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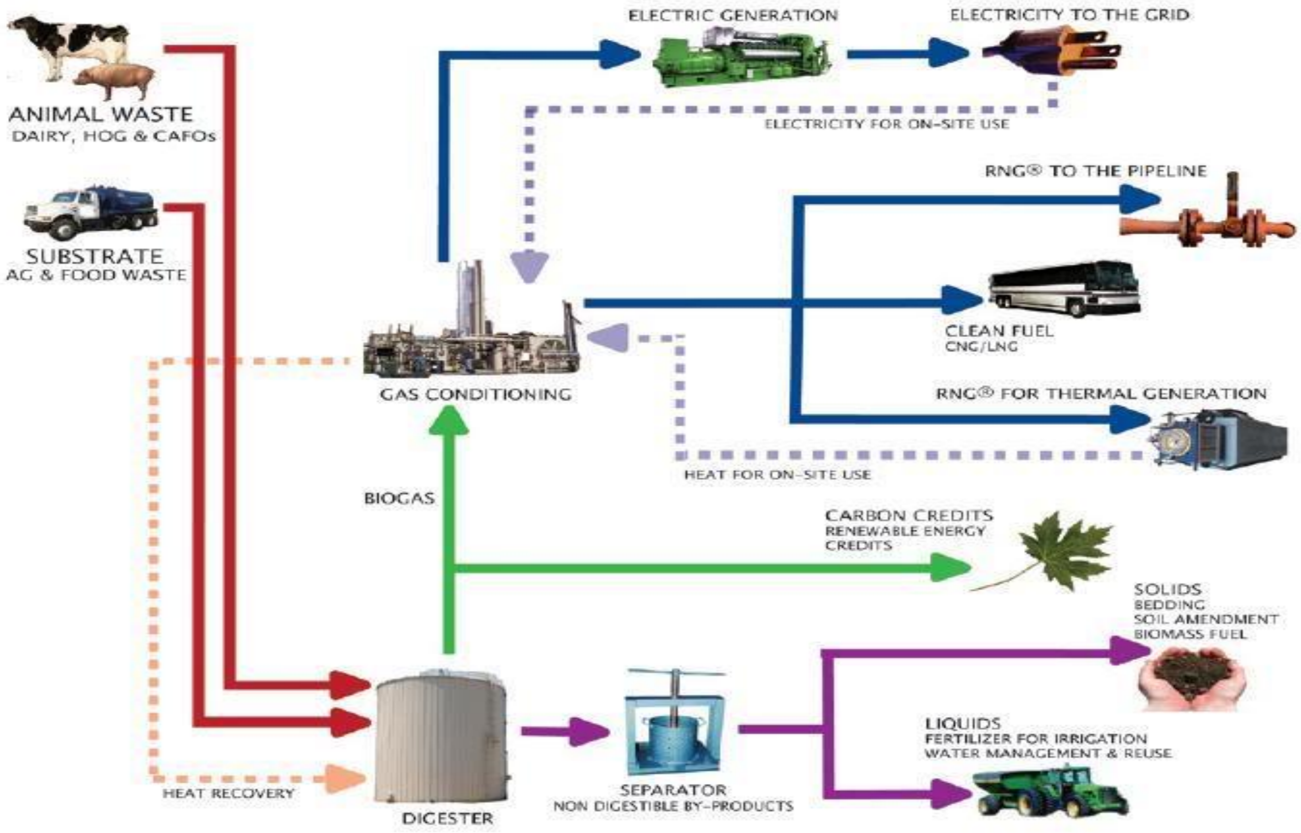
Anaerobic Co-digestion Biogas Plant

with Thermal Hydrolysis Pretreatment for WAS

HALLA Energy & Environment

Contents

Concept of co-digestion



Advantage of co-digestion

Improved overall process economics
(higher biogas production, tipping fees, renewable credits)

GHG emissions reductions

Improved fertilizer value of the digestate

Synergistic effects leading to improved C/N ratio, nutrient balances, and other parameters

Disadvantage of co-digestion

Biological inhibition and process upsets occur from constituents within the co-digestion waste

Inorganic material impact the digester performance via clogging

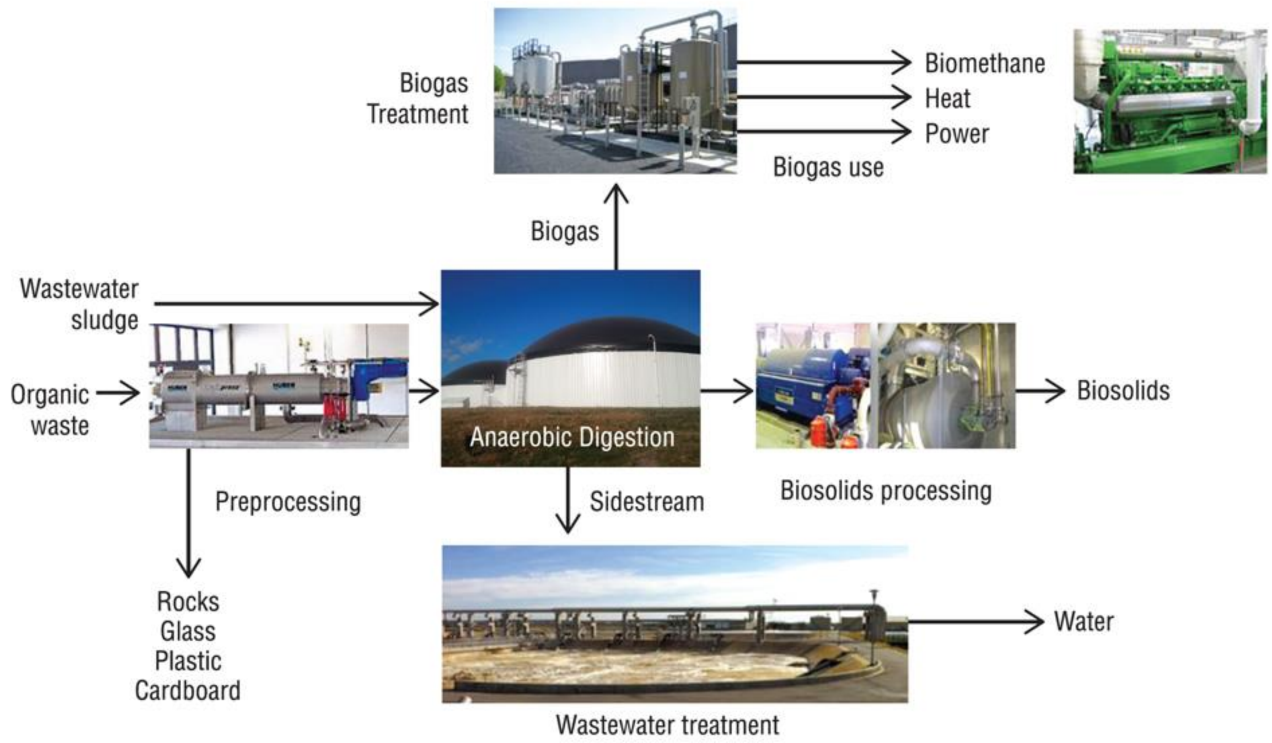
Excessive scum from flotation and mixing problems due to FOG (fat, oil, grease)

