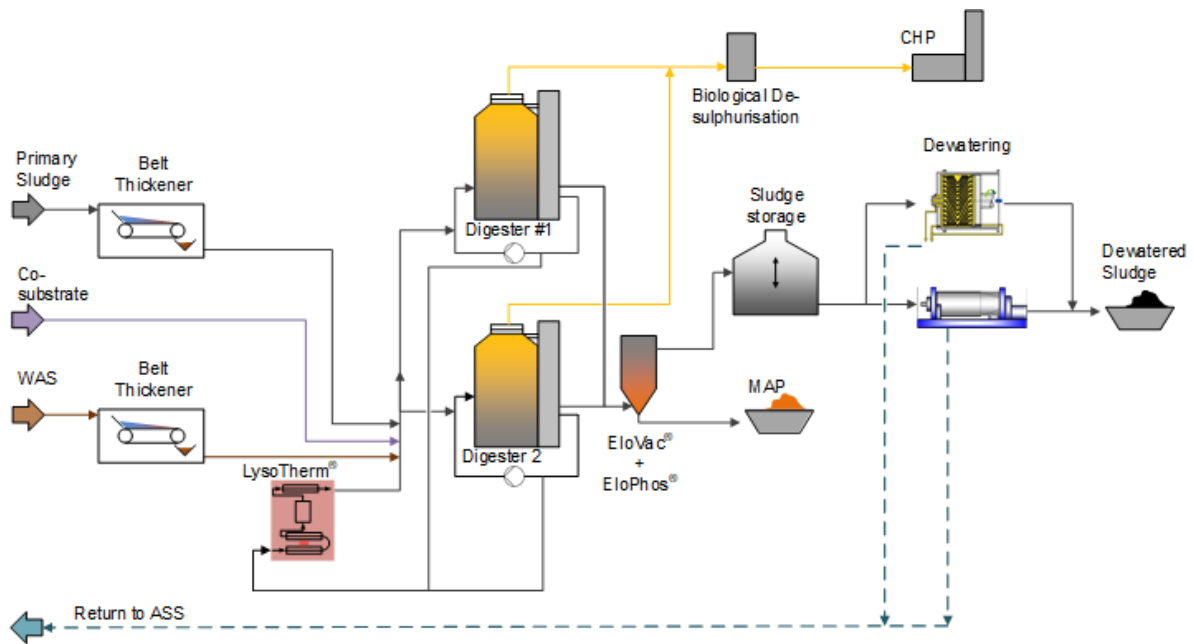


Figure 7: Process Flow Diagram phase R2

## RESULTS

### Changes of Plant Loading during the project phases

In the course of the project, a significant change of the plant loading was observed. In the original state approx. 60% of the COD load originates from the industry and mainly from the chemical industry. Due to a stepwise shutdown of an industrial site, the plant loading drops from ca. 150,000 PE in the year 2011 to 83,000 PE in 2018 – see following graph.

