INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Waste printed circuit boards (WPCBs) are one of the most vital components of any waste electrical and electronic equipment (WEEE) and contribute about 4–7% of the total E-waste. WPCBs consist of a heterogeneous mixture of approximately 30% polymers, 30% metals and 40% ceramic materials. This thesis work explores viable routes to recover these materials from WPCB using a combination of pyrolysis and metal extraction via hydrometallurgical processing, and performs a techno-economic assessment of the proposed plant. Pyrolysis is a thermochemical technology that converts organic materials to valuable oil and gas fractions. However, the brominated flame retardants (BFRs) present in WPCB are transferred into the product fractions, making these products unsuitable for use due to environmental concerns. The bromine content in the gas can be controlled by scrubbing; however, removing it from the oil fraction is difficult. The performance of the embedded metals in WPCB was evaluated to reduce bromine transfer in oil. The metal

extraction was performed using acid leaching and cementation. Finally, a plant containing comminution, pyrolysis and metal extraction sections was simulated using Aspen Plus® software, and its techno-economic assessment was performed.

This thesis contains eight chapters. The first chapter is a general introduction about E-waste and relevant literature. The second chapter provided detailed information on the materials and methods used throughout the thesis. Chapters three, four, five, six, and seven presented the experimental and simulation work along with the results and discussions. Thermal degradation kinetic study, lab-scale pyrolysis optimization using response surface methodology and product characterizations were presented in chapters three and four. Chapter five presented the effect of Soxhlet extraction and acid leaching of WPCB before pyrolysis on the distribution of bromine content across the pyrolytic product fractions. Recovery of copper from WPCB using hydrometallurgical approach that included acid leaching and cementation was presented in chapter six. The process developed from the study conducted in the previous chapters was simulated in Aspen Plus software, followed by a techno-economic assessment of the plant. All the chapters were concluded, and future recommendations were provided in chapter eight.

This thesis presented a systematic approach to the material recovery process from WPCB, with the focus on maximizing material recovery (organic and inorganic fractions) and minimizing secondary waste generation.