EnvITe

Environmental
Impacts of Technology

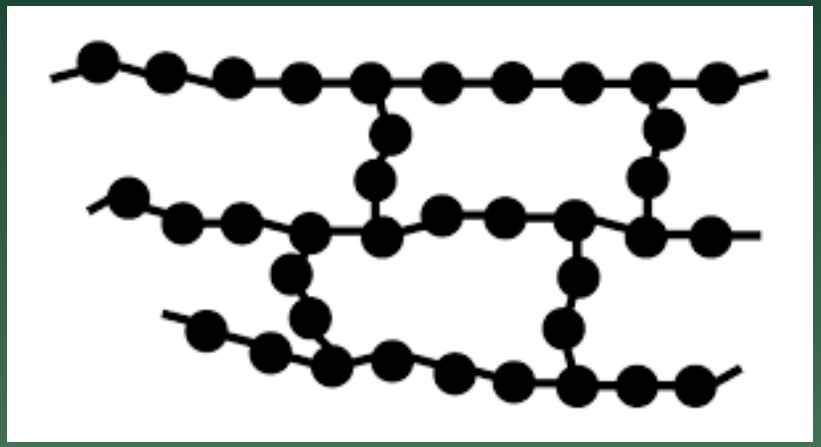
Plastics

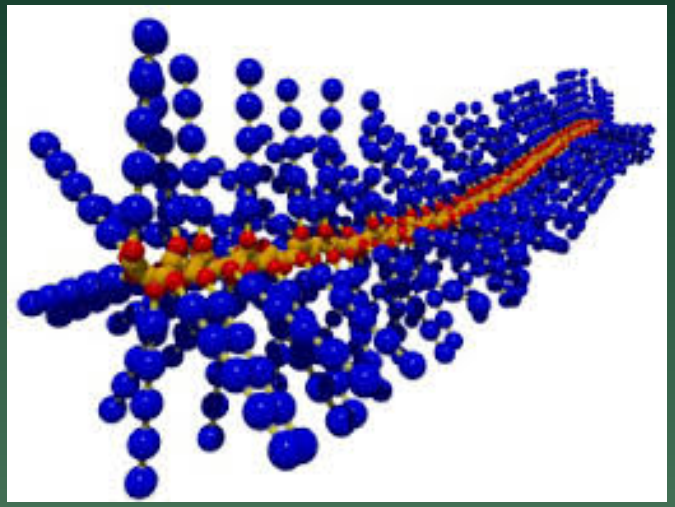
What are they?

Plastic
What is it?

A synthetic or semi-synthetic material made of organic polymers.
A polymer is a molecule of many monomers bonded together.

- Organic means containing carbon.
- Monomer means likes to bond with others like it.
- Polymer means a chain of monomers.
- Plastic becomes many chains together, some linked together and some not linked together.





Plastics
Classification

Plastics consist of molecules called monomers that like to form long chains. These long chains can be connected to one another to varying degrees. The connections between chains are called cross-links. The fewer cross links, the more likely the plastic can be recycled.

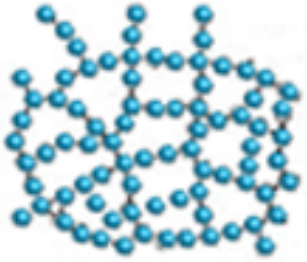
Thermoplastics
Little to no Cross-Linking

Thermoplastic

Elastomers
Some cross-linking

Elastomer

Thermosets
Extensive cross-linking



Thermoset

Plastics
Basic Classification

Thermoplastics

Little to no Cross-Linking

- Become pliable and moldable when heated.
- Solidify when cooled.
- Have a wide range of applications (e.g. food packaging, bumpers, credit cards).
- Can be recycled.
- Can be reused as filler material for lightweight concrete, composite deck boards, etc.

Plastics
Basic Classification

Elastomers

Some cross-linking

- Are composed of long polymer chains that reconfigure under applied stress.
- Become non-rigid solids above their "glass transition temperatures".
- Can be stretched repeatedly and returned to their original shape.
- Are also referred to as rubber.
- Are predominantly thermoset plastics and cannot be recycled.

