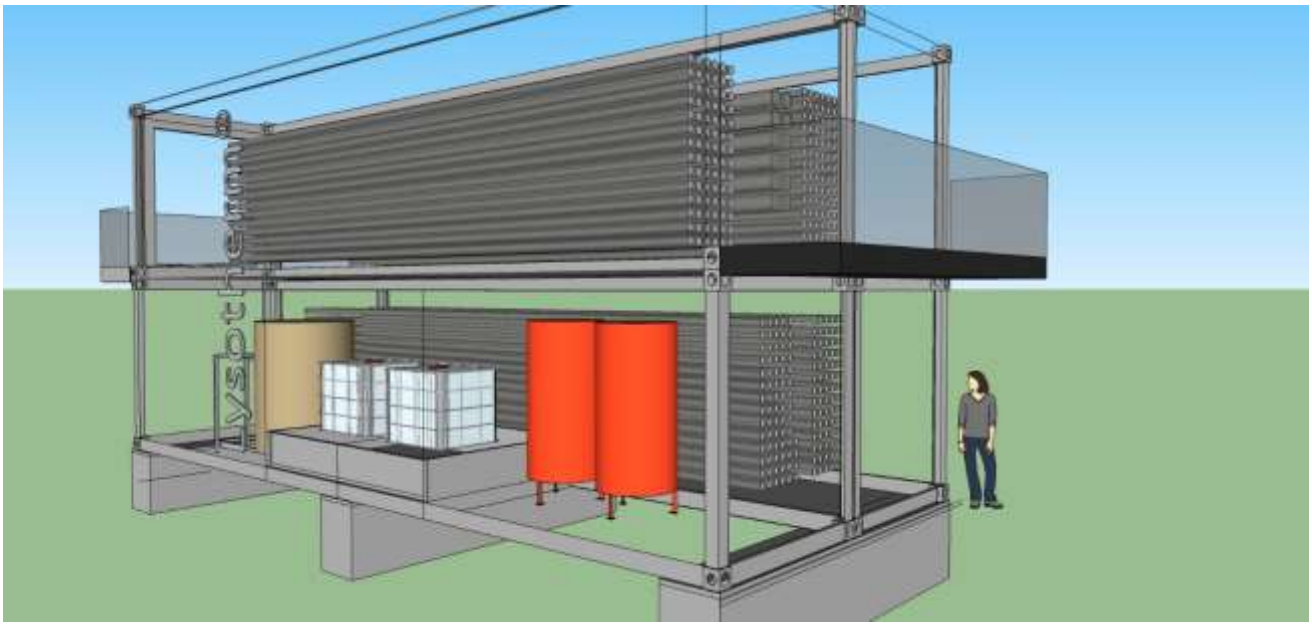
LYSOTHERM® SLUDGE HYDROLYSIS
FIVE YEAR EXPERIENCE WITH A NOVEL APPROACH FOR OPERATIONAL SAVINGS

Bert Geraats, Technology Manager
Eliquo Water & Energy BV | Member of the Eliquo Water Group
Tel. +31-646812957 Email bert.geraats@eliquo-we.com



Abstract

Steam based systems are known for thermal pressure hydrolysis (TPH) of sludge. For some operators of wwtp's, steam based systems are not preferred, for operating, safety and maintenance reasons. In addition capital costs of steam based TPH systems are high for small and medium sized wwtp's. Lysotherm® is an innovative patented system for the thermal hydrolysis of organic sludge, in particular sewage sludge, without the use of steam. Lysotherm® is a newly developed THP system designed for small scale and large scale wwtp's. The technology is based on in-house knowledge and construction of heat-exchangers.

The Lysotherm® allows continuous operation, is based on the indirect heating of sludge with two heating circuits. A closed regenerative water circuit to pre-heat and after-cool the sludge, a thermal oil circuit with heat recovered from the CHP. No steam is used.

The working principle of the Lysotherm® sludge hydrolysis and full scale results is presented. Its special design enables effective, efficient and reliable hydrolysis of the sludge.

Key words

Thermal pressure hydrolysis, heat recovery, biogas production, full scale, indirect heating, without steam, operational savings.

Lysotherm® working principle and operation

The Lysotherm® thermal pressure hydrolysis (TPH) is based on a tube-in-tube heat exchanger, originating from industrial applications, with problematic substrates. The Lysotherm® unit is fabricated in our own facilities, ensuring high quality control, with the reaction zone and heat exchange within an integrated unit. The system is optimised for robust operations, heat-exchange and the prevention of scaling and blocking using an automated cleaning system Lysoclean®.

