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## Diapers

updated July 02, 2010 by Nick Thorp

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Overview



The diaper, or nappy, has changed radically since its development in England in the 1590s. Washable diapers are usually made of cotton or other fibers, natural or synthetic, that can be washed and reused. The more modern disposable diapers contain absorbent chemicals such as Polyacrylic Acid and are thrown away after use (see photo, right). An estimated 27.4 billion disposable diapers are used each year in the US, which results in a possible 3.4 million tons of used diapers being added to landfills each year.

## History of Disposable Diapers

Richer Investment Services offers a thorough history of disposable diapers, which includes a time line. A super-absorbent polymer (SAP) called Polyacrylic Acid was patented in 1966 by Gene Harper of Dow Chemical and Carlyle Harmon of Johnson & Johnson. It was first used in diapers in 1982 in Japan. These super-absorbent diapers have been shown to reduce cases of diaper rash in

babies by absorbing more liquid and reducing excessively wet skin, which is a primary cause of these rashes (Davis et al., 2008). **However, if the super-absorbent gel found in the diapers were to come into direct contact with skin, there is potential for an allergic reaction that may cause a rash, or in the worst cases, lesions.**

Since the invention of disposable diapers there have been over 1,000 different patents.

Over 18 billion packages of diapers were sold in the United States alone in 2006. It is estimated that every child will go through 10,000 diapers before they are toilet trained (Prasad et al., 2002).

## **Design of Disposable Diapers**

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Disposable diapers typically have these basic components:

Cloth-like, plastic film that serves as the back sheet to prevent liquids from leaking out

Tissue layer to "carry" the absorbent pad

The absorbent pad, which contains: top sheet (in contact with skin), distribution layer (to move liquids to the core of the pad), cellulose or synthetic pulp, super-absorbent gel, and bottom sheet

Topical lotions added to the top sheet (some diapers)

Tapes and elastics to secure the diaper and prevent leakage

## **Polyacrylic Acid and Disposable Diapers**

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**Polyacrylic acid is added to diapers as a powder (see photo, left) at about 4-5 grams per diaper. It absorbs about 30 times its weight in water, or about 30 mL (1 oz) of water per gram, so a typical diaper can absorb 120-150 mL of water. (See Cool Science for full description on dissecting a diaper.)**

## **Disposable Diaper Exposure Issues**

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### **Diaper Dye Skin Irritation**

Certain dyes used to add color to disposable diapers have been shown to cause allergic reactions resulting in rashes. Repeated exposure to the dye can cause a long-term allergy. One study that looked at several babies who suffered from rashes found that the rashes only occurred in places where the skin was in direct contact with the dyed part of the diaper. Researchers believe that it is the

continued exposure to the dyes that causes a sensitization, or allergic reaction, in babies. (Alberta et al., 2005)

Dyes linked to sensitization (cause of an allergy)

-Disperse Yellow 3

-Disperse Orange 3

-Disperse Blue 124

-Disperse Blue 106

From Alberta et. al., 2005

## **Dioxin Exposure**

**Diapers, both cotton and disposable, contain very small amounts of dioxins, an organic compound that can be manipulated to form other compounds, the most common of which is polychlorinated dibenzodioxins, a common environmental pollutant. Dioxins form in the wood pulp when it is bleached from brown to white before being put into the diaper.**

**(The use of chlorine in the bleaching process is what creates the dioxins; chlorine-free processes are available but the majority of the pulp used in diapers is bleached with chlorine.)**

Certain dioxins have been shown to be a carcinogen and to affect the reproductive and immune systems. Several European countries have begun phasing out the bleaching of wood pulp with chlorine due to concerns about dioxin and its potential negative effects on human health.

One research study examined the potential threat of exposure to dioxins from diapers and tampons. Several brands of diapers were analyzed. Researchers found that while all of the products tested did contain dioxins, none of them contained the most potent and toxic dioxins. Researchers claimed that the levels of dioxins in these products were very low and that for dioxin exposure rates to increase, levels of dioxins in these products would need to increase between 100-1,000 times (DeVito et al., 2002). However, other studies claim that little is known about low-level exposure to dioxins and its effects (Sutton et al., 1991). In response to scares over dioxin exposure, several diaper manufacturers have started to offer diapers that are unbleached or bleached without chlorine.

## **Respiratory Effects**

One study from 1999 found that test rats exposed to emissions from disposable diapers experienced impaired breathing (Anderson, 1999). Three brands of disposable diapers were used, and two of the three brands were observed to cause "reduced mid-expiratory airflow velocity, sensory irritation, and pulmonary irritation ... and the effects were generally larger during repeat exposures to these emissions."

The study identified these chemicals in emissions from two brands of disposable diapers (specific brands tested were not disclosed):

-m-Xylene

- p-Anisaldehyde
- Ethylbenzene
- Styrene
- Isopropylbenzene
- Dipentene
- m-Methoxybenzaldehyde
- Methyl
- Toluene
- 1,3,5-Trimethylbenzene
- Trichloroethylene
- 1-Methylcyclopentylamine
- 1,2,3-Trimethylcyclopentane

cinnamate

Study authors concluded, "The results demonstrate that some types of disposable diapers emit mixtures of chemicals that are toxic to the respiratory tract. Disposable diapers should be considered as one of the factors that might cause or exacerbate asthmatic conditions."

