Control of dissolved CH_4 in an effluent of a UASB reactor treating municipal wastewater

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Anaerobic treatment

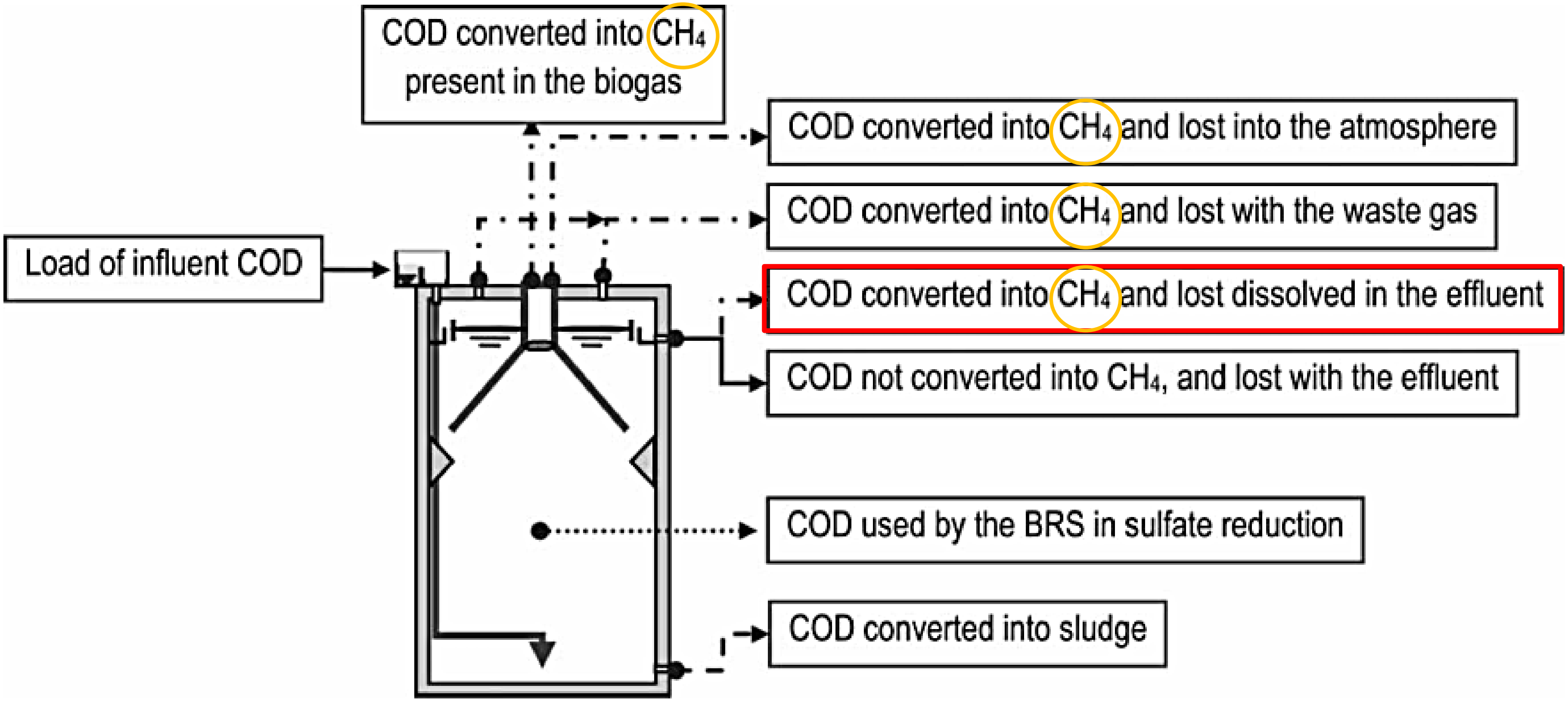
Advantages

- ✓ Low energy consumption
- ✓ Less sludge (biomass) production
- ✓ $\boxed{\text{Methane}}$ for energy production

GWP_{100} 34(*) times higher than CO_2

(*) Myhre *et al.* (2013)

Direct anaerobic municipal sewage treatment



COD conversions routes and methane flow in UASB reactors (Lobato *et al*., 2012)