Plastics *of Many Types*

In 1988, the Society of the Plastics Industry (SPI) developed a coding scheme for the many different types of plastic: Numbers 1 through 7

Polyethylene Terephthalate
(PETE or PET)

High-Density Polyethylene
(HDPE or PEHD)

Polyvinyl Chloride
(PVC)

Low-Density Polyethylene
(LDPE)

Polypropylene
(PP)

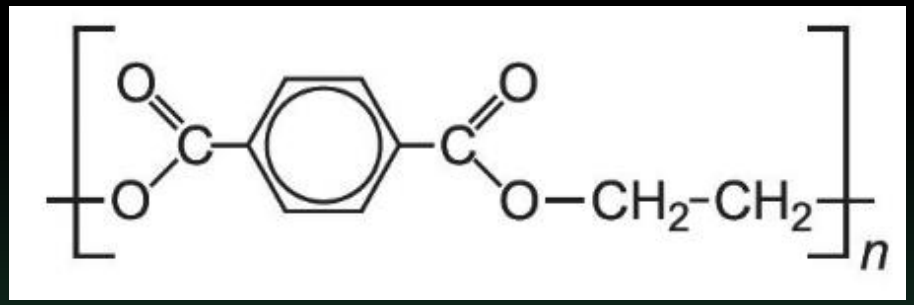
Polystyrene
(PS or Styrofoam)

Miscellaneous plastics
(That's a lot!)

Plastics *of Many Types*

1 PET

Polyethylene Terephthalate (PETE or PET)

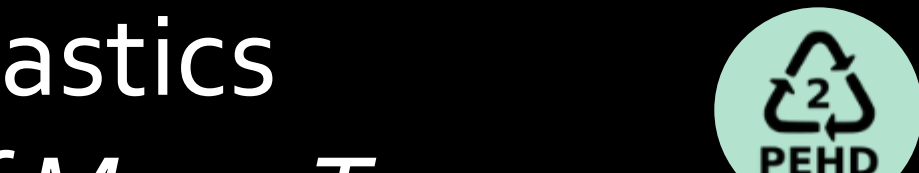


56 million tons of PET produced every year are commonly used as synthetic fibers and in plastic water/beverage bottles

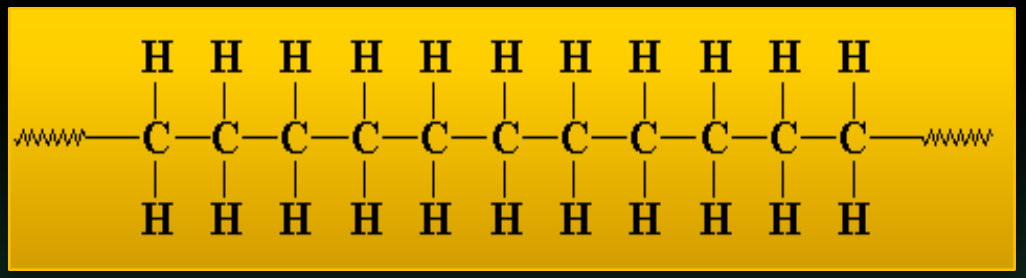
Did you know? PET is a thermoplastic and a member of the polyester family. It tends to absorb odors and flavors from what is stored inside of containers

These plastics are COMMONLY recycled: > 30% in the United States

Plastics *of Many Types*



High-Density Polyethylene
(HDPE or PEHD)



30 million tons of HDPE produced every year are commonly used in plastic containers, including bottles

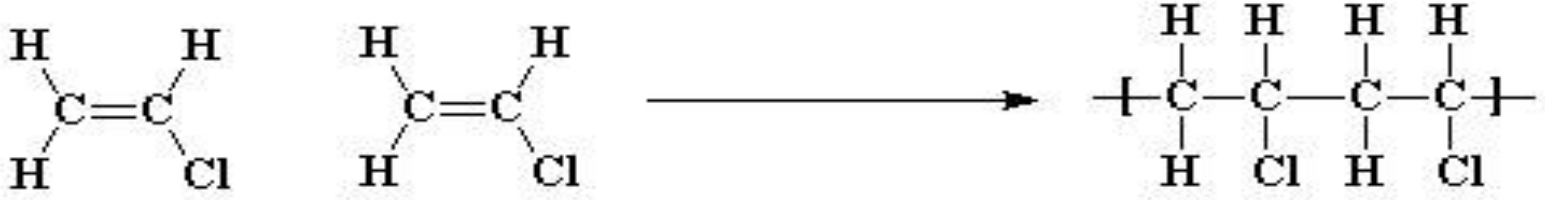
Did you know?
HDPE is a thermoplastic with high strength to density ratio. HDPE containers do not leach chemicals into food or drink BUT can become contaminated from what is stored inside of them.

