DIAPERS_DISPOSABLE

Superabsorbers

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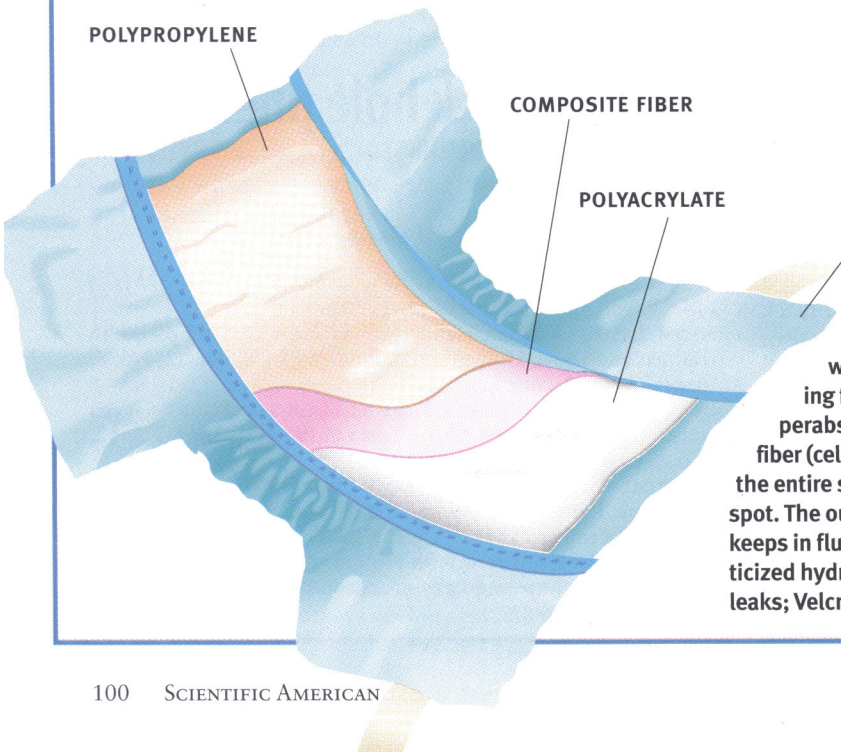
If you've taken a diaper off a baby sometime in the past decade, you were probably surprised—not at how messy it is, but at how heavy it is. Today's disposable diapers can hold pounds of pee and still feel quite dry, which may be why fewer than 5 percent of American babies use cloth diapers.

This astonishing absorbency comes from a family of hydrophilic ("water-loving") polymers called polyacrylates. Perhaps the simplest of these is sodium polyacrylate, which can hold 800 times its weight in distilled water. Of course, there's more to urine than water. Dissolved salts and ions reduce the absorbency by more than a factor of 10. The leading brands of diapers use combinations of polyacrylates that presumably do better—but it might be easier to find the recipe for an atom bomb than for a diaper filling. It's a competitive industry.

