Área: MAT

The effect of the molecular structure of HPMC on the interaction with water for cryogels prepared with and without calcium peroxide

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Highlights

The incorporation of CaO_2 particles into HPMC cryogel reduced the O_2 release.

The molecular characteristics of HPMC drive the swelling rate and wettability.

Abstract

The interaction between polymers and water is critical for determining the final characteristics of a material. Hydroxypropyl methylcellulose (HPMC) belongs to the cellulose ether family that has both hydrophobic methyl groups (DS) and hydrophilic hydroxypropyl groups (MS) on its chain. The interactions between water molecules and cryogels prepared with different types of HPMC, in the presence and absence of a linear nonionic surfactant (containing a dodecyl chain and a PEG chain) and CaO_2 microparticles, were systematically investigated using sorption experiments and Time-Domain Nuclear Magnetic Resonance (TDNMR). Solutions of HPMC at 3.0 wt% containing 0.3 wt% of citric acid (crosslinker) and 0.15 wt% of sodium hypophosphite (catalyst) were prepared. The surfactant concentration was 0.168 g L^{-1}, and 50 mg of CaO_2 was added to 1.6 g of HPMC solution. Then, the precursor gels were frozen for 24 h and freeze-dried during 10-12 h. The resulting cryogels were oven heated at 165 °C for 5 min to promote the esterification reaction between citric acid and HPMC hydroxyl groups. Regardless of the DS and MS of the HPMC, most water molecules showed transverse relaxation time t2 typical of intermediate water and a small population of more tightly bound water. HPMC cryogels with the highest DS of 1.9 had the slowest swelling rate (0.519 ±0.053 g_{water}/(g.s)) and the highest contact angle values (85.250° ± 0.004°), providing the best conditions for a slow reaction between CaO_2 and water. The presence of the surfactant increased swelling rate and decreased contact angle values, likely due to hydrophobic interactions possibly favored the exposition of the surfactant's polar head to the medium. The HPMC with the highest MS had the fastest swelling rate and the lowest contact angle. The initial rate (V_0), calculated from the kinetics of O_2 release, was slower for all cryogels compared with pure CaO_2, avoiding burst release. These findings are relevant for the formulations and reactions, where tuning the swelling kinetics is crucial for the final application, such as biomedical applications and wastewater treatment.

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