Direct anaerobic municipal sewage treatment

Greenhouse Gas, Global Warming

atmosphere

Anaerobic effluent

20 - 60% of the total mass of produced methane*

***Noyola *et al*. (1988), Souza *et al*. (2011), Heffernan *et al*. (2012)**

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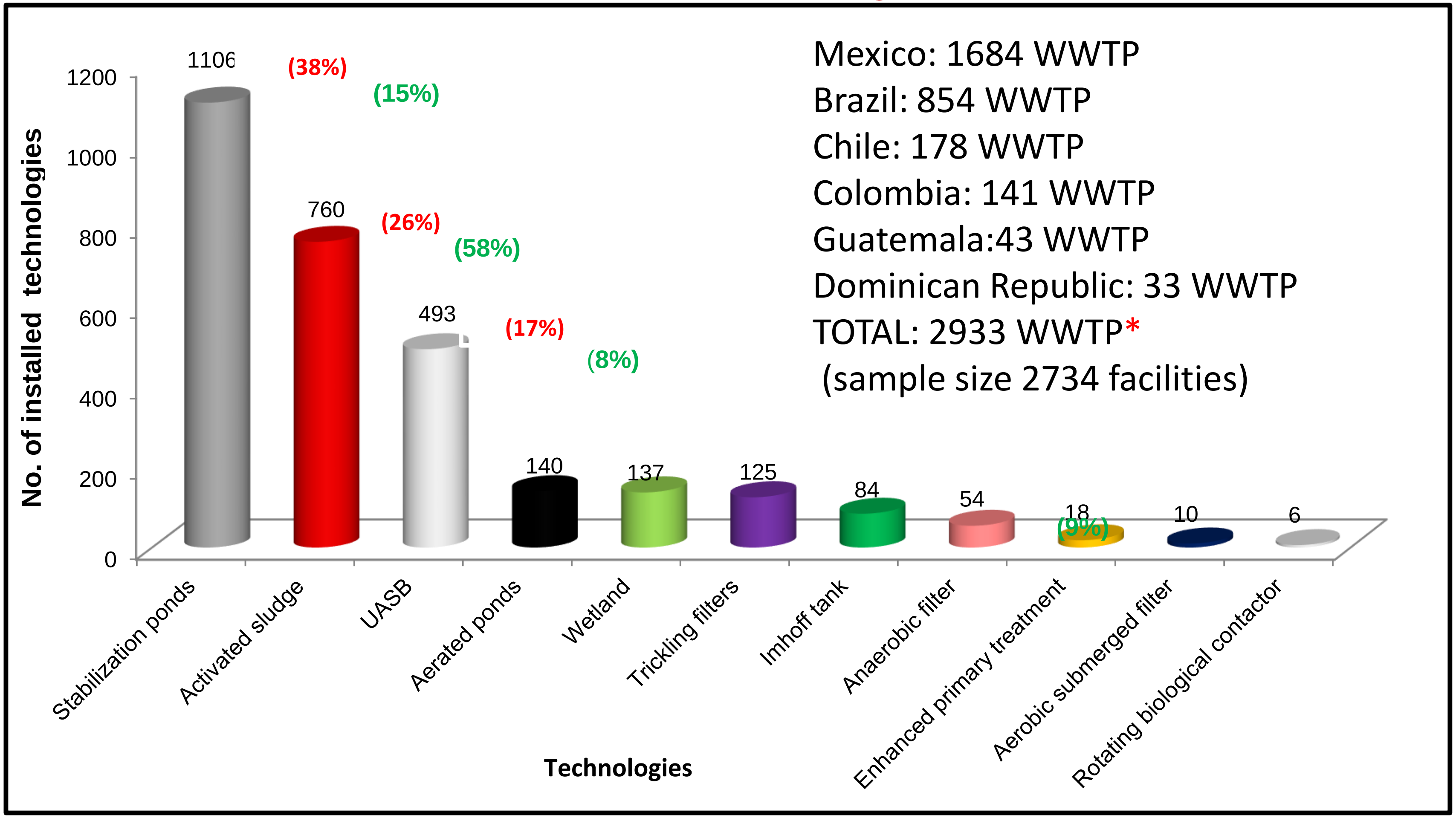
Processes applied for wastewater treatment in selected countries

Distribution per technologies



Noyola et al. (2012)

The 3 most used technologies count for 80% of the sample of WWTP and 81% of the sample of WWT capacity

- The septic tank was not considered as a technology
- * 199 WWTP are combined processes (two technologies) counted as two
- Percentages in red based on total number of WWTP in sample
- Percentages in green based on total treatment capacity of sample

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OBJECTIVE

To evaluate a pilot scale system for recovering dissolved CH_4 from an anaerobic sewage effluent and then remove it in a compost biofilter.

The system is intended for small municipal anaerobic treatment plants

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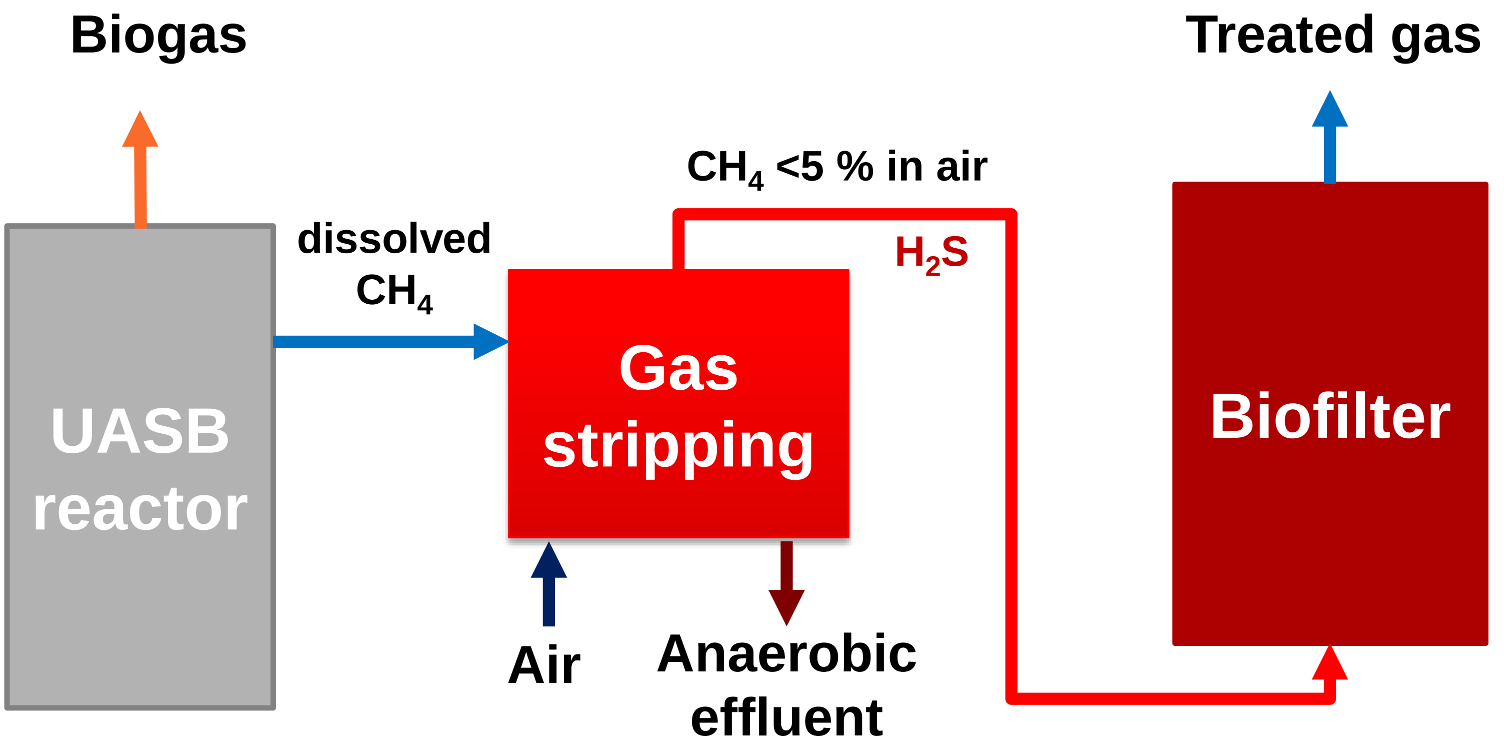
Biogas
Treated gas
CH_4 <5 % in air
dissolved CH_4
H_2S
UASB reactor
Gas stripping
Biofilter
Air
Anaerobic effluent

