Ten Common Rules of Design for Recyclability (DFR) for Plastic Packaging
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These rules have been defined with the overarching vision that, in a Circular Economy, branding and communication on a container must be effectively removable and that physical as well as chemical properties of recyclates have to resemble virgin resin as much as possible.

Packaging (rigid, flexible or semi-rigid) designed according to the following principles can be considered “recycling-ready”\(^1\) or “recyclable”\(^2\).

1. Focus on PE, PP and PET for the preferably mono-layer and mono-material main body of all plastic packaging.
   - Although some polymer types (e.g. PS and technical plastics) are being collected and recycled in some regions, they still have small market shares which are too low for them to be efficiently collected, sorted and recycled at an industrial scale.
2. Avoid any coloring/pigmenting of the main body of the packaging and stick to clear/transparent or white (if barrier to light is needed).
   - Pigments and metallization cannot (yet) be removed by recyclers.
3. Design the packaging so that it can be emptied completely.
   - Residue from filled goods negatively impacts the costs of recycling and the quality of the recycled product (odor, color, mechanical properties) and ruins the LCA of your product.
4. Avoid inseparable incompatible combinations of polymers, barrier layers, ties, and glues (PE and PP are considered compatible with each other; AlOx, SiOx, EVOH, are considered compatible with polyolefins; PVDC and PA are incompatible with polyolefins; PET and PS need to be single materials). Aluminium foil as an inseparable barrier layer is not harmful if the container (or its fragments with Aluminium particles) can be safely separated by means of eddy-current separation and sent to aluminium recycling.
   - Minimizing incompatibilities will enhance mechanical properties of the recyclates and make them more suitable to be used in consumer goods.
5. Do not use any packaging components (barrier layers, foams, fillers, etc...) that cause the specific density of the complete (or shredded) container to shift to a level above the threshold of 1 g/cm\(^3\) (for polyolefin packaging) or below 1 (for PET packaging). All labels must be removable and should have a density <1 g/cm\(^3\) if the main body is PET, and > 1 g/cm\(^3\) if the main body is Polyolefin and the label is not PO.
   - Density separation in water is the main industrial process to recover clean PET and PE/PP/PO streams.
6. For PE/PP-containers respectively use PE/PP labels, caps and closures of the same color as main body. If the label can not be removed from body during a short friction washing process (e.g. in-mold labels), ensure that inks are washable. Full body sleeves for PE/PP containers should become lose by shredding to get rid of marketing information. For

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\(^1\) Recyclability proven via regional collection separate from household waste of more than 10 million inhabitants with subsequent sorting and recycling. “Recycling ready” even in regions where collection, sorting and/or recycling infrastructure does not (yet) exist. To collect (separately) resp. to feed a collection system does not mean that recycling actually takes place.

\(^2\) Using the term “recyclable” is not permitted if based on lab tests or small scale experience.
PET containers do not use full body sleeves of a material like G-PET, PVC and PS which are different to the main polymer.

- In optical sorting the container will not be sorted correctly if its surface sends 'the wrong message'.

7. **Avoid marketing information** (reverse, trap and direct printing) that cannot be separated from the main body of the packaging (product).
   - Colors/inks cannot be removed in the recycling process other than by (short) friction washing in natural water at temperatures max 50 degrees centigrade.

8. For unavoidable and inseparable marketing information **use light colored non-gassing inks** (temperature resistant at up to 240 degrees).
   - Gassing is a major disruptor for any recycling and converting process if inks cannot be removed and thermally neutralized during recycling.

9. **Avoid paper/plastic combinations** (sleeves, labels, etc.), unless you can design the combination in a way that it has to be separated by the consumer before he can reach the packaged product.
   - Paper fibers cannot be effectively removed during a plastic recycling process, they cling to the polymer flakes and degrade under heat during processing, creating gasses, discoloring and odor.

10. **Follow the ongoing discussions on DFR which are driven by new recycling technology developments, changes in convertor’s demands, new design solutions for packaging and all technological progress for additives, inks etc., providing at the same time proper and safe separation at source.**

**Background information**

1. The above rules are based on experience and current technology available in Central Europe, the region with the most comprehensive collection, sorting and recycling obligations for plastic packaging in the world.
2. Testing protocols for different requirements as well as design guidelines for individual applications can be obtained e.g. from PRE **[Guidelines]** or Institute Cyclos/HTP **[Requirements and Assessment Catalogue]**.
3. DFR is prerequisite for setting up a functioning and affordable **collection** system that provides a clean environment as well as health and social benefits to the regions where plastic (packaging) is not yet properly collected. Unfortunately, this is the case in many areas in Europe - not even for the role-model PET-bottle, not to speak of those countries in other parts of the world which import many plastic containers designed and/or filled in Europe.
4. DFR ensures that packaging (and in fact all plastic products) can effectively be **sorted** into waste streams for PE-LD, PE-HD, PP, PO and PET recyclers with technology available today.
5. DFR enables **higher quality recyclates** (recycled plastics) and hence recycled feedstock for convertors who have to fulfil ever growing demand for recycled content by the consumer goods industry or by the law.
6. Functionality requirements for packaging and the choice of material combinations derived from them have a negative impact leading to deterioration of the recyclates. Therefore, the material combinations and the requirements for functionality must be checked regularly to see whether they are still necessary to this extent.
7. Even “recycling ready”-designed packaging will not automatically lead to 100% food-grade or closed-loop recyclates which can be used in identical applications. As true for other materials, compounding/blending with virgin polymers will be needed to tighten the loops.
8. Chemical recycling is not available for post-consumer goods and packaging at an industrial scale. Where it is being developed and tested today recycling-ready input helps that technology as well. It will last another 10 years until viable capacities will be available. For the time being, chemical recycling is not the easy way out of DFR.
9. **DFR is a separate requirement to and should not be compared with Life Cycle Assessment (LCA).** LCA is a specific tool designed to provide the user with a comparison of the **relative** environmental impacts of 2 or more product/packaging combinations. When using LCA, the utmost care needs to be taken to ensure that the boundary and other parts of the product/pack lifecycles are equivalent. This is particularly the
case if end of life benefits due to recycling are to be included relative to no recycling. Today, LCA does not yet always account for a lack of recyclability robustly and/or the lack of formal or informal waste-management systems. Also, in some cases the data used in LCA to quantify the recycling aspects are frequently outdated, incomplete, or simply not available. The DFR principles of a plastic product/packaging should be always be applied/checked during or after it has been selected. If the result is a product/pack that is not recycling ready, then one should revisit the selection criteria to see if a “recycling ready” solution can be found. Recycling criteria often mentioned when setting boundaries (concrete and wood replacement, down-cycling/up-cycling, closed loop-thinking, high quality recycling, etc.) are in many cases misleading, ill-defined or driven by recycling perceptions of the 1990s, and have to be handled with care.

10. Trade-offs between functionality, marketing and DFR are only admissible if it is documented that
   a. infringing functionality requirements are really requested as necessary by a packer, filler, brand-owner,
   b. that they cannot be met without or with lesser infringement of DFR rules.

In case you have further questions, please contact

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