Analyzing input and output of e-recycling facility for brominated flame retardants

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Keywords: E-recycling, plastics, PBDE, POPs.
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Brominated flame retardants in plastics for electronics and related equipment have been in widespread use since the early 1970s until early 2000s, when world wide bans started, especially for PBDEs (polybrominated diphenyl ethers). Typically it is printed circuit boards, plastic casings (TVs, computers, appliances), cables and connectors, etc. The first voluntary phasing out and bans started in early 2000s (USA and EU), and the bans were included in the Stockholm Convention on POPs in 2009 and 2019 in full.

Due to the widespread use over several decades, the present input of e-waste into recycling plants still contains PBDEs, which should not enter the output stream of valorised recyclate. The solution is separation of contaminated plastic parts at input and, for now, usually incineration. To plan for a separation infrastructure one must analyse the input.

As part of planing for a separation infrastructure, E-Reciklaža 2010 e-recycling company in Serbia has colaborated with the National Institute for Environmental Studies (NIES) Japan, and obtained preliminary results with asorted plastic samples from the input - and the output plastic flakes from the process. The input and output were not directly connected at sampling, but rather represent randomised cases. The samples were measured for Br content (besides 9 other elements) by XRF and AQF techniques, and polymer type was determined by FTIR.

The results reveal that most of the samples do not contain bromine or brominated flame retardants. However, some do, in very high contents, both at the input and output. One typical example is an old CRT monitor casing at the input (ca. 400 mg/kg, bolded in Table 1). The other is found in the output - a flake resulting from mixed plastic (ca. 5000mg/kg, bolded in Table 1). The FTIR analysis confirmed that bromine in the input CRT sample originates from PBDE. In the output flake, however, besides some PBDE, most of the bromine is apparently from DBDPE and TTBP-TAZ compounds. Even though only PBDE is explicitely listed in the Stockholm Convention, the latter two are labelled as SVHC.

Table 1. Bromine contents (mg/kg) in plastic samples from Serbia collected in 2024 (excerpt).

Sample ID	Sample description	Colour	Polymer type	Br (mg/kg)
SRB24-01	TV (LCD)	Black	PS	1.0
SRB24-02	TV (CRT)	Gray	PS	**604**
SRB24-03	**MONITOR (CRT)**	Light gray	ABS	<LOD
SRB24-04	PRINTER	White	PC	3.0
SRB24-07-07	**Output flake, mix.**	Black	PC	**5751**

These results are preliminary, but the findings prospectively justify planning for separation activities. Apparently, even low occurances of bromine at the input of this particular recycling facility, together with its collection region (Serbia nationwide), indicate presence of either banned POPs or SVHC compounds.

Acknowledgement:
This research has been supported by UNIDO/GEF "Global Greenchem Innovation and Network Programme" - GGINP. The work is related to the implementation of the United Nations Sustainable Development Goal 9 – Industry, Innovation and Infrastructure.