ACTIVITY # 1 Experiments with Hydrogels – Hair Gel and Disposable Nappies

REMARKS

INTRODUCTION

A smart material is one that changes shape in response to changes in its environment. Hydrogels are smart materials and their properties are exploited in a number of products that are currently available on the market. Chemists are working to develop other applications for this unusual type of material.

You are going to investigate three readily available products that contain a hydrogel: disposable nappies, plant water storage crystals ('water crystals') and hair gel. Record detailed observations as you carry out each experiment.

PROBLEM

MATERIALS

Eye protection
Hair gel
Each working group requires:
Hair gel (see note 1)
Salt
Petri dish or lid
Teaspoon or similar – an ordinary spatula is a bit small
Disposable nappies

Each working group requires:
A disposable nappy (see note 2)
Scissors
A large ice cream tub or similar container (see note 3)
Dessert spoon or similar measure
Stirring rod
Large beaker or plastic tub to hold at least 600 cm3
Plastic gloves for those with sensitive skin
Access to:
Distilled water, about 500 cm3 per group (see note 4)
Salt

Technical notes

1. For the hair gel the cheaper and nastier the better. Allow about one large teaspoonful per group.
2. Pampers Baby Dry® nappies work well, but any ultra absorbent disposables should be fine. As an alternative to using nappies and extracting the hydrogel, it is possible to order sodium polyacrylate (Low hazard) from Sigma Aldrich.
3. The ice cream tub is for collecting the inside of the nappy and is safer than collecting it over newspaper or similar. If tubs are in short supply, large zip-lock bags can be used. Students put the nappy in the bag, zip it up and manipulate it until all the hydrogel is extracted and then proceed as per the directions.
4. If distilled water is not available, tap water can be used but the results are not as spectacular.

SAFETY

PROCEDURE

HEALTH & SAFETY: Wear eye protection

Hair gel

1. Put a blob of hair gel onto the petri dish lid. A large teaspoonful is fine.
2. Gently sprinkle salt from a spatula over the hair gel.

Disposable nappy

1. Cut the middle section out of the nappy – the thicker piece that is designed to absorb the urine. Discard the other piece.
2. Make sure the ice cream container is completely dry - wipe it with a paper towel if necessary. Any moisture in the tub stops the experiment from working properly.
3. Wear eye protection for the next step. Put the centre piece of the nappy into the ice cream container and gently take it apart. Small white grains should start coming away and this is what you are trying to collect. Keep gently pulling the nappy apart until you have collected as many of the grains as you can. Do not do this roughly or you will lose your product and put a lot of dust and fluff into the air. Avoid breathing in any of the dust.
4. Remove and dispose of all the fluff and other parts of the nappy, keeping the grains in the bottom of the tub. They are heavier and fall to the bottom, which makes it easier to separate them out.
5. Estimate the volume of the grains.
6. Pour them into the large beaker and add about 100 cm3 of distilled water. Stir. Keep adding distilled water until no more can be absorbed and stir between each addition. Estimate the final volume of the hydrogel.
7. Add a dessertspoonful of salt and stir.

OBSERVATIONS

QUESTIONS

1. How much did the volume of the hydrogel in your experiments increase when it was put into water?
2. What happened to the volume of the hydrogel when salt was added?
3. Why is the hydrogel a 'smart material'?

Understanding the structure and bonding of hydrogels helps to explain their properties. This in turn helps chemists to develop new hydrogels and find further uses for them.

4. What will the negative charges do to each other?
5. What effect will this have on the polymer chain?
6. What will happen to the water molecules when they get near the polymer?

When salt (sodium chloride) dissolves in water it dissociates (splits up) into sodium ions and chloride ions.

7. Write an equation for this dissociation.
8. Which of the ions will interact with the negatively charged polymer chain? What will happen?
9. What effect will this have on the charges on the chain?
10. What effect will this have on the shape of the polymer molecule?
11. Predict what will happen when you add the hydrogel to sugar solution. Give a detailed explanation for your prediction.

12. What volume of distilled water did the hydrogel from the nappy absorb?
13. How do you think this volume compares to the volume of urine it would absorb? Explain your answer.
14. Why might manufacturers put hydrogels in hair gel?

For the Pull-Out Class

Fighting fires with Pampers?

Another use for hydrogels has recently been developed by a firefighter in the USA. John Bartlett was at a fire in which an entire house was destroyed – all except a used disposable nappy. He realized that a substance inside the nappy was responsible for preventing it from being burnt and discovered that the material was the hydrogel, which had absorbed liquid. BARRICADE® fire fighting gel was developed as a result. If the gel is sprayed with water onto a house which is in the path of a fire, the house will not burn. This is a major new tool for fire fighters to use when they are battling against the vast forest fires that can burn for days in the USA.

Explain how BARRICADE® gel might help prevent something from burning. (Hint: think about the fire triangle.)

REFERENCES

www.practicalchemistry.org/experiments/making-an-aloy-solder,131,EX.html
http://www.rsc.org/education/teachers/learnnet/inspirational/resources/4.4.2.pdf