

Plastic Manufacturing Terminology

Blow Mold

Cavity that receives the Preform, which will be blown into the desired shape.

Blow Pin

Used in Extrusion Blow Molding. Hollow tube that pierces Preform and introduces air to blow Preform into shape of Blow Mold.

Cavity

That part of the mold, which contains the reverse image of the product being formed.

Cold Runner

Flow channel for heat-softened polymer, which goes from the Plastifier to the mold cavities. Polymer in the flow channel is cooled with shaped parts in cavities and is later removed, reground, and reused.

Core

That part of a mold that allows the internal shaping of a product such as the internal threads of a cap.

Core Rod

Used in Injection Blow and Injection Stretch Blow Molding. Used in conjunction with a Preform Mold to manufacture a Preform. The Preform is formed around the Core Rod creating a hollow tube, which will then be transferred to a Blow Mold where air will be introduced forcing the Preform to take the shape of the Blow Mold cavity.

Extrusion Blow Molding

A molding process whereby heat-softened polymer is forced into the shape of a hollow tube. While still soft, a mold closes around the tube, pinching the top and bottom of the tube closed. A Blow Pin is introduced, and air is forced through the pin forcing the tube to take the shape of the Blow Mold cavity.

Flame Treating

A method of rendering inert thermoplastic objects receptive to inks, lacquers, paints, adhesives, etc. in which the object is bathed in an open flame to promote oxidation of the surface of the article. Polyolefins (HDPE, LDPE, PP, etc) are primarily those polymers that are flame treated.

Flash

Extra plastic attached to molded ware along the parting line, which must be removed before the part can be considered finished.

Gate

Used in Injection, Injection Blow, and Injection Stretch Blow Molding. The orifice through which the heat-softened polymer enters the cavity.

Hot Runner

Flow channel for heat-softened polymer, which goes from the Plastifier to the mold cavities. Polymer in the flow channel is kept softened so there is no runner material to grind up and reuse.

Hopper

Conical feed reservoir into which polymer pellets are loaded. These pellets then fall into a heated barrel (Plastifier), sometimes through a metering device.

Injection Blow Molding

A molding process in which heat-softened polymer is injected from a Plastifier into a mold cavity creating a Preform, which is then transferred to a Blow Mold where air is blown into the Preform, forcing it to take the shape of the Blow Mold cavity.

Injection Molding

A molding process whereby a heat-softened polymer is injected from a Plastifier into a relatively cool cavity, which gives the article the desired shape.



Injection Stretch Blow Molding

A molding process whereby Preforms are introduced into a cavity, stretched axially by a Stretch Rod, and then blown circumferentially to the shape of the Blow Mold cavity.

Melt Index

The amount, in grams, of a thermoplastic resin, which can be forced through a 0.0825 inch orifice when subjected to 2160 gms. force in 10 minutes at 190°C.

Mold

Contains the cavity or cavities of a desired part in which a heat-softened polymer is shaped.

Mold Seam

A line formed at the point of contact of the Mold halves.

Neck Ring

Part of the mold assembly, which forms the neck and finish of a container.

Nozzle

Hollow cored orifice that is screwed into the extrusion end of the Plastifier. The nozzle is designed to form a seal under pressure between the Plastifier and the Mold or Runner system. The front end of a nozzle may be either flat or spherical in shape.

Plastifier

Assembly whereby polymer pellets are fed from a Hopper into a barrel where they drop onto a turning screw which forces the pellets forward. Heater bands wrapped around the barrel melt the pellets as they are forced forward along the inside of the barrel. The molten polymer is then forced out the end of the barrel through the nozzle.

Preform

Used in Blow Molding processes. Heat-softened polymer is formed into a shape similar to a thick test tube with neck threads. This tube is subsequently inflated while inside a Blow Mold to create the shape of the desired article.

Regrind

A thermoplastic from a processor's own production that has been reground or re-pelletized after having been previously processed by molding.

Release Agent

A lubricant that facilitates molding.

Stretch Rod

Used in Injection Stretch Blow Molding. A rod that is introduced into the Preform to stretch it in an axial direction prior to the Preform being blown into the shape of the cavity.

Thermoplastic

Material that will repeatedly soften when heated and harden when cooled.

Plastic Resins

Listed below are the primary resins used in the manufacture of our products. Following are some of the characteristics and features of these resins.

