Cambi B2 “Packaged Unit” Thermal Hydrolysis Plant, Including Steam Explosion Disintegration

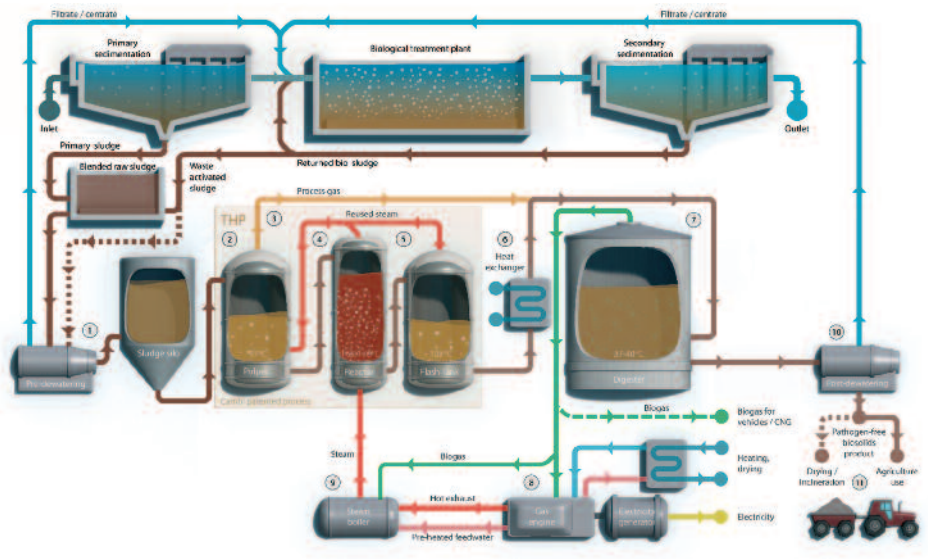
Thermal hydrolysis Sludge Treatment: Medium to large-scale application

The Norwegian company Cambi AS has developed and installed worldwide its unique “steam explosion” thermal hydrolysis process (THP), a technology for the treatment of wastewater treatment plant (WWTP) sludge prior to anaerobic digestion. Cambi THP optimises biogas production and has many other benefits, which are described below, along with a look at some real-life experiences at medium and large-scale facilities.

Introduction

- Established in 1989. Offices in Norway, Denmark, UK, and USA
- Global industry leader in our segment (advanced biogas production from sludge and biowaste) with 26 plants worldwide (530,000 metric tonnes DS/y) and 5 plants under design/construction
- Treatment capacity for sludge and biowaste equivalent to 26 million people and 768,000 metric tonnes of DS (dry solids)/year
- Production capacity of 1,900 GWh thermal energy (biogas) and 760 GWh electrical energy, when using gas engine cogeneration.
- Green energy production replaces760,000 tonnes of fossile CO_2 emissions. Avoidance of methane emissions from landfills, less transport, etc. comes in addition (about 2.5 mill tonnes CO_2 equivalents)
- Cambi THP is an eco-friendly “Paradigm-shifting Technology”, dramatically improving design and operations of biogas plants worldwide.

The use of the thermal hydrolysis process in sludge treatment for WWTPs presents some major advantages in terms of energy, public health and environmental protection. Medium-sized plants can be converted, with the import of sludge from other nearby plants, into strategic sludge treatment centers. Here biogas production from anaerobic digestion is maximised using existing capacity, generating a pasteurised sludge with high dry solids content. The generation of electricity from renewable sources, produced from biogas, allows the energy costs of the WWTP plant itself to be reduced and the WWTP may even have surplus energy production.



The thermal hydrolysis is part of a wastewater treatment plant as a pre-treatment prior to digestion

Thermal hydrolysis “Steam Explosion” process

The thermal hydrolysis process (THP) patented by Cambi AS is a pre-treatment of sludge combined with anaerobic digestion. Cambi THP works by dissolving and disintegrating sludge using pressure and temperature. Primary, biological or mixed sludge is pre-dewatered and introduced into a reactor where the direct application of saturated steam hydrolyses and changes its internal structure. This reduces sludge viscosity and increases its biodegradability and shortens hydraulic retention time. The thermal hydrolysis increases the production of biogas in digestion, reduces the volume needed for digestion, increases the dryness of the final dewatering of digested sludge, eliminates odours, and provides pasteurised final sludge Class A, a valuable and natural fertiliser.