The goal of thermal hydrolysis is to improve the anaerobic stabilisation (digestion) of organic sludge, thus:

Increasing

- gas yield
- dry solids (DS) content of the digested and dewatered sludge

Reducing

- amount of organic dry solids (oDS) in the digested sludge and the quantity of sludge for disposal
- viscosity of the sludge (see figure 1)
- residence time for digestion

In addition, usually the polymer consumption for dewatering is reduced.

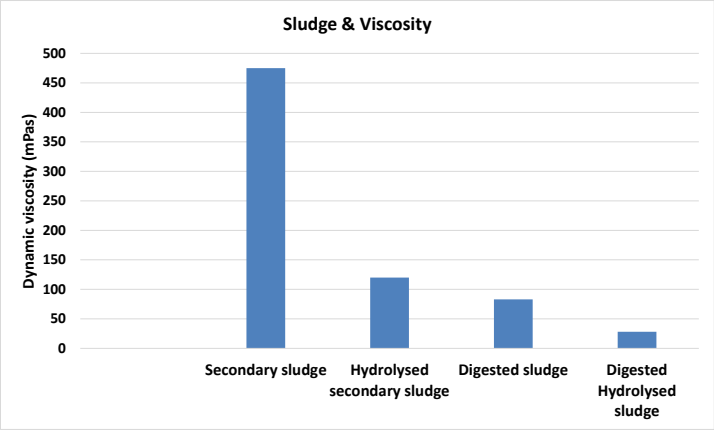
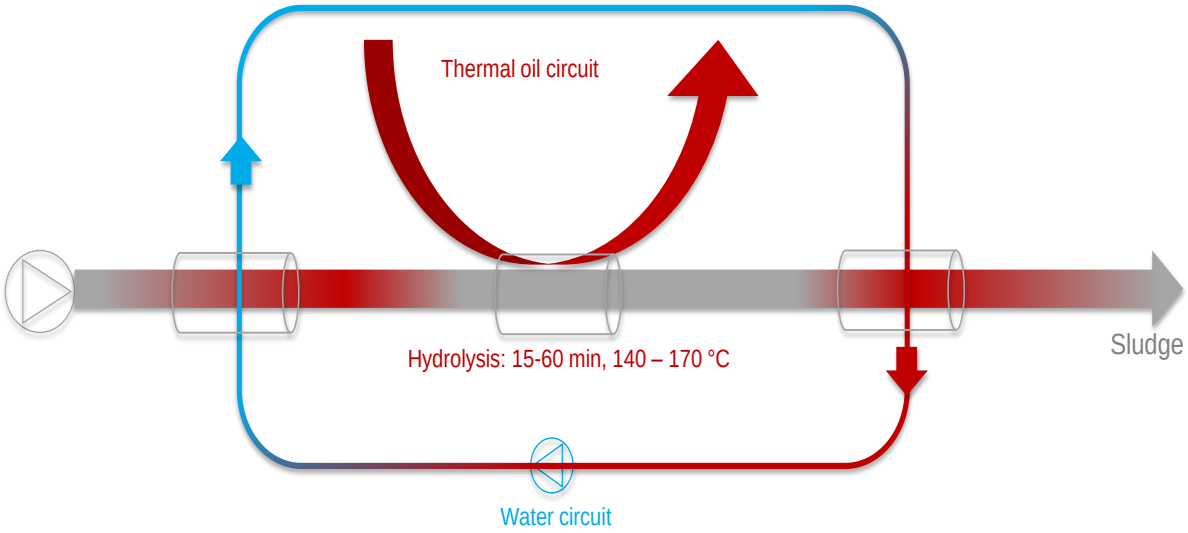


Figure 1: Effect of sludge hydrolysis on sludge viscosity

The sludge is continuously fed by a sludge pump into a multi-stage heat exchanger system.

In the first stage of the heat exchanger system the sludge is preheated using recovered heat from the cooling phase. It is then heated up to hydrolysis temperature in the tubular hydrolysis



reactor. Hydrolysis takes place at a predefined temperature (140-170 °C) in the reactor zone in which the sludge usually remains for in-excess of 15 minutes. After hydrolysis, the sludge is cooled down in the heat exchanger to the temperature required for entry into the digester. Sludge heated up to the hydrolysis temperature range and retained for several minutes provides a fully pasteurised sludge when stabilised using a subsequent anaerobic digestion process.

