Argonne NATIONAL LABORATORY

Office of Technology Transfer

Advanced Process Technology for Separating and Recovering High-Quality Plastics from Complex Waste Streams

Argonne's environmentally friendly and proven recycling technology offers an innovative approach that will benefit the recycling industry.

Benefits

- Recycling of plastics from waste saves material
- Capable of processing mixtures containing mixed wood and rubber
- Clean because process does not require the use of hazardous materials
- Reduction in greenhouse gasses due to recycling
- High-purity recyclable residue from previously unusable materials
- Test results by industry indicate that the recovered material can be used as 100% replacement for virgin plastics, depending on the performance requirements of the end product
- Economically attractive — cost savings of over 25% can be achieved by using the recycled material, in comparison with using virgin material
- Reduced energy use and carbon emissions, compared to the processing of new materials

Status

- Two patents have been awarded and one is pending
- Technology recognized by industry in the United States and internationally

The Opportunity

Every year, millions of tons of plastics-rich waste material — including over 4.5 million metric tons of shredder residue (SR) — are landfilled in the United States. This material contains plastics, metals, rubber, and other recyclables. If recovered, the polymers alone could have a market value of as much as $500 million, cut landfill waste, and save trillions of Btu of energy — but the technology to recover these materials has not been available. The complexity of many of the waste streams makes conventional recycling challenging and noneconomic.

The first step in recovering the polymers is to separate the polymers from the non-polymers as a polymer concentrate. For example, the polymer concentrate (derived from shredder residue) contains over 20 plastics and about half a dozen types of rubber, making the separation and recovery of individual polymers or classes of compatible polymers complicated.

The Solution

To solve the problem, Argonne researchers have developed patented technology for the recovery of plastics from home appliances, electronics, and shredder residue. The technology is a combination of mechanical and chemical separation processes to produce >95% pure individual plastics.

What makes the Argonne technology unique is that it separates individual plastics or groups of compatible plastics from a complex waste stream containing a mixture of plastics, other polymers (such as rubber), and non-polymers (such as fabrics, fibers, glass, wood, and metals). The technology can recover plastics from waste streams rich in plastics — such as those generated when automobiles, home appliances, and electronics are shredded and their metals are recovered.

Recovery of the Polyolefin Plastics

The Process behind the Technology

After mechanical separation to concentrate the plastics into a more manageable fraction, Argonne employs

- Several companies are evaluating the technology for implementation.
- Argonne is interested in licensing the process to develop more effective waste processing in practical applications.

Contacts

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"froth flotation" with surface modification to selectively separate the desired materials from the polymer concentrate that has already been separated from the waste stream by mechanical means. Froth flotation modifies the surface of a plastic to enhance or retard its "wet-ability" (hydrophobicity or hydrophilicity) so that air bubbles can selectively attach to the hydrophobic plastics in the mixture, causing them to float when placed in a special chemical solution as the wetted plastics sink, allowing separation.

At present, polyolefins, acrylonitrile-butadiene styrene (ABS), polyethylene (PE), and polystyrene (PS) are recoverable from automobile shredder residue. ABS and PS are also the leading candidates for recovery from home appliances.

Facilities and Results

Using in-house bench-laboratories, and a pilot-scale plant, Argonne researchers evaluate the effectiveness of recycling strategies and how they may benefit industry. Argonne's in-house pilot facility includes a 2-ton/h mechanical separation plant and a 6-stage 1,000-lb/h froth flotation process to recover separable polymers.

Argonne has processed over 90 tons of shredder residues from five different shredders in its mechanical separation plant. In the process, over 20 tons of polymer concentrate were recovered. The polymer concentrate typically contains over 90% of the plastics and rubber present in the shredder residue. The polypropylene (PP) and polyethylene (PE) were separated and recovered from the polymer concentrate at a yield of greater than 90% and a purity of greater than 95% PP and PE.

Researchers found that the properties of the recovered PP/PE were close to the properties of several grades of commercially marketed virgin material. Samples of recovered PP/PE were successfully recycled into mold trials to produce auto parts.

Argonne Froth Flotation Separation Pilot Plant

In addition to in-house resources, Argonne researchers have designed and built a number of modular plastics recycling pilot plants that have been tested at private industrial sites with excellent results. At one site, over 30,000 lb of mixed plastics were processed and about 20,000 lb of ABS were produced at a purity exceeding 98%.

ABOUT ARGONNE TECHNOLOGY TRANSFER

Argonne National Laboratory is committed to developing and transferring new technologies that meet industry's goals of improving energy efficiency, reducing wastes and pollution, lowering production costs, and improving productivity.

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