Review on e-waste recycling scenario and development of eco-friendly processes at CSIR-NML

Amrita Kumari Jha[a], Manis Kumar Jha[a], Vinay Kumar[a], Jinki Jeong[b], Jae-chun Lee[b]

[a] *Metal Extraction and Forming Division, National Metallurgical Laboratory, Jamshedpur-831 007, India*

[b] *Mineral Resources Research Division, Korea Institute of Geoscience and Mineral Resources, Daejeon-305-350, South Korea*

Abstract

Electrical and electronic devices applications in consumer products are growing enormously, resulting in increasing resources demand due to the replacement of old/ obsolete by advanced and new products. It is estimated that the total amount of e-wastes generation in European Union (EU) ranges from 5 to 7 million tons per annum or about 14 to 15 kg per capita with the growth rate 3% to 5% yearly. CSIR-NML (India) is pioneer in the field of development of e-waste recycling processes and also recognized by several national and international recognitions. Present paper focused on a detailed analysis of global e-waste recycling scenario and contribution of CSIR-NML for developing the e-waste recycling processes with several national and international collaborations. Recently, CSIR-NML has developed a process for the removal of hazardous metal elements from leach liquor of electronic scraps following solvent extraction and recovery of valuables. A novel process has been developed for the recovery of lead and tin from liberated resin of printed circuit boards (PCBs) swelled by organic. The processes meet the strict environmental regulations. In the area of rare earth processing, a process for the recovery of neodymium has been developed on laboratory scale by hydrometallurgical route from discarded hard-disk of personal computer. The laboratory scale processes are also developed for the recovery of indium, lithium, cobalt, zinc, chromium, lead, tin etc from secondary resources. Developments of several eco – friendly and energy-saving processes for e-waste recycling are underway to meet the stringent environmental regulations.