Higher production of biogas contaminants

Increased nutrients (N, P, K)

Additional regulation

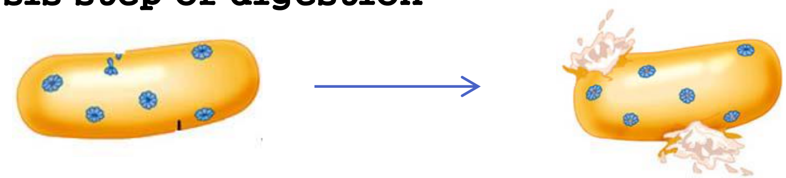
Conceptual process



Sludge disintegration for improved biogas yield

Cell wall gives cell rigidity, strength and offers protection against mechanical stress

Sludge disintegration is to disrupt cell walls and let the degradable substrates release outside cells for more approachable of extra-cellular mechanisms in the hydrolysis step of digestion



Mechanical / Ultrasound / Microwave / Ozone oxidation / Chemical / Thermal

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Solubilization and methane production of combined WAS under optimum conditions
(Neyens, et al., 2003)

Process	Solubilization (%)	Relative CH4 production (8d digestion)
Chemical *(0.6 gNaOH/gVSS)*	15.5	1.4
Thermal *(180 ℃)*	30	1.8
Thermo-chemical *(0.3 gNaOH/gVSS, 130 ℃)*	46	2.2

3 Thermal Hydrolysis Pretreatment (THP)

Application

Applied to dewatered sludge cake , upstream of anaerobic digestion

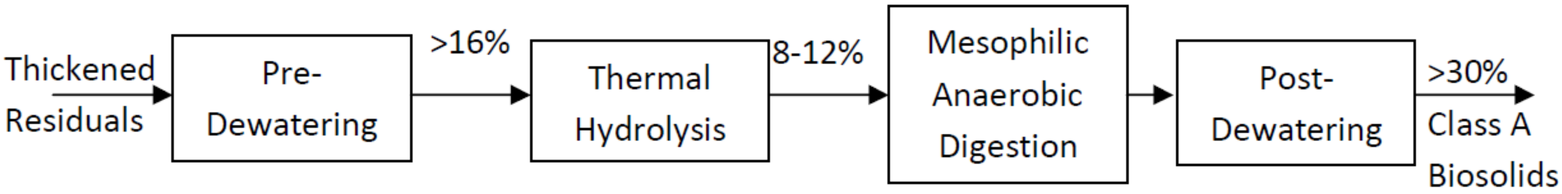
Heated and pressurized (≥165℃, 8~9 bar, about 30 min)

Producing Class A biosolid, making residuals more digestible,
and reducing the viscosity

Dewatered to higher 16% TS before feeding the THP, and diluted
between 8~12 % before feeding the anaerobic digester

Concentration of ammonia is the limiting factor to decide the percent
of solid feed to digester

Provided the digested sludge with better dewatering properties,
greater than 30% TS



