Thermal hydrolysis "wh" questions answered through pilot and full-scale experiences

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Highlights

- Thermal hydrolysis (TH) is the technology of choice to achieve Advanced Anaerobic Digestion (AAD).
- Operating results from two pilot plants and two 24/7 full-scale commercial plants are presented.
- Pre-, inter- and post-treatment to Anaerobic Digestion (AD) configurations have been evaluated.

Keywords: Advanced anaerobic digestion, Thermal hydrolysis, Configurations, Wh questions, Optimization.

Introduction

With the kinetics of anaerobic digestion (AD) limited by the hydrolysis stage, several pretreatments (biological, chemical, physical and thermal) have been developed to accelerate this step and improve the global process. While each pretreatment features distinct advantages and drawbacks [1-3], thermal hydrolysis (TH) is emerging as the preferred one because of its wide-ranging technical and economic benefits [4].

A relatively mature technology, approaching one hundred commercial plants in operation [5] worldwide, thermal hydrolysis is barely present in Latin America. By way of introduction to the region, and through the design, construction and operation of two pilot plants and through the continued, 24/7 operation of two full-scale commercial plants, the key "wh" thermal hydrolysis questions are explored.

Material and Methods

The Biomethane Potential (BMP) method is used to evaluate different substrates and different plant operating conditions, importantly hydrolysis temperature and retention time.

Microbiology analysis of selected marker parameters are used to certify the hygienization of the biosolids and compliance with ever-increasing regulations.

Different TH configurations are qualitative and quantitatively compared.

Table 1 illustrates the main key effects of TH and their impact on the global process performance and economics.

Table 1. Key TH effects and impact on AD and process economics

TH effect	Impact on AD & dewatering	Economic analysis
Improved sludge biodegradability	• Increased biogas yield • Faster kinetics • Reduced digester volume	• Power from biogas • Digesters size • Capex
Rheology changes	• Lower mixing energy in digesters • Improved dewaterability • Lower final biosolid volumes	• Opex • Poly usage • Biosolids disposal
Pathogen destruction	• Hygienized • Sludge applications (agriculture)	• Biosolid disposal options • Disposal price

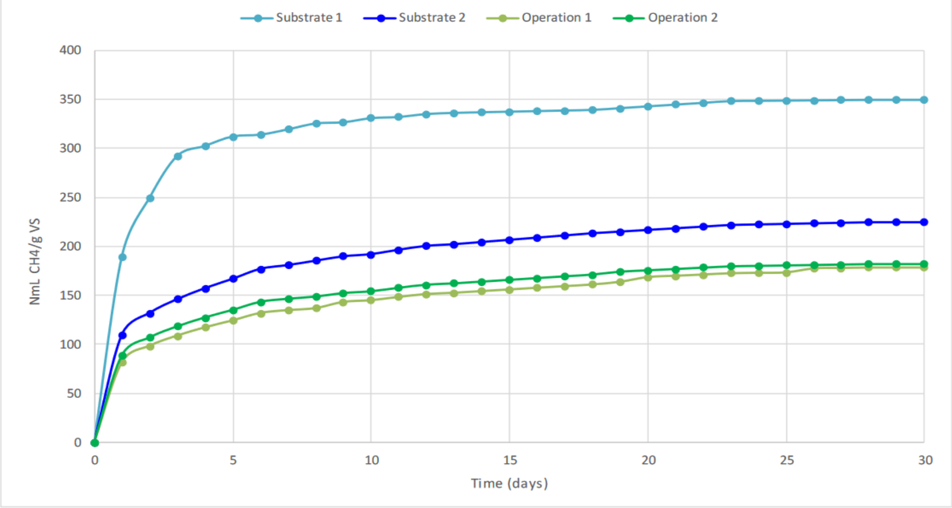
Results and Discussion

Why? The drivers behind the adoption of thermal hydrolysis technology depend on local legislation and pricing structure and include increased biogas yields, reduce digestion capacity, reduced digestate volumes and pathogens removal.

What? Depending on their inherent biodegradability, different organic materials will benefit in varying degrees from thermal hydrolysis. Various substrates have been tested and assessed via BMP analysis (sample graph in Figure 1).

How? BMP results allows to identify the optimum conditions to maximize biogas yields while minimizing the generation of non-biodegradable material via Maillard reactions (Figure 1).

Figure 1 – What (substrates) and How (operating conditions) via BMP analysis.



When? Depending on site-specific, regulatory and market drivers, thermal hydrolysis can pursue different objectives (Table 2) such as: minimize sludge line capex by reducing digesters capacity, improve energy balances in sites with oversized digestions, reduce biosolids volume and hygienize the biosolids.

Table 2. When (objective) and Where (configuration)

When? If the objective is to…	**Where?** The optimum configuration is…
Minimize capex in grassroots design or plant expansions	Pre-treatment
Minimize opex and/or oversized digestion capacity	Inter-treatment
Maximize energy production (hygienization not required)	WAS-only
Minimize biosolids volume	Post-treatment

Where? The same TH process can be placed as pre-, inter- or post-treatment to the anaerobic digestion [6]. These configurations are evaluated, alongside their relative merits to become the optimum one for different situations (Tables 2 and 3).

Table 3. Configurations comparison: key parameters

	Pre-	**WAS-only**	**Inter-**	**Post-**
Power	6%	20%	31%	20%
Biosolid volume	-36%	-30%	-42%	-50%
Polyelectrolyte dosing	32%	-7%	7%	33%
AD volume	-48%	-25%	10%	25%

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