The Cambi thermal hydrolysis process disintegrates the cellular structure of the bacteria in bio-sludge by solubilising exopolymers (proteins protecting the bacteria), producing an easily digestible product. This is done by means of a temperature of 165 degrees for 20 minutes, at 6 bar, followed by a sudden drop in pressure, resulting in so-called “steam explosion”, unique among all thermal hydrolysis technologies available in the market. The steam explosion tears cells and fibers apart, further improving the disintegration effect.

The Cambi hydrolysis system allows maximum disintegration of the cells and it enhances the production of biogas in the subsequent anaerobic digestion and allows high loads in digesters. In the Cambi plant at Thames Water’s Chertsey WWTP (London, UK) our process operators have tuned the plant to the exceptional capacities of up to 7 kg VS m^3/day and retention times as low as 10-12 days.

The use of Cambi thermal hydrolysis achieves the following:

- Generates more energy (higher biogas production).
- Reduces the final amount of sludge. It improves sludge dewatering up to 40% DS.
- Ensures sludge pasteurisation, i.e. a pathogen-free sludge
- Produces a stabilised, compost-like product, with 70% decrease in odour .
- Increases the speed and capacity of digestion (less digestion volume).
- Reduces carbon footprint.

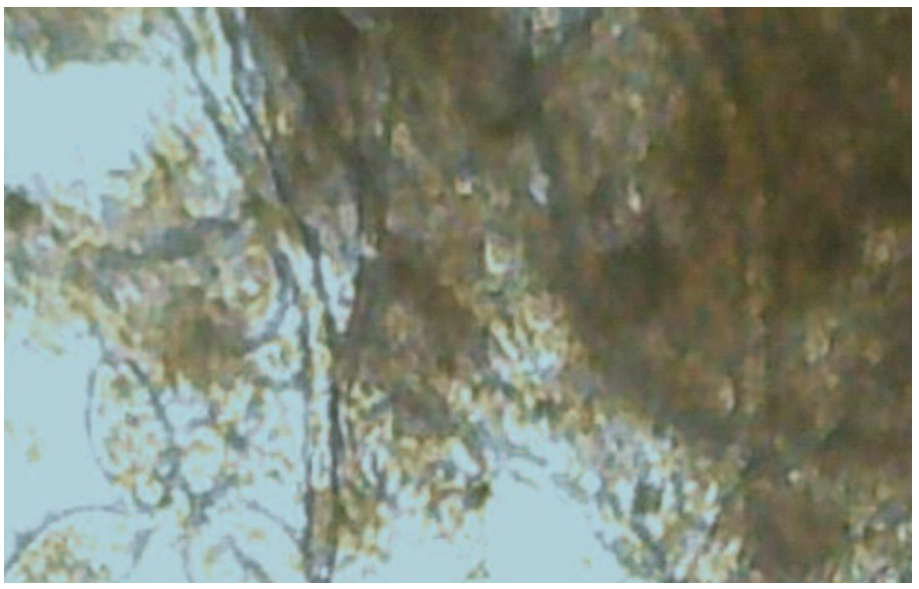


Figure 1: Thickened mixed sludge without treatment , Photo = 400x550 micras

Figure 2: Thickened mixed sludge, with thermal hydrolysis at 165ºC in 20 minutes – without pressure drop

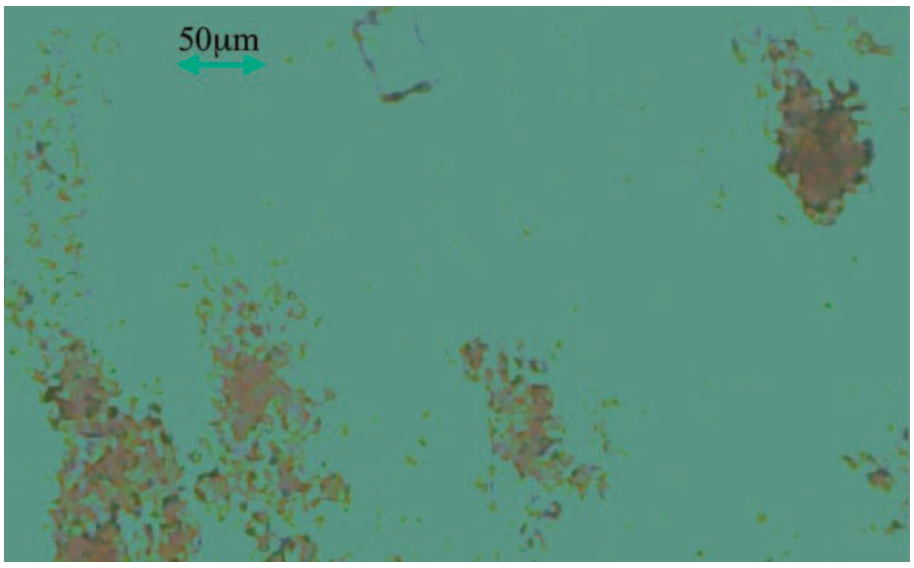


Figure 3: Thickened mixed sludge, with "steam explosion" after hydrolysis process at 165ºC and 20 minutes.