These plastics are COMMONLY recycled: > 30% in the United States

Plastics *of Many Types*

3 PVC

Polyvinyl Chloride (PVC)



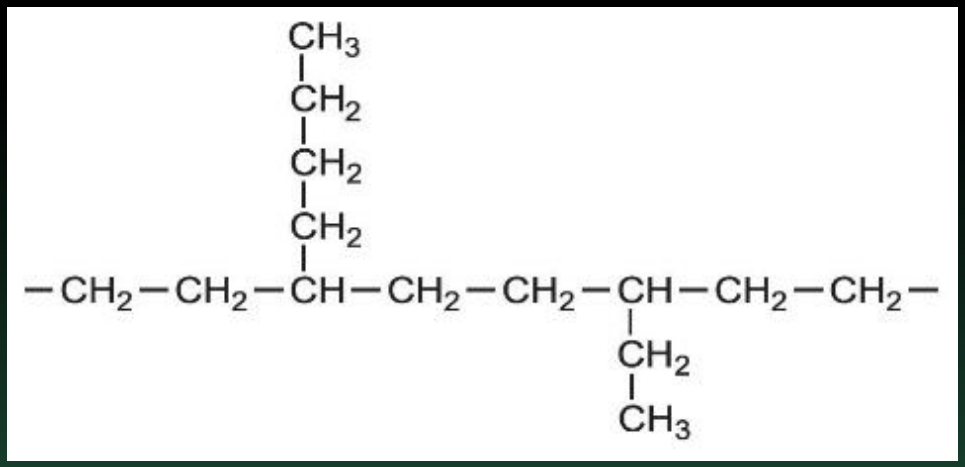
40 million tons of PVC produced every year are commonly used in doors, plumbing, pipes, electrical cable insulation, flooring, car interiors, and non-food containers

Did you know?
PVC is a thermoplastic which is often softened with phthalates. Phthalates leach easily and are known to cause harm to people.

PVC is not often recycled, but can be readily ground up and reformed into other products and materials

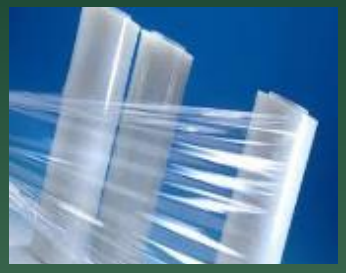
Plastics *of Many Types*

Low-Density Polyethylene (LDPE)



40 million tons of PVC produced every year are commonly used in doors, plumbing, pipes, electrical cable insulation, flooring, car interiors, and non-food containers.

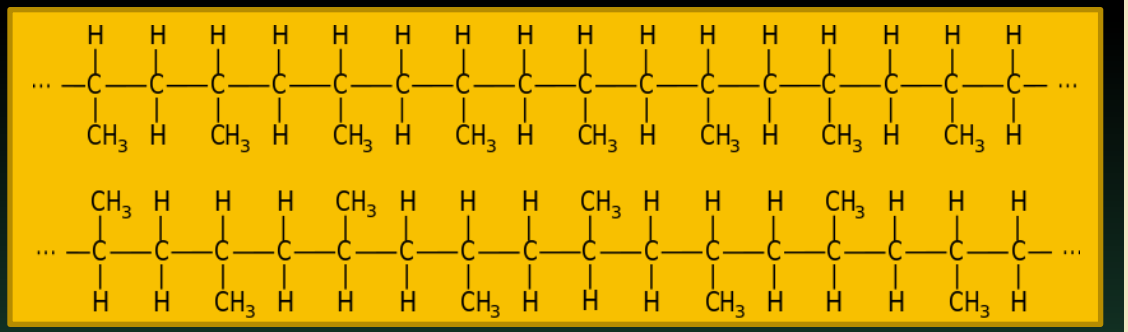
Did you know?
PVC is a thermoplastic which is often softened with phthalates. Phthalates leach easily and are known to cause harm to people.



These plastics are poorly recycled at rates less than 6% in the United States

Plastics *of Many Types*

Polypropylene
PP



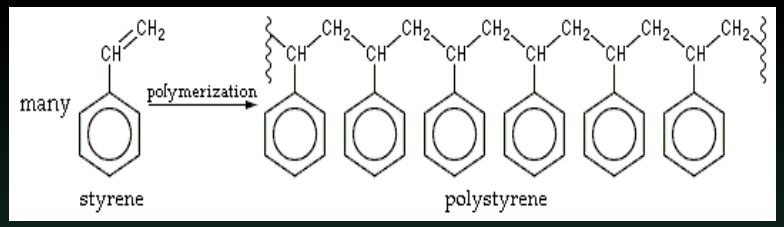
59 million tons of PP (25% of global plastics volume) are produced every year and is commonly used in Tupperware, bottle caps, prescription bottles, yogurt containers, carpets, and plastic diapers.

