Plastics Recycling Overview

- EPIC is dedicated to improving the methodology and technology needed to enable more people to recycle more plastics, and to open new markets and increase the demand for recycled plastic products.
- Just as an infrastructure of roads, bridges and tunnels permits vehicles to get from one end of the country to the other, a well-developed infrastructure that can accommodate plastics in an acceptable form will get more used plastics from consumers back to manufacturers.
- Generic post-consumer plastics recycling may vary from operation to operation, but typically involves sorting by resin type, washing and conversion into either flakes or pellets.
- Commingled plastics recycling involves the use of mixed plastics as feedstock, requires little or no sorting or cleaning, and the waste plastics are formed directly into products such as lumber substitutes.
- Chemical and thermal plastics recycling processes "unlink" waste plastics to produce new plastics or a number of petroleum products.

Plastics have become the material of choice for a variety of packaging applications because they are lightweight, shatter resistant and uniquely efficient at protecting or delivering products in the marketplace with a minimum amount of packaging.

This widespread use of plastics in packaging, however, did not occur until the 1970s. Steel food containers (tin cans), on the other hand, were developed and used for food processing in the early 1800s, while glass probably dates back to the first century A.D. As with other products and packages, the recycling of plastics has evolved over time, albeit over a much shorter time. While the plastics industry has recycled its own, in-plant scrap since commercial-scale plastics processing began many years ago, post-consumer plastics recycling is still very much in its infancy.

But as the collection infrastructures and recycling technologies have advanced, so too, have recycling rates for plastics. Recycling initiatives to convert used plastics into new, useful products have increased tremendously over the past few years. In fact, the number of plastics recycling plants in Canada has grown from fewer then ten in 1988 to more than 80 today, and over a third of these plants now process post-consumer material.

Today, recycling as many materials as practically possible is a goal shared by consumers and industry alike. A key objective of the Environment and Plastics Industry Council is to improve the methodology and technology to enable more people to recycle more plastics, and to open new markets and increase the demand for recycled plastic products.

At the same time, recycling is not a panacea. An effective program for conserving and recovering plastic resources must have many components - it must be a balanced, economically sensible, integrated strategy which also includes source reduction (making less in the first place), reuse, recovery of energy and retention in landfills.

But recycling is a vital part of an integrated resource management strategy.

Plastics Value Chain

The plastics industry's production process can be viewed in terms of adding value at each of the processing steps: from initial feedstock right through to the use of finished products by various markets. The process typically follows these steps:

- Oil or natural gas is used as feedstock to produce monomers;
- Monomers are reacted into polymers;
- Plastic resins are then fabricated into useful products such as industrial parts, bottles and containers, films, fibres, etc.,; and
- Finished products then serve market needs such as food packaging, electronics, automotive, medical products, etc.

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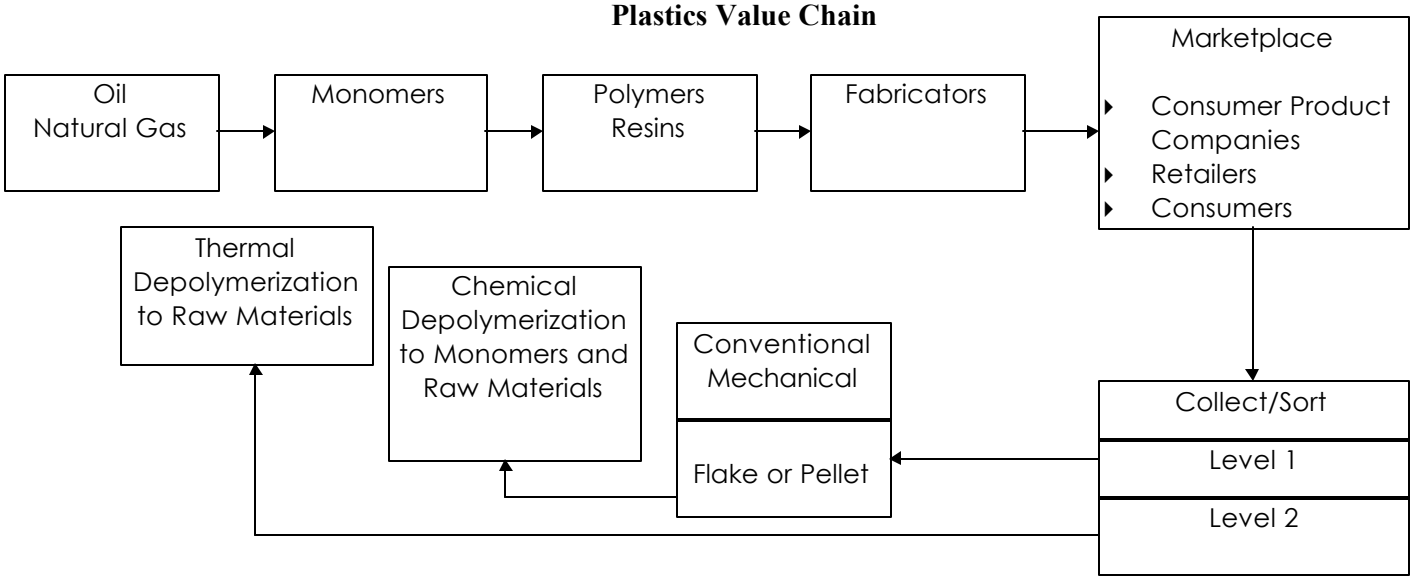
The plastics industry focuses on minimum cost/maximum value at every step of this value added chain. The industry is placing increasing emphasis on reducing the amount of material required to make its products in the first place, as well as on practical ways to reuse, recover and dispose of those plastic products once they have served their useful purpose.

