



Types of Plastic Resins

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Soda bottles, coffee cups, dairy tubs, agricultural films—all of these products are made from different types of plastic resins. The word “plastic” is a generic term used to describe various resins. Many of these plastic resins may look alike, but their composition and properties are quite different. Because of their different properties and forming techniques, plastic products usually must be separated by their resins before the products can be recycled.

Each year, the agricultural community uses hundreds of millions of pounds of plastic for products such as greenhouse and mulch film, row covers, bale wrap, and pesticide containers. The growth of recycling as an environmentally sound method to manage wastes has helped increase the possibility to recycle agricultural plastics. To promote the recycling of agricultural plastics, it is important to be familiar with the composition of plastics, the method for identifying plastic resins, and the properties of the plastic resins.

Composition of Plastics

Plastic is a man-made material that comes from natural gases and petroleum. These are the building blocks of plastic, and they form chemically linked subunits called monomers. The long chains of monomers are called polymers. All plastics are made of polymers. The different mixture of polymers is what makes up resins. (Recall that “plastic” is a broad term used to describe many different resins.) The virgin, or raw, resin material is processed for a variety of products and uses. After the plastic product can no longer be used or re-used, the product can often be recycled by being washed and then shipped to fabricators in pelletized, granulated, powdered, film, sheet, or liquid form. The resins are put through a recycling process and turned into products such as plastic lumber, trash bags, and park benches.

Identifying Plastic Resins

Sorting products by their resin allows recyclers to obtain more “pure” material for resale and helps speed up the recycling process. If the recycled plastic is not mixed with other types of plastic resins, recyclers can lower production costs and get a high price for the processed material. In other words, plastic that has already been sorted by its resin before it goes to the recycler makes the plastic more desirable to the recycler and end-user.

The Society of the Plastics Industry (SPI) has developed a voluntary coding system for plastic containers and bottles. The coding symbol consists of a triangle of chasing arrows surrounding a number from one to seven. The code, which is either molded or imprinted on the bottom of the container, helps recyclers and consumers easily identify the type of resin. The Society hopes that this coding system will increase recycling and the growth of end-use markets for recycled materials. (See Table 1 for a listing of the SPI code.) The coding system is not limited to only containers and bottles: many film producers have adopted the coding system to label their products.

Table 1: SPI Coding System for Plastic Containers.

Plastic Container Coding System (SPI)		
Code	Material	% of Total
PETE	Polyethylene Terephthalate (PET™)	20-30%
HDPE	High Density Polyethylene	50-60%
V	Polyvinyl Chloride (Vinyl or PVC)	5-10%
LDPE	Low Density Polyethylene	5-10%
PP	Polypropylene	5-10%
PS	Polystyrene	5-10%
OTHER	Other Resins	5-10%

(Information provided by the Society of the Plastics Industry)

The SPI code does not mean that the product is made of recycled material and does not guarantee that the material will be accepted for recycling. It only means that the material *may* be recycled in some communities. Numbers one and two are most commonly accepted for recycling. Four and six have limited recyclability. Three, five, and seven are rarely recycled.

Even though the coding system is not mandatory in the United States, at least thirty-seven states have passed laws that require the coding system on plastic bottles that are sixteen ounces or larger and on plastic containers that are eight ounces or larger. The SPI coding system is still voluntary in Pennsylvania.

Characteristics of Plastic Resins

The SPI coding system identifies six plastic resins that are most commonly used. The seventh category includes a large range of “other” resins. The agricultural industry primarily uses only four types of resins: high density polyethylene, low density polyethylene, polypropylene, and polystyrene. Being familiar with the properties of plastic resins and the finished products makes it easier to identify and sort the materials for recycling. (See Table 2 on the back for an informational summary about the six most commonly used resins.)

Polyethylene Terephthalate (PETE or PET™)

Commonly used in soft drink bottles and household products, PETE takes up approximately 30 percent of the plastic bottle market, which includes soda bottles and containers for peanut butter, salad dressing, juices, and liquor. PETE’s clarity and toughness have helped it grow rapidly during the last few years in the packaging industry. Its light weight provides energy and financial savings throughout the production chain from the manufacturer to the consumer.