Did you know?
PP is another thermoplastic but is typically stronger and can withstand higher temperatures than PE plastics. It is also resistant to fatigue and is used in many "living hinges" such as those found on flip top bottles and similar products.

Although PP CAN be recycled, it is typically NOT recycled

Plastics *of Many Types*

Polystyrene
Styrofoam



Over 17 million tons of Polystyrene are produced every year. PS is attractive for its light weight and ability to be molded into almost any shape. It is used for plastic cups, plates, cutlery, and many other types of food boxes as well as license plates and insulation.

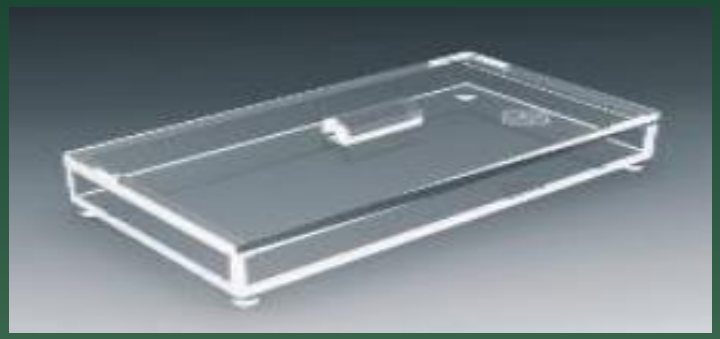
Did you know?
Polystyrene takes hundreds of years to biodegrade and "looks" like food to animals, making it a major threat to wildlife as it enters the world's oceans in massive quantities.
Threats to land-based wildlife are similar but less well understood than the harm posed to marine life.

Although PS can be recycled,
it cannot be efficiently recycled and more often than not, is discarded

Plastics *of Many Types*

Miscellaneous Plastics

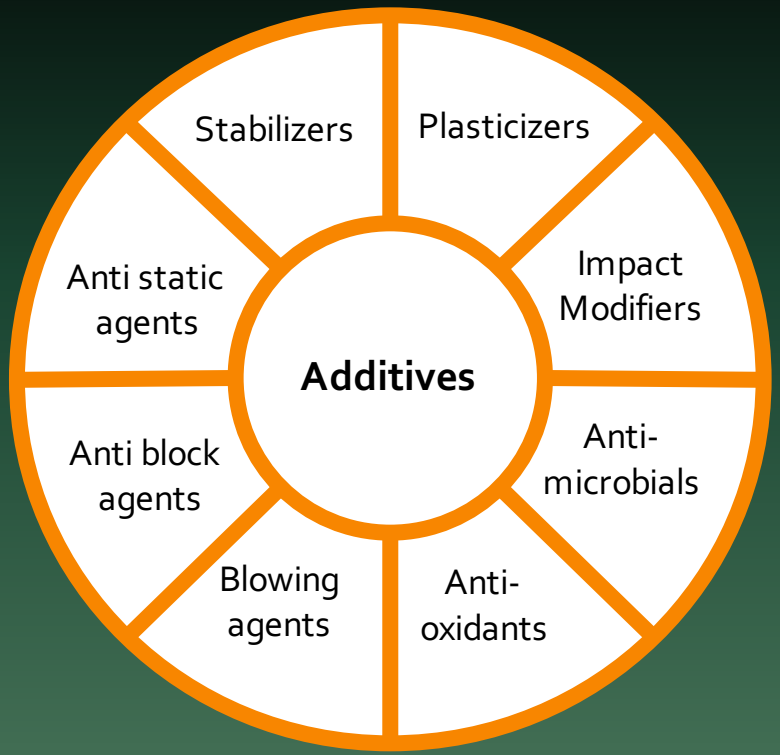
Category 7 contains miscellaneous forms of plastic, including polycarbonate, acrylic, nylon, and polylactic acid (PLA) which are used in a broad range of products.



