

TOXIC CHEMICALS IN SOME TYPES OF PLASTIC

Plastics are composed of various chemicals, including polymers and additives that enhance strength, flexibility, softness, colour, and fire resistance or protect the plastic from UV radiation and oxygen or static charge on the surface, depending on the type of plastic and its intended use. Dyes and pigments are also used as additives. In addition to these intentionally added chemicals, by-products that may be unknown or unavoidable are generated during production. Plastic components can react with each other or the environment, forming new chemicals. Plastics can also contain impurities unintentionally introduced during production or recycling. All these chemicals are collectively referred to as non-intentionally added substances.

The PlastChem¹ report identifies 16,000 chemicals that may be used in or found in plastic materials and products. Only 6% of these chemicals are regulated internationally, despite many being produced in large quantities and having a high potential for exposure. The report also emphasizes that over 4,200 plastic chemicals are of concern due to their persistence, bioaccumulation, mobility, and/or toxicity (PBMT). More than 1,300 of these concerning chemicals are known to be marketed for use in plastics. Additionally, 29–66% of the chemicals used or found in well-studied plastic types are of concern, indicating that such chemicals can be present in all types of plastics.

Given the significant number of plastic-related chemicals, regulating groups of chemicals can expedite protective measures and reduce the risks of regrettable substitutions. Therefore, during the negotiations for the new global legally binding Plastic Treaty, countries such as Norway, the Cook Islands, Rwanda, and the EU have highlighted groups of chemicals that may be suitable for an initial list of regulated substances. These groups include:

- Phthalates (Endocrine disruptors that can affect reproductive health)
- Bisphenols (Linked to hormonal imbalances and various health issues)
- Alkylphenols (Endocrine disruptors that can affect reproductive health)
- Flame retardants (Some flame retardants are associated with elevated cancer risk, developmental and reproductive harm, and hormone disruption)
- Metals and metal compounds (Metals like Antimony, Lead and Cadmium can cause various health problems, including risk of developing cancer)
- UV stabilizers (Raise concern due to their persistence, bioaccumulation, biomagnification, and toxic characteristics)
- PFAS (per- and polyfluoroalkyl substances - Even minimal exposure to PFAS has been associated with cancer, damage to the reproductive and immune systems, and various other health issues.)
- POPs (persistent organic pollutants are toxic bioaccumulative substances causing various negative health effects, including cancer)





The Stockholm Convention on POPs regulates 17 plastic-related chemicals, including those listed in Annex A for global elimination:

- PFHxS (Perfluorohexane sulfonate, a group of PFAS related chemicals) its salts and PFHxS-related compounds
- PFOA (Perfluorooctanoic acid), its salts and related compounds
- UV-328
- SCCPs (Short-Chain Chlorinated Paraffins)
- PCNs (Polychlorinated naphthalene)
- PCBs (Polychlorinated biphenyls)
- HCBd (Hexachlorobutadiene)
- HexaBDE and HeptaBDE (C-OctaBDE)
- Dechlorane Plus
- DecaBDE
- Mirex
- TetraBDE and PentaBDE (C-PentaBDE)
- HBCDD (Hexabromocyclododecane)
- Hexabromobiphenyl

Annex B of the Stockholm Convention lists PFOS (perfluorooctane sulfonate), its salts and PFOSF to be restricted. While Annex C calls for minimizing unintentional production and release of Dioxins and Furans.

Additionally, the POPs Review Committee recommended that MCCPs (medium-chain chlorinated paraffins) and Long chain PFCAs (long-chain perfluoroalkyl carboxylates) be listed under Annex A of the Convention.

How is plastic harmful to health?

