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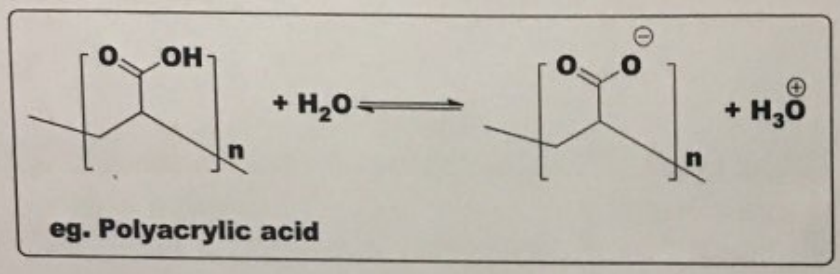
Water preservation through smart materials (hydrogel)

Expt No. 09 **Date:** 1/03/18

Principle:

Hydrogels are polymeric cross-linked network structures obtained from a class of synthetic and/or natural polymers which can absorb and retain significant amount of water due to the presence of hydrophilic groups or domains (Scheme 1). Water is brought into the network through the process of osmosis and quickly is absorbed into the central part of the polymer network. This is mainly due to the affinity of these functional groups towards water (e.g., due to the protonation/deprotonation as a result of changes in pH and temperature) and leading to a reversible change in the swelling degree as shown in Scheme 1.



Scheme 1: Absorption of water by the polymer chain of a hydrogel

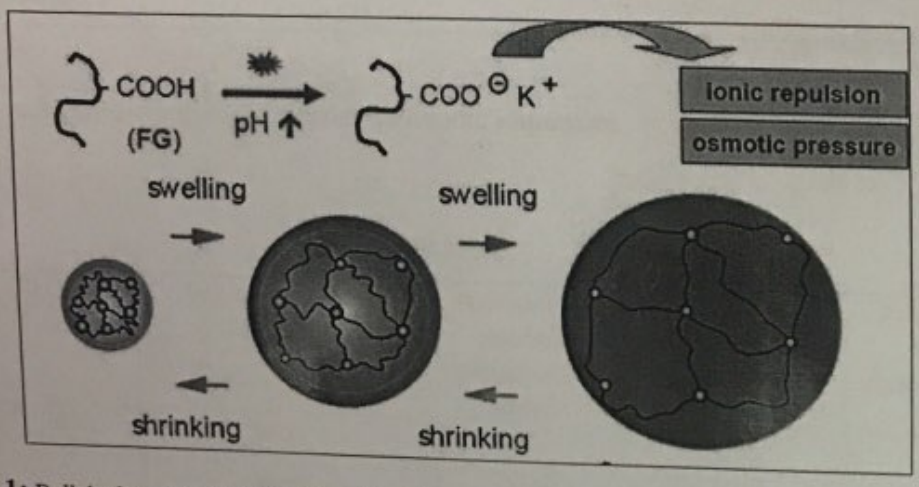


Figure 1: Bulk hydrogels with specific functional groups (FG) – the different solvation water depending on environmental conditions (e.g., pH, or temperature) leads to large reversible changes in the degree of swelling.

Hydrogels find applications mainly in tissue engineering, pharmaceutical, and biomedical and agricultural fields. Due to their high water absorption capacity and biocompatibility they are now being used in wound dressing, drug delivery, sanitary pads as well as trans-dermal systems, dental materials, implants, injectable polymeric systems, ophthalmic applications, hybrid-type organs.

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Required apparatus and chemicals

250 mL beakers -3, Glass rods-3, Filter papers -3, Funnels -2

Deionized water, Polymer material, NaCl, Sucrose, Acetone, Methanol, Ethanol, Butanol, and Urea.

Procedure

Part-A:

A small amount of superabsorbent polymer material is placed in the beaker (0.5 g, note down the exact weight of the polymer) and then 100 mL of deionized water is poured into the beaker. After 5 min the swollen polymer was separated by using a filter paper and note down the weight of the gel. By weighing the gel, one can find the swollen capacity of the polymer taken.

The swelling percentage of hydrogels was calculated based on Eq-1, which consists of the difference between the initial and the final weight of the sample divided by the initial weight. Here Ws corresponds to the weight of the swollen gels and Wd is the weight of dry polymer before immersion into the water.

$$\text{Swelling}(\%) = \frac{Ws - Wd}{Wd} \times 100 \quad \text{----Eq.1}$$

$\frac{78 - 0.5}{0.5} \times 100$

$= 15500$

Part-B

The swelling behavior of polymers is determined by ionic and neutral impurities in water. A small amount of dry polymer material is placed in the beaker (0.5 g, note down the exact weight of the polymer) and then 0.1% NaCl solution (prepared by adding 0.1 g of NaCl in 100 mL of deionized water) is poured into the beaker. After 5 min the swollen polymer was separated by using a filter paper and note down the weight of the gel. By weighing the gel, one can find the swollen capacity of the polymer taken as per the following equation.

$$\text{Swelling}(\%) = \frac{Ws - Wd}{Wd} \times 100$$

$\frac{48 - 0.5}{0.5} \times 100$

$= 9500$

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Part-C

A small amount of dry polymer material is placed in the beaker (0.5 g, note down the exact weight of the polymer taken) and then 1 % sucrose solution (prepared by adding 1 g of sucrose in 100 mL of deionized water) is poured into the beaker. After 5 min the swollen polymer was separated by using a filter paper and note down the weight of the gel. By weighing the gel, one can find the swollen capacity of the polymer using the given equation.

$$\text{Swelling}(\%) = \frac{Ws - Wd}{Wd} \times 100$$

$\frac{92 - 0.5}{0.5} \times 100$

Swelling index of the polymer material with neutral impurities = 18300

OBSERVATION AND CALCULATIONS

Result

Swelling index of the polymer material with deionized water = 15500

Swelling index of the polymer material with ionic impurities = 9500

Swelling index of the polymer material with neutral impurities = 18300

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Important questions to be answered:

1. How is water absorption affected by ionic and neutral compounds? Is it possible to increase the efficiency of absorption process?

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2. How do we separate the polymer material from water?

Students are informed to bring their choice of materials (any neutral or ionic) to carry out the experiments on their own to answer the above questions. Answers for these questions are very important to use these hydrogel materials in an efficient way with recoverability.

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