Appearance change

Before THP

TS 15%

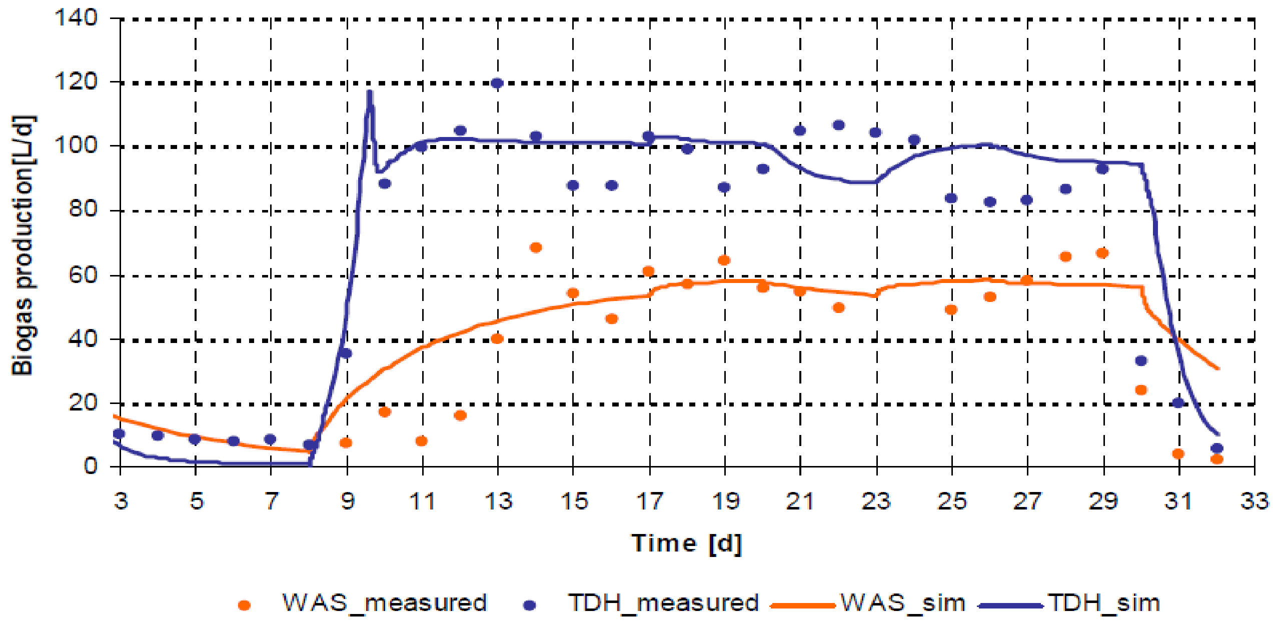
After THP

Temp : 170~175 ℃
Pressure : 8~9 bar
Reaction time: 30 min
Steam: 30% of sludge input
TS: 8~9 %

Increase of biogas production

75～80% increase of biogas production for THP sludge

However, total biogas yield increases only by 20% in case both streams of the untreated primary sludge and THP sludge are mixed

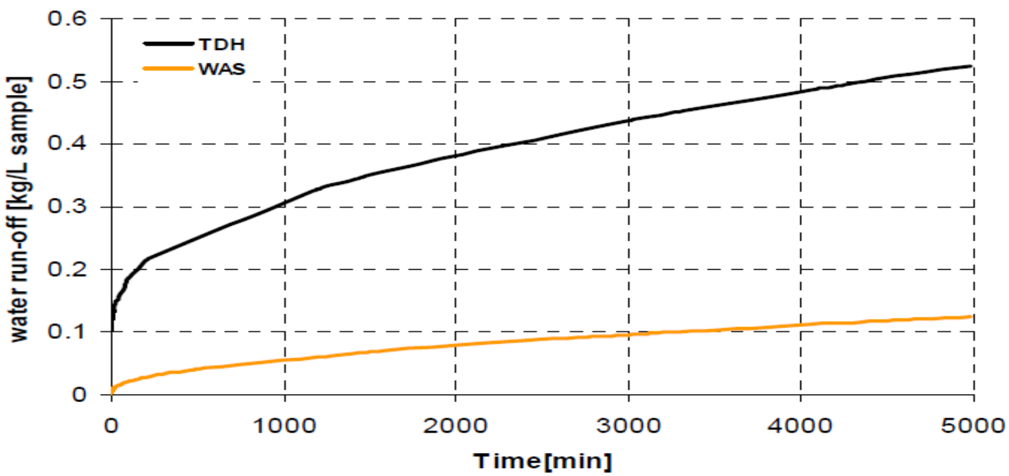


(P. Phothilangka, et al)

Improvement of dewaterability

TS content of dewatered cake for digested sludge with THP is about 33%, compared to about 25% for digested sludge without THP

Reduced the sludge disposal costs to about 25%

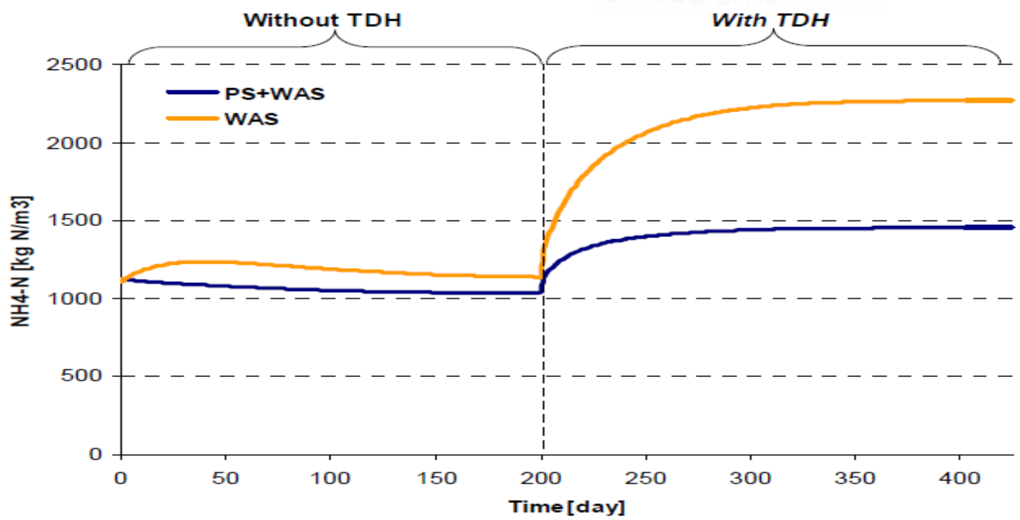


Measured water release from a lab-scale dewaterability test comparing digested sludge with and without THP *(P. Phothilangka, et al)*

Increase of ammonia release

Released nitrogen in form of NH4−N by degradation of N−containing organic matter

Inactivated aerobic biomass and decay products shows a content in nitrogen of about 6% from proteins contained in cell mass

