Functionalization of Synthetic Polymers for Membrane Bioreactors

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ABSTRACT

Membrane bioreactors (MBRs) show great promise for productivity improvement and energy conservation in conventional bioprocesses for wastewater reclamation. In order to attain high productivity in a bioprocess, it is crucial to retain the microorganisms in the bioreactors by preventing wash out. This enables recycling of the microorganisms, and is consequently saving energy. The main feature of MBRs is their permeable membranes, acting as a limitative interface between the medium and the microorganisms. Permeation of nutrients and metabolites through the membranes is thus dependent on the membrane characteristics, i.e. porosity, hydrophilicity, and polarity.

The present thesis introduces membranes for MBRs to be used in a continuous feeding process, designed in the form of robust, durable, and semi-hydrophilic films that constitute an effective barrier for the microorganisms, while permitting passage of nutrients and metabolites. Polyamide 46 (polytetramethylene adipamide), a robust synthetic polymer, holds the desired capabilities, with the exception of porosity and hydrophilicity. In order to achieve adequate porosity and hydrophilicity, bulk functionalization of polyamide 46 with different reagents was performed. These procedures changed the configuration from dense planar to spherical, resulting in increased porosity. Hydroxyethylation of the changed membranes increased the surface tension from 11.2 to 44.6 mJ/m$_2$. The enhanced hydrophilicity of PA 46 resulted in high productivity of biogas formation in a compact MBR, due to diminished biofouling. Copolymerization of hydrophilized polyamide 46 with hydroxymethyl 3,4-ethylenedioxythiophene revealed electroconductivity and hydrophilic properties, adequate for use in MBRs. To find either the maximal pH stability or the surface charge of the membranes having undergone carboxymethylation, polarity and the isoelectric point (*pI*) of the treated membranes were studied by means of a Zeta analyzer. The hydroxylated PA 46 was finally employed in a multilayer membrane bioreactor and compared with hydrophobic polyamide and PVDF membranes. The resulting biogas production showed that the hydroxylated PA 46 membrane was, after 18 days without regeneration, fully comparable with PVDF membranes.

Keywords: Bioreactor, Functionalization, Hydrophilic, Membrane, Polyamide 46, Synthetic Polymer

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