Chemicals added to plastics during manufacturing, such as plasticizers, flame retardants, and stabilizers, can gradually leach out over time and enter the human body, potentially causing endocrine disruption, reproductive issues, and other health problems. Factors like heat, UV exposure, and physical wear can accelerate this process, causing these chemicals to migrate into the surrounding environment, including food and water.²

When plastics degrade, they break down into smaller particles known as microplastics, which can be ingested by humans and animals. Microplastics are found in drinking water, food, and even the air we breathe and in human bodies. Moreover, toxic chemicals are also present in microplastics; many leach out of the plastics after entering the environment.³

In addition, pollutants in the environment can cling to plastic particles. Plastics have a high affinity for POPs and other contaminants, which can adhere to their surfaces.⁴

Overview of some common types of plastics and the toxic chemicals they might contain

In this overview, information about toxic chemicals in some well-known types of plastics is collected, including possible use in products and examples of migrating chemicals. The following plastic types are reviewed:

- Polyvinyl Chloride (PVC)
- Polycarbonate (PC)
- Polystyrene (PS)
- Polyethylene Terephthalate (PET)
- Polyethylene (high density) (HDPE)
- Polyethylene (PE)
- Polypropylene (PP)
- Acrylonitrile Butadiene Styrene (ABS)
- Polyamide (PA, nylon)
- Polytetrafluoroethylene (PTFE, Teflon)
- Melamine resin (Melamine)
- Poly(organo)-siloxane (Silicone)

Examples of toxic chemicals that can migrate from products made of these types of plastic include phthalates, bisphenols, flame retardants, POPs, PFAS, formaldehyde, melamine, butadiene, styrene, and others. Here's an overview of some common types of plastics and the toxic chemicals they might contain.



Common types of plastic and chemicals they contain

Type of plastic	Labeling	Possible use	Examples of chemicals ^{5 6 7 8} and their health concerns
Polyvinyl Chloride	PVC	Pipes, flooring, medical devices, and packaging materials	<p>Phthalates, lead, cadmium, organotins</p> <p>Phthalates: Used as plasticizers to make PVC flexible. They are endocrine disruptors linked to reproductive and developmental issues.</p> <p>Lead: Often used as a stabilizer in PVC. Lead exposure can cause neurological damage, especially in children.</p> <p>Cadmium: Another stabilizer used in PVC that can cause kidney damage and is a known carcinogen.</p> <p>Organotins: Used as stabilizers, organotins can affect the immune and reproductive systems.</p> <p>Health Concerns: Exposure can occur through inhalation, ingestion, or skin contact. Long-term exposure can lead to serious health problems including cancer, endocrine disruption, and developmental issues in children.</p>
Polycarbonate	PC	Water bottles, food containers, and electronics	<p>Bisphenols, including Bisphenol A (BPA)</p> <p>Bisphenols: Bisphenols, including BPA, are endocrine disruptors that can mimic estrogen and have been linked to various health issues, including breast cancer, prostate cancer, and neurological disorders.</p> <p>Health Concerns: Bisphenols can leach into food and beverages from containers, especially when heated. It is particularly concerning for infants and young children.</p>
Polystyrene	PS	Disposable cutlery, plates, cups, and insulation materials	<p>Styrene monomer and benzene</p> <p>Styrene Monomer: A human carcinogen that can leach out of polystyrene products.</p> <p>Benzene: A known carcinogen used in the production of styrene.</p> <p>Health Concerns: Exposure to styrene can occur through inhalation, ingestion, or skin contact. Long-term exposure can affect the central nervous system and increase the risk of cancer.</p>

Polyethylene Terephthalate	PET	Water bottles, food containers	<p>antimony; phthalates; oligomers</p> <p>Antimony: Used as a catalyst in the production of PET. Antimony trioxide is considered a possible human carcinogen.</p> <p>Health Concerns: Low levels of antimony can leach from PET bottles into beverages, especially when exposed to high temperatures. Chronic exposure can cause respiratory and cardiovascular problems.</p>
Polyethylene	PE	Grocery bags, bottles, and toys	<p>Phthalates and other stabilizers and antioxidants</p> <p>Phthalates: Used as additives in some PE products to improve flexibility.</p> <p>Stabilizers and Antioxidants: Various chemicals used to enhance the durability and stability of the plastic can have toxic effects.</p> <p>Health Concerns: These plastics are generally considered safer compared to others, but concerns arise from additives and the potential for microplastic pollution.</p>
Polypropylene	PP	Food containers, automotive parts, and textiles	<p>phthalates and certain stabilizers and antioxidants</p> <p>Phthalates: Used as additives in some PE products to improve flexibility.</p> <p>Stabilizers and Antioxidants: Various chemicals used to enhance the durability and stability of the plastic can have toxic effects.</p> <p>Health Concerns: These plastics are generally considered safer compared to others, but concerns arise from additives and the potential for microplastic pollution.</p>
Acrylonitrile Butadiene Styrene	ABS	Electronic housings, automotive parts	<p>acrylonitrile, butadiene, and styrene</p> <p>Acrylonitrile: A probable human carcinogen.</p> <p>Butadiene: A known human carcinogen.</p> <p>Styrene: As mentioned, a potential carcinogen.</p> <p>Health Concerns: Exposure to these chemicals can occur during the manufacturing process or from the degradation of the plastic. Health effects include an increased risk of cancer and respiratory issues.</p>

