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Dominant impact of the α-L-guluronic acid chain on regulation of the mass transfer character of calcium alginate membranes

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ABSTRACT

The dominant impact of the α-L-guluronic acid chain on regulation of the mass transfer character of calcium alginate membranes was investigated. The polymer frameworks of the membranes were successfully regulated by altering the mass fraction of homopolymeric blocks of α-L-guluronic acid (F_{GG}) in the entire molecular chain of alginate. Sodium alginate is well-known as a hydrophilic polysaccharide. Its molecular chain is composed of α-L-guluronic acid and β-D-mannuronic acid. The polymeric structure of calcium alginate is mainly constructed by intermolecular ionic bonds with homopolymeric blocks of the α-L-guluronic acid junction zone. The entire alginate polymer chain then forms into a swollen gel and a membrane. The water fraction of the swollen membrane and the mechanical strength changed with F_{GG}. The volumetric water fraction based on the swollen state of the membrane was evaluated from the gravitational water content (H_M). The change in the mass transfer mechanism of the membrane was evident in the effective diffusion coefficient, especially for the smaller molecules (e.g., urea). Good correlation between the volumetric water fraction and the effective diffusion coefficient strongly suggested that the mass transfer channels in the alginate membrane were dominantly regulated by the mass fraction of homopolymeric blocks of α-L-guluronic acid (F_{GG}). The relationship between the effective diffusion coefficient and the volumetric water fraction agreed with Yasuda's free volume theory. The tortuosity was markedly increased and the effective diffusion coefficient was reduced. In conclusion, the homopolymeric blocks of α-L-guluronic acid have a dominant impact on the mass transfer character in the calcium alginate membrane.

Keywords: Calcium alginate; β-D-mannuronic acid; α-L-guluronic acid; Membrane; Mass transfer; Effective diffusion coefficient

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