# Ecotoxicity assessment of bottom ash from municipal solid waste incineration

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## INTRODUCTION

- The production of incineration bottom ash (IBA) from MSW in Europe is about 20 Mt per year.
- IBA is an inorganic waste, typically with alkaline properties, that covers a wide particle size distribution with different loads of potentially toxic elements.
- IBA is commonly classified as non-hazardous [1], but in the European List of Waste [Decision 2014/955/EU] it is classified as a mirror entry (codes 19 01 11* and 19 01 12).
- The management practices differ significantly between Member States [2].
- The development of "end-of-waste" criteria could be relevant, possibly favoring reuse.
- A proper assessment of the hazardous property HP 14 (ecotoxicity) related to potential environmental risks plays an important role in this evaluation.

Fig. 1 – Waste incineration plant from Vienna, Austria (https://www.flickr.com/photos/sanyambahga/40041054701)

## OBJECTIVES

The main objective of this project is to develop a simple, reliable, low cost and low time-consuming methodology, to properly classify IBA regarding ecotoxicity (HP 14).

Depending on the result of a broad assessment involving several countries from Europe, it is intended to promote the practical use of IBA to avoid landfill.

Subsequently, it is aimed that these methodologies can be applied to other types of waste.

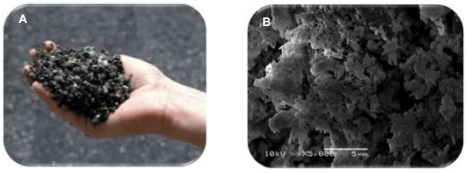


Fig. 2 – (A) IBA (https://www.cewep.eu/category/facts/recycling/) and (B) SEM photograph of IBA (adapted from [4]).

## HP14 ASSESSMENT - METHODS

- **Chemical analysis**
  - **Total elemental content** (Council Regulation (EU) 2017/997)
  - **Leaching behaviour**
  - **Modeling**
- **Biological tests**
  - **Aquatic compartment**
  - **Terrestrial compartment**

Fig. 2 – Periodic table (https://pt.wikipedia.org/wiki/)

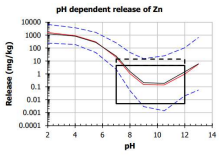


Fig. 3 – pH dependent leaching of Zn for IBA (adapted from [3])


Fig. 4 – Visual MINTEQ software interface (http://hem.bredband.net/)

Fig. 5 – *Daphnia magna* (http://www.evolution.unibas.ch/)

Fig. 6 – *Lemna minor* (https://jb.utad.pt/especie/)

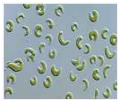

Fig. 7 – *Raphidocelis subcapitata* (https://www.ccap.ac.uk/)

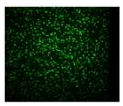

Fig. 8 – *Aliivibrio fischeri* (http://2014.igem.org/Team:TU_Delft/)

Fig. 9 – *Eisenia fetida* (https://en.wikipedia.org/)

Fig. 10 – *Folsomia candida* (https://www.flickr.com/)

Fig. 10 – *Brassica rapa* (https://openi.nlm.nih.gov/)

Fig. 11 – *Arthrobacter globiformis* (https://www.creative-diagnostics.com/)

## PROJECT TASKS

- **TASK 1 – Comprehensive physical and chemical characterization of IBA from several European Member States,** developing reliable sampling protocols.
- **TASK 2 – HP 14 assessment based on the chemical composition of waste and leaching behavior:** considering total elemental content in the calculation formulas indicated in Council Regulation (EU) 2017/997, as well as the available fraction and chemical speciation through leaching and geochemical speciation modeling.
- **TASK 3 – HP 14 assessment based on biotests responses:** the battery of biotests will encompass different trophic/functional levels both for the aquatic and soil compartment; the effect of different variables (e.g. pH and particle size) will be evaluated; the main chemical species contributing to ecotoxicity of IBA will be assessed.
- **TASK 4 – Proposal of a methodology for IBA classification regarding HP 14:** a decision protocol as simple and practical as possible will be defined; the methodology should combine chemical and biological criteria that safeguard ecosystems.
- **TASK 5 – Proposal of a general protocol for other anthropogenic resource assessment.**

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