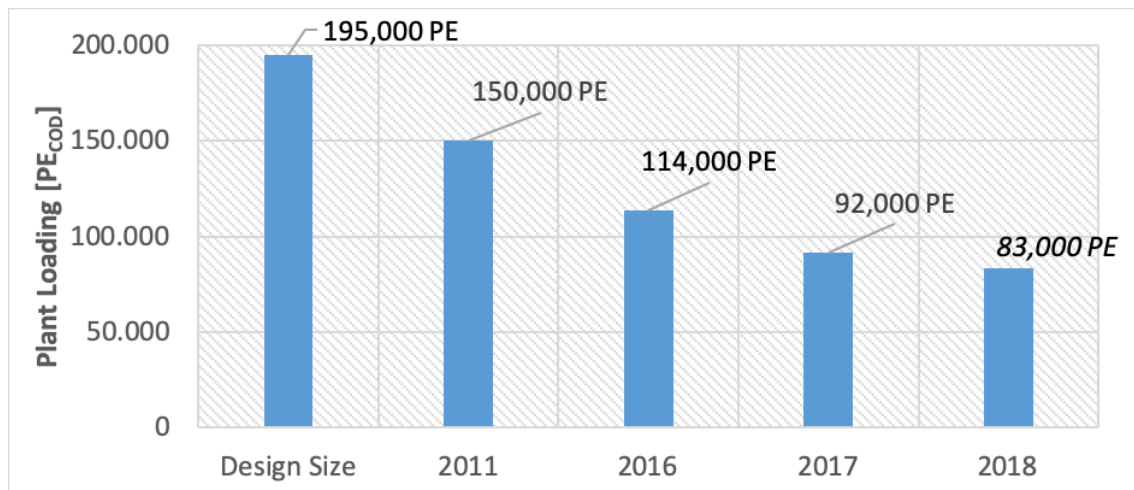


Figure 8: Population Equivalent (PE) loading

The portion of the volatile solids originating from the Primary Sludge was 46%, which is less than usual in German municipalities where the ratio is typically 50%. This ratio remained at 46% during R1 and dropped even further to 40% during R2. This means, that in phase R2 60% of VS came from Waste Activated Sludge.

## Volatile Solids Removal (VSR) and Gas Production

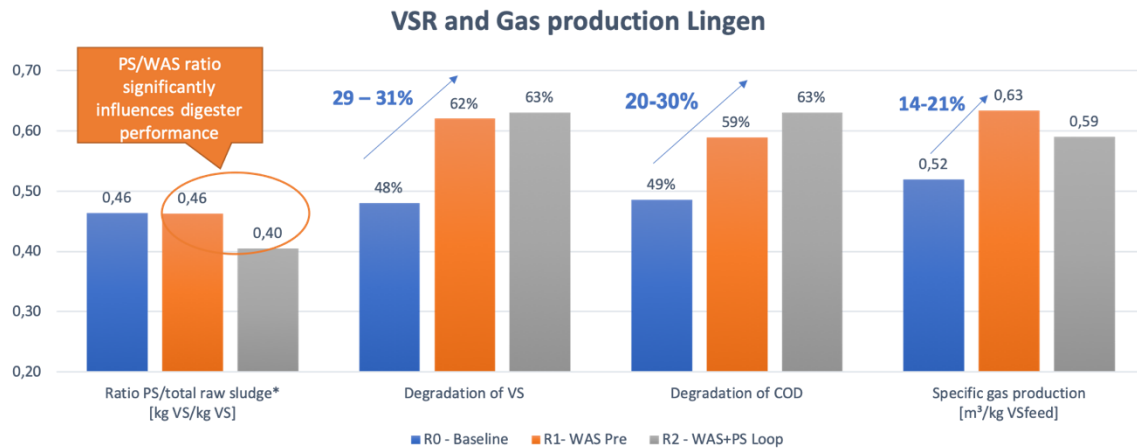


Figure 9: Volatile Solids Removal and Gas Production

In phase R1 the degradation of the VS increased from 48% to 62% and to 63% in phase R2. This corresponds to a percentage increase of 29% in R1 and 31% in R2. The same counts for the degradation of the COD, which increased from 49% (R0) to 59% in R1 and 63% in R2, respectively. The Volatile Solids Removal (VSR) of Primary Sludge is typically higher than that of Waste Activated Sludge. However, an important result from the configuration in R2 is that the total degradation of VS still increased by 1% while the ratio of the Volatile Solids coming from the Primary Sludge decreased by 6%.

In phase R1 the gas production was ca. 21% higher compared to R0. But despite a higher VS and COD removal in R2, the increase of the specific gas production in R2 was slightly lower. It is still not 100% clear what caused this discrepancy, but a likely explanation is the inaccuracy of the gas measurement devices due to incrustations on the thermal sensors.

