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Antifouling microfiltration strategies to harvest microalgae for biofuel

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HIGHLIGHTS

- ▶ Three high lipid content microalgae species were concentrated at lab/pilot scale.
- ▶ Dynamic filtration improved permeability compared with tangential cross-flow filtration.
- ▶ Pre-concentration step substantially improved posterior dynamic filtration.
- ▶ Dynamic filtration is more economic efficient than tangential cross-flow filtration.

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ABSTRACT

Microalgae are microorganisms that can fix CO_2 by using the energy from the sun and transforming it into organic molecules such as lipids (i.e. feedstock for biodiesel production). Microfiltration is a promising method to be considered in the harvesting step. In this study, two antifouling methods were tested in order to minimize permeability decrease over time, at low trans-membrane pressure filtration.

Preliminary experiments were performed to find optimum conditions of transmembrane pressure, rotational speed and membrane pore size. Pilot experiments were carried out in the optimal conditions using microalgae obtained from the culture step and from a previous concentration process based on sedimentation. Fouling was significantly minimized, and the permeability plateau increased up to 600 L/h/m^2/bar.

Three microalgae species were tested: *Phaeodactylum tricornutum* (Pht), *Nannochloropsis gaditana* (Nng) and *Chaetoceros calcitrans* (Chc).

An economic assessment was also performed, which demonstrated that dynamic filtration is economically more efficient than tangential cross-flow filtration.

1. Introduction

According to the BP Statistical Review of World Energy (June 2011) ((BP), 2011) and the Annual Energy Outlook 2011 of the US Energy Information Administration (EIA) ((EIA), 2011), fossil fuels should be replaced by environmentally friendly renewable biofuels. Petroleum is not distributed evenly around the world and, in fact, all reserves are centralized in just a few countries (more than half in the Middle East).

This means that all the countries with no reserves are sensitive to changes in these countries. In 2011, for example, the upheaval in Libya, Egypt and other countries increased the price of petroleum by more than 30% in a few months, a very good reason for decentralizing liquid fuels by providing alternative raw materials.

All regions in the world have their own raw materials that can be used, to a greater or lesser extent, as precursors to produce some sort of biofuel and, in the process, provide jobs for the population and improve their import-dependent economies (Kumar et al., 2008).

Biofuels are also being promoted by governments that hope to meet Kyoto targets to mitigate the problem of environmental pollution and the shortage of petroleum supplies (Corma Canos et al., 2007).

Using microalgae to produce biodiesel has been recognized as a real alternative to petroleum: they have high growth rates (more than three times a day duplication) and high lipid contents (more than 50% of the biomass dry weight) and they are a non-food source for biofuel production (second generation biodiesel).

In the process of producing biodiesel from microalgae there are two bottle neck steps: first a high concentrated production; and second, the harvesting of microalgae before the lipid extraction. Even though a considerable amount of effort has focused on the production step (photo bioreactors have been improved and gene modifications have been made to algae by genetic engineering) no economical and efficient method for microalgae harvesting

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