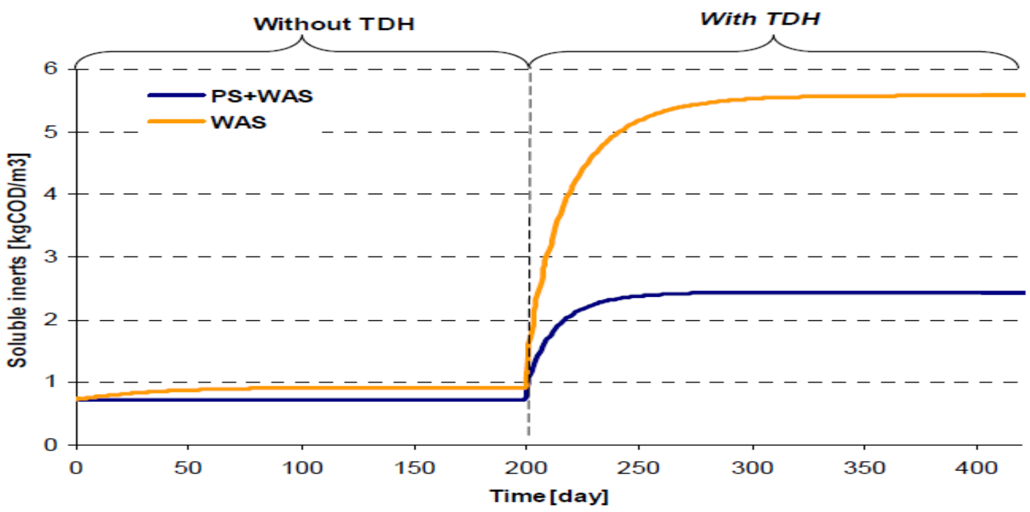


Simulation of ammonia released from digestion of WAS and the mixture of untreated primary primary sludge PS and wasted activated sludge WAS before and after THP *(P. Phothilangka, et al)*

Increase of soluble inerts

Soluble inerts are produced when sludge is pretreated at high temperature

Hardly degradable organic compounds are generated when thermal disintegration is applied for sludge pretreament



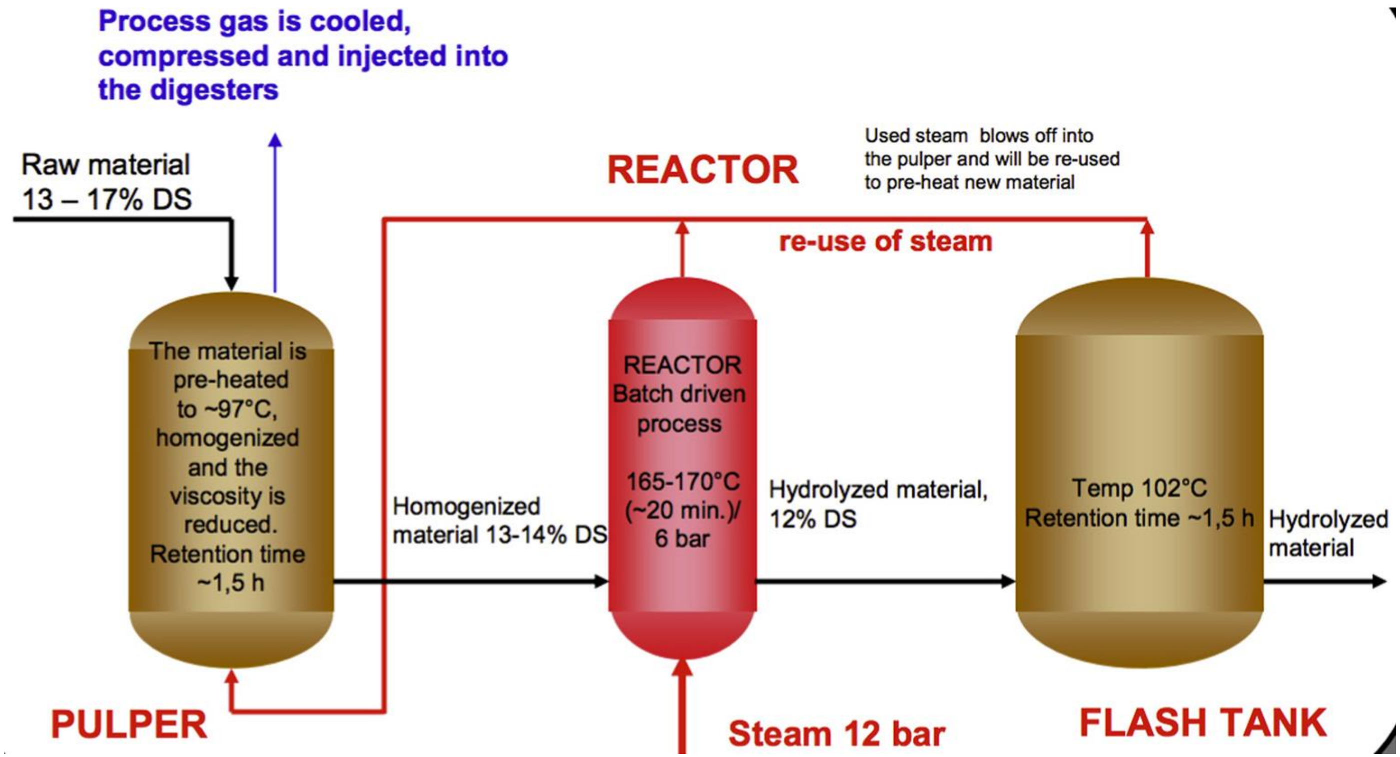
Simulation of soluble inerts after digestion generated from WAS and PS+WAS before and after THP *(P. Phothilangka, et al)*

Comparison between with THP and without THP

	without TDH	with TDH	
total biogas generation		+20%	(mixed digestion : PS+WAS)
biogas from WAS		+75%	(separated digestion: WAS)
N return load	13.0%	18.7%	
COD removal	95%	93%	
N removal	81%	80%	
aeration requirement		+ ca.3%	
solids cake reduction		- ca.25%	

Simulated WWTP key data with and without THP of WAS (no THP for PS) *(P. Phothilangka, et al)*

Cambi™ Process



Operation of Cambi™ Process

The sludge is mixed in the pulper and preheated using steam that is recycled back from the flash tank

The preheated sludge is pumped into the reactor which will be heated and pressurized