## Improvement of Dewatering

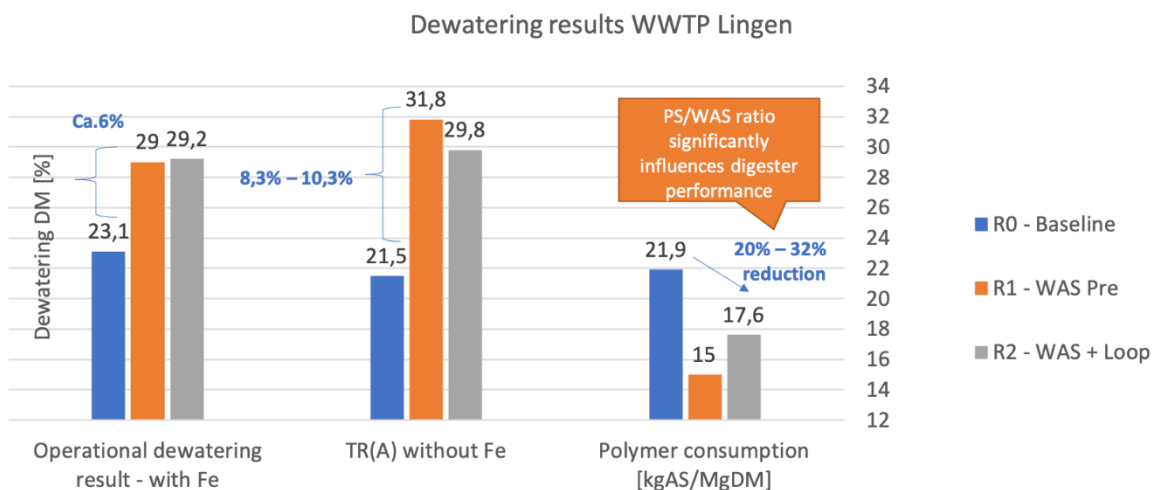


Figure 10: Improvement of Dewatering

The improvement of the dewatering and the specific polymer consumption were measured based on the operational results of the full-scale installation. The TR(A) value is a recognized method to predict achievable dewatering results in full-scale installations. These TR(A) measurements were conducted by an independent consultant firm.

In R1 as well as in R2 a significant improvement of the dewatering was observed. The operational results of the full-scale installation has shown an increase of the dry matter in the dewatered sludge of ca. 6%-points, from 23.1% to 29% in R1 and 29.2% in R2, respectively. In all phases Ferric Chloride was used to support dewatering. Due to the implementation of LysoTherm<sup>®</sup>, EloVac<sup>®</sup> and EloPhos<sup>®</sup> in the phases R1 and R2 the iron consumption could be reduced by 70%. The polymer consumption decreased in both phases R1 and R2. The performance of a digestion process is highly dependent of the PS/WAS ratio. The higher the PS portion, the higher the performance of the digestion and the dewatering. The PS portion in phase R2 dropped from 0.46 to 0.40. This was significant and thus, the polymer consumption increased from 15 kg AS/Mg DM to 17.6 kg AS/Mg DM. Despite the change in the PS/WAS ratio, a significant improvement in dewatering was achieved.

Furthermore, in Europe sludge dewatering is highly dependent on seasonal variations. In the course of a year the sludge quality changes due to lower temperature during winter time and the use of salt for the deicing of roads presumably. Winter sludge occurring from approx. December to May in general is less dewaterable and requires higher amounts of polymer. The graph below illustrates, that the data in the reference state R0 were acquired with summer sludge, whereas the data acquisition in R1 was conducted during the transition phase from winter sludge to summer sludge and R2 with winter sludge. This also might be a reason for a slightly higher polymer consumption measured in R2.

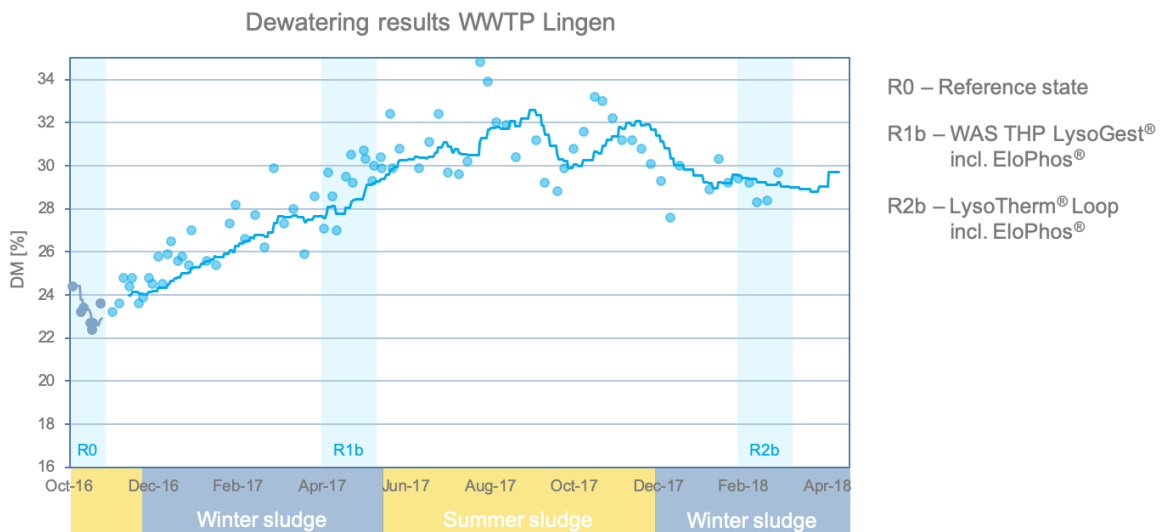


Figure 11: Dewatering Results

The mass reduction of the sludge cake is directly related to the costs for the sludge disposal. The graph below illustrates the mass reduction in the course of the project. To achieve comparable numbers, the mass reduction was calculated based on identical mass input to the digestion.