Pilot plant at a full (small) treatment facility in a UNAM campus in Mexico City (Design flow: 5 L/s; Flow diverted to pilot plant: 0.5 L/s)

Process integration: grit chamber, screen, UASB, activated sludge, disinfection, filtration

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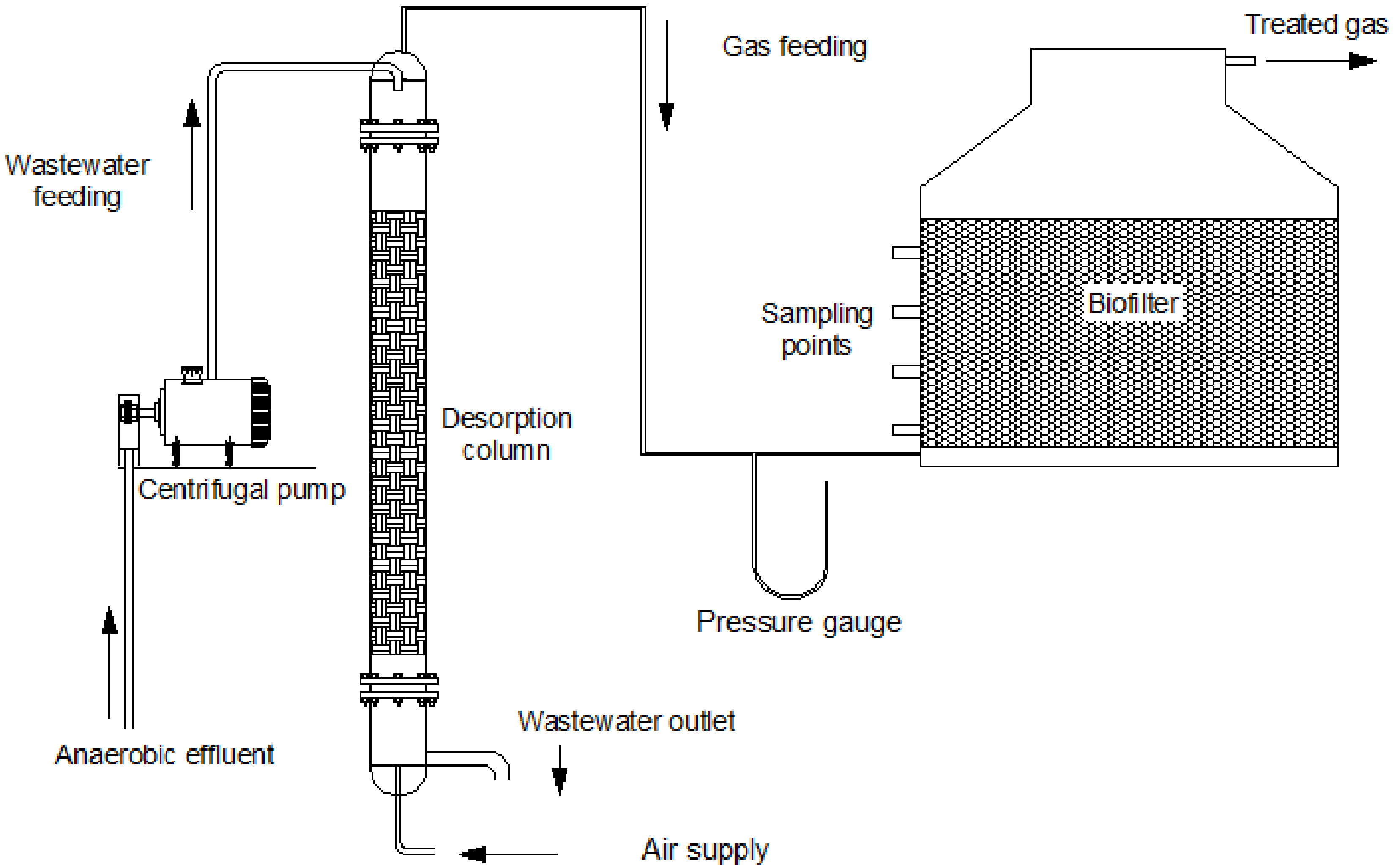
Materials & Methods

Schematic diagram of the pilot set-up composed of a desorption column and a compost biofilter.