Although many Code 7 plastics are difficult to recycle because they are thermosets, some, like PLA, are used to make compostable products

Plastics
and More --- Additives

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

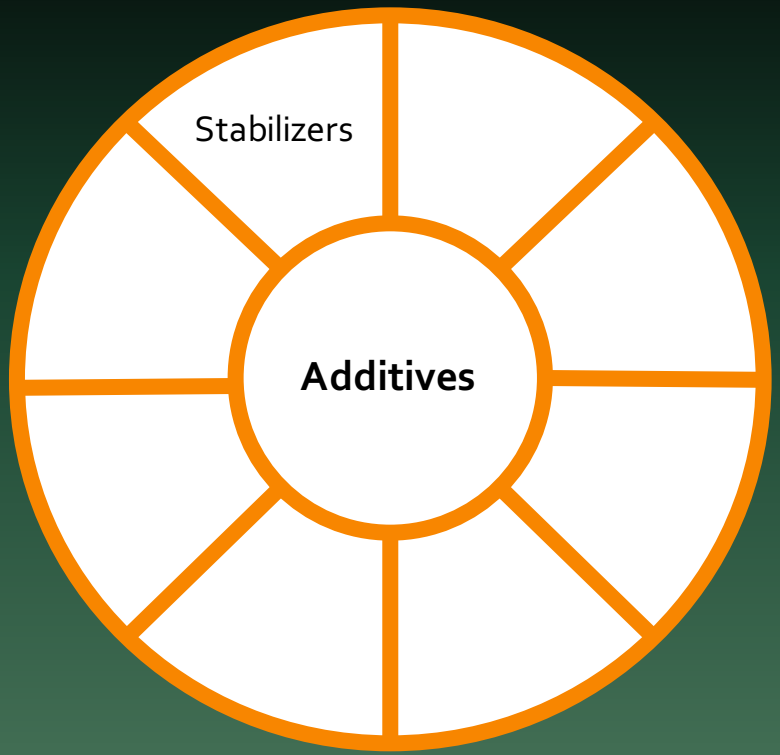


Did you know?
While many plastics, in their unadulterated form, can be readily recycled, once additives are included in the plastic, they are often no longer amenable to recycling

Plastics
Additives

Stabilizers:
Prevent a plastic product from breaking down from heat or ultraviolet light.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

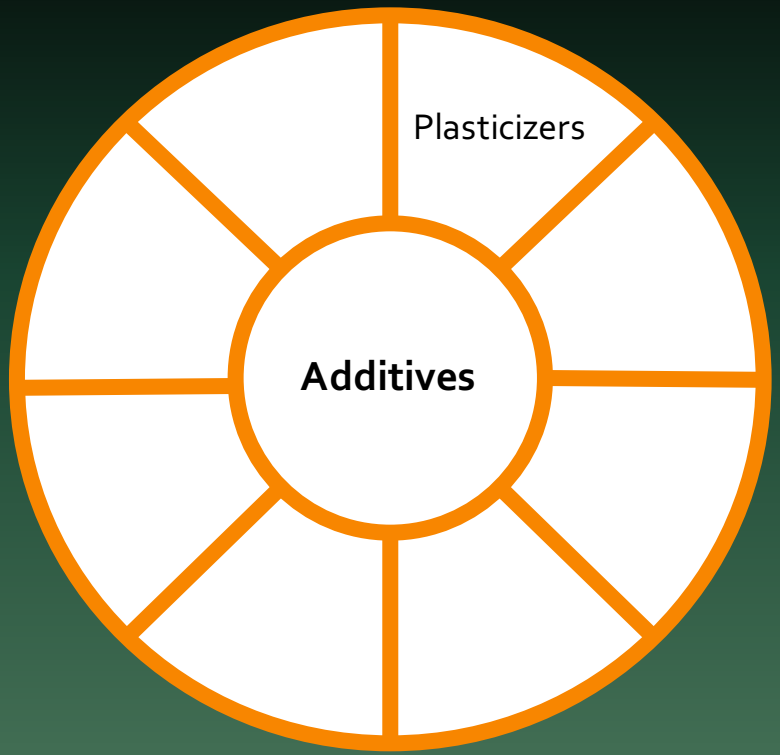


Did you know?
Heat stabilizers are most common in construction products (e.g. windows and doors exposed to outdoor heat) while light stabilizers are most common in polypropylene and polyethylene. Many stabilizers contain metals such as lead.

