A Feasible and Eco-friendly Process for the Treatment of Waste Random Accesses Memory as E-waste

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INTRODUCTION

The upgradation of waste electrical and electronic equipment (WEEE) has increased tremendously with technological development, which results in a considerable quantity of e-waste. E-waste is composed of several valuable materials and various toxic substances. The valuable metals include several precious and base metals such as Au, Ag, Cu, etc.; the toxic compounds include brominated epoxies resins, brominated flame retardants, etc. Therefore, recycling e-waste has become essential regarding resource conservation and human health hazards. Systematic recycling not only decreases the amount of e-waste but also saves our environment. Therefore, proper recycling using greener solvents can also boost the economy and contributes towards a sustainable society. Supercritical fluid technology is an emerging technology for converting e-waste materials into resources(Preetam et al., 2023; Preetam, Mishra, et al., 2022). Similarly, hydrometallurgical processes using greener solvents instead of toxic solvents such as nitric acid, cyanide, etc., can help contribute to the extraction of transition metals(Preetam, Modak, et al., 2022). Our process has the potential to solve the disposal problem of electronic waste. This process will effectively extract transition metal from e-waste and simultaneously convert e-plastic into valuable chemicals in an environmental friendly way.

In the present study, powdered RAM (random access memory) was taken as a feedstock and was pre-treated using supercritical isopropanol in a high-pressure reactor at 100-320ºC, 1:20 (g/ml) solid: liquid ratio for 0.5-3h of residence time. The supercritical pre-treatment of RAM converts a plastic fraction into oil, which can be used as a raw material in industries and simultaneously enrich the metal fraction present in the feed. The concentrated metal fraction obtained is then treated with leaching solvents $C_6H_8O_7$ and dil.HCL, respectively, along with the H_2O_2 as an oxidizing agent. A comparison in the leaching study of both the results of leaching is performed. Therefore, the study demonstrates a feasible, greener, and more efficient approach for the long-term extraction of valuable metals and materials from waste electronics.

MATERIALS AND METHODS

Feedstock for the experiment waste RAM taken in this study was taken from the IIT Delhi campus. All the reagents are of analytical grade. Supercritical fluid experiments were conducted in a high-pressure batch reactor. The parameters were taken as temperatures between the subcritical to supercritical range (100 to 320°C), with contact time between 0.5h to 2h at a solid/liquid (S/L) ratio of 1:20, and pressure was autogenous. The concentrated metal fraction obtained is then treated with $C_6H_8O_7$ and dil.HCL with H_2O_2 as an oxidizing agent at the certain condition of each leaching agent to recover base metals.

RESULTS AND DISCUSSION:

The supercritical fluid treatment showed that the polymer is quickly and effectively degraded into desired products with an oil yield of more than 85%. The solid residue, majorly composed of enriched metals and glass fiber, recovered after the supercritical fluid treatment. The enriched metals are analyzed by ICP-OES as shown in Table.1. The Cu is enriched by 33.7% as compared to that of raw RAM with 25.05% of initial wt%. The enrichment of other metals is shown in Table.1 below. More than 90% of the solvent is recovered using a rotary evaporator after the supercritical fluid technology experiment.

The enriched metals are treated with citric acid and dil.HCL is a leaching agent to extract transition metals such as Cu, Ni, and Pb from them. Cu shows the highest extraction efficiency with more than 90% from both these leaching agents. The flow diagram of the entire process is shown in figure 1.

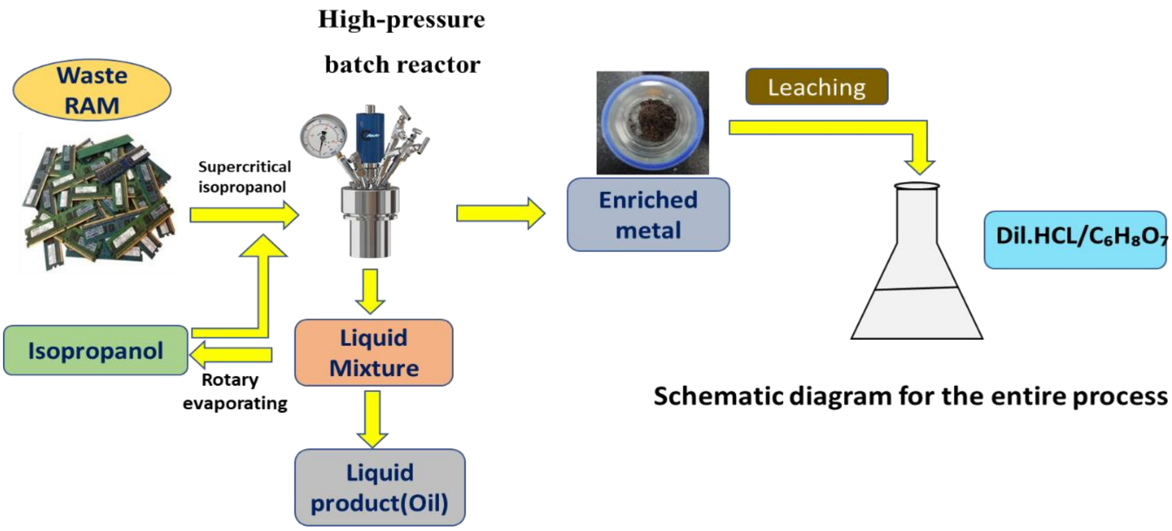

Fig. Schematic diagram of the entire process for this study

CONCLUSION:

Supercritical isopropanol can potentially convert e-waste plastic into value-added products. The liquid product (oil) with more than 85% yield was obtained. More than 90% of the solvent is recovered using a rotary evaporator after the supercritical fluid technology experiment. The Cu was extracted with more than 90% using both leaching agents. This work provides an efficient and integrated approach for recovering metals from waste RAM as electronic waste and simultaneously decomposing the plastics component of it.

References

Preetam, A., Jadhao, P. R., Naik, S. N., Pant, K. K., & Kumar, V. (2023). Supercritical fluid technology - an eco-friendly approach for resource recovery from e-waste and plastic waste: A review. *Separation and Purification Technology*, *304*. https://doi.org/10.1016/j.seppur.2022.122314

Preetam, A., Mishra, S., Naik, S. N., Pant, K. K., & Kumar, V. (2022). A Sustainable Approach for Material and Metal Recovery from E-waste using Subcritical to Supercritical Methanol. *Waste Management*, *145*, 29–37. https://doi.org/10.1016/J.WASMAN.2022.04.011

Preetam, A., Modak, A., Jadhao, P. R., Naik, S. N., Pant, K. K., & Kumar, V. (2022). A comprehensive study on the extraction of transition metals from waste random access memory using acetic acid as a chelating solvent. *Journal of Environmental Chemical Engineering*, *10*(6). https://doi.org/10.1016/j.jece.2022.108761