Materials & Methods

Pilot system for the biological removal of dissolved CH_4 in a UASB effluent

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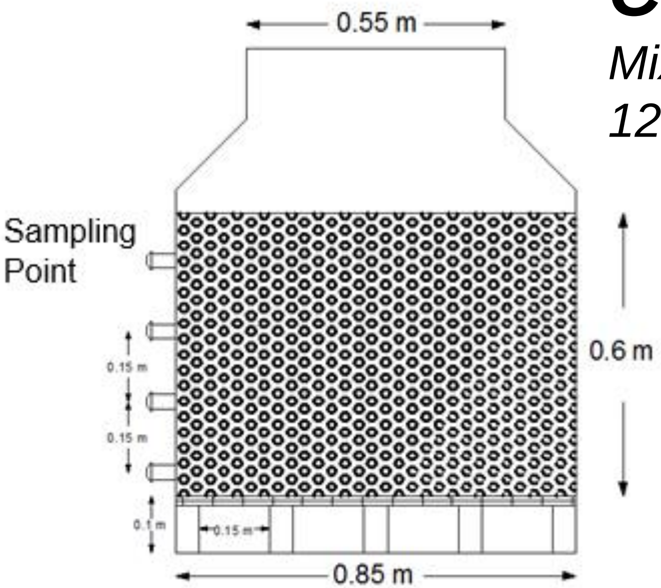
Desorption column

Diameter 0.15 m
Total height 2 m
Packed height 1 m

- Pall rings
- Diameter 2.5 cm
- Height 2.5 cm
- Specific area 280 m^2/m^3
- Void fraction 90%.

Biofilter



Compost

Mix = 338 kg (fresh compost) + 127 kg (H_2S acclimatized compost)

Total volume packed 0.340m^3
Packed height 0.60 m

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Operating conditions

Desorption column				
	Flow of wastewater feed (m^3/h)	Flow of air feed (m^3/h)	Air-to-water ratio (v/v)	Temperature‡
Condition I	0.9	0.9	1:1	17.6 ± 1°C
Condition II	1.88	0.9	1:2	20.5 ± 1.5°C

‡ Temperature of wastewater entering the desorption column

Biofilter

Empty bed retention time (EBRT) = 23 min
Flow = 0.9 m^3/h (15 L/min)

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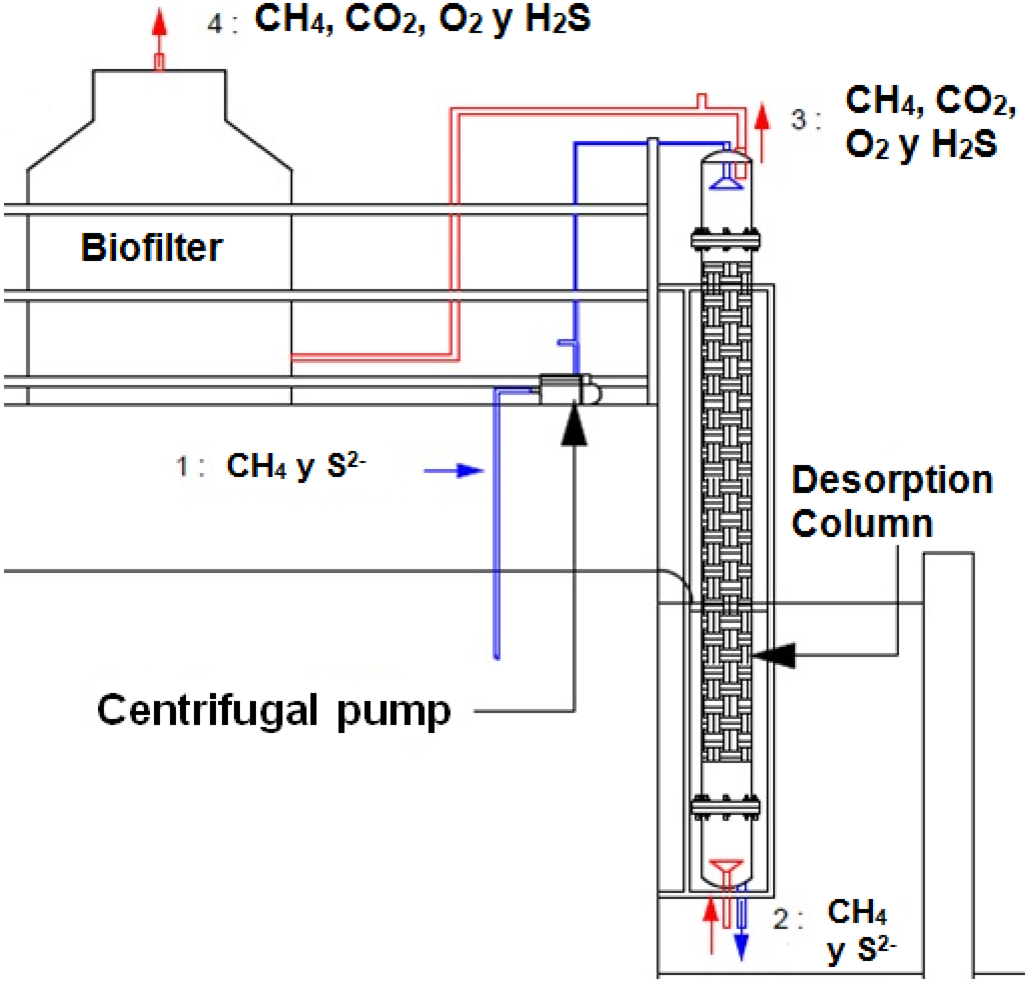
Sampling



