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Harvesting fresh water and marine algae by magnetic separation: Screening of separation parameters and high gradient magnetic filtration

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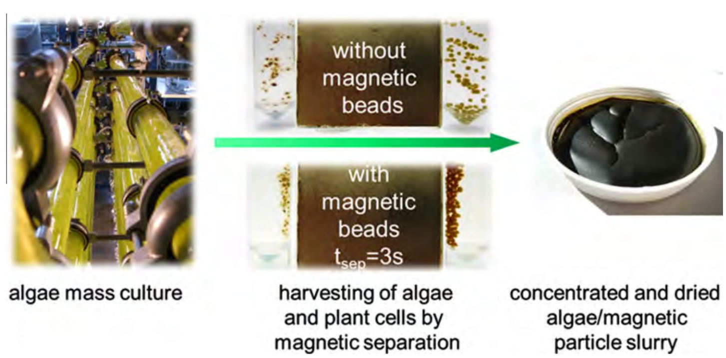
HIGHLIGHTS

- ▶ Magnetic separation for efficient harvesting of fresh water and marine algae.
- ▶ High separation efficiencies >95% can be obtained.
- ▶ Fumed silica-coated magnetite as alternative to precipitated magnetite.
- ▶ Separation efficiency depends on particle concentration, pH and medium composition.
- ▶ Scalability is possible by means of high gradient magnetic filtration.

GRAPHICAL ABSTRACT



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ABSTRACT

In this study, the focus is on magnetic separation of fresh water algae *Chlamydomonas reinhardtii* and *Chlorella vulgaris* as well as marine algae *Phaeodactylum tricornutum* and *Nannochloropsis salina* by means of silica-coated magnetic particles. Due to their small size and low biomass concentrations, harvesting algae by conventional methods is often inefficient and cost-consuming. Magnetic separation is a powerful tool to capture algae by adsorption to submicron-sized magnetic particles. Hereby, separation efficiency depends on parameters such as particle concentration, pH and medium composition. Separation efficiencies of >95% were obtained for all algae while maximum particle loads of 30 and 77 g/g were measured for *C. reinhardtii* and *P. tricornutum* at pH 8 and 12, respectively. This study highlights the potential of silica-coated magnetic particles for the removal of fresh water and marine algae by high gradient magnetic filtration and provides critical discussion on future improvements.

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1. Introduction

Magnetic separation as a method for algae removal has been reported almost forty years ago. Research was motivated by the necessity to restore the water quality of fresh water lakes as a consequence of enhanced algae growth due to eutrophication (Bitton et al., 1975). During the last decades, the importance of microalgae and their valuable products has significantly increased in the fields of human health, food, feed and biofuels (Sastre and Posten, 2010). Downstream processing of microalgae is still a bottleneck in cost-efficient production due to small algae size and low concentrations in the medium (Uduman et al., 2010). Especially lipid accumulation for the production of biodiesel can aggravate algae sedimentation due to reduced specific algae gravity (Epsztein et al., 2012). Conventional downstream methods cover sedimentation by gravity, centrifugation, microstraining, coagulation, chemical precipitation,

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