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Nom i cognoms	FABIANA LOPES DEL REI PASSOS
Títol de la tesi	Microalgae conversion to biogas: Pretreatment methods to improve the anaerobic digesiton of biomass grown in wastewater treatment systems
Unitat estructural	Departament d'Enginyeria Hidràulica, Maritima i Ambiental
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(Mínim 1 i màxim 4, podeu veure els codis a http://doctorat.upc.edu/gestio-academica/impresos/tesi-matricula-i-diposit/codis-unesco)

Resum de la tesi de 4000 caràcters màxim (si supera els 4000 es tallarà automàticament)

High rate algal ponds (HRAP) are an economic and environmental-friendly approach to treat urban wastewater. In these systems, microalgae and heterotrophic bacteria grow in symbiosis, in such a way that oxygen needed for organic matter biodegradation is produced by microalgae photosynthesis and, therefore, no mechanical aeration is required, in contrast to conventional activated sludge systems. Microalgal biomass harvested from secondary settlers may be valorised through anaerobic digestion producing biogas. However, the process is hampered by the hydrolysis, since organic macromolecules retained by microalgae cell wall are not readily available to anaerobic microorganisms.
The aim of this PhD thesis is to investigate the anaerobic digestion of microalgal biomass grown in a HRAP and pretreatment methods to improve biogas production.
Firstly, anaerobic digestion of microalgal biomass was evaluated without applying any pretreatment step. For this, a pilot HRAP and a lab-scale anaerobic reactor were monitored during one year. Average methane yield was 0.13 L CH_4/g VS when the reactor was operated with a HRT of 15 days and 0.17 L CH_4/g VS after increasing the HRT to 20 days. Microalgae anaerobic biodegradability was highly variable and often low compared to other organic substrates, such as agricultural waste. Microalgae species growing in the HRAP changed over time, due to environmental conditions, wastewater composition and interrelations with other microorganisms. Indeed, results suggested that microalgae anaerobic biodegradability depended on the characteristics of microalgae cells composing the biomass in each period, hence it was species-specific.
Subsequently, for improving biomass anaerobic digestion, four pretreatment techniques were evaluated in batch tests, i.e. microwave, thermal, hydrothermal and ultrasound pretreatments. In each case, several operating parameters (i.e. temperature, exposure time, output power and applied specific energy) were combined for selecting the best conditions in terms of organic matter solubilisation and methane yield increase, which were further assessed in continuous reactors. In all studied cases, pretreatment enhanced biomass solubilisation and methane yield, reaching the highest value for thermal pretreatment at 95 ºC (0.31 L CH_4/g VS), which was 70% higher in respect to non-pretreated microalgae. In fact, when comparing the four methods in batch tests using the same initial microalgal biomass, thermal pretreatment (95 ºC and 10 hours) led to the highest volatile solids solubilisation (27%) and methane yield increase (72%) in respect to control.
Microscope analysis indicated that the studied pretreatment methods did not cleave microalgae cell walls; however most cells were damaged beyond repair, enhancing organic molecules bioavailability and biodegradability. Microalgae species with cell walls containing proteins and carbohydrates showed higher methane yield increase in contrast with species with more resistant cell walls, such as diatoms.
The energy balance of the process suggested that pretreatments using heat (thermal and hydrothermal), rather than electricity (microwave), were more energy efficient. The best results were attained for the thermal pretreatment at 75 and 95 ºC, reaching a positive energy balance (30% higher energy production than consumption). Finally, an estimated energy balance of the whole system showed how a microalgae-based wastewater treatment plant would be energy neutral with an average biomass production of 15 g TSS/m^2•d in the HRAP, and even with a biomass production of 10 g TSS/m^2•d by applying a thermal pretreatment step.

Lloc: Barcelona

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