Material development of a textile bioreactor

All-polyamide composite for the construction of bioreactors

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Abstract

Bioreactors are manufactured from stainless/carbon steel, concrete, glass, etc., which are costly and time-consuming to install. Recently, several research studies have been initiated to find cost-efficient materials for constructing bioreactors, one of which is coated textiles. Polyvinyl chloride (PVC)-coated polyester textile (PVCT) has been used for this purpose to make bioreactors more cost-effective and easier to install. In this thesis, the thermal insulation property of PVCT was improved, that enhances the energy efficiency of the process carried out within the bioreactor. However, recycling PVCT is challenging, as it is a mixture of PVC, polyester fabric, a plasticizer for the PVC, chemical linkers, and other processing-aid additives.

A possible solution to address these issues is to use a coated textile composed of a single material. The polyester fabric can be replaced with a better performing fabric, such as polyamide, that generally has a longer lifetime as well as higher mechanical stability and is light-weight. A facile method was introduced to make a same-polymer coated textiles composite out of polyamide through the partial dissolution of the fabric's surface followed by coagulation. The all-polyamide composite coated textiles (APCT) is mechanically stronger and more thermally stable than the PVCT as well as having less weight. Additionally, the APCT is fully recyclable as it contains only a single component. This property can be beneficial for the recyclability of the material. The APCT can be used in the construction of textile bioreactors as well as other applications that require gas-/water-tightness and flexibility at the same time. In addition, a new solvent for polyamide was proposed which can be used for the preparation of the APCT. A computer-assisted theoretical solvent selection method based on the Hansen solubility parameters was also introduced. The findings of this research can increase the economic efficiency of the biofuel production process by decreasing the initial investment. From a technical perspective, the methods introduced in this thesis can encourage researchers in related fields to produce same-polymer composites and find/replace solvent(s) in a more efficient way.

Keywords: textile bioreactor; biofuel, coated fabric; all-polyamide composite, polyvinyl chloride (PVC), solvent replacement, Hansen solubility parameters (HSPs)