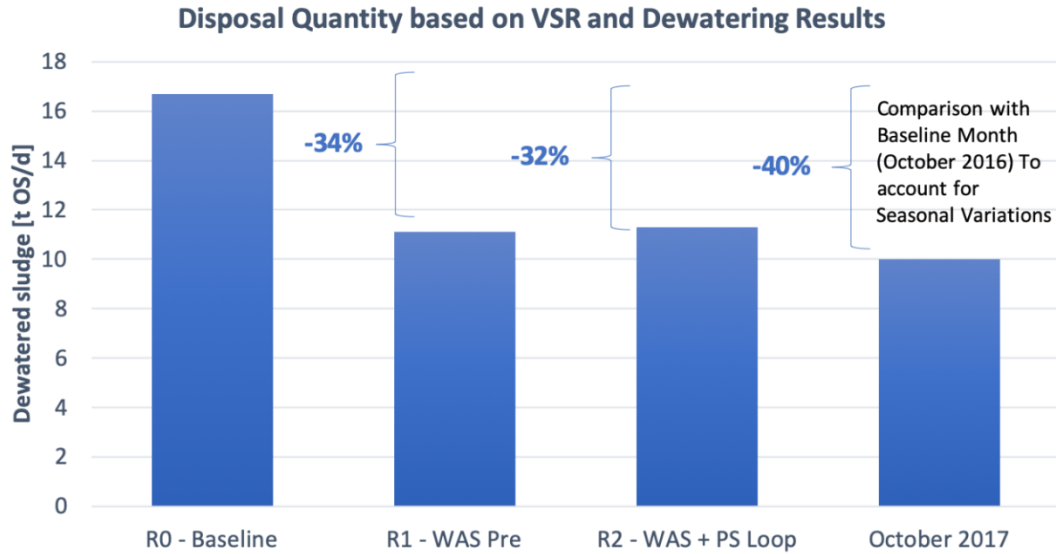


Figure 12: Disposal Quantity

In phase R1 a mass reduction of 34% was achieved. In phase R2 this was 32%. If seasonal variations are also accounted for, then compared to the baseline month of October 2016, a 40% reduction in disposal quantity was achieved in October 2017.

### Heat Demand

The heat demand of the LysoTherm<sup>®</sup> plant is shown in the following diagram. The exhaust heat of the gas motors suffices the heat demand of the LysoTherm<sup>®</sup> plant all time. During the WAS disintegration in phase R1 the heat demand was measured to 120 kW. Due to the higher efficiency of the heat exchange in the looped configuration of LysoTherm<sup>®</sup> the heat demand dropped to only 76 kW. The heat served to LysoTherm<sup>®</sup> via the thermal oil to a high extend is provided to the digesters. The diagram below also shows the heat demand of the digesters (190 kW). Since the heat demand of the digesters all the time was much higher than the heat served from LysoTherm<sup>®</sup> to the digesters, additional low grade heat has to be provided to the digesters via the conventional heating system. Cooling of the digesters was not necessary even during hot summer days with temperatures close to 30 °C (86 °F).