Cyclo Olefin Copolymer (COC)

Family of highly transparent plastic, which features high moisture barrier and excellent chemical resistance properties. Poor gas barrier properties. Sterilizable via EtO, radiation and certain grades can be steam autoclaved. SPI resin identification code number - (7).

High Density Polyethylene (HDPE)

Flexible but more rigid than LDPE. Natural color is milky white, semi-translucent depending on density. Good impact strength and stress crack resistance. Good chemical resistance. Good vapor barrier but poor gas barrier. Sterilizable via EtO or gamma radiation. SPI resin identification code number - (2).

Low Density Polyethylene (LDPE)

Very flexible, natural milky color, translucent with high impact strength. Excellent for mild and strong buffers, good chemical resistance. Good water vapor and alcohol barrier properties. Poor gas barrier, sterilizable with EtO or gamma radiation. Good stress crack and impact resistance. SPI resin identification code number - (4).

Polybutylene Terephthalate (PBT)

Good chemical resistance, clear color, resistant to water, weak acids and bases at room temperature. Can be sterilized by EtO and autoclaving, at temperatures up to 180°C. SPI resin identification code number - (7).

Polycarbonate (PC)

Rigid and strong, Excellent clarity. High impact strength. Poor barrier properties. SPI resin identification code number - (7).

Polyethylene Terephthalate (PET)

Semi-rigid to rigid depending on wall thickness. Natural color - clear and transparent. Good alcohol and solvent barrier; good gas and fair moisture barrier. Good to fair chemical barrier; not good for strong acids or bases. Good moldability. Sterilizable through EtO and gamma radiation. Good stress crack and impact resistance at room temperature and above. SPI resin identification code number - (1).

Polypropylene (PP)

Rigid, solid, durable in container or cap forms. Opaque, natural grayish yellow in natural form. Excellent stress crack and impact resistance. Excellent moisture barrier, good oil and alcohol barrier, poor gas barrier properties. Good chemical resistance. Sterilizable with EtO or autoclaving. SPI resin identification code number - (5).

Polystyrene (PS)

PS is a transparent, rigid and glass-like polymer. Good resistance to inorganic chemicals. Light and heat stable, biologically inert and non-toxic. Poor impact and stress crack resistance, poor barrier properties. EtO or Gamma sterilizable. SPI resin identification code number - (6).

Polyvinyl Chloride (PVC)

Flexible to rigid. Good for coatings; fair water and good oxygen barrier. Transparent to yellowish color in natural state. Good chemical resistance. Sterilizable by EtO. Good impact and some stress crack resistance. Poor recycling due to chloride residues. SPI resin identification code number - (3).

PTFE (TFE, FEP, PFA)

Tetrafluoroethylene, fluorinated ethylene propylene. All PTFE plastics feature opaque characteristics, excellent chemical resistance, good heat stability and thermal shock resistance. All are autoclavable, heat, and gas sterilizable. SPI resin identification code number - (7).

Table 7. Typical Properties of Plastics

	COC*	HDPE	LDPE	PET	PP	PS	PVC	TFE
Max. Temp °C	140	120	80	60	135	70	70	240
Transparency	transp	transl	transl	transp	transl	transp	transl	opaq
Sterilization* *								
Autoclave	yes	no	no	no	yes	no	no	yes
Gas	yes	yes	yes	yes	yes	yes	yes	yes
Dry Heat	no	no	no	no	no	no	no	yes
Radiation	yes	yes	yes	yes	no	yes	no	no
Disinfectants	yes	yes	yes	yes	yes	no	yes	yes
Density g/cm ³	1.02	0.95	0.92	1.33	0.90	1.06	1.34	2.15
Flexibility	rigid	semi	flex	semi	rigid	rigid	rigid	rigid
Brittleness Temp °C	+20	-100	-100	-10	0	+20	-30	-110
Tensile Strength, psi	9600	4000	2000	8000	5000	6000	5000	4000

* Topas® 6015 resin

**Depends on thickness and relates to containers and caps. Because there are many grades of resins and processing methods, the above information should be used as a general guideline only.