One valuable resource recovery technique is recycling.

Plastics Value Chain



Integrated Recycling Systems

Recycling Infrastructure

Post-consumer plastics recycling is still an emerging industry. Ten years ago, the ability and the infrastructure required to recycle post-consumer plastic was virtually non-existent. Today, real strides are being made in recycling which, when combined with other resource management strategies, are reducing the amount of material that would otherwise end in landfills.

Developing an efficient, cost-effective method of recycling plastics that have served their intended purpose, retrieving them from the waste stream, and getting them back into the manufacturing process requires an infrastructure. Just as an infrastructure of roads, bridges and tunnels permits vehicles to get from one end of the country to the other, a recycling infrastructure that can accommodate plastics will get used plastic products from consumers back to manufacturers.

As with other recyclables, the infrastructure needed to recycle plastics consists of four major components:

Collection:

Plastics are collected for recycling rather than discarded after serving their initial purpose.

Sortation/Handling:

The collected plastics are sorted to enhance quality and then baled to reduce storage and shipping costs.

Reclamation:

The sorted plastics are cleaned and processed directly into end products or into flakes or pellets of consistent quality acceptable to manufacturers.

End-Use:

Recycled pellets and flakes (or end products) are marketed.

Getting these components to march in lockstep is very much like the old "chicken and egg" conundrum. Which comes first? Collection? Handling? Reclamation? Or is it end-use?

Because of the economic and technical interdependence of each stage, including the price of the primary resource with which the secondary (recycled) resource must compete, the answer is…

They must all come first.

The coordination between handlers and reclaimers (the actual recyclers) is important. Handlers must deliver plastics in the quantities and quality that make them valuable to the available markets.

While plastics can be recycled in commingled form to make plastic lumber products, separated resins have higher values and are preferred by most reclaimers. So it helps when handlers can sort plastics by resin type to meet that demand for higher value.

The transformation of used plastic products into feedstocks for manufacturing new plastic products is called reclamation. (The companies performing this function are more commonly referred to as plastics recyclers).

The reclamation process for post-industrial plastic scrap often entails little more than granulating the scrap to yield a clean "regrind" resin that can be used as a substitute for virgin resins, or blended with them. In some cases the regrind may be washed.

But processing post-consumer plastic wastes is a more complex process, since the products are seldom as clean as virgin resins and often contain unknown residual contaminants.

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Creating a New Life for Plastics

The steps taken to recycle post-consumer plastics may vary from operation to operation, but typically involve washing and conversion into either flakes or pellets. Pellets are made by melting down the plastic and then extruding it into thin strands that are chopped into small, uniform pieces.

Pellets and flakes are the form in which plastic feedstocks are sold - whether they're virgin or recycled. The specific reclamation steps taken by a recycler may depend upon the recycler's confidence in the handler's preparation of the plastics coming into the facility.

Steps in Recycling Generic Plastics

Inspection:

Incoming plastics are inspected for contaminants, as well as for types of plastic the recycler can't accommodate. (Some plants handle several types of post-consumer plastics, while others may handle only one).

Granulating/Washing:

Plastics are "chopped" in a grinder and washed. (The waste water is not hazardous and may be filtered and reused).

Flotation Tank:

If mixed plastics are being reprocessed, they are separated in a flotation tank. (Some plastics sink, other's float).

Drying:

Clean plastic flakes must be thoroughly dried. (Dampness may result in a low-quality end product).

Melting:

The dry flake is fed into an extruder where heat and pressure melt the plastic. (Each type of plastic has a different melting point).

Filtering:

The molten plastic is forced through a fine screen to remove any contaminants that may have eluded the washing cycle.

