

## Hazardous pollutants generated by 1997-1998 generation of printed circuit boards

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### Abstract

Due to the high quantity of printed circuit boards waste generated in the last years, it is imperative to quantify their environmental impact and to find recycling solutions. In order to quantify the environmental impact of 1997-2008 generation of printed circuit boards, a leachate test was performed. The following parameters were determined: metals, fluoride, chloride, sulfates, phenol index, dissolved organic carbon, total organic carbon, total dissolved substance, BTEXs, PCBs and petroleum products. The analyses were performed using sensitive, high performance analytical techniques. The results were compared with those stipulated in the legislation in force in order to identify the appropriate waste category for their storage.

### Experimental

Four types of motherboards (Table 1) were tested according to Romanian Order no. 95 from 12 February 2005 which establish the criteria of waste acceptance in waste storages. The samples were subjected to the leachate test (L/S = 10 l/kg) and the interest parameters are presented in Table 2. The following equipment were used: ICP-MS Perkin-Elmer DRC II; AAS Teledyne Leeman Labs Hydra-AF; Methrom IC 761 Compact; UV-VIS Lambda 25 Perkin Elmer; Multi N/C 2100S Analytic Jena; GC-ECD 6890N Agilent Technologies; GC-FID 7890A Agilent Technologies .

Table 1. Sample codification

No.	Sample code	Model	Manufacture year
1.	P1	Motherboard from Compaq Deskpro MMX 2000	~1997
2.	P2	Motherboard model P5MVP3	1998
3.	P3	Motherboard model Acorp 5TX29	1998
4.	P4	Motherboard model Prescott 800 P4i65G	~2008

### Results and conclusions

The results obtained for the tested PCB boards are presented in Table 2. The results obtained were compared with the values stipulated by Order 95 from 2005. While most of investigated parameters are in accordance to acceptance criteria to inert waste storages, the values obtained for Cu, Ni, Pb, Sb and Zn showed that these classes of PCB boards can be accepted only in dangerous waste storages due to the imminent contamination of the environment with these pollutants.

Table 2. Experimental results

No.	Determination	Unit	Sample code / Values				Values according to Order no. 95 from 2005 –acceptance in inert waste storages	Values according to Order no. 95 from 2005 –acceptance in dangerous waste storages
			P1	P2	P3	P4		
1.	Arsenic (As)	mg / kg	0.01	0.01	0.01	0.01	0.5	25
2.	Barium (Ba)	mg / kg	1.93	0.890	0.720	1.48	20	300
3.	Cadmium (Cd)	mg / kg	SLQ (< 0.01)	0.02	SLQ (< 0.01)	0.03	0.04	5
4.	Cromium (Cr)	mg / kg	0.01	SLQ (< 0.01)	SLQ (< 0.01)	SLQ (< 0.01)	0.5	70
5.	Copper (Cu)	mg / kg	51.6	6.41	4.03	1.20	2	100
6.	Mercury (Hg)	mg / kg	SLQ (< 0.01)	SLQ (< 0.01)	SLQ (< 0.01)	SLQ (< 0.01)	0.01	2
7.	Molibden (Mo)	mg / kg	0.01	SLQ (< 0.01)	SLQ (< 0.01)	SLQ (< 0.01)	0.5	30
8.	Nickel (Ni)	mg / kg	0.750	1.02	1.55	2.58	0.4	40
9.	Lead (Pb)	mg / kg	8.71	26.9	34.0	0.56	0.5	50
10.	Antimony (Sb)	mg / kg	0.02	0.02	0.02	0.09	0.06	5
11.	Selenium (Se)	mg / kg	SLQ (< 0.01)	SLQ (< 0.01)	SLQ (< 0.01)	SLQ (< 0.01)	0.1	7
12.	Zinc (Zn)	mg / kg	23.6	11.0	8.79	7.35	4	200
13.	Fluorides(F <sup>-</sup> )	mg / kg	SLQ (< 0.5)	0.6	0.6	SLQ (< 0.5)	10	500
14.	Chlorides (Cl <sup>-</sup> )	mg / kg	5.35	7.9	15.0	5.35	800	25000
15.	Sulphates (SO <sub>4</sub> <sup>2-</sup> )	mg / kg	7.45	11.0	9.86	6.15	1000	50000
16.	Phenol index	mg / kg	SLQ (< 0.3)	SLQ (< 0.3)	SLQ (< 0.3)	SLQ (< 0.3)	1	-
17.	DOC – Dissolved organic carbon	mg / kg	26	55	63	52	500	1000
18.	TOC – Total organic carbon	mg / kg	39	66	82	66	30000	6%
19.	Total dissolved substance (TDS)	mg / kg	725	890	920	920	2500	100000
20.	Benzene	µg / kg	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	6	-
	Toluen	µg / kg	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	6	-
	Ethylbenzene	µg / kg	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	6	-
	Xylene (o-m-p)	µg / kg	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	SLQ (< 1.0)	6	-
21.	PCB (polychlorinated biphenyls):	µg / kg	SLQ (< 0.010)	SLQ (< 0.010)	SLQ (< 0.010)	SLQ (< 0.010)	1	-
	– PCB 28		SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	1	-
	– PCB 52		SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	1	-
	– PCB 101		SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	1	-
	– PCB 138		SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	1	-
	– PCB 153		0.017	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	1	-
	– PCB 180		0.021	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	1	-
– PCB 194	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	SLQ (< 0.011)	1	-		
22.	Petroleum products	mg / kg	SLQ (< 3.0)	SLQ (< 3.0)	SLQ (< 3.0)	SLQ (< 3.0)	500	-

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