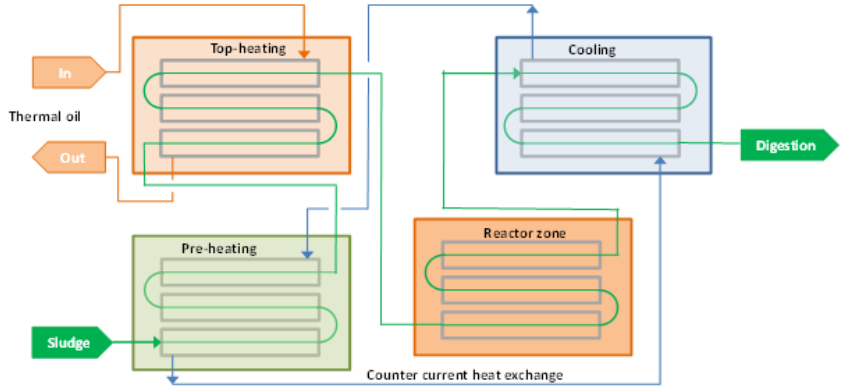
The system has two heating circuits:
1. The thermal oil circuit provides the tubular hydrolysis reactor with the required process heat. This heat is extracted with a heat exchanger from the flue gas of the associated CHP engines or from a boiler system.
2. The regenerative circuit uses water as the heat transfer medium. This circuit recovers the heat from the hydrolysed sludge cooling system and makes it available for preheating.

Except for the cooling and exhaust heat of the CHP units, no other heat resources such as steam are required. It should be noted that ALL biogas produced is usually converted into valuable green energy. Due to the heat recovery system and the insulation of the Lysotherm® units, the heat loss is limited. Usually the exhaust heat of the CHP is sufficient to drive the hydrolysis. Excess heat from CHP engines and other heat sources is available for other purposes, such as sludge drying or supply to a heat grid.

Lysotherm®: Key characteristics

- Multi-stage heat exchanger system for continuous operation and maximum operational reliability. To provide heat distribution of the heat generated by the CHP units, a modular skid mounted Lysoheat® system is provided. This integrated system contains low-grade and high grade heat for heat–exchange, cooling and emergency cooling.
- High energy efficiency as a result of the highly efficient recovery of heat from the regenerative circuit.

- Steam not required, with steam pressure vessel regulations not applicable
- No addition of water into the feed
- Robust, low-wear, space-saving design
- Standardised system sizes (modular)
- Simple operation and maintenance with low operating costs
- Manufactured according to pressure vessel regulations, TÜV approved.
- Sludge pre-treatment (such as fine screening) usually not required, when 3-6 mm screening for influent is applied.



Lysotherm®

Operational reliability, ease of operation and maintenance

- Another major benefit of the Lysotherm® system is its high operator convenience: reduced instrumentation and control requirements, thanks to the ability for continuous operation of the system and to the system configuration.
- A special benefit of the system is its high operational reliability. During heating of the sludge to hydrolysis temperature in stages, the temperature difference between the heat transfer medium and the sludge is kept low and is precisely controlled. This minimises the possibility of any caking or scorching hazards.
- Small number of potential wearing parts. The sludge feed pump, operates at ambient temperature.
- Fully automated operation LysoControl™
- Simple accessibility of all critical items, including insulated parts.
- Manufactured from standard equipment parts.
- Simple inspection and automated cleaning of the sludge-carrying pipes: the 180 °C connecting elbows of the tube bundle system can be easily removed.
- Lysotherm® is designed for continuous operation, has an excellent heat exchange and is further prevented for blocking and scaling by an incorporated CIP system (Clean In Place): LysoClean™.

- Typically the Lysotherm® is rinsed on a regular base with water (filtered plant effluent) and caustic and acid. The chemicals are low in concentration and amount and can be discharged either in the sewer system of the plant or in the digester.

A standard Lysotherm® module has a feed capacity of approx. 80 m^3/d. For this standard unit, the electric power demand (mainly the feed pump) and the consumption of water and chemicals for the Lysoclean™ cleaning are as follows:

