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WEEE – POTENTIAL RESOURCE BASE, ”ABOVE THE GROUND MINE” FOR THE FUTURE

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ABSTRACT
Modern electronics can contain over 60 elements as complex mix of: precious metals, base metals, potentially hazardous metals, halogens, plastics, glass and ceramic. It is evident, WEEE as an “above the ground mine” is a potential resource, not a waste. The question is: can we afford to leave this “mine” unexploited? Minimize losses of precious, base and special metals and spillage of toxics is very important for a high level efficiency in technology and ecology. What a world do get a better to recycle the maximum? Now, up to 50% of metals in e-scrap are collected only. This is a main reason the total recycling efficiency is about 33%. Recycling of metals from e-scrap has raised concerns over toxicity of some of its substances and may include lead, mercury, cadmium and the others carcinogenic substances (PCBs,PVC). All this before makes the processing of e-scrap is expensive and difficult for processing.
The paper discusses the problem of recycling and recovering of the metals from e-scarp in the Serbia. At first, the real technological possibilities for processing the most of quantities of e-scarp collected in it. On the basis of good experience and testing conducted by the Mining and Metallurgy Institute (MMI) in Bor created a high level annual capacity of processing all the economic and ecologic point o view.
Keywords: Waste Electric and Electronic Equipment (WEEE), recycling and recovering of the metals from e-scarp, precious metals efficiency

1. CHARACTERISTIC OF WEEE

The WEEE directive has ten categories of electrical and electronic equipment and they categorized as folows [1]:

- Large household appliance (e.g. refrigetors);
- Small household appliance (e.g. coffe machines);
- IT and telecommunications equipment (e.g. computers);
- Consumer equipment (e.g. radio and TV set);
- Lighting equipment (e.g. fluorescent lamp);
- Electrical and electronic tools (e.g. drils and saws);
- Toys (e.g. video games);
- Medical devices (e.g. X-ray equipment);
- Monitoring and control instruments (e.g. smoke detectors);
- Automatic disperses

The composition of the WEEE depends strongly on the type and the age of the eqipment. For example WEEE from IT and telecommunication systems contain a higher amount of precious metals than scarp from household appliances. In older devices the content of valuble matals is higher but also the content hazardous substances than in newer devices [2]. The important problems in the treatment of WEEE is the content of substances such as heavy metals and organic substances and effect on the formation of dioxins and furans [3].

2. ECONOMIC RELEVANCE FOR PCBs RECYCLING

For the calculation of the value metals we consider only the main metallic components in the boards, copper, silver and gold furthermore we calculate on the basic of thev metal price from the begining of 2010; teking into account that for recycling strategies long term average prices have to be calculated to show economy of the process. Table 1 shows the calculated data for the nonferrous metal in the PCBs.

Table 1. Value of nonferrous metal in PCBs scrap in 2010.

Metal	Metal weight kg (g)	Value of metals (€)	Value ratio (%)
Copper	206	1 050	37.5
Silver	(140)	53	1.9
Gold	(68)	1 700	60.6
Summary		2 803	100

A value of more that 2.8 € per tonne of PCBs shows the economic relevance for the recycling PCBs and we find the positive and atractive situation that economy and ecology can go hand in hand.

3. TREATMENT OF PRINTED CIRCUIT BOARDS (PCBs)

The amount of printed circuit boards (PCBs) in electronic scrap is approximately 3 wt%. The main problem with bakelite and plastics fixed on top of the boards are assemblies such as capacitors, semiconductors, conectors, swihes etc. Flame retardants and organic compaunds ware the treatment of PCBs difficult. The main is content of precious metal (gold, silver, palladium...) make them valuable. Treatment of PCBs is carried out mainly to recover the metals of interest (copper, noble metals etc.). Mechanical methods, smelting, hydrometallurgical treatment or a combination of those steps can lead to the desired products.

Figure 2 ilustrates a MMI experimental recycling process of PCBs, incoming PCBs stream is first hand sorting and separation of capatitors. In the pre-processing cold phase (A) it is taken out plastic, all magnetic materials and aluminium.