Table 8. Permeability of Plastics

		COC*	HDPE	LDPE	PET	PP	PS	PVC	TFE
N ₂	See Note 1	—	42	180	0.8	44	50	2	—
O ₂	See Note 1	180	150	500	5	90-140	185-485	4	—
CO ₂	See Note 1	—	580	2700	15	650	1160	4	—
Moisture	See Note 2	0.2	0.3	1.3	2.0-4.0	0.3-0.7	8.5	1.0-5.0	—

Note 1: Units are cc x mil /100 in² x day x atm @ 25°C

Note 2: Units are g x mil /100 in² x day @ 38°C, 50 - 90% RH

Factors for the Selection of a Plastic Container

Plastic containers have been developed for a variety of applications across many different industries over the years. There are many different types of Polymers used in the creation of these containers to help fill the demands for the various applications. Polymers offer a variety of properties, each having different levels of importance with different users depending on the application. Some users may have flexibility within their product formula or filling process and therefore focus on economical containers while others may need containers that are stronger, autoclavable, transparent, sterilized, etc., therefore requiring more specifications. Wheaton Science Products can help with polymer selection through comprehension of the customer's product, goals, and adaptability. Several questions should be posed to gather this understanding. Some examples include:

- **What is the container size and physical design. Narrow mouth vs. wide mouth, tall vs. short, etc.?**
- **Must the package be transparent, translucent, opaque or colored for either marketing or light protection?**
- **Are there specific shipment and storage conditions such as refrigeration, freezing, exclusion of light, etc.?**
- **Are there governmental regulations pertaining to the product?**
- **How is the product going to be dispensed by the user?**
- **Have any tests been run in plastic? Was it unsuccessful and why? What type of plastics?**

Many things govern polymer suitability for package use. These include:

- Permeation/Barrier
- Sorption Characteristics
- Chemical Resistance
- Stress Crack Resistance
- Rigidity/Flexibility
- Impact Resistance
- Sterilizability
- Recyclability
- Temperature Resistance



Table 9. Packageability of Plastic Containers

Requirement	COC	PC	PE	PET	PP	PS	PVC
Light weight	3	6	2	5	1	3	6
Clarity	1	1	3	1	2	1	1
Toughness	6	3	1	2	3	9	8
Water adsorption	1	6	2	3	2	4	2
Water vapor permeability	1	7	2	5	2	5	4
CO ₂ permeability	6	1	6	2	5	9	3
O ₂ permeability	7	8	7	2	6	8	2
Resistance: Acids	2	4	2	4	2	4	2
Resistance: Alkalis	2	7	2	2	2	2	2
Resistance: Oils	5	4	4	2	3	4	2
Resistance: Solvents	3	6	3	2	3	6	4
Resistance: High Humidity	1	6	1	1	1	1	1
Resistance: Sunlight	4	4	4	1	4	5	5
Resistance: Heat (hot fill)	1	1	3	1	2	5	1
Resistance: Cold	5	1	1	2	4	5	9

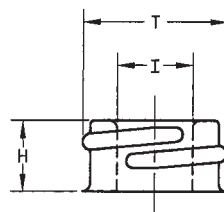
This chart is a generalization to aid in selection; there are many forms, thicknesses and various copolymers and additives available. The lower the number, the better the property. 1=Excellent; 9=Poor.

Biological Properties of Plastics

Plastic products and containers are considered to be biologically inert. For example polyethylenes, PTFEs, polypropylene, polystyrene, and polycarbonate are considered to be non-toxic to cell cultures. Distilled water for preparing culture media can be collected and stored in polyethylene containers.

Determining a Plastic Container Thread Finish

When a container finish is designated as 24-410, it means that the diameter across the outside of the threads is approximately 24mm. (See "T" dimension on illustration.) The 410 designates a specific style of thread. Tables 10a and 10b show average dimensions for comparison and to aid in sizing. The actual dimensions may vary slightly.



Opening Dimension of Plastic Containers with Thread Finish

The minimum opening dimension (I) of a plastic container can be found if the container's thread finish is known. If the thread size of the container is 38-400, the (I) can be determined from either Table 10a or 10b by looking down the "T" Dimension column (far left) until you find the number 38. Follow this row to the right, until you come to the "I" min. column that is listed under the number 400. This number is the minimum opening of the container. The opening can be larger, but it should not be smaller.

