LAB EXPERIMENT – 6

Course: Engineering Chemistry

Course Code: CHY1701

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Slot: L-25+L-26

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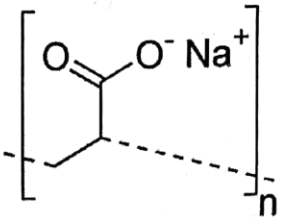
Measurement of Retrieved Water stored in Smart Material (Hydrogel)

1. Importance of the experiment: Sodium polyacrylate based hydrogel (also known as waterlock) is a sodium salt of polyacrylic acid (Density = 1.22 g/cm^3) with the chemical formula $[-CH-CH(CO_2Na)-]_n$. This superabsorbent polymer has the ability to absorb as much as 100 to 1000 times its mass in water. Sodium polyacrylate is an anionic polyelectrolyte with negatively charged carboxylic groups in the main chain. When water is added to the white crystalline polymer, it absorb many times its size, and the gel that is formed swells to form a Hydrogel.



2. Concept: Water is brought into the network through the process of osmosis and is quickly 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.

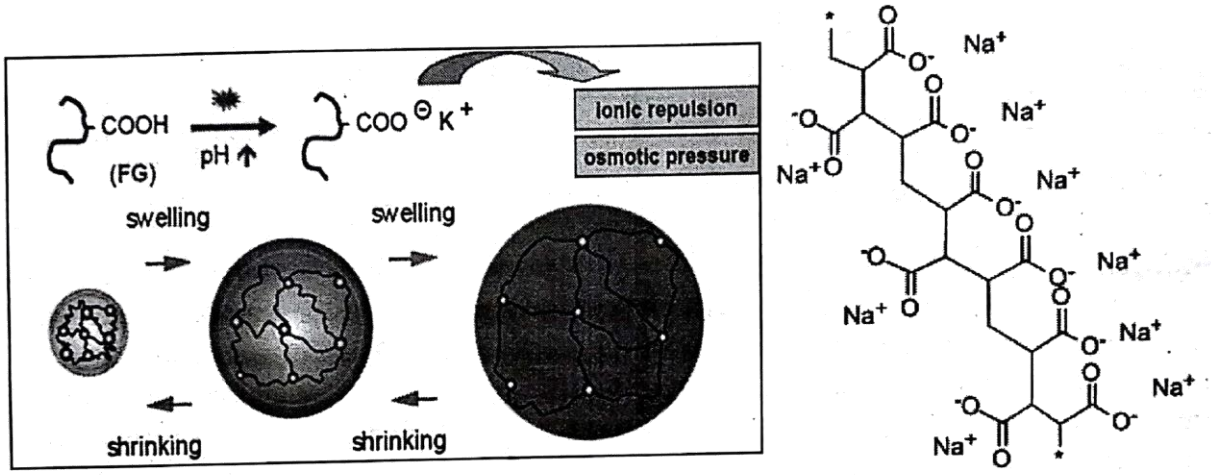


Fig. 1: Bulk hydrogels with specific functional groups (FG): the different solvation water depending on environmental conditions (pH or temp.) leads to large reversible changes in the degree of swelling.

3. Applications: Hydrogel is primarily used as a thickening agent because of its unique ability to absorb and hold onto water molecules, making it ideal for use in diapers, sanitary pads and hair gels. It is also used in industrial processes to dissolve soaps by absorbing water molecules. Due to their high water absorption capacity and biocompatibility, hydrogels are now being used in wound dressing, drug delivery, implants, injectable polymeric systems, ophthalmic applications, etc.

Important questions to be answered after performing the experiment:

1. How is water absorption affected by salt solutions (like 10% $BaCl_2$ solution)?
2. What is the white precipitate formed when the swollen hydrogel is treated with 10% $BaCl_2$ solution?
3. Can we recover the polymer from this white precipitate?