A medium-scale sludge treatment center: The case of Lindum (Norway).

Cambi hydrolysis system for medium capacities (15-40 dry tonnes per day) is based on 6 m^3 reactors. The system is modular, permitting its expansion up to 3 reactors. For lower sludge productions, Cambi has developed an even more compact plant. The whole system of hydrolysis is closed without leakage of odour and energy loss.

Drammen (Norway) has recently installed a medium-scale sludge treatment center for dewatered sludge from 9 municipalities (18,500 wet t/year), fats from the food industry (3,000 t/year), sludge from septic tanks (7,000 t/year) and other biological substrates (2,000 t/year). The project's main objective was to generate biogas and produce a safe product. Investment, operation and maintenance costs were also considered. The use of the 2 reactor Cambi B6 hydrolysis system in Lindum allows the generation of 16 GWh/year of biogas and 12,000 t/year of dewatered biosolids product used as fertiliser. This plant shows that it is possible to develop sludge treatment centers on a medium scale where you can optimise the energy efficiency of equipment by importing sludge from outside the WWTP.

Large-scale thermal hydrolysis: The case of DC Water (Washington DC, USA)

The District of Columbia Water and Sewer Authority (DC Water), in its Blue Plains plant, treats a sewage flow of 370 MGD (15 m^3/s), the largest wastewater treatment plant with advanced treatment in the U.S. DC Water will be the first to build a thermal hydrolysis plant in North America. This thermal hydrolysis plant will be the largest in the world and will be built by Cambi AS in Washington DC, with start-up in 2014. The plant will treat up to 450 t DS sludge/day, and 149,000 t DS sludge/year. Only four digesters, each with a 14,400 m^3 capacity, will be built. The biogas will go to a cogeneration facility which will cover the entire steam needs of the THP process itself and generate 13 MWe of power with initial savings of USD 20 million/year from the energy produced, the reduction of the amount of biosolids to agriculture, and by avoiding the use of lime. The carbon footprint will be reduced by about 60,000 t CO_2/year. The final dewatered biosolids quantity will be reduced from 500,000 t/year to 200,000 t/year, with safe application to agriculture as a pathogen-free product with no odour problems. The project demonstrates the effectiveness of feeding the digesters at a digester load of more than 4 kg VS/m3, twice that of conventional digestion, with low retention time in the digesters. The Cambi THP consists of 4 lines of equal capacity.

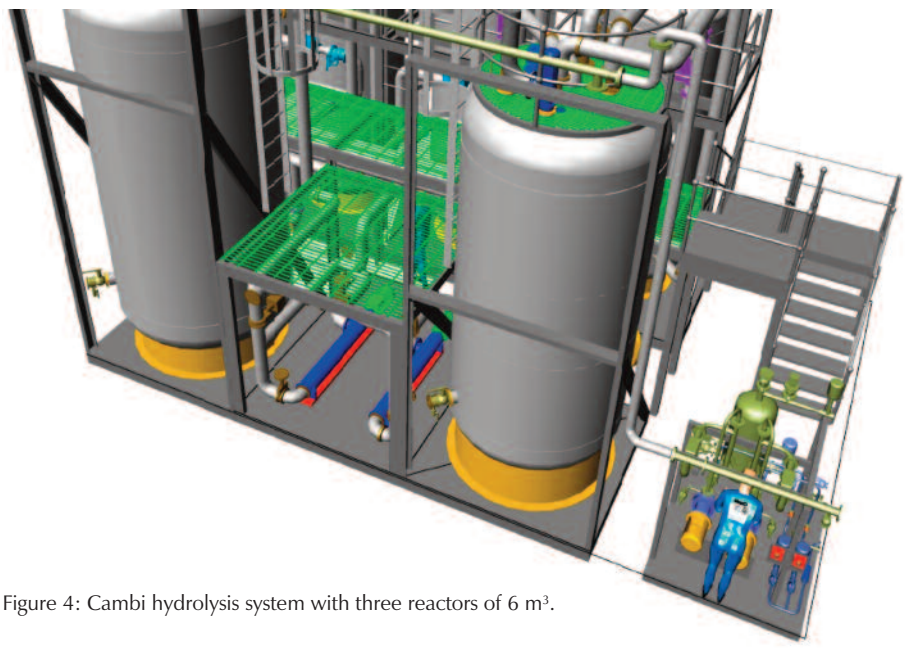


Figure 4: Cambi hydrolysis system with three reactors of 6 m^3.