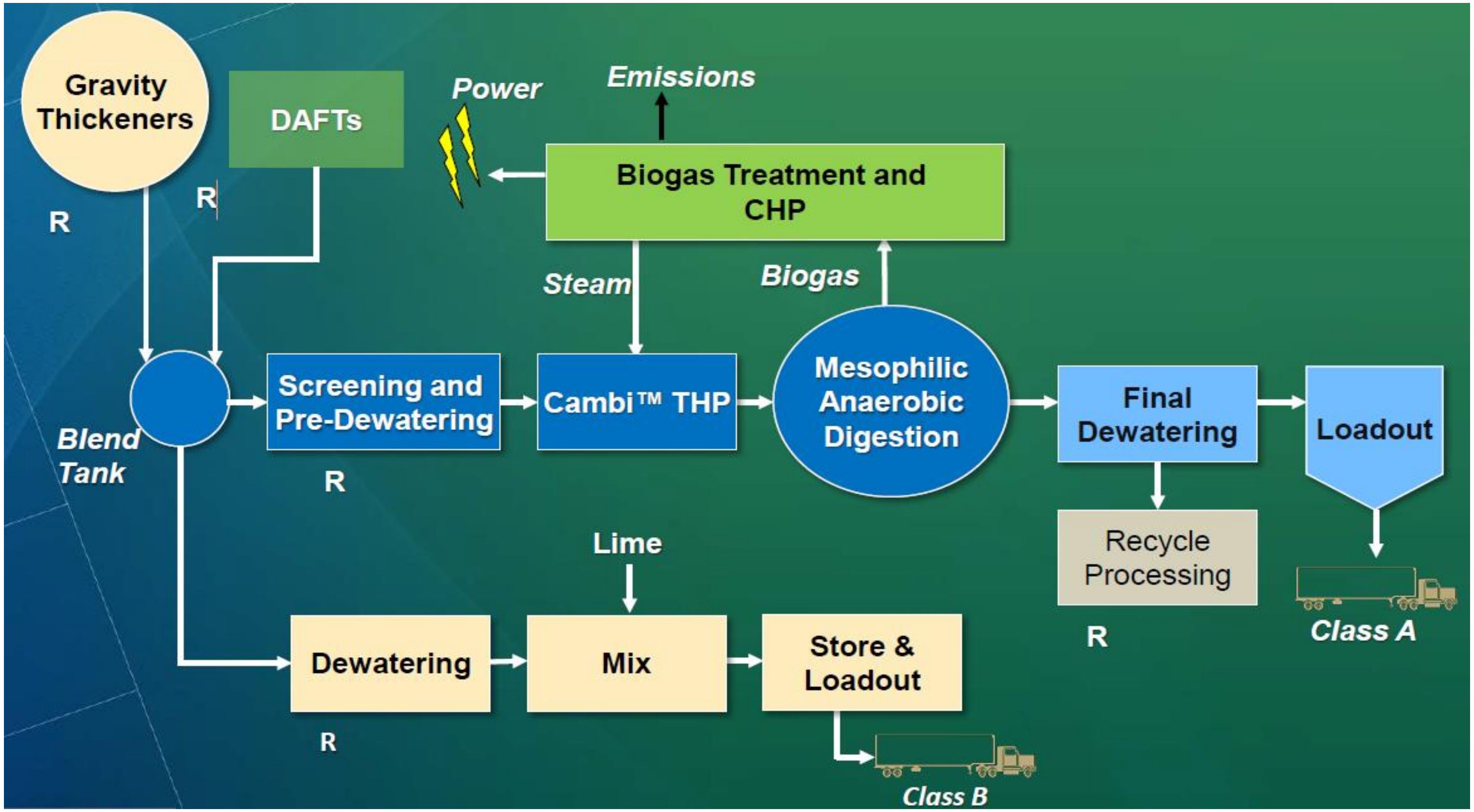
The flash tank receives the treated sludge with a solid concentration about 3~4% less than the pre-dewatered cake due to the steam injection

The temperature of hydrolyzed sludge is reduced to about 42~44 ℃ by heat transfer before feeding a digester