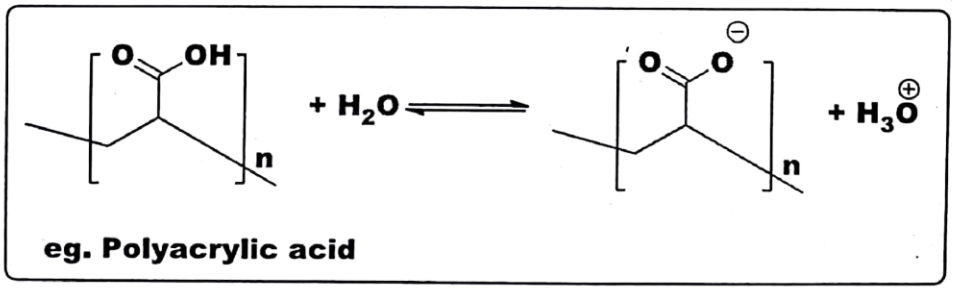
Answers for these questions are very important to use these hydrogel materials in an efficient way with recoverability.

Expt. No.: 6 **Date:** 21·09·2018

Experiment	Measurement of Retrieved Water stored in Smart Material (Hydrogel)
Problem definition	Hydrogels can absorb and retain significant amount of water due to the presence of hydrophilic groups. Reversible change in the swelling degree can be brought about by changes in pH and temperature.
Methodology	In the 1st step, the amount of water collected after filtering the hydrogel is used to calculate the water absorption capacity of the polymer. In the 2nd step, the amount of water collected after treating the hydrogel with 10% $BaCl_2$ salt solution is finally used to calculate the amount of retrieved water stored in smart hydrogel.
Solution	Measurement of retrieved water stored in smart hydrogel material.
Student learning outcomes	Students will learn a) the water absorption mechanism of a hydrogel b) to quantitatively estimate the amount of water stored in the hydrogel

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 is quickly 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.



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

Requirements:

Reagents and solutions: Deionized water, Partial sodium salt of polyacrylic acid and 10% $BaCl_2$ solution.

Apparatus: 250 mL beakers (3 Nos., 100 mL measuring cylinders (2 Nos.), Glass rod (1 No.), Spatula (1 No.), Filter paper (4 Nos.) and Funnels (2 Nos.).

Procedure

Part-A: 0.5 g of superabsorbent polymer material (Polyacrylic acid, note down the exact weight of the polymer) is placed in the beaker, mixed with deionized water (100 mL) and the

contents of the beaker were mixed thoroughly. After **15 mins,** the swollen hydrogel was separated using a filter paper/ funnel and the unabsorbed water collected into a measuring cylinder (amount of water collected after filtering hydrogel = **X** mL). Repeat the same experiment using the same procedure with another 0.5 g of the hydrogel. The water absorbing capacity of this polymer **(Y)** is calculated using Eq. 1 **(Y = 100-X, mL).**

Table-1

Sl. No.	Wt. of polymer taken, gm	Amount of deionized water added, mL	Amount of water collected after filtering hydrogel **(X)**, mL	Amount of water absorbed by hydrogel **(Y = 100-X)**, mL
1	0.5	100	10	90
2	0.5	100	18.5	81.5
Average	0.5	100	14.25	85.75

Water absorption capacity of the polymer (Y) = **(100 – X) %** ....(1) 85.75

Part-B: The swollen hydrogel is carefully transferred from the filtering funnel to a 250 mL beaker. To this, 10 mL of 10% $BaCl_2$ solution is added and the contents of the beaker are mixed thoroughly with a glass rod for **10 minutes**. The white precipitate formed is filtered through a filter paper/ funnel and the recovered water collected into a measuring cylinder (this amount of water is **Z** mL). The amount of water recovered from the hydrogel is calculated as per **Eq. 2 (Z-10/Y * 100).**

Table-2

Sl. No.	Amount of 10% $BaCl_2$ salt solution added to the swollen hydrogel, mL	Amount of water collected after treating with 10% $BaCl_2$ salt solution **(Z)**, mL	Amount of retrieved Water **(Z -10)**, mL
1	10	85	75
2	10	78	68
Average	10	81.5	71.5

Amount of water recovered from hydrogel (%) = $\frac{\textbf{(Z-10)}}{\textbf{Y}}$ **X 100** ....(2) 83.38

Final Result:

	Water absorption capacity of hydrogel (%) (From Eq. 1)	**Water recovered from hydrogel (%) (From Eq. 2)**	
Expected			
Obtained	85.75	83.38	
Marks Awarded	**(5 M)**	**(5 M)**	**(10 M)**

21/9/18