Executive Summary

The development of plastic products does not systematically take sustainability, particularly from a chemicals perspective, into account. The challenge in creating sustainable plastic products revolves around the selection of sustainable materials, but also the overall system within which the product circulates. A sustainable plastic product operates in a system, to which the design of the product and its plastic materials are adapted.

The objective of this document is to enable the creation of inherently sustainable plastic products by integrating sustainable chemistry thinking in the design process. Sustainable plastics have been outlined by the OECD to be "plastics used in products that provide societal benefits while enhancing human and environmental health and safety across the entire product life cycle".

This study builds on the OECD report 'Considerations and criteria of sustainable plastics from a chemicals perspective' and four OECD case studies in the building and packaging sectors.

The report focuses on the chemicals perspective of the material selection process when plastic is the material of choice. While other material choices could provide sustainable solutions and should be considered at the design stage, this is not within the scope of the report. The information presented equips designers and engineers with knowledge of how to manage the complexity of finding the most sustainable plastic for their products. The main contributions of this report are an overall approach to sustainable plastic selection from a chemicals perspective, and the identification of a set of generalizable sustainable design goals, life cycle considerations and trade-offs. While other elements also factor into selection of a sustainable solution (e.g. economic, societal), these are not within the scope of this report.

Designers need to set sustainable design goals as they consider sustainable plastics selection from a chemicals perspective. It is recommended that these build upon the following set of principles derived from the American Chemical Society (ACS) Green Chemistry Institute's (GC) design principles of sustainable chemistry and engineering:

- Maximise resource efficiency.
- Eliminate and minimise hazards and pollution.
- Design systems holistically and using life cycle thinking.

Based on the principles, the following sustainable design goals can be set and also added to depending on the level of ambition of the company. These design goals are further elaborated in the report.

- Select materials with an inherently low risk/hazard.
- Select materials that have a commercial 'afterlife'.
- Select materials that generate no waste.
- Select materials that use secondary feedstock or biobased feedstock.

At a final, more granular level, the following general considerations for sustainable design from a chemicals perspective were identified as key elements for designers to take into account for each life-cycle phase when selecting material composition. While presented as the main considerations of individual phases, ultimately these considerations are brought together as a whole-product assessment and optimisation taking the whole life-cycle into account.

Considerations during the sourcing phase

A. Select a base polymer (secondary or primary renewable source; secondary or primary non-renewable source) that:

- the least emissions during extraction and production.
- uses non-hazardous or the least hazardous chemicals during extraction and production.
- minimises worker exposure during extraction and production.

B. Primary renewable feedstock (i.e., bio(based)plastics) is potentially a sustainable source, when:

- the benefits of using this feedstock, demonstrated through life-cycle assessment, outweigh the costs of externalities, such as water consumption, and competition with food production or social or ecological land use.
- the availability and continuity of availability of the supply of the feedstock enables its use.

C. Secondary feedstock is potentially a sustainable source, when

- the propagation of hazardous chemicals is avoided.
- the resulting material contains a high percentage of the recycled material when designed.
- the current and future availability of the supply of the secondary feedstock enables its use.

D. Primary non-renewable feedstock can be used as last resort, if it minimises hazardous chemicals or hazardous mixtures of chemicals.

E. Strive for transparency in chemical compositions throughout the value chain.

Considerations during the manufacturing phase

A. Select a manufacturing technique that:

- generates the least emissions.
- uses the least processing aids.
- uses non-hazardous or the least hazardous chemicals.
- minimises worker exposure.

B. Consider sustainable manufacturing on a systems level.

C. Ensure transparency in chemical composition throughout the value chain.

Considerations during the use phase

A. Consider whether the determined chemical and mechanical requirements are strict, or there is flexibility to allow for more sustainable choices.

B. Select a base polymer/source material that:

- generates the least emissions.

- prevents or minimises exposure to hazardous chemicals during use and maintenance.
- enables the intended lifespan of the product.

C. Map exposure scenarios during use and reduce exposure to hazard as much as possible.

Considerations during the end-of-use phase

A. Minimise the amount of waste at end-of-use through polymer selection.

B. Simplify designs to include as few different polymers as possible.

C. Maximise the production of high-quality recycled materials as output of the recycling process.

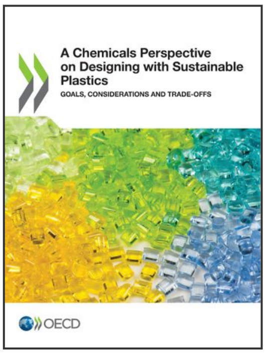
D. Minimise the amount of and exposure to chemical hazard at end-of-use through chemical selection.

E. Match the polymer selection to the waste management operations in the intended market.

F. Consider ways to mitigate the risk of littering.

G. Ensure transparency of chemical composition.

These considerations will also lead to trade-offs that will need to be carefully balanced in the decision-making process by the design team, but they are expected to promote transparency and reflection on the implications of making these choices. Ultimately, the report should help to equip designers and engineers with knowledge of relevant chemical considerations when selecting sustainable plastic and support better outcomes as a result.



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