



Adhesives in the recycling of packaging

FREQUENTLY ASKED QUESTIONS

Adhesives fulfil many vital roles in packaging and are used in nearly all types of packaging, including paper, cardboard, plastic, metal, glass and wood packaging. This includes the primary, secondary and tertiary (logistics) packaging of many goods, such as food, consumer goods, cosmetics, and electronic and industrial products. The roles of adhesives include combining the different components and/or layers that make up a final packaging, providing a hermetic seal which increases food safety and reduces food losses, and reclose features that can help prevent spoilage of food. Many functionally and environmentally beneficial packaging formats could not be produced or function correctly without adhesives.

The following Frequently Asked Questions provide some more insights into the indispensable role of adhesives in sustainable packaging.

In what applications are adhesives used in packaging?

- Production of corrugated cardboard
- Paper / cardboard box formation
- Box closing ('end-of-line')
- Labelling
- Lidding
- Sealing
- Lamination
- Attachment of components
- Multipack bonding
- Adhesive tape production
- Self-adhesive label production
- Palletising

What chemistries of adhesives are used in packaging?

- Protein glues
- Starch-based adhesives
- Natural rubber latex
- Acrylic resin dispersions / emulsions
- Polyvinyl acetate dispersions
- Polyurethane dispersions
- Polyolefin / EVA hotmelts
- Rubber based hotmelts
- Reactive polyurethanes
- Acrylic and styrene acrylic polymers

Are adhesives in packaging being recycled?

Every recycling operation or process is focussed on the reprocessing of a specific material, the target material. Adhesives, like coatings, inks, paints and other 'additive' materials, are never the main component of packaging. Therefore, they are not the target material of a recycling process. Adhesives themselves are consequently not recycled on their own; they enter the recycling process of the main material of the packaging, be it different types of plastics, paper, glass, metal or wood.

Do adhesives hinder the recycling of packaging?

When adhesive design and recycling process technology are suitably matched, adhesives are fully compatible with recycling of many packaging materials. This means that they do not negatively affect the quality or yield of recycling operations. In the case of inorganic materials such as metals and glass, recycling typically occurs at very high temperatures, sufficient to completely disintegrate any adhesive present in such packaging. In these cases, adhesives may universally be acceptable for recycling, independent of their specific properties.

How can I determine which adhesives are compatible with recycling?

Over recent years, several design-for-recycling guidelines have been published for many types of packaging which describe design principles and requirements to achieve recyclability. Such design guidelines typically also cover adhesives, even though not necessarily all adhesive applications, and can be consulted for a general understanding of adhesive compatibility with recycling.

In addition, experimental methods exist for testing the compatibility of adhesives with waste sorting and recycling operations. A third party can be involved to certify the results of such testing. The adhesive industry already offers numerous products with such certifications.

What is a 'releasable' adhesive?

A releasable adhesive is an adhesive that is capable of releasing on at least one side of its bond under the specific conditions of the recycling process. The adhesive remains on its substrate(s) and does not become part of the washing solution (e.g., process water).

What is a 'soluble' adhesive?

A soluble adhesive is an adhesive that is capable of dissolving in (wash) water during the recycling process. The dissolved adhesive remains in the water until it undergoes a recovery or cleaning step.

What is a '(re)dispersible' adhesive?

A (re)dispersible adhesive is an adhesive that transfers into (wash) water in the form of small particles rather than being physically dissolved. The (re)dispersed adhesive remains in the water until it undergoes a recovery or cleaning step.

Are releasable ('washable') adhesives better for recycling?

The benefits of releasable adhesives depend on packaging design and available recycling processes. In certain applications of adhesives in packaging, for example, the attachment of polyolefin labels onto plastic beverage bottles made from polyethylene terephthalate (PET), releasable adhesives are crucial for the successful recycling of the PET bottle.

In other cases, such as the attachment of a polyethylene label on a polyethylene bottle, it has been demonstrated that the release of the label is not strictly necessary as bottle and label material can be recycled together. In such cases, the compatibility with recycling of the adhesive can be more important than its *releasability*. The use of adhesives to bond paper with paper, for example in cardboard box production and closure, is another example where compatibility, rather than releasability, is key. One option is for the adhesive application to be *removable* by filtration ('screening'), and for this the adhesive does not have to be releasable.

In general, releasability (washability) of adhesives can provide a benefit when they bond two dissimilar materials together which can be recycled only separately and where washing processes are established that match the conditions under which the adhesive releases.

The term '*washable adhesive*' is ambiguous and can refer to any of the three options described above. It is therefore recommended to avoid this terminology.

Are all water-based adhesives soluble or dispersible during recycling?

The properties of an adhesive may change substantially between its delivery form and its final applied form in the packaging material, and it is the latter which enters recycling. Differences arise, for example, from removal of water, solvents and additives from the adhesive during its application and drying as well as due to curing and setting processes. Even though an adhesive may have been delivered in a water-based form, this does not mean that its application will be water-soluble or dispersible. Conversely, adhesives which have not been delivered as water-based products can be designed to be soluble in water.

Are water-soluble adhesives best for paper and board recycling?

