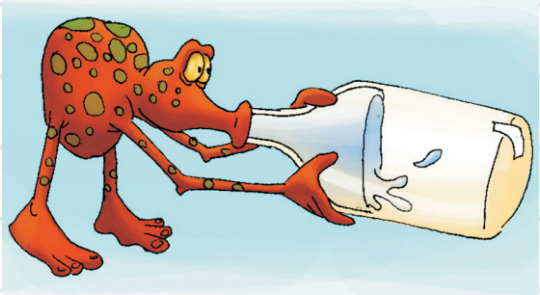
SUPER ABSORBENT POLYMER



Most common synthetic polymers are hydrophobic, or water-hating, which means that they do not absorb water. Everyday examples are: raincoats, plastic cups, bags, plastic tabletops, etc.
Some polymers, though, are **hydrophilic**, or water loving. They readily absorb water. An excellent example is sodium polyacrylate or polyacrylamide. These super absorbent polymers (SAP) contain high concentrations of sodium and potassium ions, which encourage the absorption of water through a process known as osmosis.

The SAP provided by Prof Bunsen Science is an **anionic polyacrylamide polymer**. It is made up of crosslinked copolymers of acrylamide and potassium acrylate. It is a chemical relative of cyanoacrylate which is the hardworking polymer in "Super Glue".

Hydrophilic polymers have numerous applications. To name a few:

- ★ Fuel filters in aircraft contain SAP as they have to remove all traces of water from the fuel;
- ★ Telecommunication cables are kept dry with SAP fillers;
- ★ Disposable baby nappies contain SAP to keep mom's pet dry and happy;
- ★ In agriculture as water retainers in soil, e.g. AquaSorb® and Water Grabber®. The polymer retains huge quantities of water and releases it to the plants over time to ensure a constant supply of moisture and nutrients.
- ★ Novelty toys that grow in size.

A SAP can absorb as much as 500 times its own mass in water. The best absorption ratios are achieved with de-ionised water due to the osmotic process.

Teacher Demonstrations

Required:
Super absorbent polymer (SAP);
Teaspoon
Wax paper
Table salt
Baby diaper (optional)
Two paper or plastic cups (do not use clear cups)
Water
Absorbent paper towel

Demonstration 1: The Super Slurper Trick

1. Spread a piece of wax paper on a table.
2. Secretly add one teaspoon (5 ml) of SAP to one cup.
3. Fill the other cup with water to 2/3 its volume.
4. Now dramatically announce that you can make water disappear and swiftly pour the water from the cup to the SAP containing cup.
5. Ask the students to indicate which cup contains the water. Make up time by swapping the two cups to and fro.
6. Then . . . invert both cups to show that neither contains the water!!
7. Dump the SAP gel on the wax paper and discuss the use of SAP in water absorbent applications such as aircraft fuel tanks, baby disposable nappies and soil moist retainers.
8. Put the SAP back in the cup and sprinkle table salt generously on the polymer. Inspect after a few minutes.

Alternative demonstration:
Take a commercial disposable diaper and add room temperature water in 50ml increments to it. Record the amount of water it can hold before it becomes saturated and starts to leak. Test different brands of diapers.

Demonstration 2: The magic Towel

1. Fill a lightweight plastic cup with water.
2. Place one heaped teaspoon of the SAP on one paper towel square.
3. Fold the four ends of the towel together and dip the SAP end into the water in the cup.
4. Slowly count to 30 . . .
5. Now lift the cup and water (gel) with the towel!

Explanation:

Sodium polyacrylate is one of only a few man-made polymers that are hydrophilic. The SAP has a high concentration of sodium or potassium ions which attract water through a process known as osmosis. Osmosis is the passage of water through a semipermeable membrane to an area with a lower water concentration (or higher salt concentration). It is a very important driving force in nature. As a result of absorbing the water, the SAP turns into a gel. By sprinkling salt onto the gel, the reverse osmotic process is favoured. Water now passes through the membrane to the outer higher salt concentration.

Distilled water is far better absorbed than babies' urine that contains around 0.9% salt. Superabsorbent polymers expand tremendously when they come in contact with water because water is drawn into and held by the molecules of the polymer. They act like giant sponges. Some can soak up as much as 500 times their weight in water!

The cotton-like fibers in a nappy help to spread out both the polymer and the liquids so that baby doesn't have to sit on a gooshy lump of water-filled polymer.

Safety:

- Students should not smell or handle the dry powder.
- Sodium polyacrylate is non-toxic but the dry powder may cause irritation to the mucous membranes. If necessary, flush affected areas with plenty of water. Obtain medical attention if the irritation persists.
- Ingestion may be harmful. If ingested, do NOT induce vomiting. Give water to drink. Get medical attention.
- The gelled polymer is slippery when wet. Keep off walking ways and floors. Clean spills immediately.

Disposal:

Discard the gel in the solid waste can. Alternatively, add salt to the gel to free the sodium polyacrylate, stir well and flush all down the drain with plenty of water. Untreated gel should <u>not</u> be washed down the drain as it may clog the pipes.