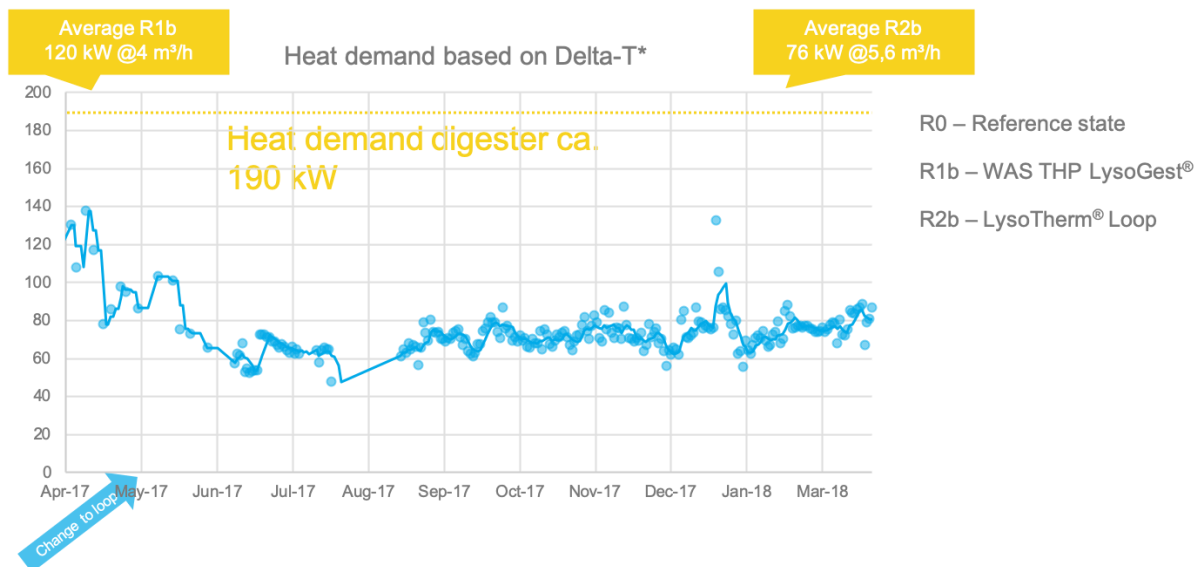


Figure 13: LysoTherm<sup>®</sup> Heat Demand

## Availability

The availability of the LysoTherm® plant in Lingen is shown in figure 14. In 2018 an availability of 93% was achieved. This value could be even higher, but in June 2018 a shutdown of the plant due to safety check after six years of operation was necessary. During this inspection it was observed, that it is advised to renew the gaskets partly. The supplier of the gaskets offered new qualities of the gaskets and thus in October and November 2018 new gaskets were tested, which required two further shutdowns of the plant.