Dissolved CH_4

Methodology proposed by Souza et al. (2011) y Martí et al. (2012)

Dissolved S^{-2}

Standard Method 4500 – S^{2-}D
Methylene Blue Method

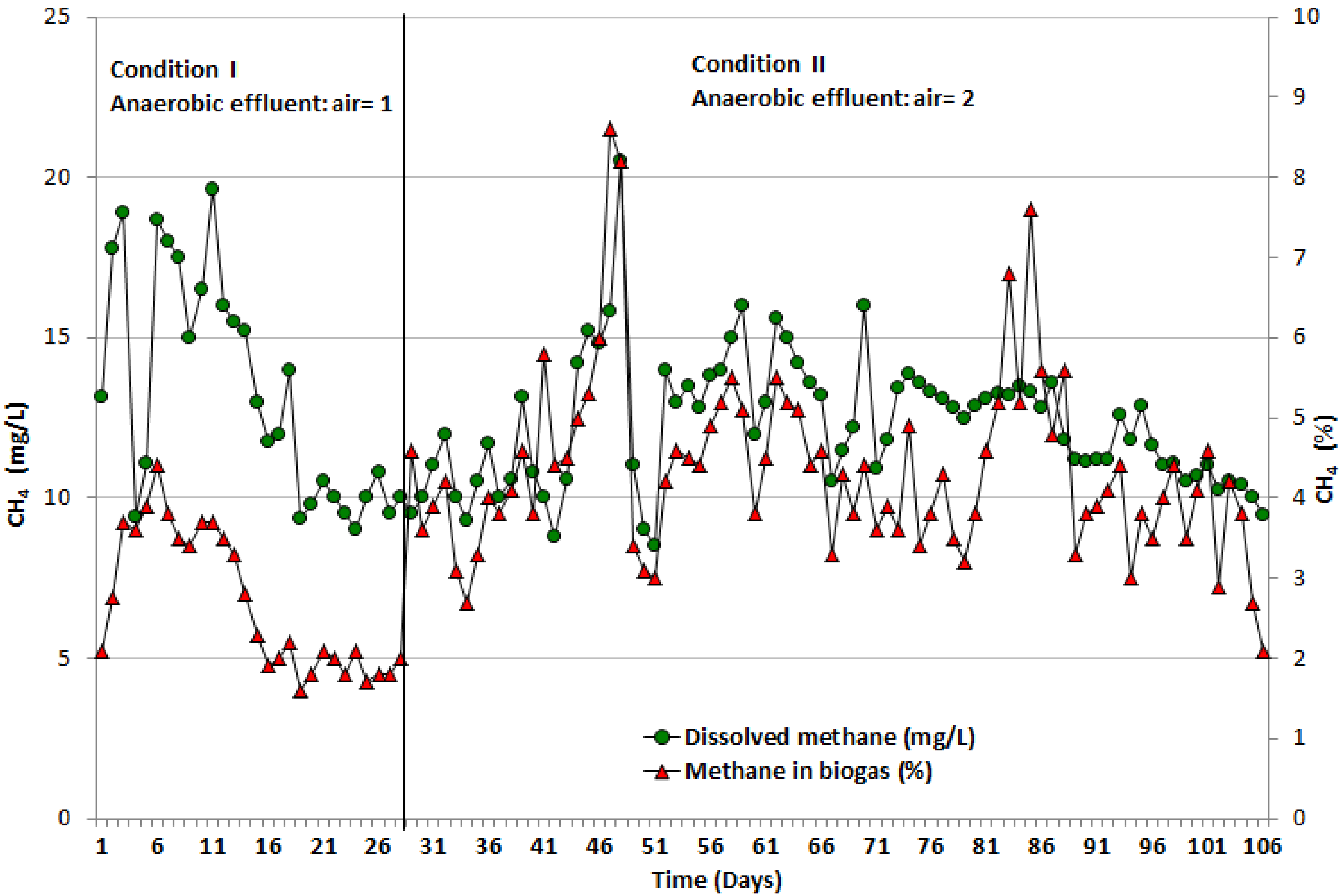
Gases

Biogas 5000

pH, T

Results

Concentration of CH_4 in the inlet (dissolved, mg/L) and outlet (gas, %) of the desorption column.