Pelletizing:

The strands are cooled, chopped into pellets, and stored for sale and shipment.

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Commingled Recycling

Commingled plastics recycling involves the use of mixed plastics wastes - essentially as received - as a feedstock. It differs significantly from generic processing since no sorting is required, no cleaning is necessary, and the waste plastics are formed directly into molded products such as wood and lumber substitutes.

Chemical and Thermal Recycling

An emerging approach to recycling used plastics may offer a means of significantly increasing the overall quantity of plastics that can be recycled.

Chemical and thermal recycling processes yield a variety of end-products that form the building blocks from which plastics are made. By actually unlinking or disassembling plastics (polymers) to their original molecular components, recyclers can produce a refined petroleum product that can be made into monomers - the basic units from which plastics are made - or a number of other petroleum products. In other words, the recycled products are virtually identical to the current feedstocks and monomers used to produce new plastics , synthetic fibres and many other petroleum - based products.

These recycling technologies - currently being tested and commercialized in North America, Western Europe and Japan for use with post-consumer plastics - will augment existing mechanical systems as part of an integrated approach to recycling to increase the volume of post-consumer plastics diverted from the waste stream. This will expand the variety of plastics that are recycled into new and useful products, and conserve natural resources.

These processes are similar in many ways to the recycling technologies used for other materials, such as steel. Used steel cans are heated and converted back to raw steel that is then used to make products such as auto bodies, construction beams and new steel cans. In comparison, these plastics recycling systems convert post-consumer plastics back to raw materials which are then used to produce a range of products, including new plastics and synthetic fibres.

Chemical Processes

The chemical process for converting certain plastics back to raw materials is called depolymerization. Two forms of this process - methanolysis and glycolysis - are used to produce polyethylene terephthalate (PET); the plastic commonly used to make soft drink bottles.

With methanolysis, clean post-consumer PET flake is mixed methanol in a chemical process under heat and pressure. In a two-step process, the PET is converted back into its raw materials (dimethyl terephthalate and ethylene glycol) which can then be purified, mixed with virgin raw materials, and re-reacted to produce PET with 25 per cent recycled content.

With glycolysis, clean post-consumer PET flake is mixed with ethylene glycol in a chemical process under heat and pressure. This process converts the PET back into its monomer that can then be purified and re-reacted to produce PET with 25 per cent recycled content.

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These processes afford an end-use for recycled PET in food and beverage containers. The primary end-use for PET, however, is in fibres, as well as in sheeting, molding compounds and non-food containers. In these applications, clean flake can be used without having to go through depolymerization.

Thermal Process

Through a process known as "thermal decomposition", post-consumer plastics are heated in a recycling unit to about the same temperature as that required to melt aluminum.

At this temperature, the plastics are converted into the liquid petroleum products from which plastics are made. These liquid products are refined and transformed into a wide variety of marketable items including new plastics, synthetic fibres, high quality lubricants and gasoline.

In addition to liquid petroleum products, this recycling technology produces small amounts of solid carbon and light gases. The carbon can be marketed for use in the production of activated carbon, pigments, rubber goods, and applications in oil remediation and agriculture. The light gases - which are similar to natural gas - can be reused on site.

When integrated with traditional mechanical recycling systems, this "thermal" form of plastics recycling offers a number of significant advantages:

- Post-consumer plastics containing high levels of contamination (food waste, labels) can be safely recycled by technology;
- The technology can recycle mixed or commingled streams of plastics; and
- The technology is a clean environmental process.

There are several commercial versions of this recycling technology currently in operation in Germany and Japan using the heat process.

While many of these plastics recycling technologies are still in a developmental stage, they do offer the possibility of greatly enhancing the capacity of the plastics recycling infrastructure to conserve natural resources and reduce waste.

EPIC is closely monitoring developments related to recycling technologies and is eager to share this new knowledge through information seminars conducted with its members, municipal recycling officials, provincial environment ministries, and federal research departments.

End-Use

The end-user is the economic engine driving the recycling process. Market demand is the fuel that makes it run.

In the past, market demand for recycled plastics was low. As a result, there were relatively few economic incentives for handlers and reclaimers (most often private companies) to become involved in post-consumer recycling . Similarly, communities - many working with limited public funds - had no incentive to expand their collection of plastics if there were few markets. Increasing the demand for recycled plastics will improve the economic incentives for plastic handlers and reclaimers to create new markets for communities tomorrow.

Can all types of plastics be recycled? Technically, the answer is yes. Realistically, however, society cannot recycle its way out of landfills. But a proper balance of source reduction, recycling, recovery of energy and, finally, retention in landfills, will provide the most-cost-effective and environmentally sound approach.

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