UNIVERSITÀ DEGLI STUDI DI SALERNO

Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria Chimica

Caratterizzazione di idrogel chimici a base di idrossietilcellulosa

Tesi in

Principi di Ingegneria Chimica

Relatori:

Prof. Ing. Gaetano Lamberti

Ing. Diego Caccavo

Candidato:

Alfredo Posocco

matricola 0612201723

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Sommario

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Abstract

Hydrogels are three-dimensional hydrophilic polymeric networks, capable to absorb large quantities of water or biological fluids. The role of hydrogels is becoming increasingly important for many applications: among these those concerning the biomedical field and especially tissue engineering stand out. For this reason, studying the mechanical behavior of hydrogels has become of fundamental importance. This work aims to increase the knowledge about hydrogel's characteristics useful for the low back pain treatment, specifically for the nucleus pulposus replacement (central element of the intervertebral disc). To this purpose, hydrogels based on hydroxyethylcellulose (HEC), a non-ionic hydrophilic polymer derived from cellulose, covalently cross-linked with divinyl sulfone (DVS), have been produced. Gels were produced at different values of the ratio R between polymer (HEC) and crosslinking agent (DVS): R= 3:1, R=2:1 e R=1:1. The mechanical and solvent transport properties were analyzed by stress-relaxation tests and gravimetric analyzes. The gels were extracted from the molds and left to equilibrate in pure water, they have shown a loss of weight over time and decreasing of swelling as the degree of cross-linking increases. These results have been explained with the Flory-Rehner theory suggesting that the elastic contribution in freshly cross-linked gels is always greater than the mixing one, leading to the contraction of the samples with consequent expulsion of water until a new equilibrium condition is reached. During the stress-relaxation test employed, a certain deformation is applied to the test sample and maintained for a certain time (3600 seconds), while the evolution of stress is monitored. Deformation values of 5, 10 and 15% were applied to the gels. Before and after each test, the gels were weighted to estimate the water lost during the stress-relaxation test. The analysis of Young's modules, obteined from the slope of the stress-deformation curve, confirm that,

by increasing the cross-linker ratio, the value of the elastic modules of the gels also increases. This also affects the maximum stress values recorded, which increase as the cross-linking ratio increases. Increasing the deformation, the Young modulus increase, showing therefore a non-linear mechanics response E(ε) characteristic of the large deformation. Once the HEC:DVS ratio has been fixed, the analyzes also show a level of relaxation that is not very marked for the 3:1 and 2:1 ratios, but higher in the case of the 1:1 ratio. A comparison of the analyzed gels with the mechanical characteristics of the nucleus pulposus was performed. The comparison showed that the 1:1 ratio gels are the best to simulate the characteristics of the nucleus pulposus and are possible candidates to replace it in biomedical applications.

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