Operated in a batch mode

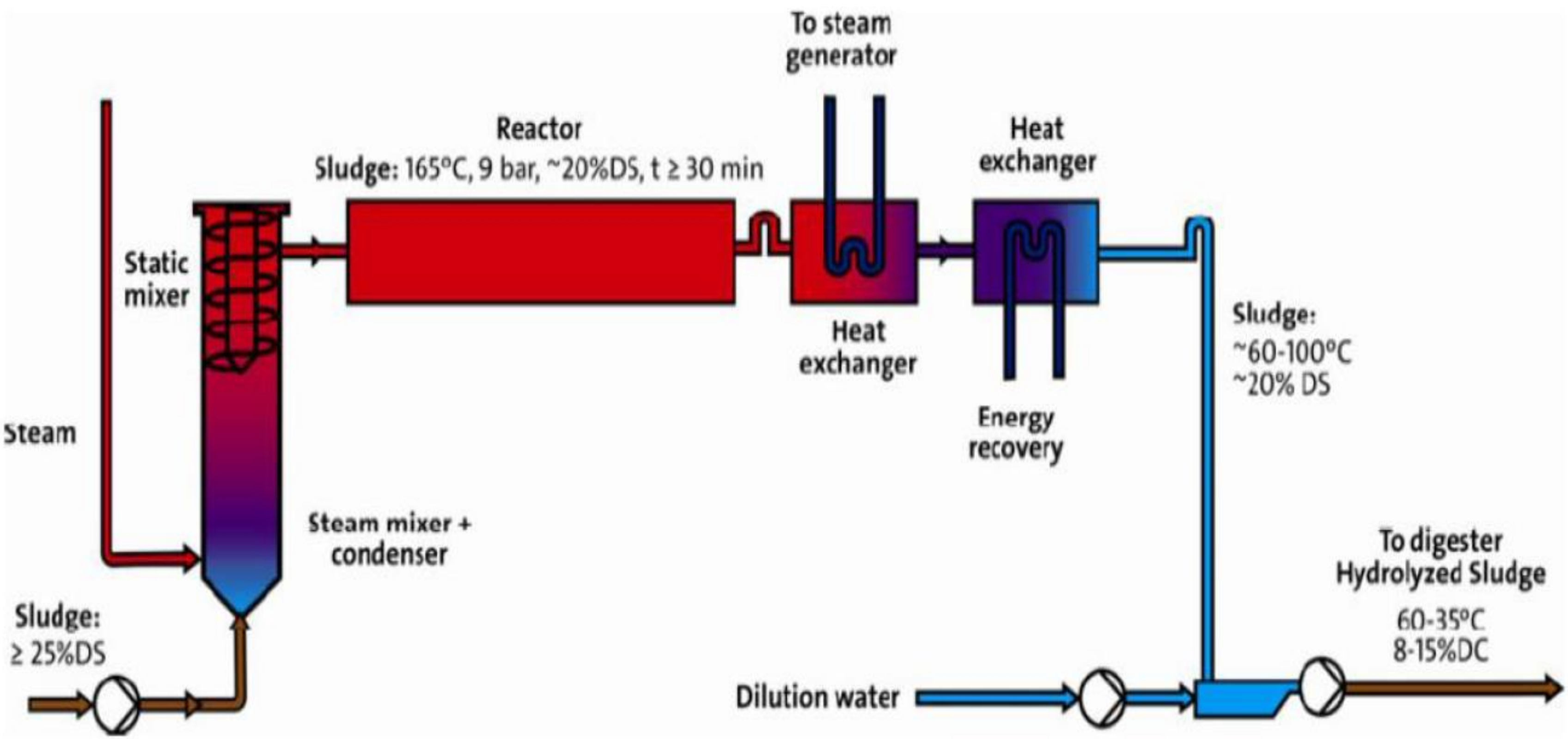
In Korea, applied at Anyang Bakdal WWTP

Application of Cambi™ Process



Process schematic of DC Water's new biosolids program, CDM Smith

Exelys™ Process



Operation of Exelys™ Process

Developed by Veolia Water Technologies

Operated in a continuous plug flow mode / Dewatered sludge and steam are continuously fed to a mixing and condensing system

The pressurized sludge are fed to a plug flow reactor with sufficient detention time for the hydrolysis reaction to occur

After leaving the reactor, the solids are cooled and diluted to feed the digester at the desired solid content and temperature

No steam recycling system, but higher input solid content compared to Cambi™

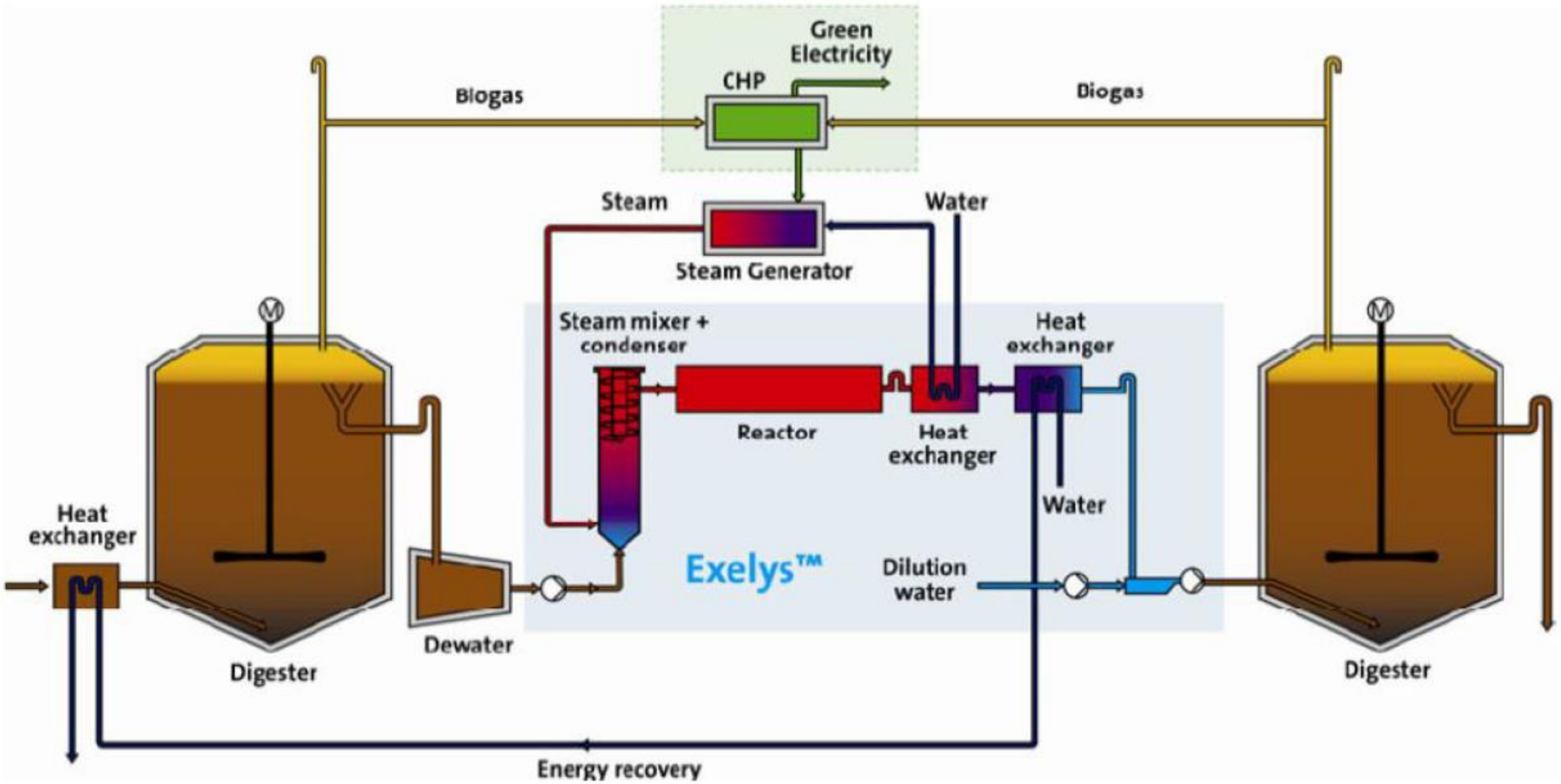
In Korea, applied at Yeosu WWTP and Geoje WWTP

