Designing an Algae-Immobilized Membrane Bioreactor for Wastewater Bioremediation and High-Density Algae Production

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Inorganic substances and heavy metals in the environment pose a chronic threat to the safety of humans and wildlife. Current wastewater treatment processes are costly, complex, and cause secondary pollution in the environment. Microalgal cultivation in wastewater allows for wastewater bioremediation coupled with simultaneous biomass production. In this experiment, an algae-immobilized membrane bioreactor system was designed to combine biological nutrient consumption with high-density microalgal cultivation. This system simplified biomass processing, increased the resistance of cell cultures to harsh environmental conditions, and achieved better biomass recovery without using chemical coagulants. In this study, two algal species, Chlorella vulgaris and Arthrospira platensis, were immobilized using chitosan and grown in nonwoven propylene, polyester, and nylon membranes using secondary-treated wastewater. Biomass production was measured using UV-Vis spectroscopy through changes in chlorophyll-a during a 6-day bioremediation period. Bioremediation was measured through changes in the concentration of nitrate, phosphate and zinc using cadmium reduction, stannous chloride chemistry, and zincon chemistry, respectively. The data showed that C.vulgaris and A.platensis experienced enhanced pigment formation and bioremediation efficiency under the membrane bioreactor system. The algae-immobilized nonwoven propylene group increased chlorophyll-a concentration by up to 4.77 times, enhanced nitrate assimilation by up to 134%, and reduced up to 85% and 82% of the phosphate and zinc concentrations in the wastewater, respectively. The algae-immobilized membrane system is an environmentally and economically viable alternative to the conventional tertiary wastewater treatment process.

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