Table 10a. Plastic Thread Finish Dimensions (Dimensions are in inches)

"T" Dim (mm)	400		410		415		425	
	"H"	"I" min	"H"	"I" min	"H"	"I" min	"H"	"I" min
13	—	—	—	—	0.452	0.218	0.310	0.218
15	—	—	—	—	0.557	0.258	0.310	0.258
18	0.371	0.325	0.523	0.325	0.617	0.325	—	—
20	0.371	0.404	0.554	0.404	0.742	0.404	—	—
22	0.371	0.483	0.585	0.483	0.837	0.483	—	—
24	0.400	0.516	0.646	0.516	0.957	0.516	—	—
28	0.400	0.614	0.708	0.614	1.082	0.614	—	—
30	0.403	0.653	—	—	—	—	—	—
33	0.403	0.791	—	—	—	—	—	—
35	0.403	0.875	—	—	—	—	—	—
38	0.403	0.987	—	—	—	—	—	—
40	0.403	1.091	—	—	—	—	—	—
43	0.403	1.165	—	—	—	—	—	—
45	0.403	1.251	—	—	—	—	—	—
48	0.403	1.381	—	—	—	—	—	—
51	0.408	1.479	—	—	—	—	—	—
53	0.408	1.578	—	—	—	—	—	—
58	0.408	1.735	—	—	—	—	—	—
60	0.408	1.853	—	—	—	—	—	—
63	0.408	1.972	—	—	—	—	—	—
66	0.408	2.090	—	—	—	—	—	—
70	0.408	2.247	—	—	—	—	—	—
75	0.408	2.424	—	—	—	—	—	—
77	0.487	2.546	—	—	—	—	—	—
83	0.487	2.753	—	—	—	—	—	—
89	0.535	2.918	—	—	—	—	—	—
100	0.597	3.344	—	—	—	—	—	—
110	0.597	3.737	—	—	—	—	—	—
120	0.685	4.131	—	—	—	—	—	—

Table 10b. Plastic Thread Finish Dimensions (Dimensions are in millimeters)

"T" Dim (mm)	400		410		415		425	
	"H"	"I" min	"H"	"I" min	"H"	"I" min	"H"	"I" min
13	—	—	—	—	11.48	5.54	7.87	5.54
15	—	—	—	—	14.15	6.55	7.87	6.55
18	9.42	8.25	13.28	8.25	15.67	8.25	—	—
20	9.42	10.26	14.07	10.26	18.85	10.26	—	—
22	9.42	12.27	14.86	12.27	21.26	12.27	—	—
24	10.16	13.11	16.41	13.11	24.31	13.11	—	—
28	10.16	15.59	17.98	15.59	27.48	15.59	—	—
30	10.24	16.59	—	—	—	—	—	—
33	10.24	20.09	—	—	—	—	—	—
35	10.24	22.22	—	—	—	—	—	—
38	10.24	25.07	—	—	—	—	—	—
40	10.24	27.71	—	—	—	—	—	—
43	10.24	29.59	—	—	—	—	—	—
45	10.24	31.77	—	—	—	—	—	—
48	10.24	35.08	—	—	—	—	—	—
51	10.36	37.57	—	—	—	—	—	—
53	10.36	40.08	—	—	—	—	—	—
58	10.36	44.07	—	—	—	—	—	—
60	10.36	47.07	—	—	—	—	—	—
63	10.36	50.09	—	—	—	—	—	—
66	10.36	53.09	—	—	—	—	—	—
70	10.36	57.07	—	—	—	—	—	—
75	10.36	61.57	—	—	—	—	—	—
77	12.37	64.67	—	—	—	—	—	—
83	12.37	69.93	—	—	—	—	—	—
89	13.59	74.12	—	—	—	—	—	—
100	15.16	84.94	—	—	—	—	—	—
110	15.16	94.92	—	—	—	—	—	—
120	17.40	104.93	—	—	—	—	—	—

Sterilization of Plastics

There are a variety of plastic materials and methods by which these plastic materials can be sterilized. However, not all plastics can be sterilized by every method. An understanding of sterilization methods, problems that can occur and terms associated with sterilization is helpful in determining plastic and plastic ware capability and performance. The following is presented to assist in gaining that understanding.

Exposure To Non-Sterile Conditions Causes Non-Sterility

While temperature and time used to melt thermoplastics kills microorganisms, manufactured ware will not remain sterile unless it is made and maintained in a sterile environment. Plastic ware is not “sterile as manufactured” since:

- ware is not blown with sterile air
- ware may be exposed to non-sterile conditions immediately after manufacture
- ware may contact non-sterile atmosphere, bags, boxes, personnel, etc. during packing after ware manufacture or during unpacking at the filling location.
- low particulate does not mean sterile

Producing ware under a shroud and using “particulate-free” or “low particulate” clean room bags does not result in sterile ware. These steps only reduce particulate in and on the ware to a lower level than would be present if ware were produced in an “unshrouded” production situation. In the future, molding may be performed in clean rooms and sterile conditions maintained after ware manufacture, however, until that time, ware cannot be represented as being sterile as molded. Until then, a secondary sterilization process must be performed.