### **Other Problem Materials**

The Alberta et. al study lists the following chemicals found in disposable diapers as associated with allergic contact dermatitis (skin rash):

- Mercaptobenzothiazole (rubber chemical)
- P-tert-butyl-phenol-formaldehyde resin (glue)
- Cyclohexylthiophthalimide (found in rubber)

### **Environmental Concerns**

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While the study mentioned above claims that the threat of harmful exposure to dioxins may be low, there may be an indirect threat from diapers after they are thrown away. Disposable diapers make up 1-3% of all solid waste that goes into landfills in the United States (Prasad et al., 2002). Dioxins may leach out of diapers and enter ground and surface water, concentrating at levels that would pose a threat to human health. Also, dioxins are released into the environment when wood pulp is bleached with chlorine.

Disposable diapers do not degrade when in landfills (Sutton et al., 1991).

Disposable diapers are often thrown into the trash, and eventually into a landfill, still containing feces. Throwing human feces into a landfill is illegal but many parents do not know that they should be dumping the feces into the toilet before throwing the diaper away. Human waste has added to the amount of dangerous bacteria that already exists in landfills and increases the threat of the bacteria leaching into groundwater (Sutton et. al., 1991).

### **Problems with Diapers**

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Recently there have been some concerns raised about Pampers Dry Max Diapers produced by Procter and Gamble.

## References

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Alberta, Lauren, Susan M. Sweeney, and Karen Wiss. "Diaper Dye Dermatitis." *Pediatrics* 116 (2005): 450-52.

Anderson RC, Anderson JH. "Acute respiratory effects of diaper emissions." *Arch Environ Health*. 1999 Sep-Oct;54(5):353-8.

Davis, James A., James J. Leyden, Gary L. Grove, and William J. Raynor. "Comparison of Disposable Diapers with Fluff Absorbent and Fluff Plus Absorbent Polymers: Effects on Skin Hydration, Skin PH, and Diaper Dermatitis." *Pediatric Dermatology* 6.2 (2008): 102-08.

DeVito, Michael J., and Arnold Schecter. "Exposure Assessment to Dioxins from the Use of Tampons and Diapers." *Environmental Health Perspectives* 110.1 (2002): 23-28.

H.R.Y. Prasad, Pushplata Srivastava, and Kaushal K. Verma. "Diapers and skin care: Merits and Demerits." *Indian Journal of Pediatrics* 73.10 (2004): 907-908.

Sutton, Marianne B., Michael Weitzman, and Jonathan Howland. "Baby Bottoms and Environmental Conundrums: Disposable Diapers and the Pediatrician." *Pediatrics* 1991 85.2 (1991): 386-388.

Diapers - history & chemistry - article by Chemistry Explained - good summary of the history and chemicals involved in disposable diapers.

Diapers - wikipedia - excellent history and general information on diapers

The Diaper Industry Source (with history)

The Diaper Hyena - Promotes Cloth Diapering Resources - has interesting information on health effects of disposable diapers

Cool Science - diapers - short intro to SAP and diapers

Superabsorbent Polymers - dated (1999) but interesting data on manufactures at that time

Acrylates - looks at the chemistry of different configurations

Breaking News Stories

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Diaper News from Environmental Health News

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( Links to articles in today's press about environmental health. Many more links available today at [www.EnvironmentalHealthNews.org](http://www.EnvironmentalHealthNews.org) )

Faecal contamination blamed for typhoid.

Typhoid used to be a rare condition in Zimbabwe but progressive deterioration of public infrastructure like water and sewage reticulation has seen it sprouting.

Jessica Alba goes toxin-free with The Honest Company.

Working mom Jessica Alba is adding entrepreneur to her many titles, shifting from movie star to businesswoman with a venture that provides parents easy access to eco-friendly natural products for babies and homes.

Sea's bounty litters South Florida's beaches.

A cow's head. Lots of truck tires and shattered wooden pallets. Fresh fruit. Even, rarely, human remains. Each morning the city's beach clean-up crew heads out like treasure hunters on a daily pre-dawn sweep of Fort Lauderdale's famous beach. They never know what has washed up overnight.

Company cautions against linking well, Ohio quakes.

At a news conference after the town forum Wednesday, D&L Energy said they voluntarily shut down an oil and gas wastewater well in Youngstown to study any links to the quakes urged caution in accepting a seismologist's finding that their injection well almost certainly caused the quakes.

Once again, more questions than answers about earthquakes.

Concerned citizens seeking confirmation that a brine-injection well located in Youngstown caused 11 earthquakes to shake the Mahoning Valley in 2011 left the Covelli Centre disappointed last night after officials were unable to provide answers.

A thing or two about twins.

To biomedical researchers all over the world, twins offer a precious opportunity to untangle the influence of genes and the environment—of nature and nurture. Because identical twins come from a single fertilized egg that splits in two, they share virtually the same genetic code. Any differences between them—one twin having younger looking skin, for example—must be due to environmental factors.

Mercury veteran: Contaminated or not, glad to help my country.

Harold Cofer remembers being covered in mercury, emptying it out of his shirt pocket, pulling it out of his hair. There were a lot of problems during the 1950s startup of lithium operations at Y-12, but the biggest problem was trying to contain the mercury within the production facilities, he said.

Sewage blunder earns engineer a criminal record.

In 2007, Lawrence Lewis and his staff diverted a backed-up sewage system into an outside storm drain to prevent flooding in an area where the sickest residents lived. The storm drain did not connect to the city's sewage-treatment system as they had thought. It emptied into a creek that ultimately feeds the Potomac River.

Three trucks sucking up oily muck in Sand Creek trying to keep more from flowing into South Platte River.

Three 2,500 gallon vacuum trucks are sucking up water and oily muck from Sand Creek north of downtown Denver, trying to keep more of the pollution from reaching the South Platte River.

Electrofuels bump up solar efficiency.

Scientists and engineers are seeking ways to improve on photosynthesis, and some of them convened in Providence, R.I., earlier this month at the Society for Biological Engineering's inaugural conference on electrofuels research to discuss their progress.

## **Topic List**

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