Annexure B

Electronic waste is defined as the discarded electronic and electrical equipments which are at the end of life and is destined for reuse, resale, salvage, recycling, or disposal. The electronic wastes are divided into two major categories according to the Indian norms: Information technology and telecommunication equipment (ITEW) and Consumer electrical and electronics (CEEW). [1] The major challenge in the recycling of PCBs is the complexity of their material composition and physical structure. It has a combination of metallic (30 wt %) and non-metallic fractions (70 wt %) [2] .The metal-rich fraction of PCBs contains 4.8 % Sn, 3.9% Pb, 29% Cu, 1.14% Fe and 0.112% Au. In this project, we focus primarily on the recovery of metals like Tin and Lead. [3]

To achieve this, we have developed a robust process to recover these valuable metals from Printed Circuit Boards (PCBs) through the hydrometallurgy route using a single mineral acid. This process is carried sequentially to decrease the complexity of the downstream process.

Initially, the tin and lead in the solder are removed using nitric acid in the dissolution reactor.Tin forms Meta stannic acid (MSA) (hydrated tin oxide) and it is present in a colloidal form in the system at the end of the dissolution. The lead reacts with nitric acid and forms lead nitrate, which is soluble in low concentrations of nitric acid. The colloidal MSA particles in the solution leaving this step are transferred to another vessel where the particles are allowed to agglomerate in the solution. This solution is then passed through a filtration unit to separate the particles and then washed with water to remove all traces of nitric acid. Hot air is passed through the filtration unit to dry the Meta stannic acid particles. The MSA is collected from the filter and then solar dried to obtain tin oxide powder. The filtrate containing the Lead Nitrate is collected in a tank, which is the feed for evaporation. During evaporation, as the concentration of nitric acid increases, the lead nitrate crystallizes out due to its low solubility in concentrated nitric acid. This hot solution is cooled and passed through a filter to separate the lead nitrate from the solution. The concentrated nitric acid is reused for the next batch. The nitrogen-oxide gases emitted during the reaction (NOx) are converted to nitric acid in the presence of water using an absorption system. This entire process is developed to handle the different streams continuously and recycle them back to the system to make it a zero-discharge process.

REFERENCES

[1] *E-Waste Management Rules.* (2016).

[2] Recycling of non-metallic fractions from waste printed circuit boards: A review. (2009) *Journal of Hazardous Materials*.

[3] Recycling of WEEEs: An economic assessment of present and future e-waste streams. *Renewable and Sustainable Energy Reviews*. (2015)