Terms Associated with Sterilization

Bioburden

This is the number of microorganisms (bacteria, virus, fungi, etc.) present. Microbiologists can test for these. When sterilizing ware, it is important to reduce or eliminate the bioburden to a safe level.

Pyrogens

A pyrogen, which means fever causing, is a remnant of bacteria that carries chemicals called endotoxins. Endotoxins can cause a fever if injected into a mammal. Detecting a fever in a rabbit after injecting it with an extract detects the presence of pyrogens.

Something may be sterile, but still have pyrogens on it. Glass can be sterilized and de-pyrogenated at the same time. Exposure to high temperature (600°F or higher) will kill microorganisms AND burn up endotoxins. The higher the temperature, the shorter the exposure time needed for de-pyrogenation. Most plastic ware is incapable of being exposed to these high temperatures. Therefore, plastic ware may be sterilized but, if it needs to be de-pyrogenated, it is usually washed with pyrogen free water.

Sterilization Techniques

Sterilization techniques are designed to kill microorganisms. There are varieties of sterilization methods, however the three basic approaches used to sterilize plastic ware are:

- Ethylene Oxide (EtO)
- Steam Autoclave
- Radiation (gamma radiation, electron beam radiation)

Tests should always be run on plastic ware to determine suitability for a given sterilization method.

Ethylene Oxide

Ethylene oxide (EtO) is a toxic, cancer causing gas. Technology and worker protection legislation allow continued EtO use. Most plastic can be EtO sterilized. EtO must contact the surfaces to be sterilized. There are several ways EtO sterilization can be accomplished.

Pure EtO

Empty ware in an open bag or ware in a sealed bag with a “breather” window, is placed in a chamber. Air is evacuated and moisture introduced (dry microorganisms are resistant to EtO sterilization).

Pure EtO is flooded into the chamber. Chamber internal pressure is kept lower than external pressure to ensure gas will not leak. Exposure time varies dependent on ware and bioburden. After exposure, the chamber is purged with filtered sterile air to eliminate residual EtO.

Dilute EtO

Since it is safer than pure EtO, a 10-15% mixture of EtO with inert gas is used. Empty ware in an open bag or ware in a sealed bag with a “breather window” is placed in a chamber. Air is evacuated, and moisture is introduced (dry microorganisms are resistant to EtO sterilization). Dilute EtO is flooded into the chamber and the chamber’s temperature increased up to 60°C (140°F). Exposure time of 4 to 24 hours varies dependent on ware, bioburden, and sterilization parameters. After exposure, the chamber is purged with filtered sterile air to eliminate residual EtO.

Most plastic ware is capable of being EtO sterilized. However, zinc stearate process aid, used in injection blow molding, can cause precipitants (particulate) to form in liquid products packaged in EtO sterilized ware.

Therefore, only special LDPE grades and colorants that do not require zinc stearate for injection blow molded ware should be used with EtO sterilization processes. Additionally, tests should always be run on plastic ware to determine suitability for a given sterilization method.

Steam Autoclave

Autoclaving can sterilize empty OR filled, sealed ware. The effect of temperature AND moisture kills microorganisms. Autoclaving involves exposing ware for a time to steam. The autoclave acts like a pressure cooker allowing steam temperature to get above the boiling point of water (100°C=212°F). Typically, autoclaving is done at 15 psi (pounds per square inch) steam being at 121°C (250°F).

Autoclaving Empty Ware

Empty ware must withstand autoclaving temperature for the exposure time. If it does not, parts will distort. Of the common plastics, polypropylene (PP) and polycarbonate (PC) have enough

heat resistance to be autoclaved. Generally, PP homopolymer is slightly more heat resistant than PP copolymer. Also, there is a grade of a new transparent plastic material identified as a cyclic olefin copolymer (COC) that is capable of withstanding steam autoclave sterilization.