Polyamide	PA, nylon	Textiles, carpets, automotive components, kitchen utensils, reusable shopping bags	<p>caprolactam (monomer used in production) and additives</p> <p>Caprolactam: Used in the production of nylon, it can cause irritation to the skin, eyes, and respiratory system</p> <p>Additives: Various stabilizers and plasticizers that may have toxic effects.</p> <p>Health Concerns: Generally considered safe for consumer use, but concerns exist over the chemicals used in its production and the potential release of microplastics.</p>
Polytetrafluoroethylene	PTFE, Teflon	Coated pans and pots	<p>Perfluorooctanoic Acid (PFOA) and other per- and polyfluorinated, Alkyl compounds (PFAS)</p> <p>PFOA and other PFAS may impair fertility or cause harm to the fetus; persistent, bioaccumulative and toxic; probably carcinogenic</p>
Melamine resin	Melamine	Reusable tableware and cups for small children	<p>Melamine, formaldehyde</p> <p>Melamine: Suspected carcinogen; currently under investigation for persistence, bioaccumulation and toxicity as well as endocrine activity</p> <p>Formaldehyde: Can cause cancer; probably causes heritable mutations in human germ cells</p> <p>Health Concerns: Exposure may occur due to the migration of melamine from food-contacting materials, especially into high acid foods or when products are microwave-heated</p>
Poly(organo)-siloxane	Silicone	Baking tins, sealing rings, hoses, kitchen utensils, lids	<p>Siloxane oligomers</p> <p>Siloxane oligomers, e.g. cyclic siloxanes D4 and D5: Can potentially cause hormone imbalance, thyroid disease, and other autoimmune diseases</p> <p>Health Concerns: They are generally considered non-toxic to humans and the environment, or only slightly toxic. However, several publications challenge this view. Many researchers have shown that the degree of polymerization and the structure influence silicone ability to penetrate cellular barriers and affect absorption into the body, migration within the organism, accumulation, degradability, and toxicity. Oligomers made from silicones are considered to be very difficult to break down and can accumulate in organisms</p>



Reducing exposure to toxic chemicals in plastics

- Use Bisphenol-free products: Choosing products labelled as bisphenol-free is a good step, but it's important to remember that BPA-free labels do not guarantee the absence of other bisphenols.
- Avoid heating food in plastic containers: Heat can cause chemicals to leach out of the plastic.
- Choose alternatives: Consider using glass or stainless steel for food and beverage storage.
- Check recycling codes: Avoid plastics labelled with recycling codes 3 (PVC), 6 (PS), and 7 (other, which often includes polycarbonate).

How to Handle Specific Types of Plastics and Identify Safer Alternatives

Polyvinyl Chloride (PVC)

Handling Tips	Safer Alternatives
<ul style="list-style-type: none"> • Avoid using PVC products for food and drink storage. • Look for „PVC-free“ labels on products. • Use protective gloves when handling PVC in industrial or craft settings. 	<ul style="list-style-type: none"> • Use polyethylene (PE) or polypropylene (PP) for pipes and containers. • Opt for natural materials like wood, glass, or metal instead of PVC.

Polycarbonate (PC)

Handling Tips	Safer Alternatives
<ul style="list-style-type: none"> • Avoid heating polycarbonate containers, as this can cause BPA and other bisphenols to leach out. • Check for recycling code #7 and avoid using it for food or drink. 	<ul style="list-style-type: none"> • Use glass or stainless steel bottles and food storage containers.

Polystyrene (PS)

Handling Tips	Safer Alternatives
<ul style="list-style-type: none"> • Avoid using polystyrene containers for hot foods or drinks. • Do not microwave polystyrene products. • Limit the use of disposable polystyrene items. 	<ul style="list-style-type: none"> • Use paper or glass for disposable items. • Opt for reusable containers made from glass.