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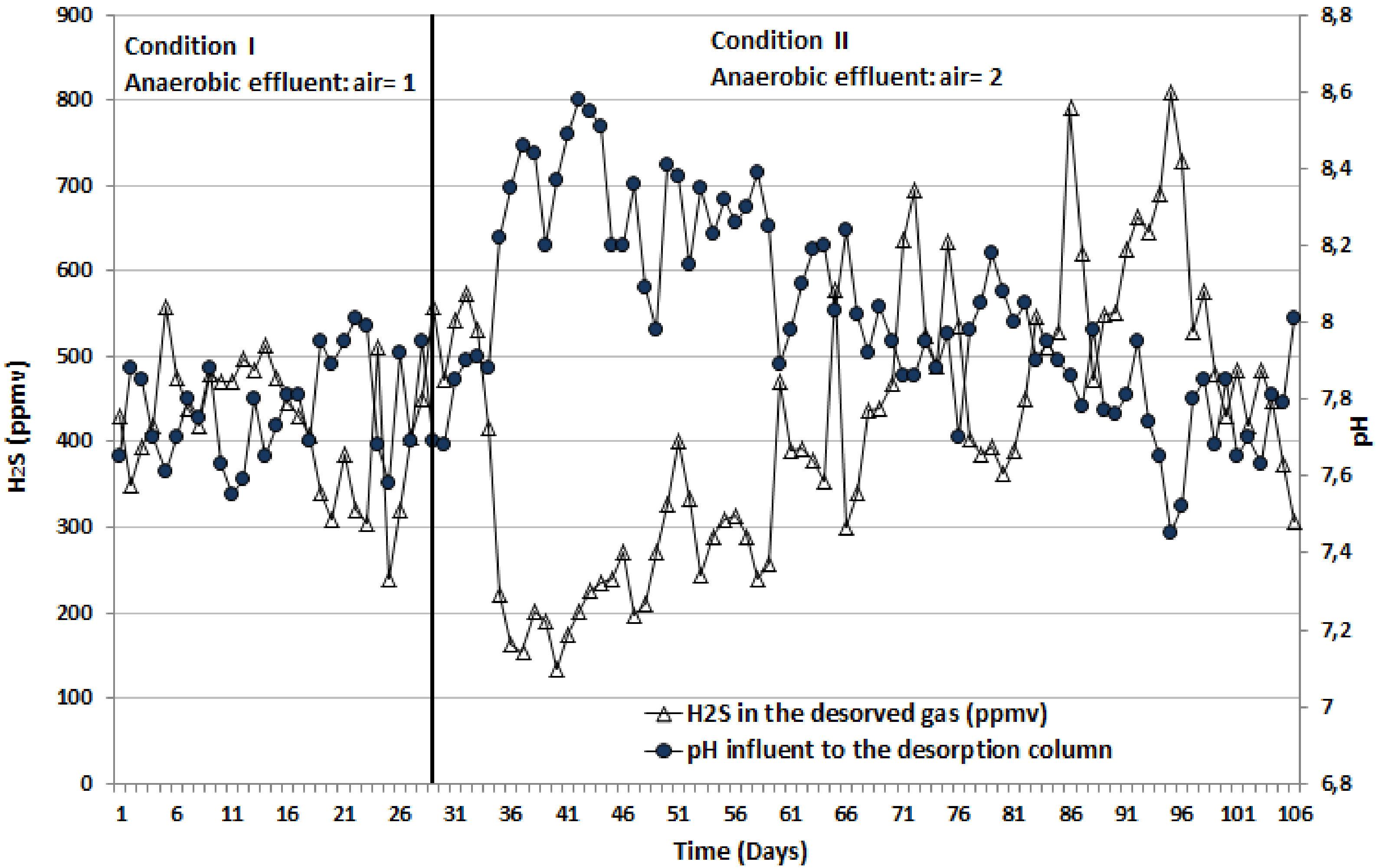
Results

Concentration of H_2S in the desorbed gas and pH of the anaerobic effluent at the entrance of the desorption column.