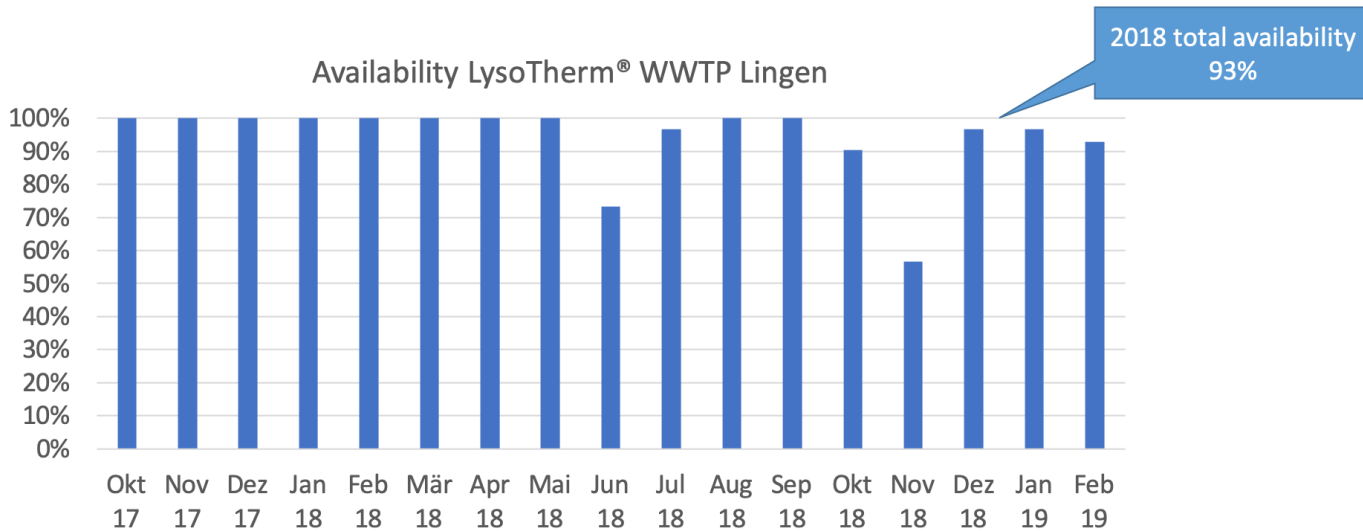


Figure 14: LysoTherm® Availability

## CIP Cleaning

The periodic rinsing and cleaning of the LysoTherm® plant is an automated process (CIP), which requires minimal operator time. The rinsing of the plant is conducted with treated effluent water once a day automatically without operator intervention. The chemical cleaning, which is typically conducted every 20 to 25 days requires a manual startup, which is a equivalent to the ‘push of a button. Every chemical cleaning requires ca. 60 liters of caustic soda and the same amount of nitric acid to remove baking and scaling from the heat exchanger surfaces. In total this results in less than 1,000 L of caustic soda and nitric acid per year. In contrast, a TCHP plant has approximately a specific consumption of ca. 0.5 L of (NaOH) per/m<sup>3</sup> of sludge, which in Lingen’s example would be thirty times higher than what is required for the CIP process.

## Minimal Maintenance

The high availability of the plant and the fully automated process requires less maintenance. For the Lingen plant less than one man hour per day is required. These works are mainly related to the lab works for the regular performance check of the plant.

## Thermal Oil Duration

The thermal oil is checked on a regular base. Every year a sample of the thermal oil is taken and analyzed in the lab of the supplier. The thermal oil used in the system is suitable for temperatures up to 300 °C (572 °F). The temperature in the system is maintained below 180 °C (356 °F). This might be the reason, that even after more than 6 years of operation no change of the thermal oil is required.

## Odor Free Operation

The LysoTherm® process is a totally closed process. In the course of the hydrolysis gases are released from the sludge. These gases remain in the hydrolysate and will be provided to the downstream digesters where at least a partly re-solubilisation of the gases takes place. Hence, no treatment of exhaust gases from the LysoTherm® process is necessary.




## DISCUSSION

In the course of the project the effect of the WAS-only Thermal Hydrolysis Process (THP pre configuration) and of digested sludge (THP loop configuration) was investigated. Compared to the original state, significantly higher Volatile Solids Removal (VSR) and much higher gas production were achieved, while the VSR was even higher in the loop configuration. In all phases of the project the LysoTherm®'s demand on high temperature heat could be covered by the exhaust heat of the CHPs fired with the biogas from the digesters. No supplemental natural gas has to be used to generate heat. In loop configuration a lower heat demand than in the pre configuration was achieved, which also supports the ambitions of the wwtp Lingen to serve a local heat network with green energy. De-coupling of processes operated in series is one of the key success factors in this process technology. In loop configuration the largest buffer in sludge treatment, the digesters, are used for this purpose. Regular shut-downs of the upstream mechanical thickeners, e. g. for frequent manual cleaning of the belts, do not have any effect on the operational stability of the LysoTherm®. Lower pressure in the system, also contribute to a lower energy consumption, lower wear and tear, lower maintenance and thus, lower operational costs.





## CONCLUSION

Thermal Hydrolysis process (THP) is widely recognized as an effective mechanism for sludge pre-treatment to ensure higher Volatile Solids Reduction (VSR) leading to higher biogas production while also helping increase the capacity of the digestion train. The LysoTherm® process offered by Ovivo, is a modular system that is capable of thermal hydrolysis without the use of steam or chemicals. The process employs a series of heat exchangers providing closed loops for thermal oil as well as water, ensuring optimum heat balance, while bringing about the temperature and pressure exposure to the sludge. This not only eliminates the need for a steam operator but also removes the need for pre-treatment chemicals. The process also does not require a pre-dewatering step, thereby helping reduce both capital expenditure on dewatering equipment as well as operational costs associated with polymer addition for the extra step. Since municipal wastewater treatment plant operators are typically quite familiar to heat exchangers, the LysoTherm® THP concept provides an operator friendly and a reliable biosolids management option.

In summary, with two full scale references, including the project in Lingen, LysoTherm® has been proven to deliver on all of the benefits of Thermal Hydrolysis:

LysoTherm® delivers all of the superior benefits of THP:		
	Reduce biosolids disposal cost	Average savings > 30 %
	Increase gas yield	Biogas increase >30%
	Increase digester capacity	Increase digester capacity with lower BRT and viscosity

*Table 2: Unique differentiators of LysoTherm®*

<b>With more efficiency, safety and simplicity than any other THP technology in the market:</b>		
	Minimal Maintenance	High reliability and availability with (CIP) system
	Flexible Configuration	Loop configuration is unique and suited to treat all sludge
	Heat Recovery > 90%	Low heat demand and energy positive operation
	Odor Free operation	Closed heat exchanger system with no head space

## REFERENCES

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