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Beyond mechanical recycling: Exploring new ways to recycle plastic packaging

Summary

In its European Strategy for Plastics in a Circular Economy adopted in January 2018, the European Commission presented its ambition to see 10 million tons of recycled plastic materials reincorporated into new products by 2025. It requires that more than 50% of plastics is recycled by 2030 and that the demand for recycled materials is multiplied by four by 2030. Moreover, Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment requires that all beverage bottles contain at least 30% of recycled content by 2030.

To be able to play its role in achieving these goals, the food and drink industry needs to be able to rely on regular supply streams of high-quality recycled plastic materials which can be used in contact with food. Unfortunately, recycled materials meeting the technical and legal requirements for use in contact with food is not widely available, either in terms of quantity of supply or economic cost. Moreover, not all plastic waste collected today is recycled. In 2016, only around 30% of collected plastic waste got converted into secondary raw materials[1].

In this context, there is a need to develop new technologies to recycle plastics, going beyond the limitations of mechanical recycling which can mainly be used for PET and HDPE and provide limited supply. This requires investing into R&D and innovation, developing adequate framework conditions, and above all, ensuring that the recycled materials and articles are safe for use in contact with food. While research and innovation should certainly not be limited to specific innovative technologies, chemical recycling processes already present opportunities which are worth exploring further.

This paper presents the preliminary views of the food and drink industry on exploring new ways to recycle plastic materials with a view to move towards a circular, sustainable use of plastic packaging for food and drink products. A close up on chemical recycling is provided in the annex.

[1] https://www.europeandatajournalism.eu/eng/News/Data-news/Plastic-recycling-uneven-progress-in-Europe

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I. Context

The European food and drink industry has long been working to improve the circularity of food and drink products' packaging and to drive future innovation. This presents challenges as the various plastic materials used in food and drink packaging have different characteristics from a circularity perspective.

In particular, a significant share of plastic materials used in food and drink packaging cannot be easily recycled or are not recyclable to date. This is particularly the case of mixed, complex and multi-layer plastic products, plastics contaminated with e.g. food residues, plastic lined fibre-based packaging, and plastics which are not sorted or recycled due to technical or economic reasons. These materials are selected based on multiple criteria to provide the best delivery of packaging's primary role to maintain product safety and quality and reduce waste. Pure plastic materials, like PET and HDPE, are fairly easy to recycle through mechanical recycling, these materials cannot be recycled indefinitely, as the material properties and performance of products change with increased number of recycling cycles, and furthermore only a fraction is recycled into food contact materials.

In this context, it is of utmost importance that efforts are made to increase research and investment in enhanced recycling technologies and infrastructure. Collection rates should also be increased and sorting optimised across all EU Member states. This will help the European food and drink sector to increase recycling rates and use of recycled content, as well as ultimately contribute to the circularity of materials.

II. Developing recycling technologies for plastic packaging

Increasing recycling rates for food and drink plastic packaging and the use of recyclates in new packaging requires the further development of new and existing recycling processes, including mechanical and chemical recycling processes. It also requires ensuring that recyclates are safe and of high quality to allow these to be used in the production of food contact materials and articles. To achieve this, the following measures are needed:

- Foster the development of technologies and infrastructure

  The technologies and infrastructure for recycling plastic materials, especially materials not easily recyclable through mechanical recycling, need to be further researched, developed and adapted to meet the needs of upscaling and of heterogeneous waste streams. This requires an increase in research and investments, and in particular a more prominent and targeted space in Horizon Europe, the future EU Framework Programme for Research and Innovation.

  Research efforts should be technology neutral to avoid stifling innovation by killing off promising technologies or creating undesirable technology lock-in effects. In parallel, research efforts should be accompanied with life-cycle assessments to be able to evaluate and compare the environmental impacts of the various technologies and make decisions on the way forward especially in relation to their development at large scale. The aim should be to ensure that new recycling processes are effective and suitable alternatives to incineration or landfill.

  In relation to food and drink packaging, research should also look into the development of analytical methods to support risk-based assessment of substances which may be present in recycled plastic materials and could migrate into food.