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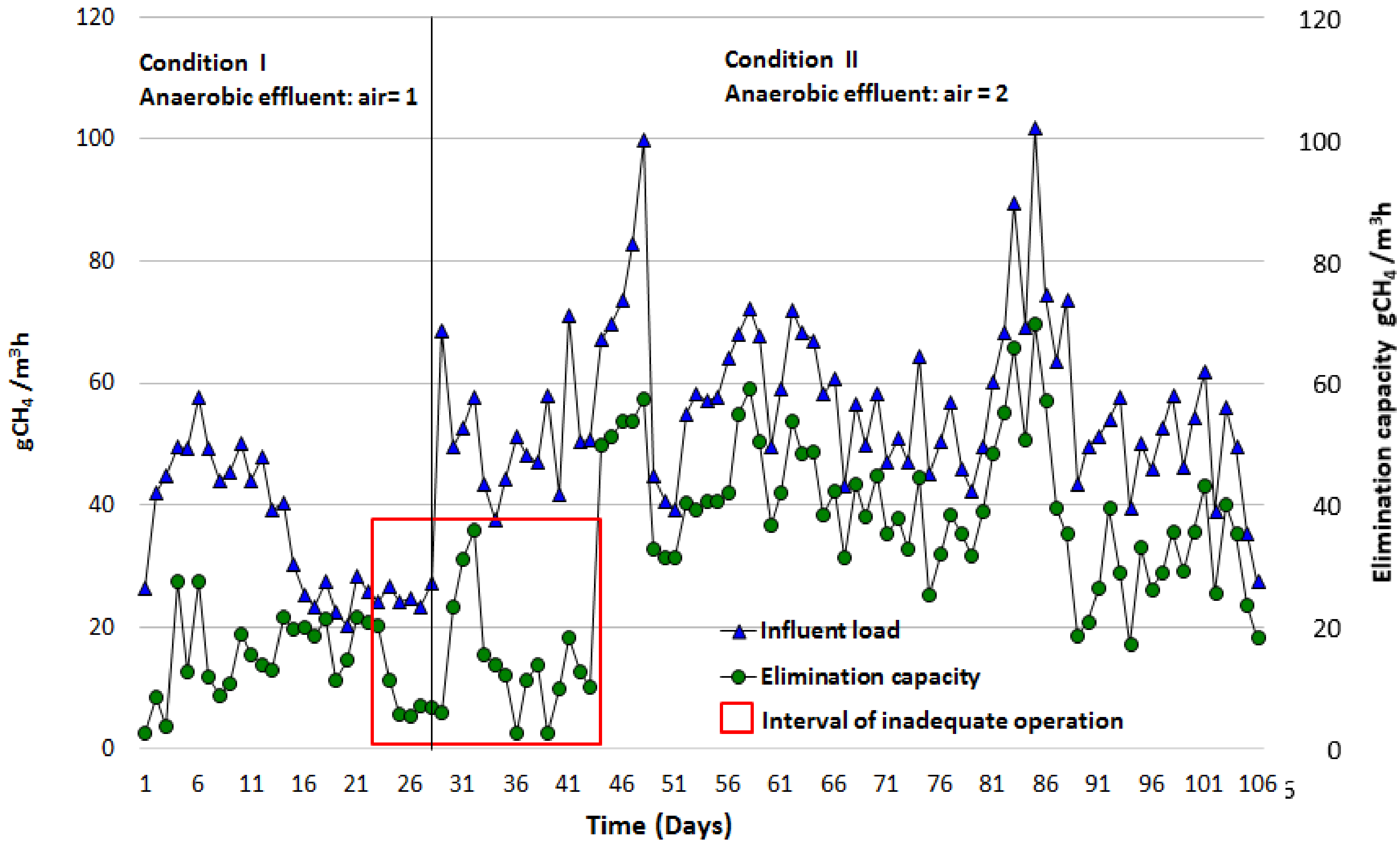
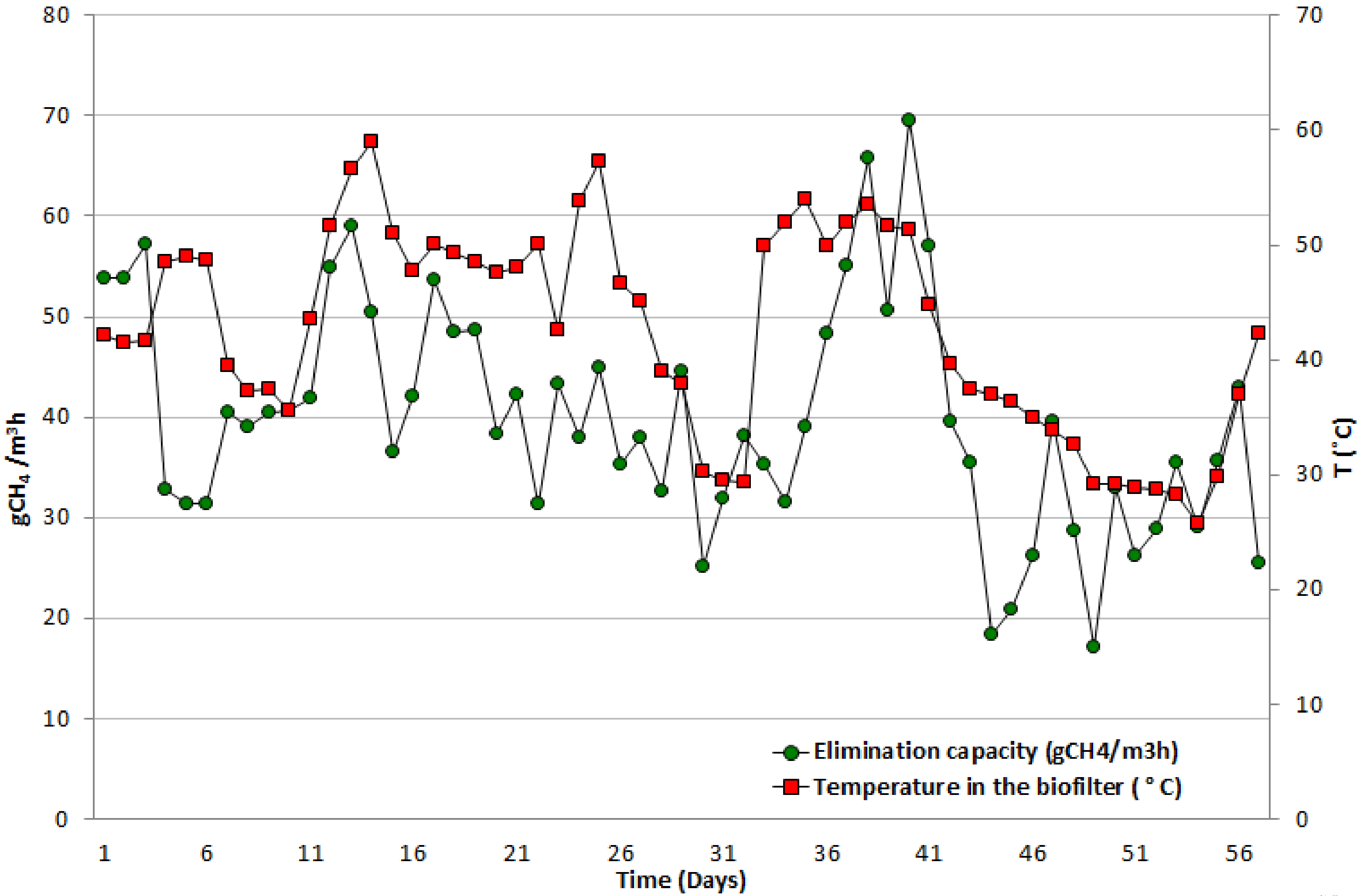
Results

CH_4 load and elimination capacity of the biofilter.

