Chapter 6. Considerations During the Use Phase

This chapter focuses on the use phase of the life-cycle and provides considerations for sustainable design from a chemicals perspective that are most relevant for this phase. Examples of trade-offs that arise in the use phase are presented.

In the use phase, the plastic product is acquired by a user and consequently utilised. Users could be exposed to substances above levels considered harmful during the use of the plastic product. These substances could be emitted by the product itself or by maintenance products needed during the lifespan of the product. From a designers' perspective, the material selection journey starts with the use phase as the functionality of the product depends on its purpose during use and its use context. The considerations at the use phase are as follows.

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.

6.1. Considerations during the Use Phase

In this section, the considerations for the use phase are further explained.

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

The determined chemical and mechanical requirements can be restrictive to genuinely sustainable chemical selection and material innovation. These requirements might be set with safety margins of a supplier in addition to safety margins of a manufacturer, making them excessive or they might include requirements that are tentative in nature. Consider whether the requirements are unnecessarily restrictive in relation to the intended use of the product.

B. Select a base polymer/source material that:

- **generates the least emissions.**

For plastic products that are continuously transported during their lifespan, plastics with lower densities or foamed plastics can be considered to reduce CO_2 emissions and consequently fuel use. For plastic packaging, always consider the use phase of its content. If the packaging is to be used as food packaging, then shelf life should be considered as one of the most important factors for prevention of food waste. In addition, other spoilage of content should always be prevented with the choice of the right type of polymer and additives. Furthermore, the shedding of microplastics or microfibres during use of the product should be prevented.

Box 6.1. Examples of a transportation and agriculture sector-specific considerations during the use phase

Transportation: Consider impact of light-weighting on fuel use; consider the dispersion of microplastics by vehicles' tyres. For plastic products that are continuously transported during their lifespan, plastics with lower densities or foamed plastics can be considered to reduce CO2 emissions.

Agriculture: Due to high risks of littering and loss of films (or parts of films) or clips used in agriculture, soil degradable plastics can be considered for use (e.g. for applications like mulch films). However, caution may be needed even if soil degradable plastic is chosen. Under certain conditions it does not degrade for a very long time and can also disperse chemicals into the environment.

- **prevents or minimises exposure to hazardous chemicals during use and maintenance.**

Consumers or professional users can be exposed to hazardous chemicals or volatile organic compounds (VOCs) emitted during the use or maintenance of the product. Exposure depends on a variety of factors such as the type of contact with the product (e.g. skin contact, food contact). Hazards can emerge from the input chemicals, the production process (e.g. production residues, reaction products and non-intentionally added substances (NIAS), and from the conditions in which the product is being used or maintained (e.g. temperature, the way it reacts to cleaning agents). These hazards should be discussed with the supplier/producer.

- **enables the intended lifespan of the product.**

The use phase of products can range from seconds to half centuries. Usually expensive, high-end engineering plastics are not used for packaging that is rapidly disposed of. However, designers should consider that multiple recycling loops affect the quality of polymers and that it could be beneficial in the long term to use higher quality polymers for products that have long lifespans as well as products that are recycled very often. In addition, polymer quality can be maintained during multiple recycling loops by using techniques that can counter degradation and also due to the typically heterogeneous nature of the source of input materials. Moreover, some plastics are recycled differently than others. PET, for instance, can be recycled about eight times before a noticeable degradation in quality takes place due to chain length shortening.

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

Study the use context of the plastic product. How does the use alter the product after manufacturing (e.g. installation, tear and wear, heating)? Consequently, consider the risks linked to these types of exposures. For example, chemical leaching, microplastic shedding and degradation of the product with time could expose users and the environment to harmful chemicals. Hazards associated with plastics are often linked to non-polymeric substances such as unreacted monomers, partially reacted oligomers or additives. Together with the supplier, identify the molecular weight ranges of production residues. Lower molecular weight will make chemicals more likely to migrate and more easily gain entry into biological systems. Molecules of 1 000 Daltons are considered as immobile in this respect.

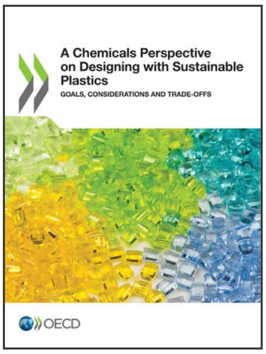
Determine if microplastics or fibres will be directly released into wastewater during use, or microplastics expected to shed from the product during use/washing. To reduce this exposure, consider how (important) information about the chemical composition of the plastic and relevant control measures could be conveyed to the user.

Although the priority remains on expected use scenarios, consider the exposure under plausible misuse and worst-case scenarios.

6.2. Trade-Offs within the Use Phase

Table 6.1. Various trade-offs emerging from taking use phase considerations into account

Prevention of maintenance aids	*vs*	Uncertain chemical hazard
Nano chemicals can be used to create surfaces to which dirt cannot attach itself, so no cleaning agents or sometimes extra paint layers are necessary. However, these chemicals might have gaps in hazard data.		
Waste created	***vs***	**Waste avoided**
The waste created from the plastic in a packaging application vs the waste of the product it contains. For example, weigh the impact of plastics vs impact of food waste.		
Low emissions	***vs***	**Low maintenance**
Certain plastics require low or no maintenance but emit VOCs during the use phase.		
Low emissions	***vs***	**Long lifespan**
Certain plastics (like soft PVC) have a long lifespan but emit VOCs or other particles during the use phase.		
Reduce weight	***vs***	**Efficiency of transport**
Foamed plastics will weigh less but may take up a lot of space and thus require more shipments for the same functional unit.		



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