Contribution of Spent Batteries to the Metal Flows of Municipal Solid Waste

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Executive SUMMARY

The scope of the current report is the evaluation of the contribution of spent batteries to environmental emissions of metals associated with the post consumer phase of batteries and particularly their emissions at the disposal phase of Municipal Solid Waste (MSW).

In the past, there was little information available on the quantification of the real contribution of the metals content of batteries to the overall metal load towards the environment. Emissions to the environment have been quantified in EU-Risk Assessment Reports (RAR) for metals such as lead, zinc, cadmium and nickel. From these individual RAR, it is possible to consolidate information in order to evaluate the respective contribution of different types of spent batteries systems to the overall metallic emissions.

This study takes into consideration measured data on the overall metallic content of Municipal Solid Waste (MSW) and also on the content of spent batteries in MSW. These data have been obtained in countries where collection schemes for spent batteries are in operation for several years: Austria, Belgium, Sweden, The Netherlands, France and Germany. In those countries, it is also possible to quantify the specific and relative contribution of batteries to metals emissions from MSW. The study takes also into consideration the fact that in a majority of Member States there is no collection programme in place.

The main waste strategies considered for MSW in this report are landfilling and incineration. Based on measured emissions data and on estimated scenarios, the environmental contribution of different battery types (both primary and rechargeable batteries) to the overall emissions of nickel, cadmium, zinc and lead is evaluated.

1. The contribution of Municipal Solid Waste to the overall emissions of metals (zinc, lead, nickel & cadmium) to air and water.

Zinc emissions to air (total of 2’096 Tonnes) are mainly originated from industrial production activities (67.2 %) and traffic (25.2 %). MSW incineration accounts for 2.4 % of the total zinc emission. The contribution of incineration and landfill to the overall zinc emissions to the water compartment (total of 5’196 Tonnes) is only 0.2 %. Effluents from sewage treatment plants (41.3 %) are for this compartment the most important source.

Lead emissions to air from waste incineration represents 2 % of the overall lead emissions (total of 891.3 Tonnes). Most lead air emissions pertains to industrial activities (88 %) and related mainly to manufacturing of iron and steel and ferro-alloys. Emissions of lead to the water compartment (Total of 853.3 Tonnes) comes mainly from households (35 %), industry (20 %) and effluents from sewage treatment plants (17 %) and other sources (20 %). Water emissions from incineration and landfills only constitutes 1.3 %.

For nickel emissions to the air compartment incinerating MSW contributes 0.6 % to the overall nickel emissions (total of 642 Tonnes) . The two largest sources are industrial activities (including combustions) with a contribution of 86.3 % and traffic (10.2 %). Households (2 %) and agriculture (0.9 %) are minor sources. The contribution of incineration and landfill to the overall nickel emissions towards the water compartment is 14 % (total of 632 Tonnes). Effluents from sewage treatment plants (55.8 %) are for this compartment the most important source next to several industrial activities (25.5 %).

Considering cadmium emissions to the air compartment (total of 124 Tonnes), the incineration of MSW only contributes 2.6 % to the overall cadmium emissions to air .Oil and coal combustions (43.5 %) and the iron and steel production (25 %) are the largest cadmium sources to the environment. With regard to water emissions (total of 39.1 Tonnes), iron and steel production (40 %) is one of the larger contributors together with the non-ferrous industry (24.9 %). The contribution of landfilling and incinerating MSW to water emissions are minor (2.3 %).

It can be concluded that the relative contribution of the Municipal Solid Waste phase is limited to a few percent to the overall metal emissions from all anthropogenic sources.

2. The contribution of batteries to metallic emissions from Municipal Solid Waste.

When the contribution of spent batteries is considered it is clear that the environmental contribution of the metals present in batteries to the overall metal load is limited. The following contributions are evaluated according to the results obtained in this report.

- Primary batteries are only responsible for 2 % of the observed zinc content in MSW.
- NiMH, which is a relatively young technology has only a marginal contribution (0.2 %) to the Ni content for which Ni-Cd batteries contribute to 2.7 %.
- The contribution of Pb-acid batteries to MSW is also estimated to be negligible (0.4 %).
- In the case of cadmium, Ni-Cd batteries would account for 17 % of the observed Cd content of MSW or approximately 0.5 % of overall cadmium emissions to air and to water.

Further analysis of the contribution of the different battery types to the overall anthropogenic metal emissions to air and water clearly indicate that for the metals considered, spent batteries **represent a minor contributor to overall metallic emissions** and that the general premise

that spent batteries and accumulators may act as a major source of metals emissions (when compared to other sources) to the environment is not supported by measured and modelled data.

Indeed, during the post-consumer phase, the environmental contribution of the different battery systems (Zn-C, Alk-Mn, Ni-Cd, Ni-MH and Pb-Acid) to the overall anthropogenic metal emissions towards the environment is small to negligible in comparison with the nickel, zinc, lead and cadmium emissions from other anthropogenic sources. Ni-Cd batteries contributes 0.4 % to total air emissions (equal to 0.5 tonnes Cd) and 0.4 % to total water emissions (i.e. 0.15 tonnes Cd). Ni-based batteries contribute 0.021 % (i.e. 0.1 tonnes Ni) and 0.4 % (i.e 2.5 tonnes Ni) to the nickel air and nickel water emissions of all sources. An estimated 0.05 % (1 tonnes Zn) of all anthropogenic zinc emissions to the air can be allocated to the end-of-life stage of primary batteries (Zn-C; Zn-alk). The emissions to water are very small (0.006 % or 0.5 tonnes Zn) in comparison with other sources. In a similar way the contribution of Pb-acid batteries to the overall lead load is negligible (0.007 % (i.e. 0.1 tonnes Pb) to air, 0.01 % (i.e. 0.1 tonnes Pb) to water)

Although the contribution of batteries to the metal emissions from Municipal Solid Waste have been estimated based on data that have been obtained in countries where collection schemes for spent batteries are in operation for several years, the conclusions reached can be extended to those countries which have not yet a dedicated collection system in place.

Indeed, when no dedicated collection system is in place emissions for zinc can be calculated with a factor of 3.7 higher than emissions obtained when collection systems are in operation. It would result in an emission to air of 3.7 tonnes Zn (0.2 % overall Zn air emissions) and 1.9 tonnes Zn to the water (0.02 % overall Zn water emissions) which are still representing a minor fraction of averall emisisons.

For rechargeable batteries the case of a 10 % collection rate was calculated in the frame of the Targeted Risk Assessment Report on the use of cadmium in batteries (TRAR). It was calculated that the difference in potential emissions due to batteries between a country with a collection system in place and one with no collection system in place is a factor of 3.6.

If this factor is applied, it leads to an emission to air of 1.8 tonnes Cd (1.4 % overall Cd air emissions) and 0.5 tonnes Cd to the water (1.4 % overall Cd water emissions) which are still minor fractions of total emissions from anthropogenic sources.

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