Recycling of paper and board occurs by repulping, that is, the disintegration of paper and board into an aqueous slurry of paper fibres, the 'pulp', by mechanical action and temperature. After cleaning, the pulp is converted into recycled paper and board. It is generally desired that adhesive

applications be removed from the pulp, and one option is for the adhesive to be water-soluble. An alternative and at least equally accepted option is for the adhesive application to be removable by filtration ('screening'). This approach has been very successfully applied over decades, for example, in the removal of hotmelt applications that are used to make and close cardboard boxes. Accordingly, test methods for paper recyclability include a filtration ('screening') step that can lead to the removal of adhesive applications.

Are solvent-based adhesives bad for recycling?

Independently of whether an adhesive has been delivered in solvent-based form, in water-based form or in pure, liquid form, the final packaging and therefore the packaging waste that enters recycling will contain only the adhesive itself, not its original medium (e.g., water or solvent). So any solvent that may have been present in the adhesive as delivered will not be present in packaging (waste) and therefore has no influence on the recycling process or the purity of the recycled material.

Are thermoplastic adhesives better for plastics recycling?

The main plastic materials being recycled today are thermoplastic (i.e., PET, PE, PP and PS) and their recycling process typically involves remelting ('extrusion') of the plastic waste into pellets of plastic recycle. Such remelting is possible only for thermoplastic materials, which soften and liquify at high temperature. While certain adhesives (such as, for example, polyolefin or EVA hotmelts) are thermoplastic, many other types are not (for example, polyurethane laminating adhesives).

As adhesives are always only a minor element of any packaging and as they are generally applied in very thin layers (in the order of micrometres), the requirement of thermoplasticity which is placed on the main packaging materials does not directly apply to adhesives. Numerous third-party tests have demonstrated that non-thermoplastic adhesives can be fully compatible with recycling of plastic materials, by either being removable or by being compatible with the remelting process itself. So the principal factor in the choice of an adhesive should generally be the availability of information on its compatibility

with recycling (from design guidelines or from test results), not its thermoplasticity.

Do adhesives create 'stickies' in paper and board recycling?

An essential element of designing paper and board packaging for recyclability is ensuring the absence of unacceptable levels of so-called 'stickies', that is, small sticky particles which can cause disruptions in papermaking. While certain adhesives may contribute to the formation of stickies, there are many examples of adhesives that have been used successfully for decades in the production of paper and board packaging without issues for recycling. In addition, numerous products are available to adhesive users with a third-party certification of compatibility with paper recycling. It should also be noted that other elements of paper and board packaging may also generate 'stickies', so the detection of stickies formation during recyclability testing does not automatically signify that the issue is caused by an adhesive.

Are pressure-sensitive adhesives bad for paper and board recycling?

While pressure-sensitive adhesives, which are used to produce self-adhesive labels and tapes, are by their very nature 'sticky', they do not necessarily create stickies in paper recycling. With correct design of the adhesive and its application on paper or board packaging, passing a recyclability test with a result of full compatibility is possible. The adhesive industry offers numerous products with third-party certification for compatibility with recycling of paper and board.

Can adhesives be repulpable?

'Repulping' refers to the process of disintegrating waste paper or cardboard into a slurry of paper fibre bundles in water (the so-called '*pulp*'). Repulpability is therefore a property of paper and board, not of adhesives, which are not made from pulp and cannot form pulp. While certain materials, such as wet-strengthening agents and plastic coatings, are known to affect repulpability of paper and board packaging, adhesives are not known to affect this property.

For materials that are recycled at high temperature, such as glass or metals, does the choice of adhesive matter at all for recyclability?

While high temperature processing will destroy adhesives that are present in a packaging, and thus ensure high quality of the recycled material, adhesives may still affect the yield of recycling. For example, an adhesive for the labelling of glass bottles may, when not suitable, prevent the full release of crushed glass fragments from the label material. In such a case, a certain amount of glass may, together with the label, be sent to disposal rather than recycling. As with other adhesive uses in packaging, choosing the right adhesive can prevent such losses.

Do adhesives influence waste sorting operations?

The *sorting* of waste is an important preparatory step for recycling. Only after the separation of waste into different fractions or streams (by target material, e.g., paper, PET, PE, aluminium, glass and so on), can high quality and high yield recycling be realised. The *sortability* of packaging waste into the correct fraction is therefore of high importance.

The key sorting techniques in application today are *sieving, density-based separation, wind sifting, ballistic separation, magnetic separation, eddy current separation* and *sensor-based sorting* (near infrared sorting).

Adhesives as minority components and mostly not present on the surface of packaging, have consistently been found to not impact sortability. Sieving, density-based separation, wind sifting and ballistic separation sorting based on packaging waste properties such as weight, surface area and stiffness, are all not significantly influenced by the small amounts of adhesives present. Adhesives are also generally neither ferromagnetic nor conductive and therefore cannot impact magnetic or eddy current separation. While they could in principle impact near infrared sorting, studies (for example, the CEFLEX study, available at <https://guidelines.ceflex.eu/testing-results/>) have consistently shown that this does not occur in practice due to the small material share and thin layers of adhesive applications, compared to the materials that they bond together.