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## **Superabsorbent Polymers**

### **Abstract**

Pour Milli-Q water into one glass beaker containing a small amount of the polymer; the water turns into a solid gel. Pour Milli-Q water into a second glass beaker containing a different form of the powdered polymer, immediately a snow like powder that begins to grow and rise up overflowing out of the beaker.

### **Materials**

Reaction tub	4- 2000 mL beakers
Disposable Gloves	Safety Glasses
Sodium polyacrylate	Milli-Q or deionized water
PolySnow	

### **Safety**

Both sodium polyacrylate and PolySnow are relatively non-toxic polymers. However, care should be taken when working with these substances as they can cause irritation to the skin and nasal passages. When massing them out into a beaker they are light and airy and it's easy to lose control releasing them in the air. Try to work in a properly vented area and avoid breathing the dust and particles, which could be inhaled causing irritation. Take precautions by wearing gloves and goggles whenever working with these chemicals.

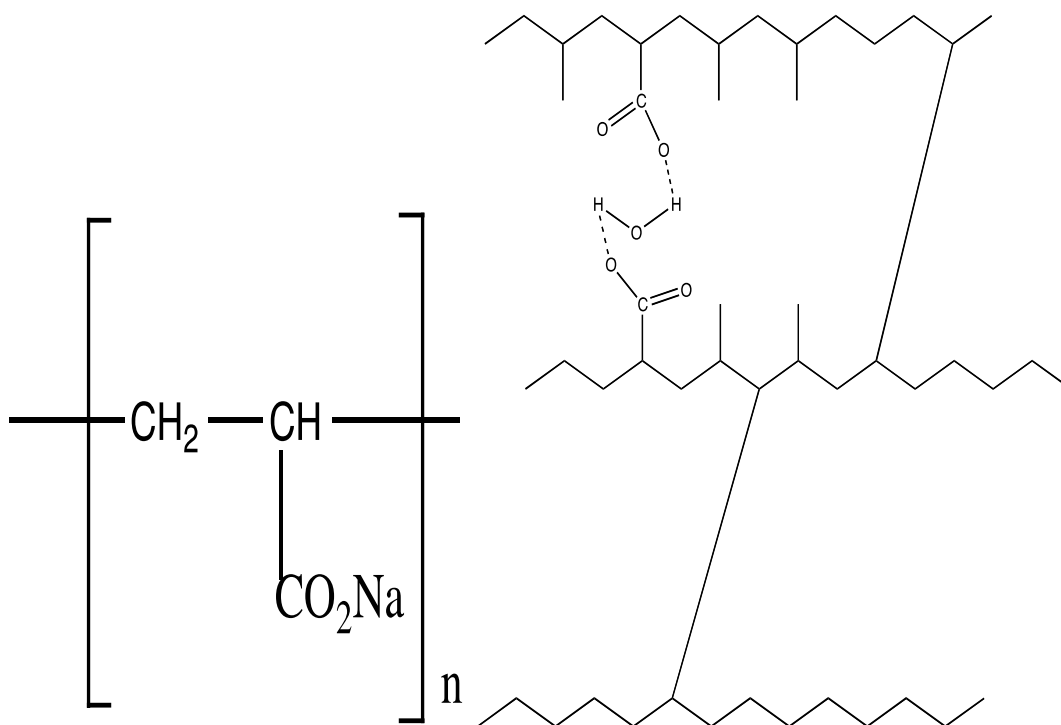
### **Procedure**

Add 9.4 grams of sodium polyacrylate to one of the empty 2000 mL beakers. To a second 2000 mL beaker add 1600 mL of Milli-Q or deionized water. Quickly pour the water into the beaker containing the sodium polyacrylate. Gently swirl the

beaker then after a few moments turn it upside down showing that the water has disappeared or been absorbed and now exists as a gel.

Add 60 grams of PolySnow to another empty 2000 mL beaker. In a second 2000 mL beaker add 1200 mL of Milli-Q or deionized water. Quickly pour the water into the beaker containing the PolySnow. Immediately, a white powdery snow forms and begins to rise up filling the beaker. If you like you can dump the snow out onto a tray so that the students can see the product of the reaction.

## Discussion



The basic difference between the sodium polyacrylate and the PolySnow is that the former contains more carboxylate groups and is less cross-linked. Consequently, it is able to absorb much more water per gram than the cross-linked PolySnow. Sodium polyacrylate is the main chemical ingredient used in diapers one of the reasons why they are called superabsorbent polymers. PolySnow is actually formed by taking the sodium polyacrylate polymer and cross-linking it. The heavily cross-linked polymer folds over on itself until water is absorbed causing it to open up and expand. The entire process works on the principle of osmosis. The number of  $\text{Na}^+$  ions inside or outside the polymer determines the osmotic pressure at any given time, which directly relates to the number of carboxylate anion sites that exist that is  $\text{COO}^-$  vs.

COOH. The amount of cross-linking also comes into play here for it is the cross-linking that allows for the creation of a membrane layer on the surface of the polymer. It's the membrane layer that's permeable to water allowing water to enter into the inside of the cross-linked polymer and hydrogen bond at the sites of high ionic strength. If there are more sodium ions inside the polymer the amount of water absorbed will be large as the polymer tries to adjust the concentrations of sodium ions inside and outside. The use of Milli-Q or deionized water decreases the ions present outside of the polymer and dramatically increases the amount of water that can be absorbed. In the case of PolySnow the powder consists of small individual cross-linked clusters. When water is added and absorbed, the individual clusters form hydrogen bonds internally, the hydrated clusters then become fluffy, not sticking to any of the surrounding clusters resulting in the artificial snow like appearance. If too much water is added the outside of the clusters will become hydrated resulting in the clusters sticking to each other producing a slush like effect instead of the powdery snow effect.

### **Disposal**

The waste must be disposed of following local, state, and federal guidelines for nonhazardous materials suitable for approved solid waste landfills.

### **References**

Buchholz, F. L., *J. Chem. Ed.*, **1996**, 73 (6), 512-515.

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