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How Do Disposable Diapers Work? Why Do They Leak?

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Question: How Do Disposable Diapers Work? Why Do They Leak?

Answer: Disposable diapers contain the same chemical as astronaut "maximum absorbency garments", fire-control gels, soil conditioners, those toys that grow when you add water, and floral gel. The super-absorbent chemical is sodium polyacrylate [monomer: $-\text{CH}_2-\text{CH}(\text{CO}_2\text{Na})-$], which was invented by scientists at Dow Chemical Company and results from polymerizing a mixture of sodium acrylate and acrylic acid.



Disposable diapers hold more water than other liquids.

Marco Arlesen, stock.xchng

How Sodium Polyacrylate Absorbs

Superabsorbent polymers are partially neutralized polyacrylate, with incomplete cross-linking between units. Only 50–70% of the COOH acid groups have been converted to their sodium salts. The final chemical has very long carbon chains bonded with sodium atoms in the center of the molecule. When sodium polyacrylate is exposed to water, the higher concentration of water outside the polymer than inside (lower sodium and polyacrylate solute concentration) draws the water into the center of the molecule via osmosis. Sodium polyacrylate will continue to absorb water until there is an equal concentration of water inside and outside the polymer.

Why Diapers Leak

To some extent, diapers leak because pressure on the beads can force water out of the polymer. Manufacturers counter this by increasing the cross-link density of the shell around the bead. The stronger shell allows the beads to retain water under pressure. However, leaks occur mainly because urine is not pure water. Think about this: you can pour a liter of water into a diaper with no spill, but the same diaper probably can't absorb a liter of urine. Urine contains salts. When a child uses the diaper, water is added, but also salts. There will be salts outside of the polyacrylate molecules as well as inside, so the sodium polyacrylate won't be able to absorb all the water before the sodium ion concentration is balanced. The more concentrated the urine, the more salt it contains, and the sooner the diaper will leak.

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