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Chan Cho Yin

Chan Shui Shing

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Effective harvesting of microalgae biomass by using novel synthesized cationic polymer coated magnetic nanocomposites

Kwan-Shing Chan, Shu-Kei Leung, Sum-Yi Wong, Shui-Shing Chan and Cho-Yin Chan*
Faculty of Science and Technology, Technological and Higher Education Institute of Hong Kong (THEi), Hong Kong SAR, China
*Correspondence: chan_choyin@thei.edu.hk

Abstract: Increasing energy consumption due to rapid urban development has generated huge amount of CO_2 emission over the decades, resulting in alarm level of global CO_2 concentration (>400ppm) and adverse climate changes have been frequently shown that such global environmental impact should be mitigated. In order to achieve the goals of sustainable growth and carbon neutrality by 2050, a significant reduction of fossil fuels combustion for electricity generation should be implemented. Apart from traditional renewable energy sources like solar and wind energy that have been adopted for many years, microalgae biofuel recently has been proposed for potential large scale application and promising results have been reported. However, due to the properties of diluted cells densities and small cells size of microalgae that a high energy consumption was required for its biomass collection before downstream processing of the biofuel production, for example, conventional cells harvesting methods like centrifugation and filtration consumed 20-30% of the overall energy requirement of the processes. On the other hand, past studies showed that microalgae cells with negatively charged surface can be easily flocculated by simple and inexpensive cationic flocculants, however, effective collection of the flocculated cells and removal of residual flocculating agent from spent medium were required. In the present study, a marine green microalgae *Tetraselmis* sp. was selected for conducting the growth optimization study under different pH and salinities conditions. A novel cationic polymer (polydiallyldimethylammonium chloride; PDDA) coated iron oxide (Fe_3O_4) was synthesized to conduct the rapid microalgae cells flocculation (<5min) followed by magnetic separation (<5min) using simple permanent magnet. Besides, different synthesis methods of the cationic magnetic nanocomposites and the mass ratio between polymer and iron oxide were also investigated. The spent medium culture and cationic polymer coated magnetic nanocomposites after cells desorption can be reused, thus, both the operational cost and water footprint can be significantly reduced.

Keywords: Microalgae biomass harvesting, cationic magnetic nanoparticles, microalgae biofuel production, flocculation and magnetic separation