EFFECT OF MONOMERS AND REACTION INITIATOR ON SWELLING PROPERTIES OF ACRYLIC ACID/ACRILAMIDE HYDROGELS.

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Abstract

The type and quantity of monomers are variables that define the swelling properties of polymeric hydrogels. In addition, the initiator used in the synthesis provides the way it builds the network of polymer hydrogel. In this work were synthesized three hydrogels with different ratios of the monomers acrylic acid/acrylamide as: 25/75, 50/50 and 75/25. The materials were crosslinked with an acrylic chemical agent with short chain, as is the ethylene glycol dimethacrylate (EGDM). Were used 1, 4, 6, 8 and 10%, in relation to the amount of monomers. The EGDM provide hydrophilic groups for improving the swelling property and compaction of the network in the hydrogel polymer. The hydrogels were synthesized with a REDOX initiator by free radical polimerization reaction in solution at 60 °C, using a mixture of $K_2S_2O_8$ and $NaHSO_3$. Swelling properties were determined as function of the quantity of crosslinking agent and time. The EGDM provides high hydrophilic degree to get maximum swelling of 24,000 % wt. of water for 1 % of EGDM in 140 hours. Increasing the amount of crosslinking agent, the swelling decreases. For monomer ratio 75/25, swelling was larger than the other two monomers relations.

Introduction

Polymers are important materials in modern life. One kind of these, are the polymeric gels. In a polymeric gel, long chains crosslinked produces a three-dimensional net and it is able to contain a liquid. For many applications, the gels hold big quantities of water in thier microscopic network. These materials are named hydrogels. They swell in water until an equilibrium volume while preserving their shape and transparency. The nature of polymeric unions and the functional groups along chains could be modified using chemical agents and by changes of temperature, pH, and other factors. Generally, macroscopic changes in the hydrogel shape are reversible and produces materials that could be use like “microscopic sponges” or systems for retain and deliver some chemical substances.[1-3] The polymeric gels have many applications

and actually they are use in hygienic products, paints, food, agriculture, electronic devices, molecular filters, or drug delivery systems.[1, 4-9.]

In general, hydrogels were synthesized by solution polymerization. Many variables affect final properties of product. Mean characteristic of hydrogels are swelling behavior and the maximum swell. The type and chemical nature of monomers, are variables that define swelling properties of the hydrogels. Other influence for the polymerization reaction are the type of the initiator. It was compared maximum swelling to the same system studied here, but using a photoinitiator, and is reported to only 1% of content of crosslinking agent[10]. Here, were synthesized hydrogels using acrylic acid and acrylamide as monomer with different monomer ratios. Swelling properties were determined as function of the amount of crosslinking agent and the time.

Experimental Procedure

Substances used for synthesis were: Acrylamide (AM), Acrylic acid (AA) as monomers; salts of $K_2S_2O_8$ and $NaHSO_3$ dissolved in water, as initiator system; purity of these substances were 98, 98, 99 and 99 % mol respectively, all of them were acquire from Aldrich. Was used ethylene glycol dimethacrylate (EGDM) as crosslinking agent, and doubly distilled and deionized water was used.

