

Research to Industry and Industry to Research

CHALLENGES AND PERSPECTIVES OF DIRECT TEST METHODS FOR ASSESSING WASTE HAZARDOUS PROPERTIES (HP)

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Waste generation is a global problem, not only environmentally but also the economic loss it represents. Annual waste generation is projected to increase by 70% by 2050 (OECD, 2019a). Consequently, waste management should be planning and managing a circular economy, to ensure that resources used remain in the EU economy for as long as possible, while ensuring the best degree of environmental safety (European Commission, 2020). In this context, hazard waste classification plays a crucial role.

Hazard waste classification entails safe handling and disposal of discarded materials, with significant impacts on waste producers' budgets, their legal conduct, and public perception. The regulatory criteria should be realistic and scientifically sound ensuring full transparency while providing a level-playing field for all industrial sectors. According to European regulations, waste is defined as hazardous if satisfies at least one of the 15 hazard properties (HP) or contains concentrations of certain persistent organic pollutants over specific legal thresholds (European Commission, 2014; European Parliament and European Council, 2019). Equally, wastes are classified as hazardous according to the 6-digits codes enlisted in the European Waste Catalog, established by the European Commission, (2000). Accordingly, among "absolute non-hazardous" waste, "absolute hazardous" waste, and the so-called "mirror entries" (i.e., waste streams potentially classified as hazardous by their composition), only these latter require an effort to assess specific HPs.

HPs can be assigned by an "indirect" approach, from the total content of hazardous substances (selected according to "expert judgment"), or a "direct" approach, which relies on outcomes of single HP-specific laboratory tests (European Commission, 2014). Based on widespread analytical methods, the "indirect" approach is cheap and

currently the most adopted. Notably, it is characterized by some challenges: the subjectivity of the "expert judgment," the impossibility of detecting all substances and elements that compose the waste material, and the so-called "worst-case" approach, which considers the waste constituents detected as in the most hazardous form (Bishop and Hennebert, 2021; Hennebert, 2019). These drawbacks have been limited by the development of non-targeted organic and mineral analyses, giving an analytical mass balance > 90% (Hennebert et al., 2013), and the speciation of so-called "worst-case with information" pre-calculated approaches (Hennebert, 2019). However, the classification as hazardous can sometimes be judged as incomplete or unrealistically conservative. In these cases, specific testing methods to evaluate "directly" (i.e., without further assumptions) different HP-related effects, closely associated with the real speciation (and environmental fate) of waste constituents. The European legislator suggested the latter approach given the information about the waste composition is not sufficient for a correct evaluation. The European legislation affirms that direct test results will prevail over the results from chemical composition analyses (European Commission, 2018). The EU law-maker also suggests the methods used to be guided by the CLP regulations for performing direct testing, toward the harmonization of products and wastes law frameworks (European Council, 2008).

There are still some challenges to be faced:

- A limited number of laboratories are accredited for the methods available, increasing in costs but not in use;
- The methods designed for classifying products under CLP Regulation (European Council, 2008) can be unsuitable for testing wastes;