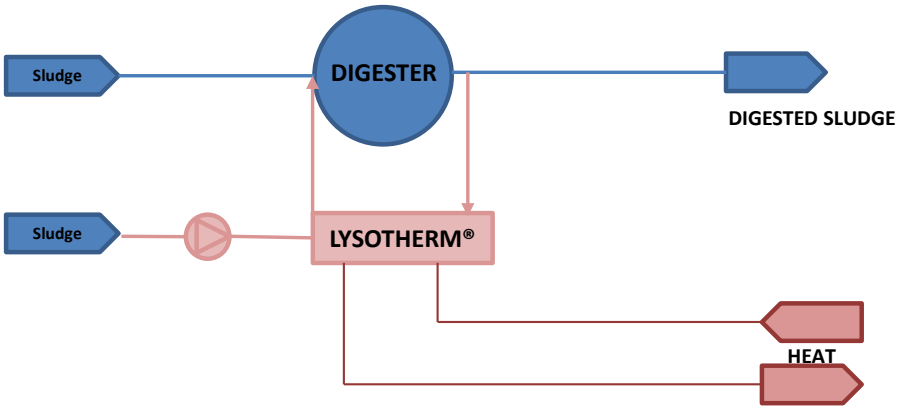
- Electric power demand: 7.5 kW
- Rinse water (filtered plant effluent): 2-3 m^3/day
- Caustic and acid consumption: typically 3 m^3/year each.

Installation

The plug & play design facilitates fast installation and commissioning of the system. The Lysotherm® modules are ready made in our quality controlled factory, with all interconnecting pipework, switchboards and control. Connection to sludge inlet, sludge outlet, main power lines and control panel, together with commissioning are the only on-site activities. This facilitates high quality control and minimises health & safety risks.

Options for Lysotherm® configuration

Primary sludge can be digested at high biogas yields and low hydraulic residence time. Sludge hydrolysis is specifically effective for the treatment of secondary sludge, reducing digester residence time, increasing biogas yield and dewatering characteristics. For Lysotherm® different process configurations are available, with sludge feeding in the range of 6-13% dry-solids. Lysotherm® primary hydrolysis typically focusses on the treatment of secondary sludge only. The secondary sludge is treated by Lysotherm® and subsequently fed to a digester, according to the following process configuration:



LYSOTHERM® (patent)

Performance of Lysotherm®

Typically a minimum residence time of 15 days is sufficient in order to yield a breakdown of organic matter of typically 55% for hydrolysed secondary sludge. Obviously the improvement in biogas production is similar to the increase in the breakdown of organic matter. The Lysotherm® performance data are based on 5 year experience of full-scale Lysotherm® units with supporting laboratory results. In 2009 a full-scale demonstration plant was started, in which one 1000 m^3 digestion line equipped with Lysotherm® was running in parallel to a conventional 1000 m^3 digestion reference line.

Full scale operational experience of a Lysotherm® unit at a municipal wwtp shows that at a digester residence time of 15 days, the additional gas yield on secondary sludge increases from approx. 0.25 m^3 biogas per kg of OTR fed to digester to approx. 0.40 m^3 biogas per kg OTR fed to digester. Figure 2 clearly shows the effect of Lysotherm® operations on secondary sludge. The specific biogas production is shown as a function of time.

