Resumen de Tesis Doctoral

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola de Doctorat

DNI/NIE/Pasaporte	
Nombre y apellidos	Raquel Gutiérrez Martínez
Título de la tesis	Microalgae harvesting in wastewater treatment plants: Application of natural techniques for an efficient flocculation
Unidad estructural	751- Departament d'Enginyeria Civil i Ambiental (ECA)
Programa	Enginyeria Ambiental
Códigos UNESCO	250811 / 330800 / 330809 / 330811

(Mínimo 1 y màximo 4, podéis verlos en http://doctorat.upc.edu/gestion-academica/carpeta-impresos/tesis-matricula-y-deposito/codigos-unesco)

Resumen de la tesis de 4000 caracteres máximo (si se superan los 4000 se cortará automáticamente)

Research of new sources of bioenergy is nowadays driving attention to microalgae. Cost-effective biomass harvesting poses a challenge for full-scale microalgae production for biofuels. In the context of wastewater treatment with microalgae cultures, coagulation-flocculation followed by sedimentation seems to be the most suitable option for microalgae harvesting as low energy and no extra materials are required.

The main objective if this PhD thesis was to evaluate and improve the harvesting efficiency of microalgal biomass grown in wastewater treatment high rate algal ponds (HRAPs) by means of flocculation-based pre-concentration techniques (i.e. coagulation-flocculation with organic flocculants and biomass recycling). Moreover, the energy assessment of a full-scale wastewater treatment system based on HRAPs followed by anaerobic digestion of harvested microalgal biomass located in a Mediterranean Region was assessed.
Firstly, coagulation-flocculation and sedimentation with two tannin-based polymeric flocculants (Ecotan and Tanfloc) was evaluated by means of static sedimentation tests in conventional settling columns. Low flocculants doses (10-50 mg/L) enabled over 90% biomass recovery. Furthermore, both flocculants increased microalgae settling velocity, leading to fast and efficient biomass recovery (> 90% recovery in 10-20 min).
Subsequently, dynamic sedimentation tests were performed in a water elutriation apparatus in order to evaluate the settling velocities distribution of microalgal biomass with and without flocculants. This time, a tannin-based flocculant (Tanfloc) and a cationic starch were evaluated. The amount of biomass reaching settling velocities higher than 6.5 m/h increased from 10-14% (without flocculant) to 70-84% when 20-40 mg/L of Tanfloc were added. On the other hand, 10-25 mg/L of starch enabled more than 95% biomass recovery, increasing from 46% to 78% the amount of particles with settling velocities higher than 6.5 m/h. According to the results, a settler designed with a critical settling velocity of 1 m/h (which is a typical value in secondary settlers) would enable over 90% biomass recovery while reducing the hydraulic retention time and the settler surface as compared to biomass harvesting without flocculants.
Microalgal biomass harvesting was also tested by recycling some of the harvested microalgal biomass (2% and 10% dry weight) to the pilot wastewater treatment HRAP in order to increase the predominance of rapidly-settling microalgae species. Results indicated that biomass recycling had a positive effect on the harvesting efficiency, obtaining higher recoveries in the pilot HRAP with recycling (91-93%) than in the pilot HRAP without recycling (75 – 88%), and increasing the percentage of biomass with high settling velocity. This was due to the fact that the abundance of rapidly-settling strains such as Stigeoclonium sp. and diatoms increased when 10% (dry weight) of harvested biomass was recycled.

Experimental results from this PhD thesis suggested that either flocculation with natural organic flocculants or biomass recycling improves harvesting efficiency of microalgal biomass with high biomass recoveries (>90%), increasing by 2-8-folds the amount of biomass with high settling velocities (6.5 m/h) and obtaining the best results in those experiments in which rapidly settling species (e.g. Stigeoclonium sp. and diatoms) were dominant. Finally, the energy balance of a microalgae-based wastewater treatment plant located in the Mediterranean Region was assessed based on experimental results. The harvested microalgal biomass grown in wastewater HRAPs would undergo anaerobic digestion (with or without thermal pretreatment) to produce biogas and generate electricity and/or heat. The energy assessment concluded that the system should achieve microalgal biomass production of at least 15 g TSS/m2d and/or a methane yield of 0.5 m3CH4/KgVS all over the year to be energy self-sufficient.

Lugar: Barcelona Fecha: 11/03/2016

Firma