

BIOGAS PRODUCTION FROM ALGAE BIOMASS GROWN IN HIGH RATE PONDS FOR WASTEWATER TREATMENT

Fabiana Passos¹, Sabina Cordón, Maria Solé, Ivet Ferrer²

GEMMA-Departament d'Enginyeria Hidràulica, Marítima i Ambiental
¹e-mail: fabiana.lopes.del.rei@estudiant.upc.edu, ²e-mail: ivet.ferrer@upc.edu

Key Words: wastewater treatment, microalgae, anaerobic digestion, methane, renewable energy

Abstract: *High rate ponds are wastewater treatment systems that combine heterotrophic bacteria and microalgae communities in a symbiosis relation, which triggers a series of reactions that eliminates pollutants from the water. Moreover, during the last decade, there has been a growing interest in investigating the energy potential of biofuels obtained from microalgae cultures. The high lipid content of microalgae makes them an alternative to terrestrial energy crops for biodiesel production. A major drawback of microalgae anaerobic digestion is the hydrolysis of cell walls. The aim of this project is to study the potential of high rate ponds for wastewater treatment, biomass and biogas production and finally evaluate the technology as a new energy source.*

High rate ponds are extensive natural wastewater treatment systems where heterotrophic bacteria and microalgae communities grow in a symbiotic relation. Algae photosynthetic activity produces the oxygen necessary for organic matter degradation by aerobic bacteria, which generates carbon dioxide used by the microalgae communities for photosynthesis. In this way, algae biomass growth also contributes to the reduction of greenhouse gases emissions, since the inorganic carbon used for photosynthesis is mostly atmospheric. Therefore, the system is a carbon dioxide gas sink.

Regarding the wastewater treatment, high rate ponds are secondary treatment systems, since aerobic bacteria oxidize the organic matter. Moreover, the system is efficient in elimination of nutrient by microalgae biomass assimilation. For this reason, an important issue is the effective separation between algae biomass and treated effluent.

During the last decade, there has been a growing interest in investigating the energy potential of biofuels obtained from microalgae cultures. The high lipid content of microalgae makes them an alternative to terrestrial energy crops for biodiesel production. However, this technology is still at an initial research phase. According to the literature, the cultivation of microalgae in photobioreactors to produce biofuels has a number of requirements that may limit its implementation at industrial scale.

Anaerobic digestion of microalgae was first studied in the 1950s by Oswald and Golueke in California, USA. These authors used algae biomass from high rate ponds, pointing out biomass separation from the liquor as a major limitation of the process. Up to date, the

literature on microalgae digestion is very limited compared to other substrates like sewage sludge. However, it is known that a major drawback of microalgae anaerobic digestion is the hydrolysis of cell walls.

The pre-treatment of substrates to increase the anaerobic biodegradability has been the subject of intense research in recent years. Chemical, thermal and mechanical processes (i.e. ultrasounds and microwave) have proven successful at improving the disintegration and anaerobic biodegradability of sludge [2]. Moreover, positive energy balances of these processes have been reported.

The electromagnetic radiation of microwaves has been investigated as sludge pretreatment process [3]. This pretreatment condition can result in changes in the secondary and tertiary structure of proteins and accelerate cell hydrolysis. Microwave thermal effect was studied previously, concluding that the microwave pretreatment increased cell disruption and biogas production compared to conventional thermal pretreatments [1]. Cell hydrolysis is caused by the polarization of macromolecules sidechains, which align in direction with the electric field, influenced by microwave frequency, radiation time, concentration and penetration depth [3].

REFERENCES

- [1] Park, W., Ahn, J., Hwang, S., Lee, C. (2010): Effect of output power, target temperature, and solid concentration on the solubilization of waste activated sludge using microwave irradiation. *Bioresource Technology* 101, S13-S16.
- [2] Ferrer, I., Ponsá, S., Vázquez, F., Font, X. (2008): Increasing biogas production by thermal (70 °C) sludge pre-treatment prior to thermophilic anaerobic digestion. *Biochemical Engineering Journal*, 42 (2), 186-192.
- [3] Eskicioglu, C., Terzian, N., Kennedy, K. J., Droste, R. L., Hamoda, M. (2007): Athermal microwave effects for enhancing digestibility of waste activated sludge. *Water Research* 41, 2457-2466.