Comparison between two THP processes

Exelys™	Cambi™
Continuous Plug Flow Reactor	Series of Batch Tanks (Pulper, Reactors and Flash Tank)
Need to be tested for meeting USEPA Class A	Meets EPA Class A requirements
Continuous Steam Injection	Intermittent Steam Injection Based on Timers and Number of Reactors
No Flash Steam Heat Recovery	Flash Steam Heat Recovery to Reduce Live Steam Injection Requirements
New Technology (only 1 operating demonstration plant)	Established Technology (> 20 operating installations)
Sludge Feed > 20%	Sludge Feed at 16-17%
Offers Lysis –Digestion (LD) or Digestion – Lysis – Digestion (DLD) Configurations	Offer only Lysis – Digestion (LD) configuration
Process design is specific to plant and offers option to lower size plants	Standard size process (multiple of ~20 dtpd)

(Mohammad Abu-Orf, et al., 2012)

Exelys™ DLD Process

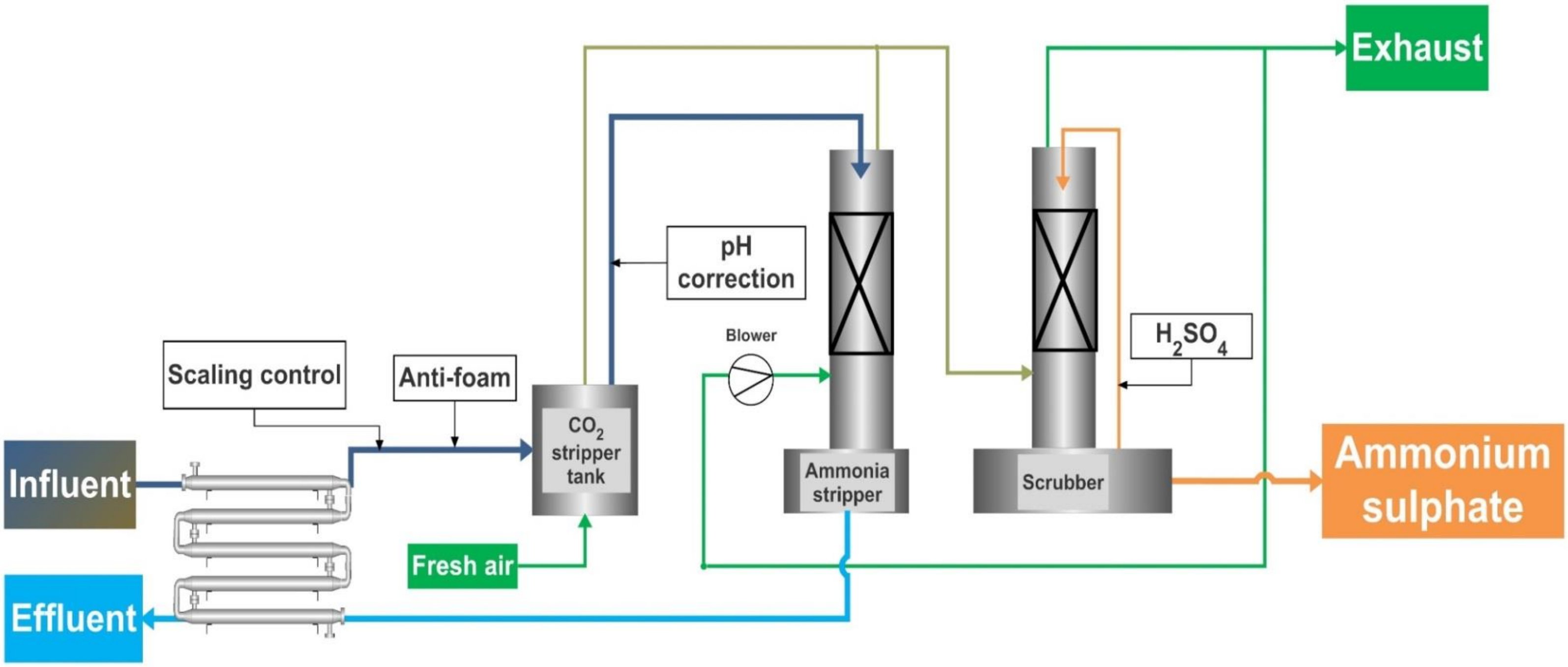


Higher VS reduction, increased biogas production and improved energy balance

Major disadvantage is the bigger volume required for conventional THP

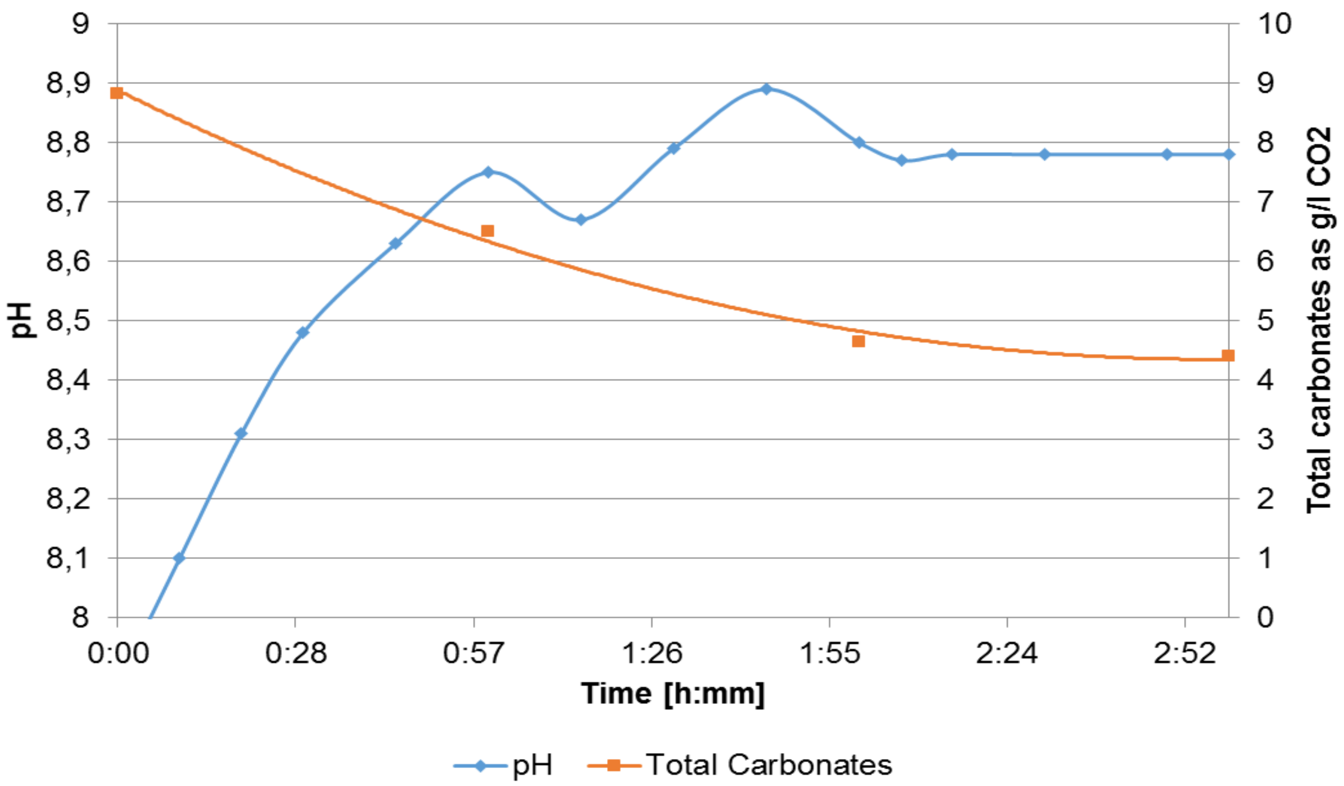
5 Ammonia Stripping for Digestate Treatment

Ammonia stripping process



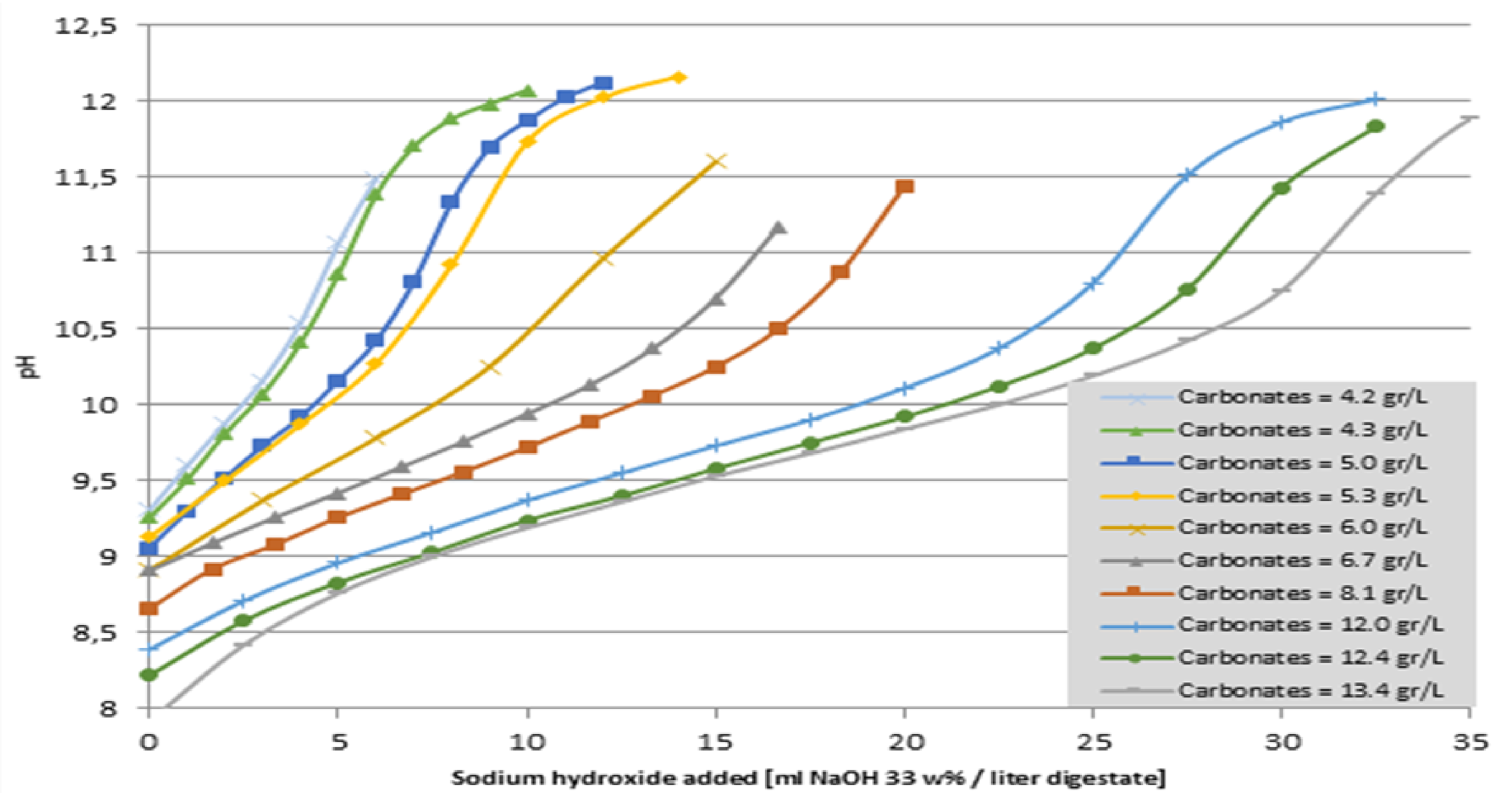
by Nijhuis Industries, 2016

pH increase due to CO_2 stripping



by Nijhuis Industries, 2016

Caustic savings due to CO_2 stripping



by Nijhuis Industries, 2016

Q&A