Since PETE is non-biodegradable and inorganic, it can’t be used for compost. Because of PETE’s high B.t.u. (energy value), incineration is a possible method for managing PETE waste, but recycling has proven to be the most promising method. PETE can be recycled into many products such as plastic lumber, carpet fiber, industrial strapping, fiber-fill for sleeping bags, or ski jackets. It can also be recycled back into PETE bottles.

Polyethylene (PE)

Used in a wide range of products from milk jugs to plastic wrap, PE is the most common and least expensive household plastic. It resists moisture and chemical reactions. PE is the family name for such resins as low density polyethylene (LDPE) and high density polyethylene (HDPE).

Introduced in the early 1940s, LDPE is the oldest PE family member. Its toughness, flexibility, light weight, moisture resistance, and clarity has helped make LDPE the most widely used resin in today’s plastics industry. LDPE is commonly used as an agricultural film for greenhouses, mulching, and overwintering and fumigation houses. LDPE is also used for plastic wrap, bags, and tubes for storing silage and hay. In 1990, the agricultural industry used 234 million pounds of LDPE film. Even though the amount of LDPE used in agriculture is only 3.6 percent of the total LDPE in the United States, it does represent the largest percentage of agricultural plastics, and this amount is expected to grow rapidly.

LDPE can be recycled back into LDPE products, but the contamination of the film makes this difficult in agriculture. By the time the film is ready for disposal, it is often contaminated by dirt, moisture, vegetation, pesticides, and UV light degradation. Research is being conducted to develop methods for limiting the contamination of LDPE film.

Available in the marketplace since 1956, HDPE is rigid, resists breakage, and is inexpensive. This resin is used for nursery and pesticide containers, dairy tubs, milk jugs, and detergent bottles. HDPE is either blow molded to make bottles or injection molded to make containers. In 1990, nurseries consumed 80-100 million pounds of blow molded HDPE containers and 100 million pounds of injection molded HDPE containers. Each year, the agricultural community uses approximately 40 million pounds of HDPE for chemically-resistant pesticide containers. New products and markets continue to grow for this resin.

Like most plastics, HDPE can’t be composted and won’t degrade in landfills. HDPE has a high recycling rate of ten percent and currently is the fastest growing segment in the plastics recycling industry. This resin can be made into products such as animal pens, plastic lumber, trash cans, and flower pots. Because it is easier to transport and recycle than LDPE, HDPE is even being used to make mulch film, which has traditionally been made of LDPE.

Polyvinyl Chloride (PVC or Vinyl)

Because vinyl blends well with plasticizers, stabilizers, and other additives, vinyl had the second highest sales percentage in 1990, placing it right behind LDPE. Its puncture and chemical resistance, relatively low cost, and versatility has made vinyl popular in the building and construction industry—65% of vinyl sales come from these industries. Many products are made of vinyl, such as food wrap, shampoo bottles, automobile parts, home siding, floors, water hoses, and windows.

Vinyl is often used for meat packaging because it blocks grease and oils, but allows oxygen to enter so that the product can “breathe.” Less than 0.5% of the total waste stream is composed of vinyl. Even though recycling vinyl is possible, only 0.01% is recycled. Vinyl can be recycled into many products including drainage pipes, tiles, garden hoses, and traffic cones.

Polypropylene (PP)

Perhaps the most valuable property of PP is its versatility—PP is used in nursery pots and containers, row covers, yogurt cups, weed barriers, tree netting, and battery cases. In 1990, the agricultural industry used 50 to 60 million pounds of PP for nursery containers. PP is lightweight, durable, moderately inexpensive, and chemical resistant. It can be found in either film or rigid form. Many of these properties make PP popular to use for food packaging such as screw-on caps, juice containers, and straws.

Although the technology to recycle PP is available, this resin is rarely recycled by community recycling programs. Products and potential markets for recycled PP include auto parts, new battery cases, bird feeders, furniture, pails, and recycling containers.

