



THE POOP ON DIAPER RECYCLING

One small town's groundbreaking program may lead the way for recovering valuable materials from an unlikely waste.

by Clarissa Morawski

Last November, a California community boldly did what few have done — or even imagined possible: They began to recycle their diapers. Just to be clear, this means dirty diapers, disposable bed liners and feminine hygiene products, technically known as absorbent hygiene products (AHPs).

Billions of diapers

Only 2 percent of parents living in the U.S. are using reusable cotton diapers for their babies. Everyone else takes the more “convenient” route with the one-way, disposable diaper. In fact, the U.S. Environmental Protection Agency (Washington) estimates that the country generates annually about 18 billion disposable diapers. That's about one ton of disposable diapers per baby before toilet training.

EPA research also suggests that the average diaper takes about 500 years to decompose. American landfills are composed of

about 1.5 to 4 percent by weight of AHPs. This amount is also on the rise, as the large baby boom generation gets older and consumption of adult incontinence products increases. Given these facts, it's not surprising that AHP recycling is gaining interest.

In the beginning

About 14 years ago, a mother from Ontario began to research possible solutions for this growing waste problem. After several years of raising money for research and development (and good timing, considering recent mandatory provincewide hikes in landfill tip fees designed to stimulate recycling), Knowaste LLC was born.

The company's first pilot facility opened in Mississauga, Ontario and then processed about 4,000 to 5,000 tons of AHPs. At the

time, tip fees (gate fees) were competitive with the cost of local landfills, at about \$150 (\$/Cn) per metric ton. But it didn't take long for Ontario's waste to start flowing south to cheaper disposal options in the U.S. A few years later, Knowaste LLC shut its Ontario facility because it could not compete against the disposal alternatives.

Throughout most of the 1990s, Knowaste LLC, now based in New York City, refined the recycling technology and began looking for opportunities in Europe and Asia where disposal costs were more cost competitive.

Recycling AHPs today

In 1999, Knowaste opened a large-scale state-of-the-art facility in Arnham, Holland. The facility can process up to 100,000 tons of used AHPs per year collected from

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Western European old-age facilities, day-care centers and other commercial establishments.

Last November, a small-scale version of the technology called Knowaste Diaper Processor (KDP) began recycling used diapers from 220 households involved in a six-month test pilot in Santa Clarita, California. If successful, the program will expand to the entire community of 143,000 households.

Today, Santa Clarita is collecting about one ton of AHPs a week. The material is placed by residents in plastic bags and stored in 64-gallon bins usually placed outside of the home or in the garage (bags and bins were provided by the city). Although haulers and processors elsewhere have expressed concern about handling AHPs, Santa Clarita city staff report that their program is very popular with residents and collection is going smoothly.

With a throughput of only one ton per week, however, poor economies of scale make it difficult to market output material. Knowaste LLC plans to use the secondary fiber to produce paper-based flowerpots for the 220 residents involved in the pilot. Knowaste estimates that a throughput of 10 tons a week would make secondary material marketing viable. Once the pilot is completed in May, the city council will be provided with a cost-benefit analysis to determine whether to expand the program or to continue the pilot for another six months.

This small-scale KDP seems to be gaining ground in smaller community diversion programs. With a footprint of 1,500 square feet and 18-foot height clearance, the KDP can be placed directly in a municipal materials recovery facility (MRF). The unit has a maximum capacity of 5,000 tons (based on three shifts) of AHP per year (one ton per hour), and can result in up to 1,000 to 1,200 tons of pulp and 500 to 600 tons of plastic output for end-use markets.

The technology

The Knowaste recycling process separates the components of AHPs into:

- ◆ 55 percent moisture
- ◆ 24 percent paper fiber
- ◆ 10 percent plastic (60 percent low density polyethylene and 40 percent polypropylene)
- ◆ 6 percent sludge
- ◆ 5 percent super absorbent polymer (which provides the water retention function).

Bagged material is loaded onto a conveyor belt and shredded into small pieces. The material then is sent to a pulper, which sanitizes the material and initiates the process of separating the components to expose them for chemical treatment. The plastic is removed by finger conveyors and is sent to

Table 1 Absorbent hygiene product recycling loop

Material	Percent by weight	Processed into	End use
Moisture	55	sanitized and clarified waste water	re-circulated in the recycling process
Fiber	24	high-quality fiber, pressed and packaged for shipping	paper products and packaging, construction materials
Plastic	10	pelletized plastic	artificial wood and plastic products
Sludge	6	collected and chemically treated material	used in compost in Holland; discharged to municipal sewer system in California
Super absorbent polymer	5	deactivated absorbent polymer	can be reactivated for agricultural applications to help soils retain water

Source: Knowaste LLC, 2003.

trommels where residual fibers and waste are removed by washing. Plastics are pressed and pelletized for sale to the market.

The pulp stream goes through a series of coarse screens to further remove plastics. The pulp stream is treated to deactivate the super absorbent polymer (SAP), which makes it possible to separate out the fiber.

The deactivated SAP, along with residual small plastics, is separated from the fiber through a cleaning process. The deactivated SAP can be collected and reactivated for reuse. Currently, however, deactivated SAP is not being reused because AHPs from the commercial sector contain much less SAP than diapers, resulting in poor economies of scale to develop a SAP market in Holland.