- Ensure the quality and safety of recyclates

  To increase the recycled content in packaging, the food and drink industry needs access to high quality and safe recyclates, in which any residues or contaminants are in quantities as

low as technically feasible and that do not endanger human health. In this context, it is important to swiftly develop harmonised and standardised analytical methods as well as guidelines to verify the absence of migration of both legally added substances and non-intentionally added substances (NIAS).

We also call for the European Commission to accelerate the ongoing authorisation procedure for mechanical recycling processes, following the positive safety assessment by the European Food Safety Authority (EFSA). A swift conclusion of the procedure will provide:

- Clarity on the respective roles and obligations of the various operators involved in the waste management process;
- The general conditions for the operation of a recycling process regarding quality assurance, the quality of the input and output material, the technical suitability of the process, and the applicable administrative processes;
- Clarity on the procedures for official controls including in case of non-compliance and suspension of the use of an authorisation.

- Create a supportive waste legal framework

To ensure a harmonised regulatory framework and avoid fragmented implementation by Member States, a common understanding of the different existing enhanced recycling technologies is needed to ensure a common language and allow for the adoption of specific measures, including legislative ones where needed.

The European waste policy framework should be reviewed to be consistent and able to provide long-term visibility to secure investments in recycling technologies. It should make sure that new technologies, such as some chemical recycling methods, will be legally considered as valid contribution to achieving recycling targets in every EU Member State if deemed effective to produce recycled plastics. The Extended Producer Responsibility principles should also apply to all recycling technologies, including all chemical recycling techniques.

- Ensure the traceability of materials

An efficient EU harmonised system of traceability should be established to enable the tracking and monitoring of collected and sorted plastic materials, by types of materials/ polymers and by function. Such a system will help monitor progress in relation to legal targets set in the Single-Use Plastics Directive and industry's voluntary pledges, while informing future political and investment decisions.

To make the system effective, reliable data on collection and sorting of plastic (packaging) waste, as well as supply and demand of recycled plastics, will need to be made available to all actors of the supply chain, and to decision-makers. The work of the Circular Plastics Alliance will play a key role in this monitoring exercise.

- Ensure a sufficient, affordable and steady supply

Alongside efforts to improve recycling techniques, actions should be taken to improve separate collection and sorting systems for plastic materials, following a holistic approach at both technical and political level. This will help guarantee that there are sufficient and economically sound input materials to be able to achieve recycled content targets for plastic packaging.

Efforts are therefore needed from national authorities and regulators to ensure that waste management systems are further developed and optimised throughout the EU Member States. Minimum quality requirements for collection and sorting infrastructure are also needed. In this context, close collaboration with the Circular Plastics Alliance will be crucial.

Competition in the demand for recycled plastic materials among different industry sectors is expected to rise in the next years. Future legislation should encompass comprehensive measures to assure availability and affordability of recycled materials against virgin materials to promote sustainable packaging and materials in circular economy.

ANNEX: Close-up on chemical recycling

In recent years, chemical recycling has been high in research programmes and political discussions at national and European level and major technological developments have taken place in this area. This section is therefore a close-up on the opportunities and shortcomings which chemical recycling currently presents for the food and drink sector and it aims to serve as background to the measures suggested in the main section of this paper.

- The different chemical recycling processes

  While classification may differ widely, it is generally understood that chemical recycling processes, which present opportunities for plastic packaging recycling, can be classified as follows:

  - *Depolymerisation*, which consists of transforming plastics such as polystyrene and PET into monomers which can be repolymerised into new products. It includes different processes such as *catalysis, solvolysis, hydrolysis* and *enzymatic recycling*;
  - *Feedstock recycling* is a broader – and ambiguous – term used to refer to any thermal process that converts polymers, such as polyolefins, into smaller molecules which can be used to replace fossil oils as starting material for the manufacture of plastics. Today, the most developed feedstock recycling processes are:
    - *Pyrolysis*, which consists of converting mixed plastics into shorter chain molecules that can be used to make new plastic and chemical products;
    - *Gasification*, which can be used to process mixed, contaminated plastic waste into gaseous products (syngas), which can be transformed into new polymers and other chemicals as well (e.g. methanol).