Plastics
Additives

Plasticizers:
Increase the flexibility and decrease brittleness in plastics.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

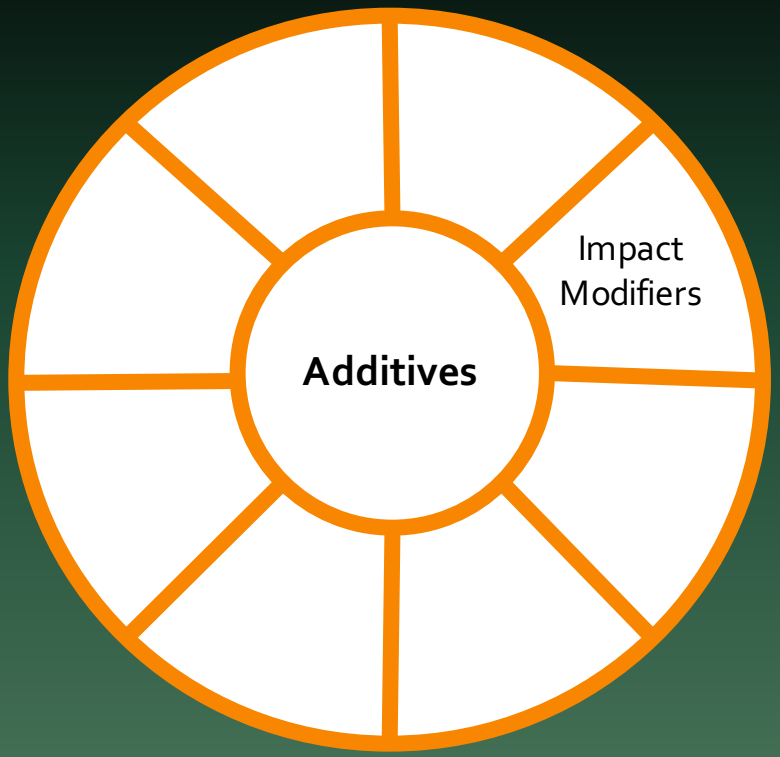


Did you know?
Over 8 million tons of plasticizers are produced every year. Most are used to soften PVC (polyvinyl chloride) in cables and film applications. A common group of plasticizers, the phthalates, are thought to be endocrine disrupters and bear serious harm to human health.

Plastics
Additives

Impact Modifiers:
Make plastics tougher,
and increase durability.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

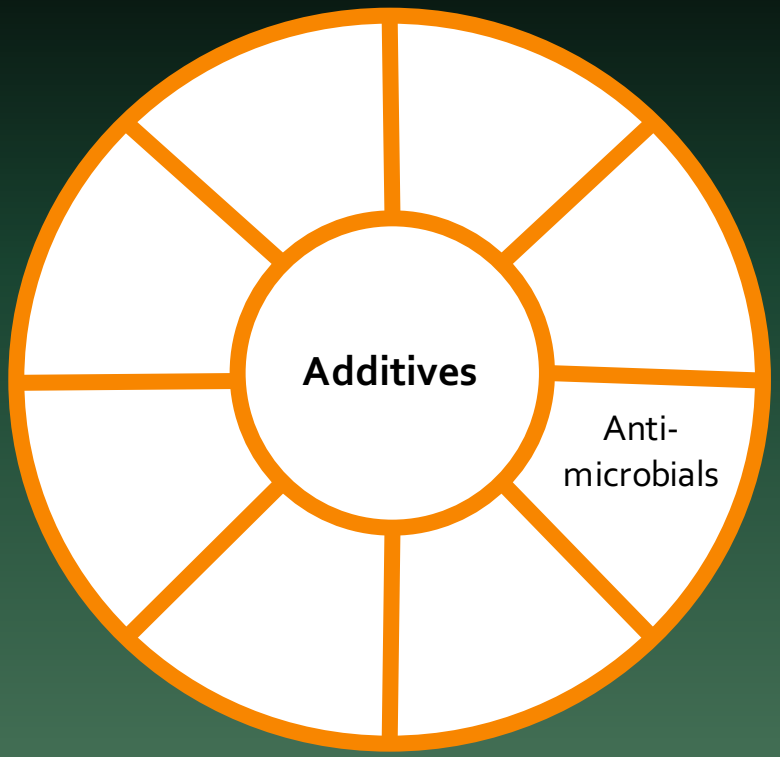


Did you know?
Impact modifiers are used with extruded plastics and are very attractive to products that are subject to high impact forces or that operate in cold weather.