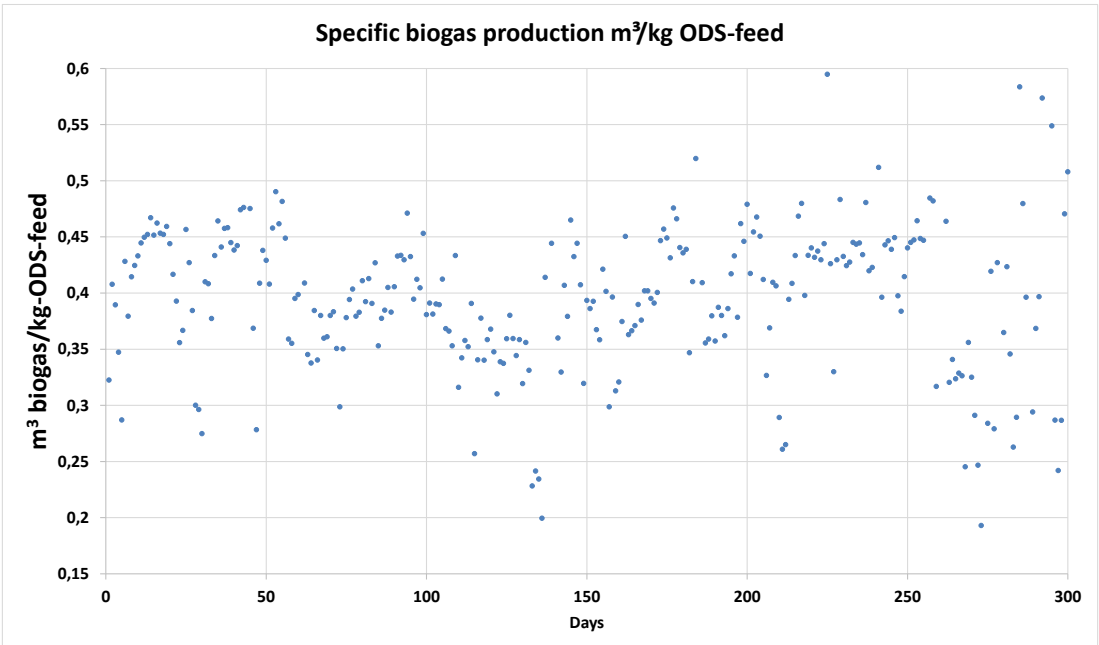


Figure 2: Specific biogas production

The data represents an operational period of 10 months. This biogas performance data correlates nicely with the digester organic matter mass balance. The correlation with the actual measured biogas production is shown in figure 3. yielding a specific biogas production of 0,40 m³ biogas per kg-OTR-fed to digester for hydrolysed secondary sludge.

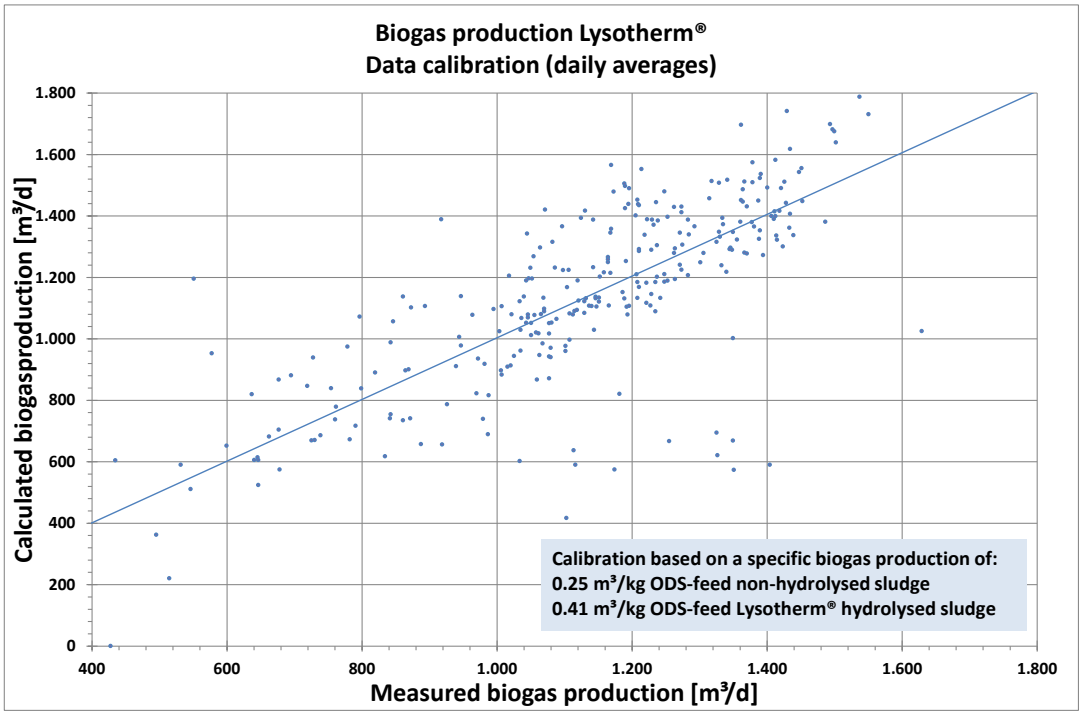


Figure 3: Correlation of actual measured biogas production

Treatment of secondary sludge with Lysotherm® not only reduces organic matter but also improves dewatering:

- Typically 3-5 percent-points improvement in dry solids percentage can be reached with dewatering (for example from 20% ds to 26% ds).
- In addition, the polymer consumption reduces by typically 10%. Careful polymer selection is advised to achieve the optimum reduction of polymer consumption and improved dewatering.

Results of centrifuge (10-15 m³/h capacity) dewatering of hydrolysed secondary sludge and of a 50/50% mixture of hydrolysed secondary sludge and primary sludge are shown below.

	Dry-solids dewatered sludge %	Specific polymer consumption gram/kg-dry-solids
Hydrolysed secondary sludge	25	16
Mixed secondary & primary sludge (50/50)	27,9 29,7 31,7	9,1 11,3 14,1

For further information:

Bert Geraats	Eliquo Water & Energy BV	bert.geraats@eliquo-we.com
Ulrich Knörle	Eliquo-Stulz GmbH	ulrich.knoerle@eliquostulz.com