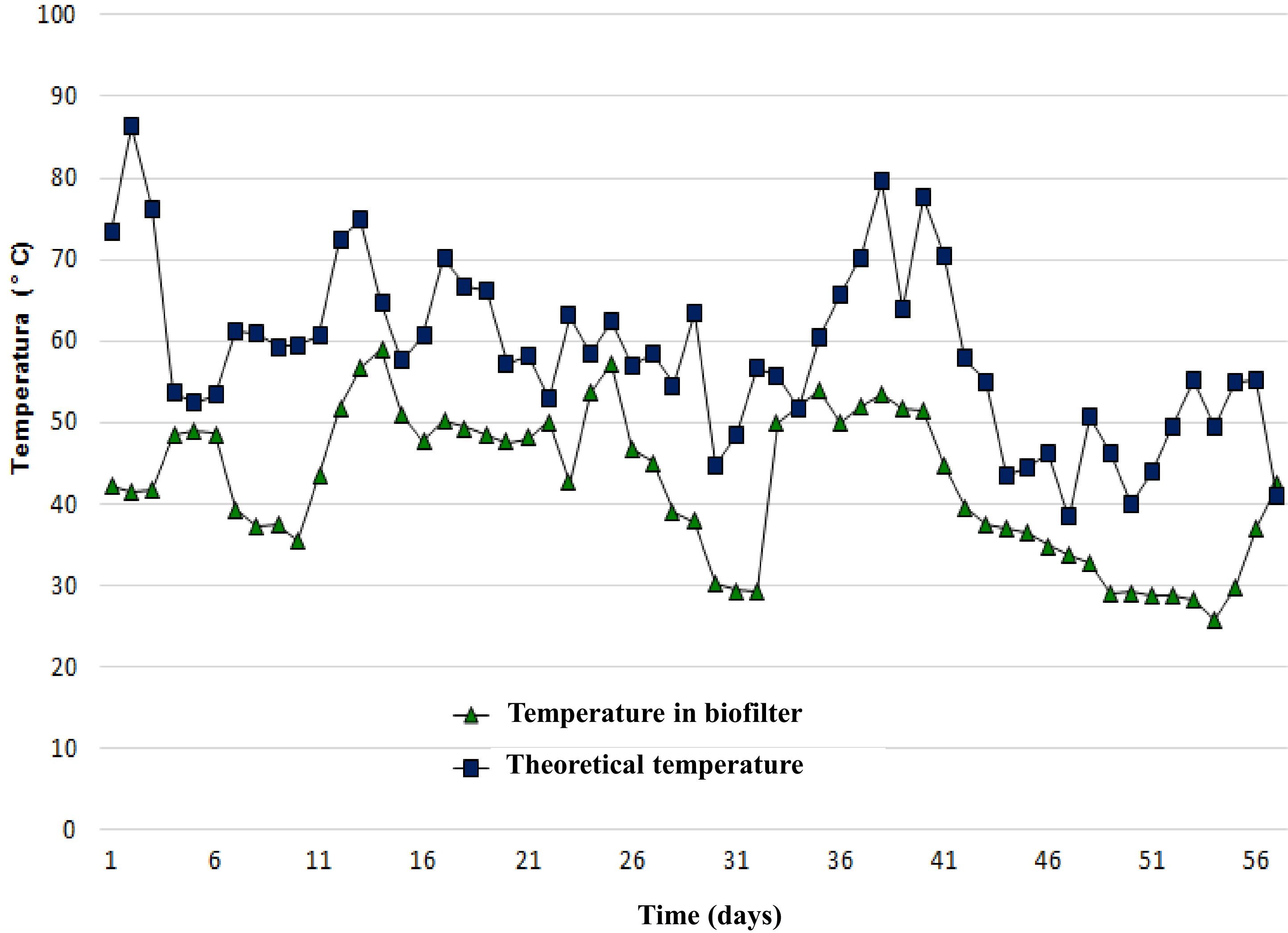


Results

Temperature variation in the biofilter as a function of CH_4 removal capacity.



Temperature variation (measured and theoretical, ΔG°) in the biofilter as a function of CH_4 and H_2S removal capacity.



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Conclusions

- *The concentration of CH_4 in the gas outlet of the desorption column was directly proportional to its dissolved concentration in the anaerobic effluent.*

- *The desorption of H_2S occurred as a function of the pH of the liquid effluent.*

- *Under the applied operating conditions in the desorbed gas stream (CH_4 at 4.3% and H_2S of 421 ppmv), the biofilter removed 70 and 100% of these gases, respectively.*

- *The average temperature inside the biofilter was 42 ± 9 °C due to the heat generated by the exothermic reaction of CH_4 oxidation. The control of temperature and water content in the filter media is particularly important for CH_4 biofiltration.*

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