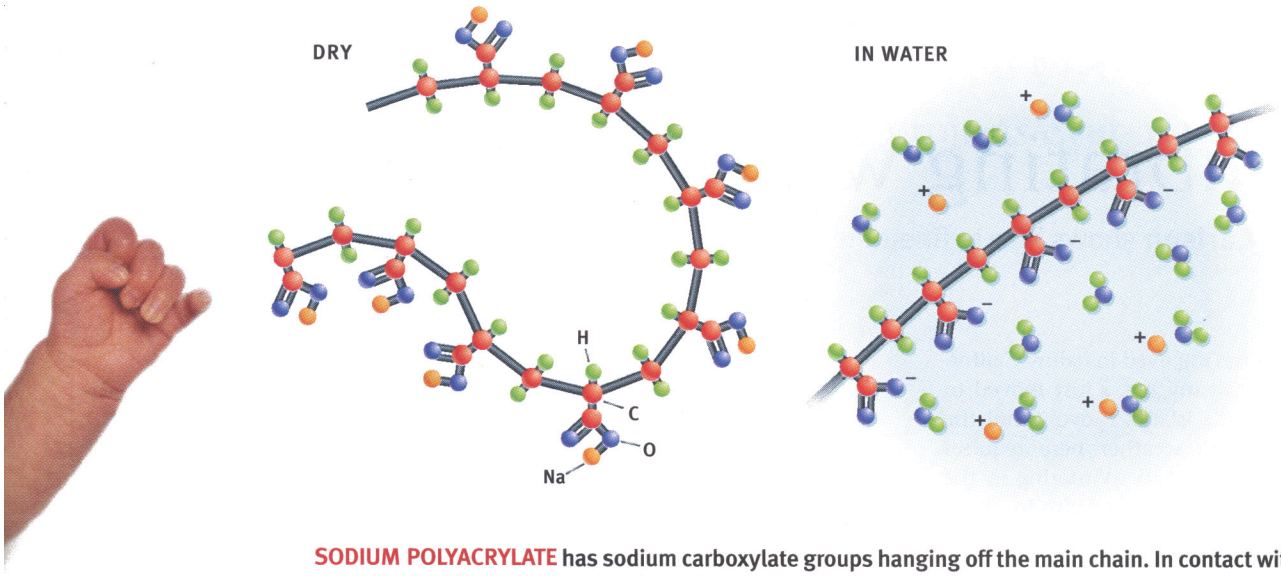
Because they keep the skin drier than cloth, disposable diapers are probably better for baby, although the margin is unclear in practice—babies in cloth diapers are changed more often and don't have seem to have diaper rash more frequently. Advocates of cloth diapers point to the enormous environmental cost of disposables. The overall environmental equation of washable versus disposable diapers is hard to quantify, but the latter form a significant chunk of the urban waste stream. Disposable diapers add about 2.7 million metric tons of pee, poop, plastic and paper to U.S. landfills every year.

In tropical countries, babies often go diaper-free; it's cheaper just to mop up the floor. In fact, as this mother was informed (sometimes by virtual strangers) during a visit to India, it's considered cruel and unusual treatment to subject a baby to the breezeless confinement of a diaper. Result: no rash and no trash.

—Madhusree Mukerjee, staff writer



MOST MATERIALS used in a disposable diaper are synthetic. Polypropylene, used in winter athletic underwear, makes up the inner layer; it is soft and stays dry, drawing fluid away from the skin. At the core is the polyacrylate superabsorbent powder, combined with fluffy cellulose. A layer of fiber (cellulose or synthetic) fights gravity by distributing fluid over the entire surface of the powder instead of letting it pool in one spot. The outermost layer is mostly microporous polyethylene; it keeps in fluid but lets out vapor. Adhesives hold it all together: elasticized hydrophobic polypropylene cuffs around the thighs contain leaks; Velcro or sticky tabs hold the diaper on the baby.



SODIUM POLYACRYLATE has sodium carboxylate groups hanging off the main chain. In contact with water the sodium detaches, leaving only carboxyl ions. Being negatively charged, these ions repel one another so that the polymer unwinds and absorbs water, which is attracted to the sodium atoms. The polymer also has weak cross-links, which effectively leads to a three-dimensional structure. In addition, it has molecular weights of more than a million; thus, it cannot dissolve but instead solidifies into a gel.

LARGE DISPOSABLE DIAPER can hold half a gallon of water. Superabsorbents are the secret.

DID YOU KNOW . . .

- Superabsorbents are useful not only for personal hygiene (diapers, adult incontinence pads, and so on) but also for mopping up medical wastes in hospitals, for protecting industrial power and optical cables from water leaks, for filtering water out of aviation fuel and for conditioning garden soil to hold water—not to mention as toys that expand when placed in water.

- A study published in 1999 found that mice who were exposed to disposable diapers suffered eye, nose and throat irritations, some resembling an asthma attack. Gases emanating from solvents and other chemicals in the diapers were suspected to be responsible. Superabsorbents were withdrawn from use in tampons after an outbreak of toxic shock syndrome in 1980.

- Babies in cloth diapers are toilet-trained almost a year earlier than babies in disposables. Although that could be a matter of cultural mores, it is probably also because the disposables are so absorbent that often neither baby nor caregiver can tell when the baby eliminates, and so the child can't easily associate the act with using the toilet.

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