Comparative hydrolysis parameters vs. conventional digestion

The advantages of applying thermal hydrolysis are summarised in the table below, which compares conventional digestion values with thermal hydrolysis and digestion for mixed sludge.

Figure 5: THP at Lindum under construction

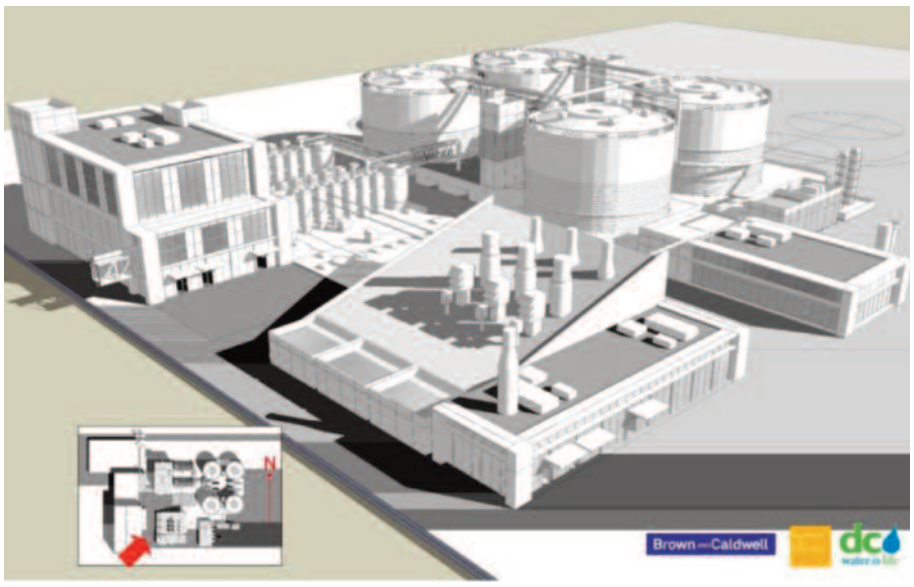


Figure 6: Overview of Project of Cambi Thermaly Hydrolysis and digestion in DC Water (Washington – USA)

CONVENTIONAL DIGESTION versus CAMBI THERMAL HYDROLYSIS		
Parameters	Digester "Cambi" Primary + Secondary	Digester Conventional Primary + Secondary
Retention time	12-15 days 1/3 - 1/2 versus	20 days
Volume	Conventional	1
Load DS	9 - 12 %	4 - 6 %
Load VS	5 - 7 kg/m^3/day	2-3 kg/m^3/day
pH	7.5 - 8	6.8 – 7.5
Temperature	38 - 42 ºC	35 - 37 ºC
VFA / Alkalinity total	0.1 - 0.5	0.1 – 0.5
Ammonia	2500 - 3000 mg/l 65-68% CH_4,	600 - 1000 mg/l 60-65% CH_4, H_2S
Biogas quality	$H_2S\downarrow\downarrow$*	↑↑*
Foaming	No	Nocardia, Microthrix
Biosolids type	Class A	No Class A
Dryness % DS Dewatered biosolids.	32 - 40% (**)	20 - 25 %
Destruction % MS	< 60 %	40 - 45 %

(*) Cambi give very low H_2S in biogas, avoiding H_2S removal systems for cogen

(**) Usually 32 - 35 % with belt press or centrifuge. Up to 40% with filter press.

Conclusions

From 1996 to the present, Cambi thermal hydrolysis units installed and under design/construction worldwide have a capacity of 768,000 t DS/year, to serve a population equivalent of more than 26 million. It is a fully proven technology for small to large scale anaerobic digestion plants.

With the Cambi thermal hydrolysis process you can:

- Improve the energy efficiency of the WWTP. More biogas = more power.
- Reduce the final volume of dewatered sludge.
- Ensure an agriculture output of the final pasteurised sludge, with low odour, and without pathogen regrowth risk.
- Eliminate or reduce the need for subsequent thermal drying or incineration.
- More than double the capacity of anaerobic digesters.
- Have a smaller carbon footprint.
- Have an installation that is reliable and robust with high availability and automation.