- Potential benefits of chemical recycling processes

  Combined with mechanical recycling, the development of chemical recycling processes can help foster plastic waste recycling and contribute to achieve plastic recycling targets faster and more efficiently. Some chemical recycling processes can also provide virgin-grade recycled material, allowing for continuous recycling loops.

  The use of chemically recycled plastic materials for food packaging and films will depend on the quality and safety of the resulting products and whether these comply with the legal provisions for food contact materials.

  Pyrolysis and gasification processes show advantages from a food and drink industry perspective. These processes can indeed transform all sorts of plastic materials into raw chemicals that can replace fossil feedstock and be used to produce all kinds of plastics. However, as pointed out in Section II, some new chemical processes should be developed further and assessed from a safety and sustainability point of view to guarantee steady provision of food-grade recycled plastics.

  On the other hand, there is a need to remove non-organic waste from the input materials or to purify the secondary materials to ensure that the recycled materials are of equal quality to conventional materials and can in turn be used in contact with food. In terms of investment, gasification plants also need to be built at larger scale and therefore require greater investment than pyrolysis.

Enzyme technology and enzymatic recycling could also help create new waste management systems which may need fewer resources, lower energy input, may handle mixed and poor plastic waste and produce higher quality food-grade monomers and virgin resin.

- Applicable legislative framework

  Chemical recycling technologies are currently not included within the scope of Regulation (EC) 282/2008 on recycled plastic materials and articles intended to come into contact with foods and, hence, no provision exists for EC authorisation or input restrictions.

  In parallel, according to Regulation (EU) 10/2011 on plastic materials and articles intended to come into contact with food, recycled materials need to comply with the positive list of authorised monomers and additives, as required for all plastic materials. Therefore, the requirements on the input material will depend on the type of chemical recycling technology used. Those which are presently not explicitly mentioned by Regulation (EC) 282/2008 might be brought into scope and clarity would therefore be needed on the outputs of different technologies.

  Chemical recycling processes thus need to be evaluated based on the exclusion of potential contamination. If authorisation is needed, it should be granted based on evidence that any incidental contamination will be removed during the process.

  The degree of depolymerisation can offer a parameter to exemplify the differences and place them in the appropriate regulatory context:

  - In case of partial depolymerisation where the input plastic material will be depolymerised and all polymer substances present in the input will be reused to form the new polymer (melt-in/paste-in processes already in use in Europe): As these substances remain in the polymer, they should be listed in the list of authorised substances. This can only be ensured if the input originates from food contact material compliant with Regulation (EU) 10/2011,
  - In the case of full depolymerisation technologies, the recovered plastic input material is depolymerised into primary building blocks/monomers which will be used to form new plastic: As long as the building blocks which will be recovered are authorised under the EU 10/2011 Regulation on plastics in contact with food and are of suitable technical quality and purity (Article 8 of Regulation (EU) 10/2011), any type of input material should be allowed to be used.

In the Autumn 2019, the Commission informed that amendments to Regulation (EU) 282/2008 are planned to be made in 2021 with a view to potentially bring all recycled plastics into scope, including those originating from chemical recycling. The Commission is however considering exempting feedstock recycling from authorisation as the pyrolysis step should ensure removal of potential contamination.

It is also important that EFSA cooperates closely with relevant stakeholders, similar to what was done for mechanical recycling of PET in 2011[2]. This should include defined input material requirements to ensure manageable levels of incidental contaminants and avoid legacy substances issues. The defined scientific evaluation criteria should take carefully into account the differences between chemical recycling processes and anticipate closing possible gaps between regulations 282/2008 and 10/2011.

[2] EFSA Scientific Opinion on the criteria to be used for safety evaluation of a mechanical recycling process to produce recycled PET intended to be used for manufacture of materials and articles in contact with food

Various elements should therefore be considered: characterisation of background contamination; sorting efficiency; cleaning efficiency; challenge tests, and final use of the material for food grade application.

In relation to the EU Waste legislation, and end-of-waste criteria in some countries, some forms of chemical recycling are also not considered as recycling processes for plastics, as plastic waste can be considered recycled only if it is not subject to energy recovery and if it is reprocessed into new materials which are not to be used as fuels. The use of specific chemical recycling processes to produce recycled plastics – going away from fuel production will therefore need to be addressed in the context of the implementation of the Plastics Strategy.