Polyethylene Terephthalate (PET)

Handling Tips	Safer Alternatives
<ul style="list-style-type: none"> • Do not reuse PET bottles multiple times, especially if they have been exposed to heat. • Check for any visible damage or wear before using PET bottles. 	<ul style="list-style-type: none"> • Use stainless steel or glass bottles.



Polyethylene (PE), Polyethylene (high density - HDPE) and Polypropylene (PP)

Handling Tips	Safer Alternatives
<ul style="list-style-type: none">• Avoid exposing these plastics to high temperatures to prevent leaching of additives.• Check for any certification indicating that the product is food-safe.	<ul style="list-style-type: none">• Choose consumer products made with materials that are alternative to plastic, like cotton or wool for textiles.

Acrylonitrile Butadiene Styrene (ABS)

Handling Tips	Safer Alternatives
<ul style="list-style-type: none">• Use ABS products in well-ventilated areas to reduce inhalation risks.• Wear protective gear when cutting or shaping ABS materials.	<ul style="list-style-type: none">• Use polypropylene (PP) or polyethylene (PE) for similar applications if possible.• Opt for natural materials for consumer products.

Nylon (Polyamide)

Handling Tips	Safer Alternatives
<ul style="list-style-type: none">• Avoid using nylon products in high-temperature applications unless specifically designed for it.• Check for certifications indicating safety for food contact if used in kitchenware.	<ul style="list-style-type: none">• Use stainless steel kitchen utensils instead of nylon.• Opt for natural fibers like cotton or wool for textiles.

Melamine

Handling Tips	Safer Alternatives
<ul style="list-style-type: none">• Never put your melamine dishes in your oven or microwave• Do not use melamine dishes for acidic foods	<ul style="list-style-type: none">• Use ceramic, glass or stainless steel cookware.

Identifying Safer Alternatives

Recycling Codes: Familiarize yourself with recycling codes on plastic products. Codes 1 (PET), 2 (HDPE), 4 (LDPE), and 5 (PP) are generally considered safer options.

Labels and Certifications: Look for „Bisphenol-free,“ „phthalate-free,“ and other safety certifications.

Material Choices:

Glass: Inert and non-reactive, ideal for food and drink storage.

Stainless Steel: Durable and safe for both hot and cold items.

Wood: Durable and safe for cold items

Ceramic: Durable and safe for hot and cold items

Practical Tips for Reducing Plastic Use

- **Bring Your Own Bags:** Use reusable shopping bags instead of plastic ones.
- **Read Labels Carefully:** Look for labels that specify “BPA-free,” “phthalate-free,” or “free of harmful chemicals.” However, be aware that “BPA-free” doesn’t necessarily mean free of all bisphenols.
- **Reusable Containers:** Invest in high-quality, reusable containers for food storage. When possible, opt for glass or stainless steel containers instead of plastic. These materials are less likely to leach harmful chemicals.
- **Avoid Single-Use Plastics:** Choose products that are designed for multiple uses rather than disposables.
- **Avoid Plastic Containers with Recycling Codes 3, 6, and 7:** These codes indicate the presence of chemicals like phthalates, styrene, and bisphenols. Instead, choose plastics with codes 1, 2, 4, or 5.
- **Avoid Microwaving Plastic:** Heating plastic can cause chemicals to leach into food. Use glass or ceramic containers for microwaving.
- **Check Personal Care Products:** Many personal care products are made of plastic and contain harmful chemicals. Look for products with natural ingredients and avoid those with parabens, phthalates, and synthetic fragrances.
- **Stay Informed:** Keep up with the latest research and recommendations on harmful chemicals in plastic products. Knowledge is your best defense.
- **Recycle Properly:** Follow local recycling guidelines to ensure plastics are disposed of correctly.

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HEJSupport Website:
www.hej-support.org

More information about the project:
www.hej-support/ecca-plastic



Endnotes

- 1 <https://plastchem-project.org/>
- 2 <https://www.scienceabc.com/pure-sciences/what-is-plastic-leaching-and-why-is-it-bad.html>
- 3 <https://pmc.ncbi.nlm.nih.gov/articles/PMC10675727/>
- 4 <https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3001131>
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