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Detoxification of highly acidic hemicellulosic hydrolysate from wheat straw by diananofiltration with a focus on phenolic compounds

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Abstract

Nanofiltration was studied for detoxification of lignocellulose hydrolysates obtained in harsh conditions. A hemicellulosic hydrolysate obtained from sulfuric acid steam explosion of wheat straw and presenting very low pH (=1) and high osmotic pressure (28 bar) was studied and 8 inhibitory compounds were followed, among which 4 phenolic compounds. Several polymeric nanofiltration membranes were compared for separation performances and permeabilities; DK membrane (GE Osmonics) proved suitable with high rejection of sugars (> 99%) and lower rejections of inhibitors. Acetic acid and furfural were quasi-fully transmitted whereas the rejection of compounds ranked as follow: HMF (5-hydroxymethyl-furfural) <coumaric acid < levulinic acid <vanillin < ferulic acid < syringaldehyde with values of 40, 50, 60, 80, 90 and 98%, respectively, at a permeate flux of 14 L h^{-1} m^{-2}. Diafiltration was carried out at a transmembrane pressure of 26 bar until 3 DV (Diafiltration Volume) to complete detoxification, and continuous and sequential-dilution modes were compared. Thanks to the permeability of the membrane to the monovalent form of sulfuric acid $HSO4^-$, effective transmembrane pressure was increased and pH reached 2. At 3 DV, both modes showed removal performances between 92% (acetic acid and furfural) and 25% (syringaldehyde). Irreversible fouling was observed, leading to 30% permeability loss after diafiltration.

Keywords

Hemicellulosic hydrolysate; detoxification; nanofiltration; diafiltration; phenolic compounds;