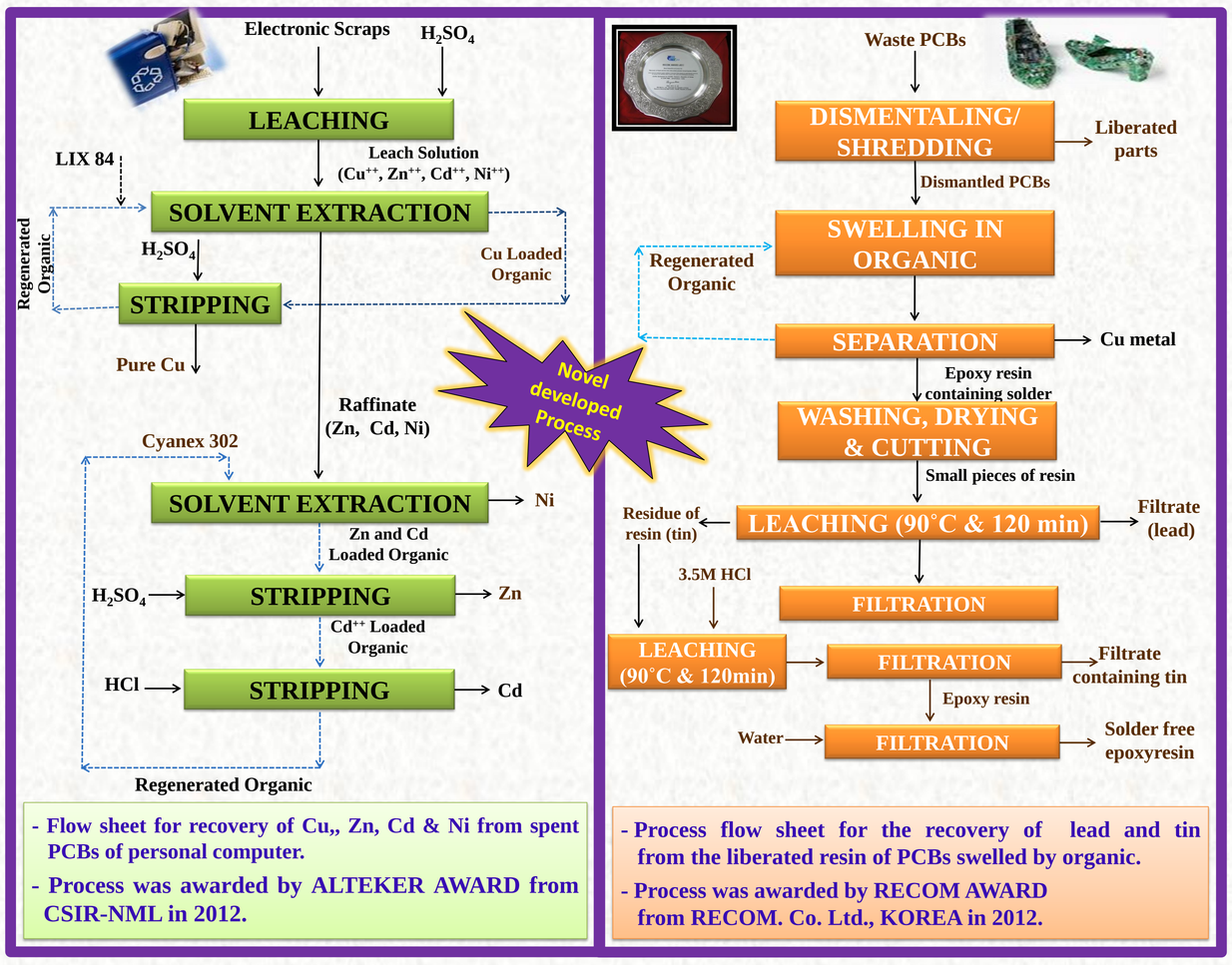
Introduction

- With the development of science and technology, the market demand for production of electrical and electronic equipment (EEE) is increasing rapidly. Therefore, huge amount of waste EEEs generation takes place globally, especially in industrialized/ developing countries such as USA, India, China etc.
- Huge volume of e-waste causes environmental pollution and thus appears to be adverse to the quality of life.
- Environmental and ecological remediation requires significant investment and labor cost

Recycling

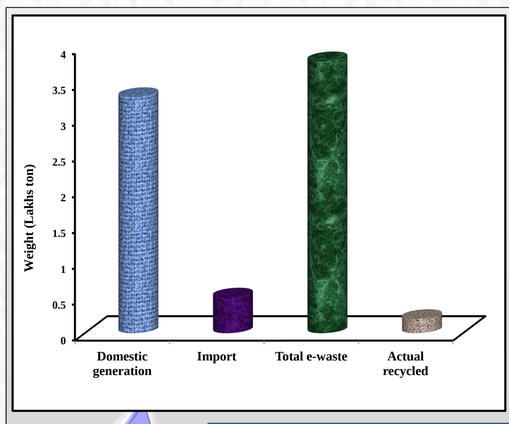
- ✓ plays a decisive role in minimizing environmental pressure by reducing waste and lowering dependence on natural resources.
- ✓ energy saving as well as less pollution compared with the utilization of natural resources.

- CSIR-NML already initiated electronics waste recycling through hydrometallurgical route as it is more favorable from environmental point of view, suitable to process complex EEEs on small scale.
- A novel process also developed "To recovery lead and tin from the liberated resin of PCBs swelled by organic" which was awarded by Recom Co. Ltd., Korea in 2012.



- Flow sheet for recovery of Cu,, Zn, Cd & Ni from spent PCBs of personal computer.
- Process was awarded by ALTEKER AWARD from CSIR-NML in 2012.

- Process flow sheet for the recovery of lead and tin from the liberated resin of PCBs swelled by organic.
- Process was awarded by RECOM AWARD from RECOM. Co. Ltd., KOREA in 2012.