Plastics
Additives

Antimicrobials:
Kill micro-organisms,
or stop their growth.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

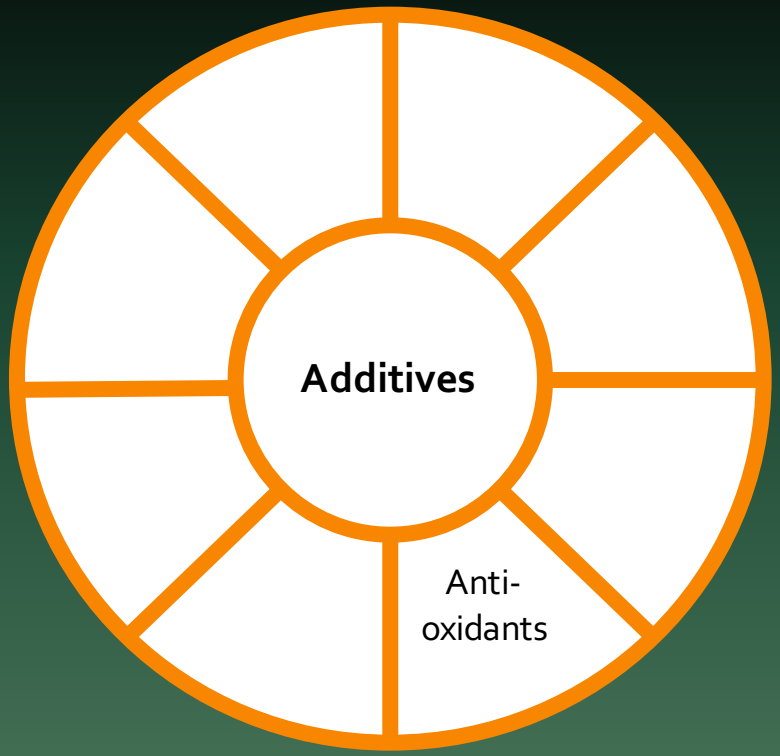


Did you know?
Antimicrobial additives to plastics can kill mold, mildew, yeast, and algae, stopping discoloration and odor as well as preventing premature degradation of the plastic.

Plastics
Additives

Antioxidants
Reduce degradation in plastics from both light and heat.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

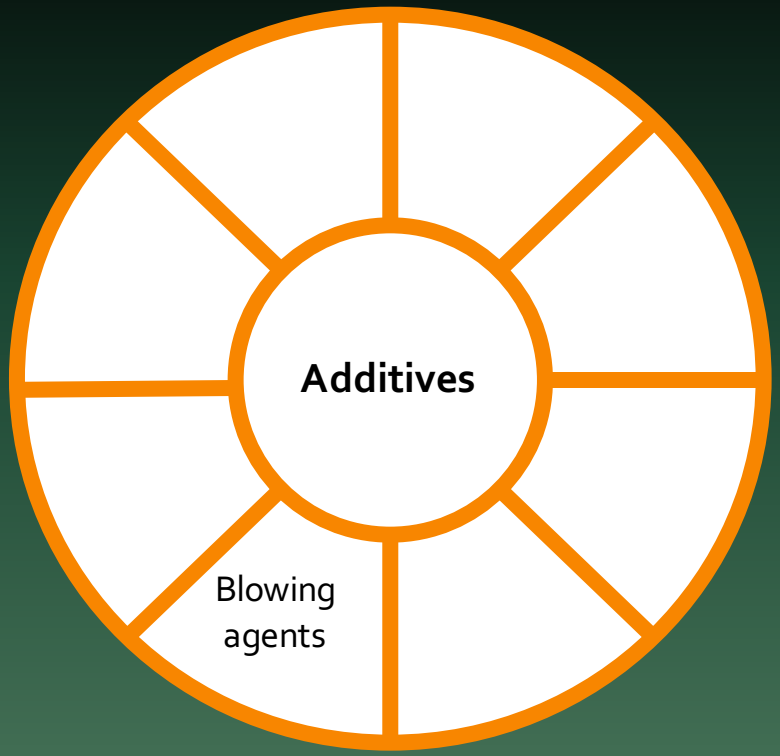


Did you know?
Antioxidants reduce degradation by limiting the production of free radicals.

Plastics
Additives

Blowing Agents
Decrease density, reduce weight, and increase stiffness.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

