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Magnetic microparticles for harvesting Dunaliella tertiolecta microalgae

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Microalgae based biofuels have been considered as a sustainable alternative to traditional fuels due to the higher biomass yield and lipid productivity, and the ability to be cultivated in non arable land making them not antagonistic with food supply chain. Due to the dilute nature of algal cultures and the small size of algae cells, the cost of microalgae harvesting is so far a bottleneck in microalgal based biofuel production. It is estimated that the algal recovery cost is at least 20-30% of the total biomass production cost. Various processes have been employed for the recovery of microalgal biomass, which include centrifugation, gravity separation, filtration, flocculation, and flotation. Recently, magnetophoric harvesting has received increased attention for algal separation, although it has been first applied for algal removal since the mid of 1970s. The magnetic separation process is based on bringing in contact the algal cells with the magnetic particles, and separating them from the liquid by an external magnetic force.

The aim of this work was to investigate the harvesting of microalgae cells using Fe3O4 magnetic microparticles (MPs). Dunaliella tertiolecta was selected as a representative for marine microalgae. D. tertiolecta was cultivated under continuous artificial light, in 20 L flasks. Fe3O4 MPs were prepared by microwave irradiation of FeSO4 $7H_2O$ in an alkaline solution. Numerous batch and flow-through experiments were conducted in order to investigate the effect of the magnetic material addition on microalgae removal. Batch experiments were conducted examining different initial algal and MPs concentration, and algal culture volume. Flow-through experiments were conducted in a laboratory scale column made of Plexiglass. External magnetic field was applied by arranging at various points across the column length NdFeB magnets. Algal removal in flow-through experiments ranged from 70 to 85% depending on the initial MPs concentration and the hydraulic retention time. In batch tests, algal removal was up to 97% depending on algal and MPs concentration.