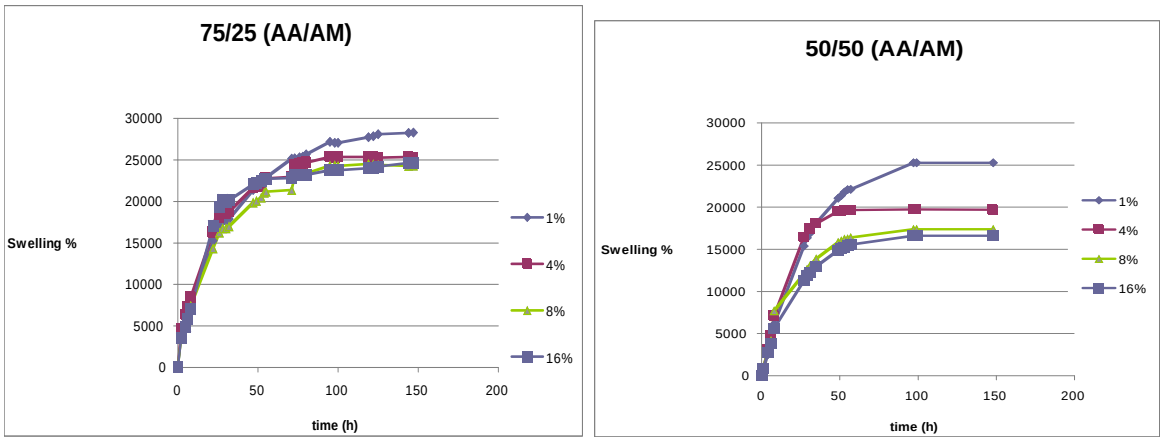
Each synthesis of the hydrogels was realized by aqueous solution polymerization between the acrylic acid and the acrylamide, previous established amount of EGDM as cross-linking agent was then added. Concentrations used of cross-linking agent were from 1, 4, 8, and 16 %wt. These reaction systems were prepared with different amounts of the monomers acrylic acid/acrylamide: 25/75, 50/50 and 75/25., and then pH was rise to a neutral value by addition of 0.2 M KOH solution. The polymerization was started by addition of the initiators solutions.

Sweeling properties were determined as function of the quantity of crosslinking agent and time, using a gravimetric method with an analytical balance. At certain time, hydrogels were weighed to evaluated water uptake.

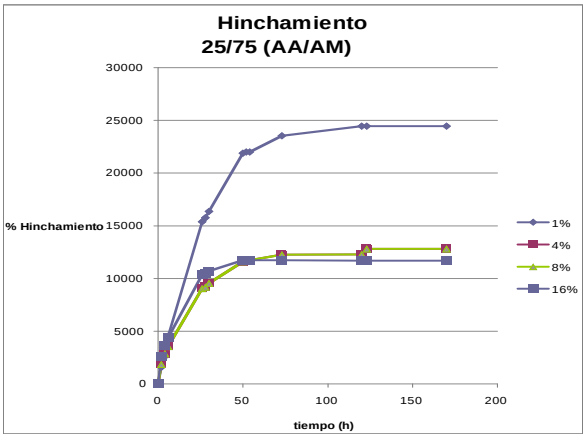
Results and Discussions

Swelling characterization for synthesis of the hydrogels are demonstrated at figure 1. First (figure 1a), showed swelling for hydrogels with 75/25 ratio, as function of the content of EGDM. Evidentially, material for 1% of EGDM has the maximum swelling getting a swelling percent of 28,280 % at 150 h. This maximum swelling decreases as EGDM content was rise. More compact polymeric net was formed with 16% crosslinking agent content. In the same way, figure 2 illustrates swelling in water for relation 50/50 of acrylic acid/acrylamide. Again, low content of EGDM was the material with maximum swelling, in this case, about 25,200 % but in 100 h. Also, we could see, that for hydrogels with 4% of EGDM, is near 20,000 %,

This observation provide evidence that monomeric ratios produces similar materials but microscopic copolymerization was different and this can be used to verify that the excess of the hydrophillic functional groups, for applications such as exchange resins.



a) b)



c)

Fig.1 Swelling behavior for the hydrogel synthesized with different monomer relations. a) 75/25 acrylic acid/acrylamide; b) 50/50 y c) 25/75.

A comparison was made of a hydrogel with the same characteristic, but the reaction was initiated with a photoinitiator (Irgacure 754 de Ciba). For both hydrogels with1% of crosslinking agent content, maximum swell was 70,000% and 25,200% for photoinitiator and for REDOX initiator, respectively and using monomer relation 75/25. These values indicate that redox initiator produces a material with low swelling properties, but not necessarily worst properties.

Conclusions

Swelling properties of polymeric hydrogels based on acrylamide and acrylic acid were determined as function of the concentration of EGDM and time. Ratio 75/25 for acrylic acid/acrylamide was material with improved water uptake. Acrylic acid provide hydroxyl functional groups, increasing water caption by hydrogel.

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