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Tunable permeability and selectivity: Heatable inorganic porous hollow fiber membrane with a thermo-responsive microgel coating

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Abstract

In recent years, the interest in responsive materials to design membranes with tunable properties increased in order to customize membranes for adaptable process requirements. The majority of development methods require external adjustment of the feed stream temperature to achieve a responsiveness of the membrane. In this study, we propose a concept in which the temperature of the membrane itself can be directly controlled to initiate a response of the membrane surface. We use an electrically conductive membrane composed of silicon carbide and carbon on which thermo-responsive poly(*N*-vinylcaprolactam) (P-VCL) microgels have been immobilized. By controlling the applied electrical power to the membrane, the permeability and selectivity of the membrane can be adjusted.

Immobilization of the microgels on the membrane has been realized via filtration coating. The microgel coating is stable with no change in permeability, hence no microgel loss, over time. Also during backwash, the permeability remains constant. Thermo-responsiveness remains reversible and stable in all conducted experiments. The controlled hydraulic resistance of the membrane behaves according to the hydrodynamic radius of the microgel, as a function of temperature. The electrical heating of the membrane shows to be more energy efficient compared to heating of the whole feed stream when operating in crossflow conditions, saving 14 % of the consumed energy. The retention of a 200 kDa dextrane can be controlled in a range of 10 % to 80 % by heating the membrane.

Keywords: Tunable permeability, heatable membrane, adaptive selectivity, thermo-responsive P-VCL microgel

1. Introduction

Our natural environment is a complex and highly efficient system of interacting structures. One of its most pre-eminent characteristics is the ability of biological materials to regenerate and reverse their behavior as a response to external stimuli. Over the last decades, research interest in synthesis of smart or stimuli-responsive materials has expanded vastly. Stimuli-responsive polymers achieve attention for undergoing physico-chemical or structural

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