If empty ware becomes distorted due to autoclave sterilization, it may be due to:

- High stresses molded into the ware during manufacture
- Unusual hot spots in the autoclave
- Use of the wrong plastic

Tests should always be run on plastic ware to determine suitability for a given sterilization method.

Autoclaving Filled, Sealed Ware

Autoclave sterilization of filled, sealed ware, is also known as "Terminal Sterilization". Many companies prefer terminal sterilization IF their product can withstand the rigors. Autoclave temperature must be minimally 121°C (250°F). Of the common plastics, polypropylene (PP) and polycarbonate (PC) have enough heat resistance to be autoclaved. Also, there is a grade of a new transparent plastic material identified as a cyclic olefin copolymer (COC) that is capable of withstanding steam autoclave sterilization. However, autoclaving filled, sealed plastic ware is tricky. Temperature and pressure in the autoclave must be controlled and balanced with temperature and pressure being generated in the filled, sealed ware during autoclave heat up AND cool down. If not, ware could be crushed or ballooned. Special autoclaves are sold to enable this temperature/pressure balancing act.

If filled, sealed containers become distorted during autoclave sterilization, it may be due to:

- Improper balancing of temperature/pressure upon heating or cooling
- High stresses molded into ware at the time of manufacture
- Unusual hot spots within the autoclave chamber
- Use of the wrong plastic

Tests should always be run on plastic ware to determine suitability for a given sterilization method.

Autoclaving Closures

Polypropylene (PP) closures should be capable of withstanding steam autoclave sterilization. However, autoclaving may cause blooming of additives in PP. PP homopolymer is more heat resistant than PP copolymer. Linerless closures (closures with specially molded-in sealing features) may or may not be acceptable for autoclaving dependent on many factors (e.g. as application torque, autoclave conditions, closure design, etc.) If a closure is lined, the liner and the adhesive used to affix the liner inside the closure must also be considered. Lastly, PP closures applied to containers present a special case. Closures are designed with tolerances that cause interference between the closure and container. This interference results in stress. Since all thermoplastics become softer as temperature increases, stress may be relieved or closure dimensions may change upon autoclaving. This can result in closure torque reduction or seal loss.

If closures distort or a torque retention problem results, it may be due to:

- High stresses molded into ware at the time of manufacture
- Unusual hot spots within the autoclave chamber
- Use of the wrong plastic

Due to moisture absorption, pulp liners are NOT anticipated to be acceptable for autoclaving. Tests should always be run on plastic ware and liner/adhesive combinations to determine suitability for a given sterilization method.

Radiation

Ware is exposed to ionizing radiation that knocks electrons off atoms it contacts. Ionizing radiation is lethal to microorganisms because of its destructive effect upon the contents of living cells. There are two common sources of ionizing radiation used for sterilization:

- Cobalt 60 (gamma radiation) OR
- Electron beam or E-beam (high energy electrons)

The amount of radiation from either Cobalt 60 or electron beam is measured in MegaRads (MRads) or KiloGrays (KGy). One MegaRad equals ten KiloGrays. Because gamma sterilization and E-beam both use radiation, packaging materials react similarly in both systems.

Cobalt 60 Gamma Radiation

A gamma radiation sterilization facility consists of a thick walled concrete maze in a room built around a well filled with water. In the well are a number of pencil-sized steel rods impregnated with radioactive Cobalt. Articles to be sterilized are placed on conveyors that bring them through the concrete maze into the room where the radioactive rods are located. The number of rods raised from the well and the exposure time controls the degree of exposure. After exposure, ware is conveyed from the room via the maze.

A radiation dose sufficient to kill bacteria and spores is about 2.5 MRads. To minimize costs plus attain sterilization, bioburden is determined then the minimum dosage plus a safety factor is selected.

Gamma radiation has high penetrating power (about 50 cm or close to 20 inches of the same unit-density material). Thus, many parts can be packed together for sterilization. In this instance, the dosage reaching the center of ware multi-packs is validated. Slightly higher doses occur at the outside edges of multi-packs.

Usually, empty packaging components are sterilized via gamma radiation. Since effects of radiation are cumulative, twice the normal dose is sometimes examined to insure minimal problems.

