

Mass balance approach for the chemical recycling of non-hazardous plastics

May 2023

In the context of this note, chemical recycling is for the moment limited to:

- the pyrolysis of plastic waste followed by;
- the production of recycled monomers from the pyrolysis oil via a steam cracker (which simultaneously receives a non-recycled input in known proportions).

1/ Design for recycling and recyclability should give priority to mechanical recycling

- Mechanical and chemical recycling technologies are complementary in achieving contact-sensitive and non-contact-sensitive recycling and reincorporation targets.
- However, the balance of mechanical recycling is better in terms of:
 - environmental impact;
 - cost;
 - process performance.
- The design for recycling must give priority to mechanical recycling. Chemical recycling should be seen as a complementary solution when mechanical recycling is not possible. It must therefore be proven that a mechanically recyclable alternative solution is not possible/desirable before chemical recycling is considered. Thus, for example, "70% recyclability" should be understood as "70% mechanical recycling".

2/ Ensuring a level playing field between mechanical and chemical recycling to guarantee fair competition based on the environmental performance

- The definition of recycling and the waste treatment hierarchy are and must remain technologically neutral in the Waste Framework Directive.
- Therefore, competition between these recycling technologies should be based mainly on the overall environmental performance of each technology according to the objectives to be achieved (plastic waste stream, contact-sensitive or not, need for decontamination, etc.).
- This implies the implementation of a methodology (chain of custody) allowing comparability, in particular in terms of contribution 1/ to the global recycling objectives and 2/ to the reincorporation objectives which are currently developed in the legislation.

3/ Choosing the right chain of custody in the context of the mass balance approach for the chemical recycling of plastics

- A level playing field implies the choice of a chain of custody for chemical recycling which ensures good traceability and offers the most accurate picture possible of the reality and yields of chemical recycling and, ultimately, of its contribution to the production of recycled plastic.
- As the chemical recycling of plastics is a multi-output process, the mass balance approach is needed as a chain of custody, as recommended by the JRC in its report.
- In its report, the JRC does not take sides on the type of mass balance that should be chosen. We believe that not all mass balance approaches are equal and that only an approach that makes at least a direct proportional link between the input (virgin or recycled pyrolysis oil) and the output (different products coming out of the cracker, i.e. monomers, energy products and other materials) should be advocated. In this respect, a book and claim approach should be excluded from the outset as it cannot represent reality. Below is a ranking of the remaining approaches:

(1) Credit/free allocation methods

- Free allocation method: this approach should not be used because it allocates the entire recycled input to a single output (monomers in this case) even though the output is composed of various elements: monomers, energy products and other materials.
- Free allocation fuel-use exempt: this approach is an improved version of the previous one as it takes into account the production of energy products, which reduces the part allocated to monomers, but does not take into account the simultaneous production of other materials. As such, it cannot be recommended for plastics recycling as it artificially increases the recycled share allocated to monomers.

2) Proportional methods

- Proportional allocation (monomers only): This approach should be the one used as a minimum standard. It consists of applying the same proportion of recycled material to each type of outgoing product. In the absence of detailed knowledge of the yield of the steam cracker per material, this statistical approach is the closest to scientific reality.
- Rolling average: Stricter than the previous one, this method prevents the free allocation of the recycled part to a single type of monomer. It requires the same proportion of recycled part to be applied to all outputs (monomers or others).
- **Conclusion**: the only acceptable methodologies are those that take into account all the "material" and "energy" outputs, while ensuring proportionality between the incoming recycled share and the recycled share allocated to the different types of outgoing products: proportional approach and its rolling average variant.

- Note 1: The mass balance approach chosen must be audited to ensure reality and transparency.
- Note 2: the legal status of energy products also needs to be clarified: it is energy recovery.

4/ Keeping pyrolysis oil under the waste status in the framework of recycling targets

- We have seen attempts at national level to develop an end of waste status for pyrolysis oil. We question these initiatives and their purpose. Indeed, unpurified pyrolysis oil is an intermediate element that can be used for several material or energy purposes and contains multiple impurities (nitrogen, chlorine, metals, etc.) that are not present in the products it replaces (naphtha for example). An early end-of-waste point implies a loss of traceability, which makes it impossible to ensure that the oil is actually used for recycling purposes. Consequently, these oils which would have ceased to be waste would not be able to contribute to the recycling objectives.

FNADE is the French professional association representing environmental and waste management industry. With 247 private member companies operating in the field of waste management, it represents 48,940 employees in France, 9.2 billion euros in turnover and 894 million euros in investment. It is a member of the European Federation of Waste Management and Environmental Activities (FEAD).

FNADE's EU Transparency Register number: 232455019331-89.