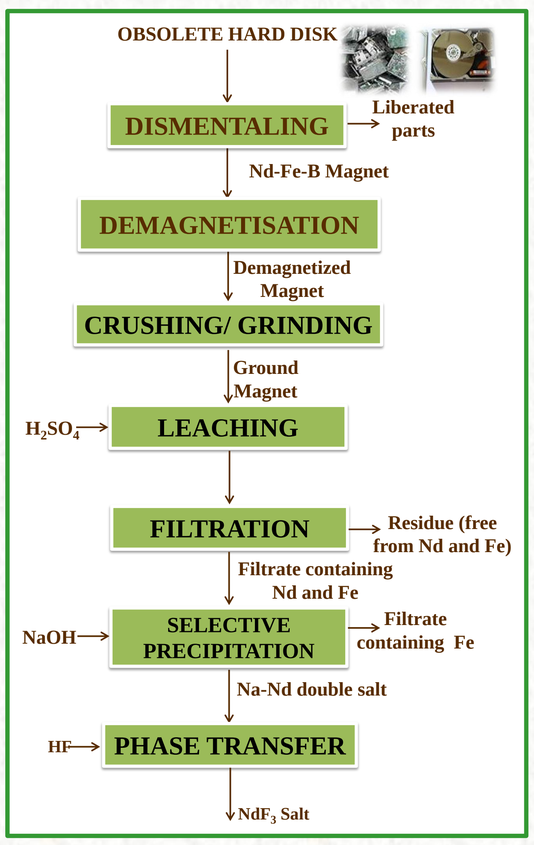


E-Waste generation & Recycling Scenario in India

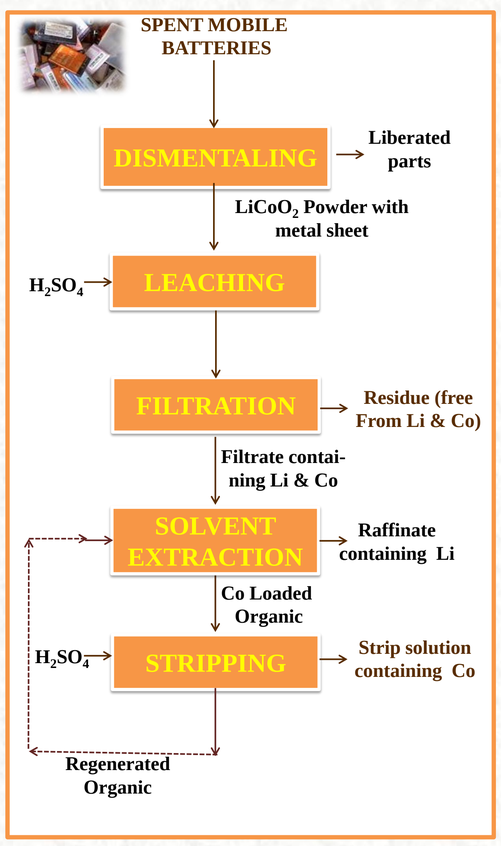
Recycling by
non-formal unit: 95%
No. of formal unit: ~8

No. of non-formal unit: >3000
No. of formal unit: ~8

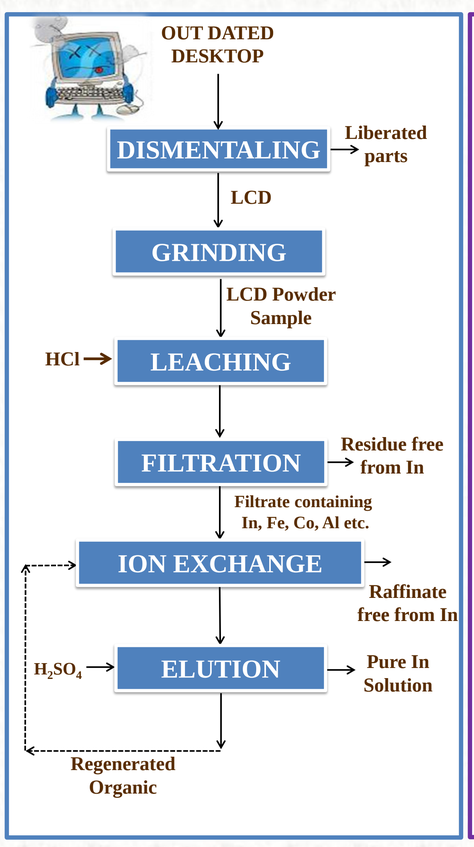
- Total amount of e-wastes generation in European Union (EU) ranges from 5 to 7 million tons per annum or about 14 to 15 kg per capita with the growth rate 3% to 5% yearly.
- Ten states generate 70% of the total e-waste generated in India includes Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab.
- Among top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.
- In India, increased demand for the key products like PC, TV, and Telephones in last 5-10 year has been responsible for the increasing amount of e-waste generation.



