

Some Plastic Fundamentals

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Definition of Plastic

- A synthetic material made from a wide range of organic polymers such as polyethylene, PVC, nylon, etc., that can be molded into shape while soft and then set into a rigid or slightly elastic form.
- The key point is that plastic is a solid at room temperature.
- There are a wide array of plastic materials, including plexiglass (poly methyl methacrylate, PMMA), PVC (poly vinyl chloride), and Teflon[®].
- The recycle industry has come up with number designations so that plastics that can be recycled can readily be identified.

Plastic Designations

- The plastic designation system ranges from 1 to 7, pretty much based upon the ease of recycling.
- These are the numbers inside the triangle on most plastic materials.
- Cities, towns, and regions designate which materials can be recycled in their community.
 - Most common are designations 1 and 2
 - Single stream recycle will accept up to level 6
- At one point in time, China accepted a lot of waste materials for recycle as a source of raw materials was needed. This has changed since 2018.
- It is thought that more of these materials will be subject to combustion.

Plastic Designations

- 1 – PET Poly Ethylene Terephthalate (also PETE) (also polyester)
 - $(C_8H_8O_4)_n$
 - Used in microwave food trays; soft drink, salad dressing, water, and beer bottles
 - Can be recycled to make carpet, furniture, new containers, and fleece
 - Heat distortion temperature – 119 F
 - Melting temperature – 448 F
 - Ignition temperature – 824 F

Plastic Designations

- 2 – HDPE High Density Polyethylene
 - $\text{H}(\text{CH}_2)_n\text{H}$
 - Used in household cleaner and shampoo bottles, milk jugs, and yogurt containers
 - Can be recycled to make detergent bottles, floor tiles, fencing, and pens
 - Heat distortion temperature – 167 F
 - Melting point – 266 F
 - Ignition temperature - 644

Plastic Designations

- 3 – PVC Poly Vinyl Chloride
 - $(C_2H_3Cl)_n$
 - Used in cooking oil bottles, food packaging, mouthwash bottles, and pipes
 - Can be recycled to make envelopes, floor tiles, lumber, and trash can liners
 - Heat distortion temperature – 198 F
 - Melting point – 212 F
 - Ignition temperature – 734 F

Plastic Designations

- 4 – LDPE Low Density Polyethylene
 - Branched $(CH_2)_n$
 - Used in bread and shipping bags, carpet, clothing, and furniture
 - Can be recycled to make battery cables, brooms, ice scrapers, and rakes
 - Heat distortion temperature – 122 F
 - Melting point – 230 F
 - Ignition temperature – 615 F

Plastic Designations

- 5 – PP Poly Propylene
 - $(\text{CH}_2\text{CHCH}_3)_n$
 - Used in ketchup bottles, medicine and syrup bottles, and straws
 - Can be recycled to make battery cables, brooms, ice scrapers, and rakes
 - Heat distortion temperature – 284 F
 - Melting point – 324 F
 - Ignition temperature – 1100 F

Plastic Designations

- 6 – PS Poly Styrene
 - $(\text{CH}_2\text{CHC}_6\text{H}_5)_n$
 - Used in disposable cups and plates, egg cartons, take out packaging, and shipping cushion materials
 - Can be recycled to make foam packaging, insulation, switch plates, and rulers
 - Heat distortion temperature – 122 F
 - Melting point – 410 F
 - Ignition temperature – 633 F

Plastic Designations

- 7 – Other (contains bis Phenol A, poly carbonates, etc.)
 - Various
 - Used in 3 and 5 gal. water jugs, nylon, some food containers, resins, and epoxy
 - Can be recycled to make custom products
 - Heat distortion temperature – 302 F
 - Melting point – melts as it burns
 - Ignition temperature – 1022 F

Plastic Combustion Issues

- Plastics are designed to be non-reactive. However, they are mostly hydrocarbons. At a high enough temperature and sufficient residence time they burn to make CO₂ and water vapor.
- Compounds with chlorine and/or fluorine mostly form HCl or HF as long as the temperature is maintained and water vapor is present.
 - EPA incinerator rules call for 2 seconds residence time at 1800 F.
- In the late 70s and early 80s some pulverized coal plants co-fired plastic materials as long as the material was shredded and conveyed pneumatically.
- Difficulties arise with grate type technology when the plastic melts before it burns and causes agglomerates.

Plastic Combustion Issues

- Some plastics can be classified as hazardous wastes (PFAS, certain insulating materials, PCBs)
- Burning any hazardous waste converts a boiler to an incinerator, which must follow the emission rules for incinerators.
- **Incineration** is a [waste treatment process](#) that involves the [combustion](#) of [organic](#) substances contained in waste materials.^[1] Incineration and other high-temperature waste treatment systems are described as "[thermal treatment](#)". Incineration of waste materials converts the waste into [ash](#), [flue gas](#) and heat. The ash is mostly formed by the [inorganic](#) constituents of the waste and may take the form of solid lumps or [particulates](#) carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the [atmosphere](#). In some cases, the heat generated by incineration can be used to generate [electric power](#).