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Waste electrical and electronic equipment plastics with brominated flame retardants – from legislation to separate treatment – thermal processes

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Abstract

Bromine is used as the building block for some of the most effective flame retarding agents available to the plastics industry today. Brominated flame retardants (BFRs) are used to protect against the risk of accidental fires in a wide range of electrical and electronic equipment (EEE). It is the industry's responsibility to come up with solutions to handle the waste plastics in an environmental manner in order to comply with the WEEE directive. In this context, EBFRIP, the European Brominated Flame Retardant Industry Group, is committed to sharing its knowledge regarding opportunities in handling plastic waste containing BFRs.

Keywords: Brominated flame retardants; Electrical and electronic equipment; Waste of electrical and electronic equipment; European Brominated Flame Retardant Industry Group

1. Emerging legislative picture for Europe

The recycling of WEEE foreseen in the new EU Directive on the waste of electrical and electronic equipment (WEEE Directive) is based on the experience of a few European Countries, where organisations managing voluntary take back systems on behalf of the EEE producers have been responsible for the collection and recycling of the WEEE. In order to comply with this directive, the existing national associations managing the WEEE take-back systems have set up a WEEE Executing Forum. This Forum, founded in April 2002, today includes associations from 6 countries: Austria, Belgium, The Netherlands, Norway, Sweden and Switzerland. The Dutch association has taken the lead in the European forum. This directive, which is currently been transposed into national legislation, contain a number of prescriptive requirements such as collection per capita, treatment standards and recovery targets. During the last couple of years these countries have already established individual targets rating from 4 to 8 kg WEEE per inhabitant per year. The targets set by the Directive can easily be met by recycling metal, glass and other materials, and therefore the plastic parts of the WEEE will not be an immediate issue in the coming years. However plastic treatment will be encouraged as a consequence of the implementation of both the landfill directive (ban on dumping high calorific valued waste-plastics) and the incineration directive, which encourages handling (incineration) high calorific waste for energy recovery.

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2. Current practices

The existing collecting systems in the different countries deal with the E&E Equipment once it has become waste. This is done via local municipal depots with the support of the original electro manufacturers (OEMs), who in many countries are already responsible for the collection of the WEEE. The equipment is manually dismantled: glass and large parts are separated. Those components which can be of potential hazard are separated as well. Plastics are very often shredded with metal to recover the metal itself. A plastics waste stream which includes metals like copper (up to 8%) represents the feed stream for the different thermal processes. These processes can be a preferable recovery route when mechanical recycling turns out to be impractical.

As long as legislation is not in place, the industry will look for the cheapest solution. Landfill still represents the cheapest solution in many EU member states. More than 90% of the waste stream is landfilled as landfilling is the cheapest option currently available (prices vary from 50 to130 Euro). Replacing fuel in cement kiln processes with waste can be an additional available option. However a large part of the E&E waste from household waste ends up in household waste incinerators.

During the dismantling process printed wiring boards are manually separated and shredded, as they contain valuable precious metals A metal smelter like Boliden, in Sweden, has restrictions regarding the treatment of material containing substances like PCB, Hg, Be. Furthermore penalties have to be paid for excess contents of substances like chlorine and mercury (need for extra handling), alumina (extra slag losses), antimony (too much of it causes process problems) etc. Boliden [1] has carried out some full scale trials with E&E plastic waste. Because of PXDD/F and other emissions many smelters have installed and adapted gas-cleaning devices to keep emissions of dioxins well below European emission limits (<0.1 ng TCDD/m3N). As metal values in the products from these gas-cleaning units are sufficiently important, it becomes attractive to recycle them internally, and therefore landfilling is minimal. These trials show that it is possible to treat this plastics waste from the local communities as replacement of fuel. Finally the trials clearly demonstrate that Brominated flame retardants do not increase the dioxin/furan emissions, if industrial processes are carried out with the appropriate technical and hygiene standards The Rönnskär Smelter recycles more than 35,000 tonnes of electrical scrap per year, containing base and precious metals and other substances needed in electronics. Boliden has checked the stack emissions, slags, heavy metal and polybrominateddiphenylethers (PBDEs) in worker's blood, as well as emission deposition around the plant and technicians came to the conclusion that electronic scrap can be handled on a large scale without leading to any environmental and health and safety problems.

Another metal smelter using large quantities of precious material is Umicore. Umicore [2] treats 250,000 ton/year in their metal smelter plants. Typical materials are TV's, video's, desktops, laptops, servers and mobile phones. The printed circuit boards contained in mobile phones represent from 2% up to 30% of a mobile phone weight. Umicore thinks that out of a 75% recycling target, 10% can be achieved through energy recovery from replacing fuel with plastic, and 65% thanks to a metal recovery process. Since the volumes of printed circuit boards (PCBs) are growing worldwide from 90,000 mtons in 2003 up to 156,000 mtons/y in 2009 the importance of this process will increase in time. This process offers many advantages: the recovery rate for metals is as high as 98%, which is the highest possible recovery rate in any thermal process; in this process antimony, used as synergist to BFR's in most of the electrical and electronic (E&E) plastic in concentrations of 4%, is recovered (this is not possible in other thermal processes).

An eco efficiency study carried out by APME in Belgium shows that metal smelter provides the highest recovery rate for handling mobile phones, without high dismantling costs.

3. Potential solutions

New technologies for handling plastics from E&E waste already exist. These basic technologies are used in commercial installations for plastics coming from the packaging waste. This waste does not contain high amounts of heavy metals or halogens. Therefore these processes need to be upgraded for the E&E waste.

3.1. Feedstock recycling

According to an economic evaluation carried out by Jung [3] from the Belgian University ULB Brussels Belgium, the potential energy value of polymers is nearly 40 MJ/kg which corresponds to €80/mton (at €2/GJ). This study compares all thermal processes and shows that the transformation of plastics into fuel or gas through feedstock recycling results in a very high yield in terms of energy and end material. It is also a particularly clean process, with emissions close to zero.

For plastic waste from E&E, energy recovery in cement kilns or in the steel industry can be a possible option. An alternative one consists in pelletizing the mix in order for it to be gasified, but the preparation costs are relatively high. A clean alternative consists in producing solid, liquid and gaseous fuels by pyrolysis.