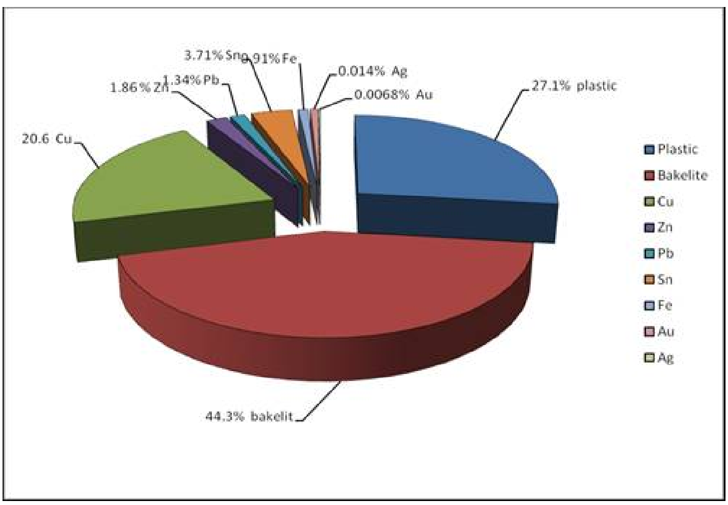

Fig. 1. Characteristics material composition of PCBs

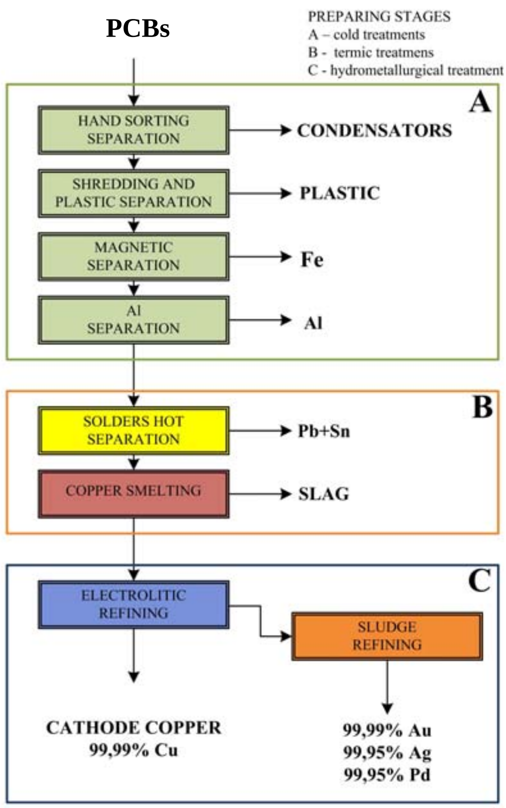

Figure 2. MMI experimental recycling process of PCBs

4. MECHANICAL SEPARATION

A different components and devices can be separated in a first mechanical step into various fraction contaminants such as PCP containing capacitors, batteries, mercury switches etc. This hand sorting and removal of the contaminators may be used to remove ferrous metals from conveyers. Often precede to separate pieces by size the nonferrous metal separation process based on Eddy current air, float-sink or centrifugal force. Size reduction may also include subsequent shredding or hammer milling processes connected by conveyors. The range of devices in usage depends strongly on the composition of the PCBs. The obtain fractions are enriched in certain materials and have to be further processed using other treatment methods such as pyrometallurgy or hydrometallurgy.

5. THERMAL TRETMENT

Pyrometallurgical processes include incineration smelting in a arc or blast furnace, melting and reactions in a gas phase at high temperatures. Copper granulate rich in P.M., after separating plastic, ferrous, aluminium and solders can be melting to further concentrate the metals. In smelting reactions a collector metal such as copper or lead can be used. Silver and gold containing PCBs materials can be treated in a copper smelter, but silver as well as other noble metals are tied up in process for a long period.

During fire and electrolytic refining a anode mud is processed. Figure 1 illustrates a recycling process of PCBs according to experiments in MMI Institute Bor.

The anode composition and the quality of the dust and sludge fluctuate significantly due to heterogeneity of the input materials. Another possibility to recover base and noble metals form electronic scrap is the recovery via copper smelting process.

6. HYDROMETALLURGICAL TREATMENT

Hydrometallurgical process with electrolytic treatment anoda to cathode copper (99,99%Cu) and anoda mud refining is the main operation mode to production high quality of precisious metals (silver, gold, palladium). The electrolytic solution is regenerated.

7. CONCLUSION

As the dramatically increasing price for energy and also for row materials show the fact is that these resources on earth are limited. Last few decades all over the world has grown up more and more secondary row materials as well as “above the ground mine“, especially electronic scrap rich in copper, precisious and the other valuble metals. Electronic scrap as a new type of row materials is a complex material with more compliates, during processing, than it seems at the moment. The emmision of hazardous substances to air, ground or water during recycling e-scrap. Compared to the numbers of PCBs sold, we have to multiply the number of sold PCBs in 5 to 10 years by 3 to 4. For the pretreatment of the electronic scrap new sorting and separation processes and combinations thereof have be developed, without to much loss of metals component in too much process steps. If we take the risk upcoming from electronic scrap minimize, we will recognize that electronic scrap is an exelant raw materials.

8. REFERENCES

[1] Directive 2002 96 EC of the European Parlament and of the Concil of 27 January 2003 on Waste Electric and Electronic Equipment (WEEE)

[2] H. Antrehowitch, M. Poteser, W. Spruzina, F. Prior, Metallurgical recycling of electronic scrap, Proceeding of EPD Congres, 2006, 899-908.

[3] E.Y.L. Sum, The recovery of metal from electronic scrap, Journal of Metallurgy,43(1991), 53-61.