Fibers then are put through a fine mechanical washing, cleaning and screening process. The high-quality clean fiber is pressed, baled and sold to the market.

The water extracted in the washing and thickening steps is sent to internal treatment using a dissolved air clarifier and then recycled in the system as dilution water. In Arnhem, sludge from the clarifier, as well as the fine screening and cleaning rejects, are thickened and sent for composting.

In the KDP version, the technology incorporates a batch processor and a continuous fiber processing system. The batch processing in the first stage combines the functions of shredding, pulping, SAP deactivation, sanitization and separation in one step.

The process begins with loading the diapers into the batch processor, along with the chemicals (chlorine and aluminum sulfate) for sanitization and SAP deactivation. As the processor turns, it shreds the diapers and exposes the contents to the chemicals. Similar to a washing machine, water is continuously pumped into and extracted from the unit, a process that continuously removes the fiber, deactivated SAP and waste.

At the end of the cycle, the washed plastic is extracted and pelletized, while the

remaining materials are directed into the continuous part of the process for fine screening and cleaning to produce a quality pulp. The pulp then is thickened and sold.

The water is clarified in a dissolved air flotation (DAF) tank and recycled in the facility as dilution. Waste diverted from the screen and cleaner, along with the sludge extracted by the DAF, is sent to the municipal sewage system (a requirement of the plant's permit). All discharged water is treated internally to reduce suspended solids.

Costs

The cost of a KDP machine is \$750,000 with a two-year warranty. Although operational costs will vary depending on factors such as energy, labor and water costs, Knowaste estimates direct operating costs including maintenance will run at about \$60 per ton (not including material revenues). If a KDP machine is set up within a MRF, then bagged material can be collected curbside or via drop-off sites and sorted with other recyclables, incurring only incremental collection costs. Depending on the costs of alternatives, diaper recycling can prove to be not only envi-

Shifting the cost

The average diaper costs between 20 and 30 cents each. At about 5,500 diapers per ton, the cost to recycle diapers (not including capital or collection costs) would be about a penny per diaper. By applying a standard model to a diaper recycling program, one can estimate that an extended producer responsibility (EPR) program could result in a consumer cost increase of 3 to 5 percent per unit. In light of this expense, the diaper industry instead has been promoting taxpayer-funded, municipal composting as the diversion solution for one-way diapers.

The greenest diapers of all

In the end, the most environmentally preferable way of mitigating the impacts of disposable diapers is not to use them at all. Cotton diaper services exist in most large urban cities, and the environmental savings are huge. Reusable diapers use about half as much water, three times less energy, 20 times less raw materials, generate 60 times less waste and cost taxpayers nothing.

Environmentally preferable to disposal, but economically viable as well, say company officials.

A statewide system?

The development and implementation of diaper recycling technology may get a boost from a California politician. State Senator Don Perata (D-Oakland) advocates a quarter-cent recycling fee on disposable diapers. The tax would cover both child and adult diapers, adding up to between \$12 and \$20 over a child's typical diaper-wearing lifetime. Monies would be turned into grants to fund diaper recycling programs around the state. The bill is co-sponsored by Californians Against Waste (Sacramento).

Environmental savings

According to Knowaste LLC, the upstream environmental savings of recycling AHPs are significant. They estimate that for every ton of AHP waste recycled, 400 kilograms of wood, 145 cubic meters of natural gas and 8700 cubic meters of water are saved.

Roy Brown, president and CEO of the

Composting diapers

The diaper-producing industry has claimed that diapers can be composted effectively in municipal solid waste composting plants. In fact, they have conducted pilot studies in communities that they claim have had "very positive results." One large diaper company put a message on its packaging stating, "This product is compostable in municipal composting units. Support recycling and composting in your community."

The problem is that few centralized municipal composting facilities are prepared to handle the material. Orga World for example, one of Holland's larger composting facilities, was receiving absorbent hygiene product (AHP) material from the commercial sector for composting. The material was difficult to deal with and, in the fall of 2001, Orga approached Knowaste and to develop a plan to process the AHPs and Orga to compost residual sludge.

The problems associated with AHP composting can be numerous. The first difficulty is the issue of health and safety of facility workers' exposure to fecal matter and other human waste. Second, finished compost is contaminated by plastic, which incurs additional costs to remove. Third, diapers usu-

ally are tightly bundled-up before thrown away. This necessitates acquiring a front-end shredder at the compost facility. Shredding material at the front end means shredding contaminants, which are usually pulled out from the finished compost (such as batteries, metal products, etc.). Once shredded, extracting the contaminants from the back end is impossible, resulting in a less-than-grade compost quality (for a related discussion of plastic film removal from compost, see also "Skimming the Film Off Compost" in the February 2002 issue of *Resource Recycling* magazine). And finally, end markets for finished compost are fairly undeveloped all over the world, which may result in another waste problem.

However, if sustained end markets exist and properly designed facilities with the necessary health and safety measures are established, then composting is an option for diverting small volumes of materials. In fact, Toronto, Canada's largest city, is in the process of rolling out a wet waste program that will accept diapers, incontinency pads and sanitary products for composting. Because the program is still in its infancy, however, results cannot be reported yet.

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For more information about Knowaste LLC technology, visit www.knowaste.com or call (905) 568-0334.

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