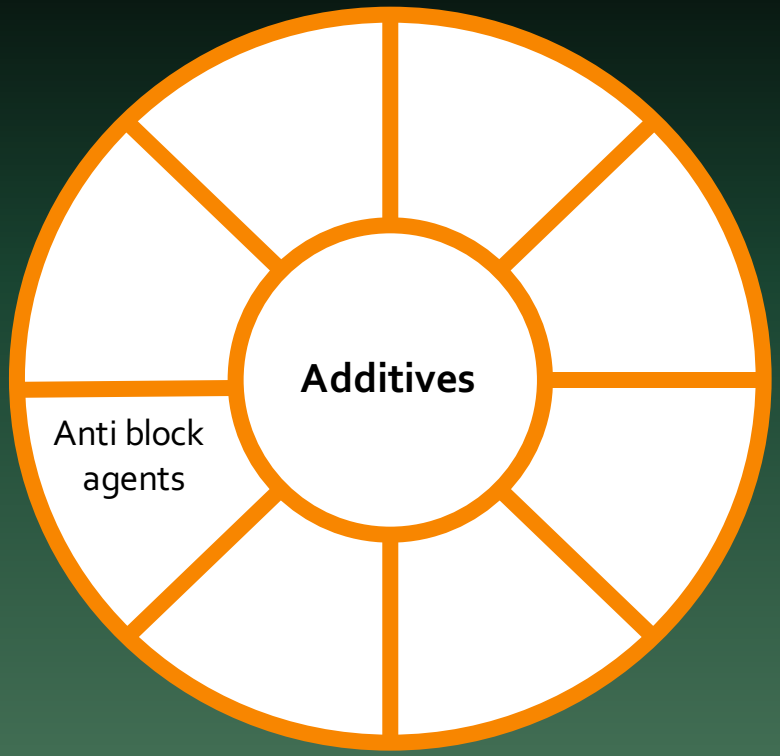


Did you know?
Blowing agents work by creating a foam-like or cellular structure within plastic, thereby making them less dense. CFCs are a form of blowing agent but have been eliminated because of their ozone depleting effects.

Plastics
Additives

Anti-Block Agents
Prevent adhesion between layers of plastic films.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives

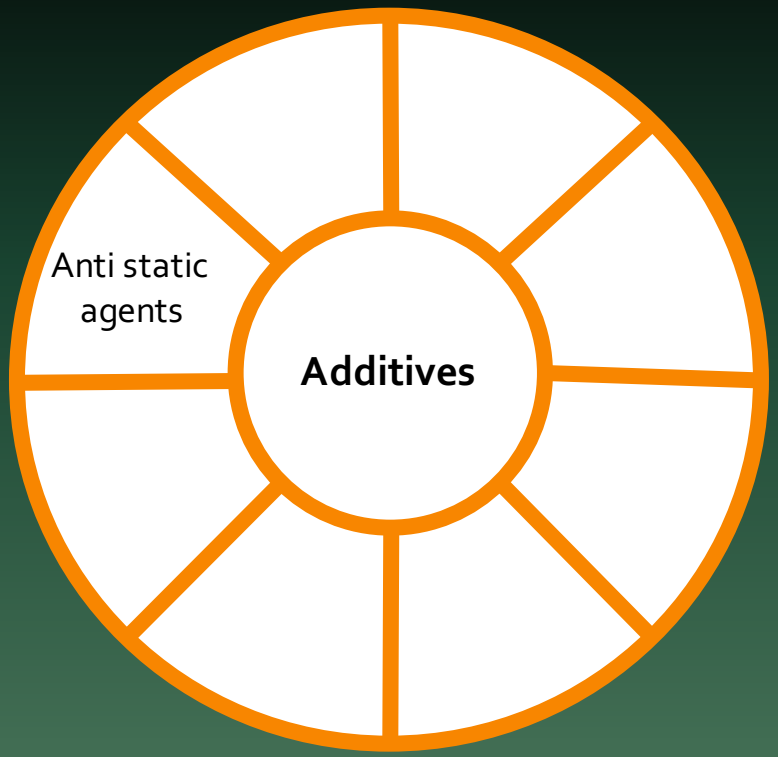


Did you know?
Anti-Block agents are used primarily in polyethylene and polypropylene films to reduce the Van der Waals forces that make plastics stick together, often to the dismay of the user.

Plastics
Additives

Anti-Static Agents
Reduce the build-up of static electricity in plastics.

In practice, there is more to plastic than just plastic….
Most Plastic Products = Plastic + Additives



Did you know?
Anti-Static agents work by making the surface of the plastic slightly conductive, thereby protecting electronics and other static-sensitive devices from harm. Military fuel uses anti-static agents to reduce the risk of sparking in the fuel itself.

Plastic
What is it?

Plastic is a generic term for molecules (monomers) that like sticking together and forming large chains. How the monomers stick to each other and how the chains stick to other chains have a direct relationship to what a plastic can do & how it does it.

Every Year:
300 million tons are produced.
22%-43% ends up in landfills.
Only a small portion is recycled.

Plastics:
Are more than their base material and contain a wide range of additives that often prevent the plastic from being recycled and in some cases, cause harm to human health.