Polystyrene (PS)

PS has a wide range of properties including versatility, rigidity, clarity, and brittleness. It's a poor barrier to oxygen and water vapor. But the most unique property of PS is thermoforming, the ability to form and foam. Two familiar products made of foamed PS are coffee cups and fast food clam shell containers. Used in a variety of applications because of its low cost and easy ability to be processed, PS is often used in automobiles, insulation, disposables, packaging, toys, construction, electronics, and housewares. PS is also used for sour cream and cottage cheese containers, and horticultural products such as trays, packs, and flats.

Like polypropylene, PS is rarely recycled. Recycled PS can be made into insulation board, waste baskets, videotape cassettes, household products, and desk accessories.

Other Types of Plastic

There are many other types of resins that are not used or recycled as much as PETE, PE, Vinyl, PP, or PS. Yet, these “other” resins have unique characteristics and are found in many different products from computer housings to automobile parts. Products that are made from these resins are placed in the SPI's “Other Plastics” code category along with multi-layered products such as squeezable ketchup bottles and degradable products such as certain brands of diapers. The following resins are listed as SPI code number seven:

Polyvinylidene Chloride (PVDC, Saran™):

PVDC is an excellent barrier to moisture and gases. It is commonly used as a household wrap and as an added layer for many other resins.

Ethylene-Vinyl Alcohol (EVOH): Introduced in the mid-70s, EVOH is one of the best barriers to gases in the plastics industry. But EVOH loses these properties when exposed to moisture. Often used as an interior coating for juice containers and food packaging, EVOH is fully recyclable in its multi-layered form.

Polycarbonate (PC): This resin is a good barrier to ultraviolet light, but a poor barrier to gases and water vapor. PC, which is tough and clear, is often found in reusable bottles and oven-safe plastic trays.

Nylon: This resin is durable and a good barrier to oxygen. Nylon is often used for fiber applications, microwave and conventional oven cooking items, food wraps, and layers in juice containers.

Ethylene-Vinyl Acetate (EVA): EVA is inert, flexible, and tough. Not only is this resin crack-resistant, but it makes an excellent adhesive. EVA can be found in food wrap, carton liners, wires, cable insulators, and ice bags.

FOR MORE INFORMATION:

Recycling Plastics is a free brochure published by the Institute of Scrap Recycling. This brochure describes the recycling process and the coding system for plastics. To receive a copy, contact the Institute of Scrap Recycling Industries, Inc. at 1325 G Street N.W., Suite 1000, Washington, DC 20005-3104 or call them at (202)466-4050.

The Society of the Plastics Industry publishes a brochure called *Plastic Packaging: Opportunities and Challenges*, which gives a detailed description of some of the most commonly used plastic resins. For a copy, contact the SPI at 1275 K Street N.W., Suite 400, Washington, DC 20005 or call them at (202)371-5319.

Table 2: Plastic Resin Characteristics, Markets and Products.

Polyethylene Terephthalate (PET)	Tough; shatterproof	Packaging; consumer products	Soft drink bottles; food and medicine containers
High Density Polyethylene (HDPE)	Flexible; translucent	Packaging	Milk and detergent bottles; horticultural containers
Polyvinyl Chloride (PVC or Vinyl)	Clear, brittle unless modified with plasticizers	Building and construction; packaging	Construction pipe; meat wrap; cooking oil and shampoo bottles
Low Density Polyethylene (LDPE)	Moisture-proof; inert	Packaging; film	Mulch and greenhouse film; bale wrap, coated paper, food packaging
Polypropylene (PP)	Stiff; heat and chemical resistant	Furniture; packaging	Syrup bottles, pesticide containers; yogurt tubs; office furniture
Polystyrene (PS)	Brittle; clear; good thermal properties	Packaging; consumer products	Disposable foam dishes and cups; cassette tape cases, insulation

(Adapted from the EPA's "Methods to Manage and Control Plastic Wastes.")



Please recycle this fact sheet

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