Listed below are thermoplastic materials that are recognized as capable of being gamma radiation sterilized, although tests should always be run on plastic ware to determine suitability for a given sterilization method:

- Low Density Polyethylene
- Linear Low Density Polyethylene
- High Density Polyethylene (those containing phosphite stabilizers may yellow)
- Polyethylene Terephthalate
- Polystyrene
- Polycarbonate
- Nylon
- Cyclic Olefin Copolymers (a newly emerging group of polymers)
- Polyethylene Naphthalate (a newly emerging group of polymers)

Problems can occur when gamma radiation sterilizing polyvinyl chloride (PVC) or fluoropolymers (PTFE, etc.)

Important Note About Polypropylene Gamma Radiation Sterilization

Normal PP grades yellow noticeably and exhibit long term embrittlement when sterilized via gamma radiation techniques. Special radiation resistant PP grades, having special stabilizers, are available for radiation sterilization. Also, if ware is to be colored, then the concentrate carrier should be a radiation resistant grade of PP. PP copolymers are more radiation resistant than PP homopolymers. Tests should always be run on plastic ware to determine suitability for a given sterilization method.

Electron Beam (E-Beam) Radiation

An E-beam radiation sterilization facility consists of a protective maze built around an E-beam generator. The E-beam generator delivers a high dose of electrons focused in a narrow beam at the items to be sterilized. After exposure, ware is conveyed from the maze.

A radiation dose sufficient to kill bacteria and spores is about 2.5 MRads. To minimize costs and attain sterilization, bioburden is determined and the minimum dosage plus a safety factor is selected.

Electrons from the E-beam generator have limited penetrating power (a 10-MeV E-beam will penetrate only about 5cm or 2 inches of a unit-density material). Thus, a limited number of parts can be packed together for sterilization. The dosage reaching the center of a ware multi-pack is validated. Higher dosages will occur at the outside edges of ware multi-packs.

Usually, empty packaging components are sterilized via E-beam. Since effects are cumulative, twice the normal dose is sometimes examined to insure minimal problems.

Listed below are thermoplastic materials that are recognized as capable of being electron beam radiation sterilized, although tests should always be run on plastic ware to determine suitability for a given sterilization method:

- Low Density Polyethylene
- Linear Low Density Polyethylene
- High Density Polyethylene (those containing phosphite stabilizers may yellow)
- Polyethylene Terephthalate
- Polystyrene
- Polycarbonate
- Nylon
- Cyclic Olefin Copolymers (a newly emerging group of polymers)
- Polyethylene Naphthalate (a newly emerging group of polymers)

Problems can occur when E-beam sterilizing polyvinyl chloride (PVC) or fluoropolymers (PTFE, etc.)

Important Note About Polypropylene E-Beam Sterilization

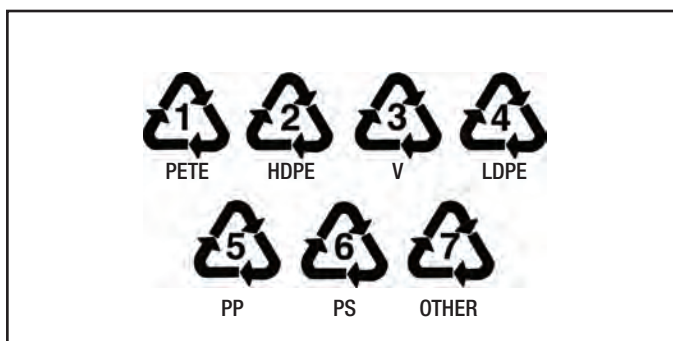
Normal PP grades yellow noticeably and exhibit long term embrittlement when sterilized via E-Beam. Special PP grades, having special stabilizers, are available for E-beam sterilization. Also, if ware is to be colored, then the concentrate carrier should be a radiation resistant grade of PP. PP copolymers are more radiation resistant than PP homopolymers. Tests should always be run on plastic ware to determine suitability for a given sterilization method.

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Resin Identification Codes

Wheaton follows the Society of the Plastics Industry guidelines for marking plastic containers with the appropriate resin identification code numbers as shown below:



Wheaton Science Products mold-marks our containers on the bottom with the appropriate resin identification code. These codes are to assist in identifying material used to manufacture ware to aid in recycling efforts.

- 1 = PETE (polyethylene terephthalate) (PET)
- 2 = HDPE (high density polyethylene)
- 3 = V (vinyl/polyvinyl chloride) (PVC)
- 4 = LDPE (low density polyethylene)
- 5 = PP (polypropylene)
- 6 = PS (polystyrene)
- 7 = Other



PET Media Bottle