

UNIVERSITY OF SOUTHERN MISSISSIPPI  
RESEARCH EXPERIENCE FOR TEACHERS

RET POLYMER ACTIVITY # 1  
SUMMER 2008

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THE SCIENCE OF SUPERABSORBENCY

Introduction:

This is a two day lab. On the first day students will investigate the absorbency of sodium polyacrylate and HDPE. On the second day, students will apply their knowledge from the previous lab to determine the efficiency of popular diaper brands.

DAY ONE – What is the absorbency of different polymers?

Materials:

Tables will share the following:

- Sodium polyacrylate
- 1/4 cup measure
- HDPE powder

Each set of lab partners will have:

- 1 Bottle of colored water
- 1 Bottle of salt water
- 1 Paper plate
- 1 Popsicle stick
- 1 Pencil
- 1 Plastic cup

Substitutions:

Paper towel  
Wooden splint or plastic knife  
Ball jar lids or small petri plate

Procedure:

1. Place the paper plate on your work surface.
2. Use the top of the cup to draw two circles on the paper plate.
3. Place ¼ cup of sodium polyacrylate in a pile in the center of **one** of the circles.
4. Place ¼ cup of High Density Polyethylene (HDPE) powder in a pile in the center of the **other** circle.
5. Slowly add drops of colored water to the center of the circle with the HDPE powder. Count the drops and continue adding them until the water reaches any part of the circle. Record the number of drops and what happened on your lab sheet.
6. Now add the same number of drops in the center of the pile of sodium polyacrylate. How does this compare to the way the water spread in the first circle? (answer on lab sheet)
7. Continue to add about 100 more drops. How would you describe the pile of sodium polyacrylate now? (answer on lab sheet)
8. Split the sodium polyacrylate gel in half with a popsicle stick and then move each half

to a clean and dry part of the paper plate.

9. Add 5 drops of the colored water to one pile and 5 drops of salt water to the other pile.

Watch the gels closely with each drop. Which pile is getting the paper plate wetter? What do you think is happening here? (answer on lab sheet)

10. Answer additional questions on student lab sheet.

### **DAY TWO – Which diaper is more absorbent?**

Materials:

Substitutions:

Each group will need:

2 glass jars, labeled A and B

2 clear plastic cups

1 graduated cylinder

4 pre-cut diaper squares (2 of each different brand)

10% saline solution

Tap water

Procedure:

1. Write down observations about the two different brands of dry diapers on lab sheet.
2. Carefully measure 100 mL of tap water with your graduated cylinder and pour into Jar A. Repeat with Jar B.
3. Place Diaper sample A in Jar A and sample B in the Jar B.
4. Write down observations on lab sheet about the diapers in the tap water after three minutes.
5. Carefully pour excess water from Jar A into graduated cylinder. Record the amount on lab sheet. Repeat procedure with Jar B and record on lab sheet.
6. Dispose of wet diaper samples.
7. Repeat Steps 2 – 5 using a 10% saline solution in place of the tap water. Record all data on lab sheet.

Lab experiment adapted from American Chemical Society's "Kids and Chemistry" program and an experiment sponsored by Rohm & Haas and written by Amy Hancock Neff, Eugene Dougherty, and Albert Schweitzer.

## Teacher Notes:

### Background:

HDPE is a linear polymer that has no branching. The absence of branching results in a more closely packed structure with a higher density and somewhat higher chemical resistance. HDPE is resistant to many different solvents and has a wide variety of applications. HDPE has a water absorption percentage of less than 0.01%. Because of this, it is used in milk jugs and other food containing plastics to reduce leeching.

Disposable diapers are filled with the polymer, sodium polyacrylate, which is used in the experiment on day one. It is composed of a cross-linked polymer which traps and absorbs many times its weight in water. It is termed a hydrophilic or “water-loving” polymer because of its great affinity of water. In the dry powdered state the chains of the polymer are coiled and lined with carboxyl groups or (-COOH). When hydrated with water, the carboxyl groups dissociate into negatively charged carboxylate ions ( $\text{COO}^{-1}$ ). These ions repel one another along the polymer chain thereby widening the polymer coils allowing water to move into contact with more carboxyl groups. As the polymer continues to uncoil the ultimate swelling forms a gel-like consistency. The polymer does not form a solution because it still has cross-linking due to hydrogen bonding where hydrogen atoms in water are being attracted to the oxygen atom in the carboxylate ions between chains. To reliquify the gelled polymer for disposal purposes, common table salt is added. When salt is added, each ion of sodium (Na) and each ion of chlorine (Cl) is quickly surrounded by six molecules of water which is drawn out from the polymer-water complex. The presence of sodium chloride in the solution greatly decreases the ability of polyacrylate to absorb and retain water. Other ionic compounds such as baking soda or vinegar can also be used. Once the gel has been liquified, it can be safely poured down the drain. While sodium polyacrylate is non-toxic, it would be advisable to ask any of your students if they are allergic to disposable baby diapers. If they are, allow them to be an observer or recorder.

- Jars used on Day Two need to have a capacity of at least 200 mL
- To make 10% Saline solution, use a balance or scale to weigh 10 g of sodium chloride and dissolve in 100 mL water.
- For the two different brands of diapers, we suggest using a cheap brand for one sample and a more expensive brand for the other.

### Extension activities:

- Have students write a commercial for a baby diaper based on their experimental results.
- Organize a debate on the pros and cons of superabsorbers.
- Plant seeds or plant clippings in the tap water only diaper samples.

### Answers to additional questions from Day One:

- #5 – get bigger
- #6 – get smaller
- #7 – absorbent
- #8 – gel
- #9 – hydrophilic
- #10 - hydrophobic