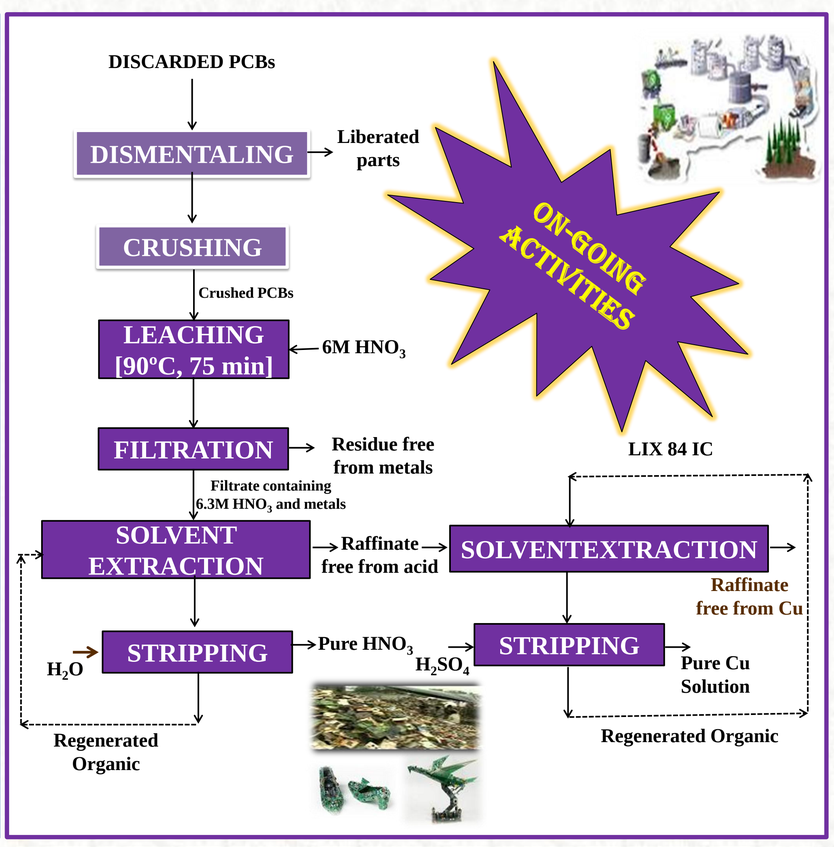
PROCESS FLOW SHEET FOR ECOVERY OF AND FROM OBSOLETE HARD DISK OF PCS



PROCESS FLOW SHEET FOR RECOVERY OF CO AND LI FROM SPENT BATTERIES OF MOBILE



PROCESS FLOW SHEET FOR ECOVERY OF IN FROM OUT DATED DESKTOPS OF PCS



PROCESS FLOW SHEET FOR RECOVERY OF HNO_3 AND CU FROM DISCARDED PCBS OF PCS

Conclusion

- Based on the proof of concept process flow sheet has been proposed for recovery of metals from electronic waste.
- These process flow sheet will be helpful to the scale up studies for the metal recovery from the scrap electronic equipments.
- After recovery of lead and tin from the liberated resin of PCBs swelled by organic, metal free epoxy resin could be disposed of safely/ used as filling material without affecting the environment.

Future Aspects

- The development of process for metal recovery from electronic waste is underway.
- Large scale studies.

References

[1] Cui, J., Zhang L. Metallurgical recovery of metals from Electronic waste: A review. Journal of Hazardous material (2008).

[2] Jha, M. K., Kumari, A., Choubey, P. K., Lee, J. C., Kumar Vinay, Jeong, J. Leaching of lead from solder material of waste printed circuit boards (PCBs). Hydrometallurgy 121-124 (2012) , pp- 28-34.

[3] Li, R. C., Tee, T. J. C. A reverse logistics model for recovery option of E-waste considering the integration of the formal and informal waste sectors. Procedia – Social and Behavioral Sciences 40 (2012) 788-816.

[4] Aizawa, H., Yoshida, H., Sakai, S. I. Current results and future perspectives for Japanese recycling of home electrical appliances. Resources, Conservation and Recycling 52 (2008) 1399-1410.

[5] Pant, D., Joshi, D., Upreti, M. K., Kotnala, R. K. Chemical and biological extraction of metals present in E waste: A hybrid technology. Waste Management 32 (2012) 979-990

[6] Jha, M. K., Choubey, P. K., Jha, A. K., Kumari, A., Lee, J. C., Kumar, V., Jeong, J. Leaching studies for tin recovery from waste e-scrap. Waste Management (2012).

[7] Lee, J. Y., Jha, A. K., Kumari, A., Kumar, J. R., Jha, M. K., Kumar, V. Neodymium recovery by precipitation from synthetic leach liquor of concentrated rare earth mineral. Journal of metallurgy and material science 54 (4) (2011), pp-349-354.

[8] Jha, A. K., Kumari, A., Choubey, P. K., Kumar, V., Jha, M. K. Waste lithium ion batteries- An alternative resources to recover lithium and cobalt. . Journal of metallurgy and material science, 53 (3) (2011), pp-225-231.

[9] Facts and Figures on e-waste and recycling. www.electronicstakeback.com