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Separation of microalgae cells from culture medium after cultivation (so called 'harvesting') is one of the most challenging steps in a large-scale autotrophic production of microalgae. Due to a very low concentration of cells in medium (usually in range 0.5–3 g/L),[1] small cell diameter (3–30 μm)[1] and low wet cell density (1030–1100 g/L),[2] low cost harvesting methods as sedimentation or filtration are inapplicable. Currently, the most common type of microalgae harvesting on industrial scale is centrifugation, although it is expensive due to high energy demands. Coagulation was proposed to be a suitable process for microalgae suspension pre-concentration prior to centrifugation in order to decrease the volume of suspension needs to be centrifuged. During coagulation, cells are induced to form large aggregates (flocs) with relatively high sedimentation velocity, which can be subsequently separated by gravity sedimentation, flotation or filtration. Various types of coagulation including inorganic and polymer chemical coagulation, autocoagulation, biocoagulation and electrocoagulation were tested during past few years for microalgae harvesting.

Electrocoagulation, a well-known process in industrial wastewater treatment, was proposed to be a promising technique for harvesting single-cell freshwater and saline water microalgal species. In our laboratory, we employed an electrocoagulation process with iron sacrificial anode leading to the separation of *Chlorella vulgaris* cells with high efficiency and at the same time acceptable low contamination of separated biomass by iron. Comparing to only centrifugation, the total energy costs of harvesting using electrocoagulation as a pre-concentration step prior to centrifugation were reduced by more than 80%. After extensive study of the influence of relevant process parameters such as pH, electric charge, temperature, agitation intensity, initial biomass concentration and residual salt concentration conducted in laboratory scale equipment, three bench-scale electrocoagulation devices were designed and tested. The best results (highest separation efficiency and lowest iron contamination) were obtained using contin-

uous pneumatically agitated channel flow reactor with submerged perforated plates. Subsequently, this device was scaled up from the working volume of 13 L to the working volume of 160 L. Final electrocoagulation device consisted from three functional domains (i) electrolyser, where the iron = coagulant dissolves into microalgal suspension, (ii) aggregator, where the microalgal cells form aggregates by appropriate mixing achieved by the flow of the suspension through the series of perforated plates and (iii) lamellar settler, where the aggregates sediment. The hydraulic characteristic of this reactor was determined to be a dispersed plug flow. Using this device, harvesting efficiency of *Chlorella vulgaris* higher than 85% was achieved while the iron content in the separated biomass was below the limit for potential food application. Thus, electrocoagulation was evaluated as a suitable and cost-effective method for harvesting of single cell microalgae for human consumption.

References

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