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Extraction separation of Cu(II) and Fe(III) using a hydrophobic eutectic solvent TIBPS /octanoic acid

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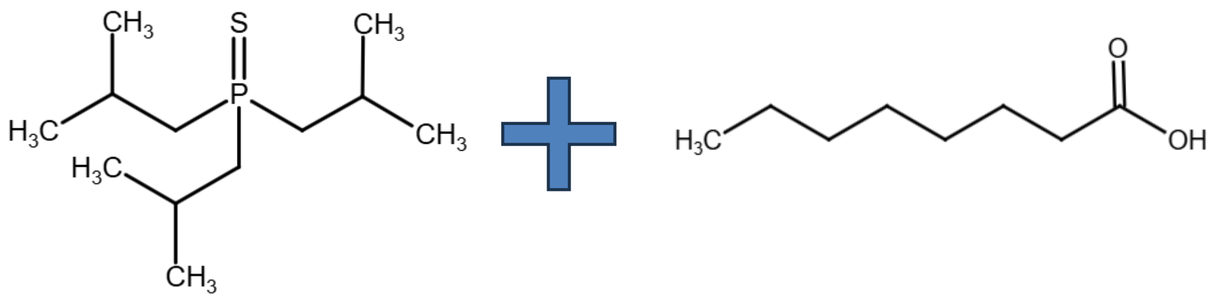
INTRODUCTION & AIM

Recently, the processing of metals from secondary sources has been actively developing to meet the rapidly increasing demand for metals. The main secondary sources of metals are electronic and electrical wastes. Fe and Cu account for the largest share of the total amount of electronic waste. Therefore, effective separation of Cu and Fe is important in terms of comprehensive e-waste recycling. This problem can be solved via extraction methods using hydrophobic eutectic solvents (HESs). HES is considered a promising alternative to conventional extractants, which are organic extractants (carboxylic acids, oximes, DEHPA, TBP) dissolved in diluents (kerosene, toluene, chloroform). An important advantage of HES is its non-volatility, non-flammability, and the ability to control its properties by changing its composition.

In this work, the extraction of Fe(III) and Cu(II) using a hydrophobic eutectic solvent based on triisobutylphosphine sulfide (TIBPS) and octanoic acid was investigated.

METHOD

HESs preparation: stirring, 60 °C, 30 min, molar ratio 3:7

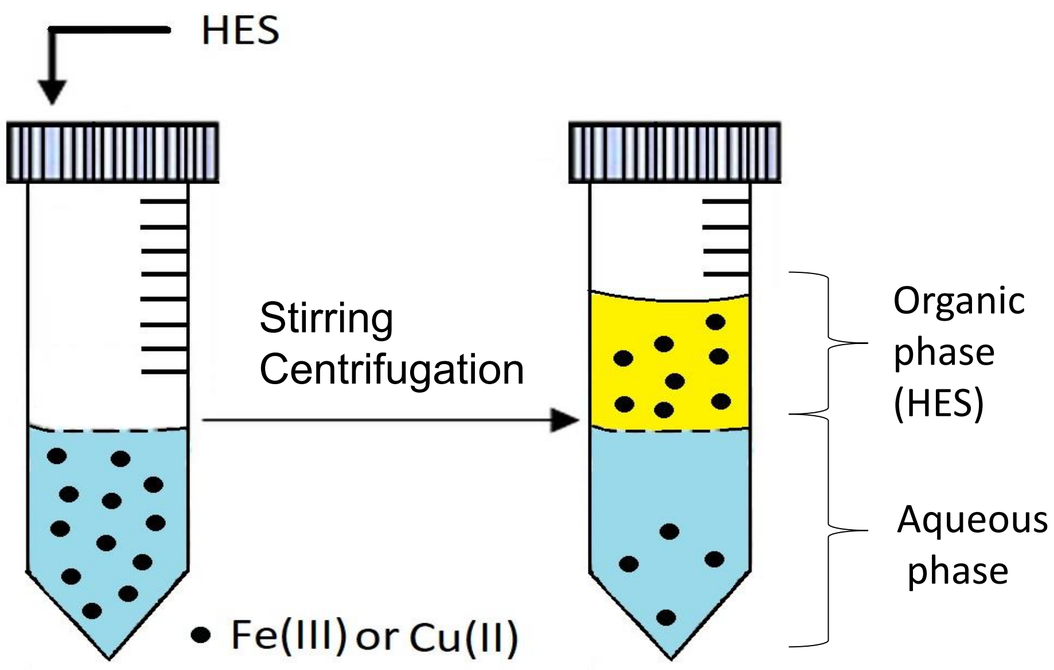


TIBPS octanoic acid

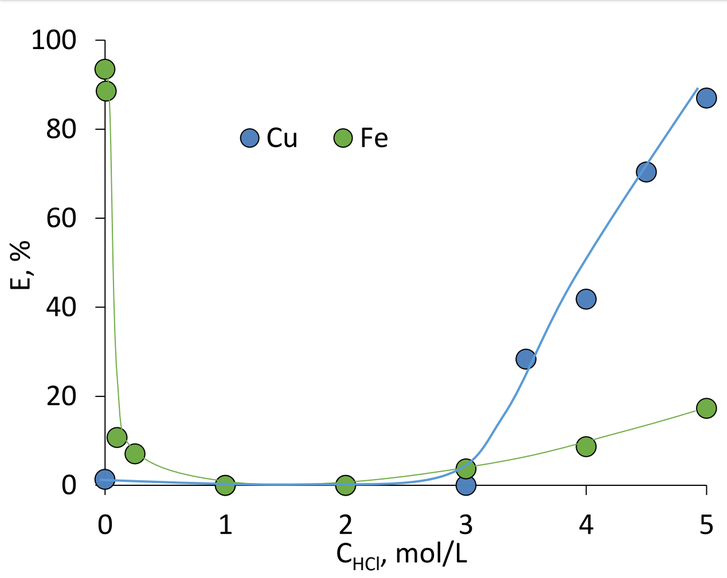
After mixing, a stable homogeneous liquid phase was formed

Extraction experiments: V_{org}/V_{aq}=1, $[Metal]_{init}$ =0.01 mol/L

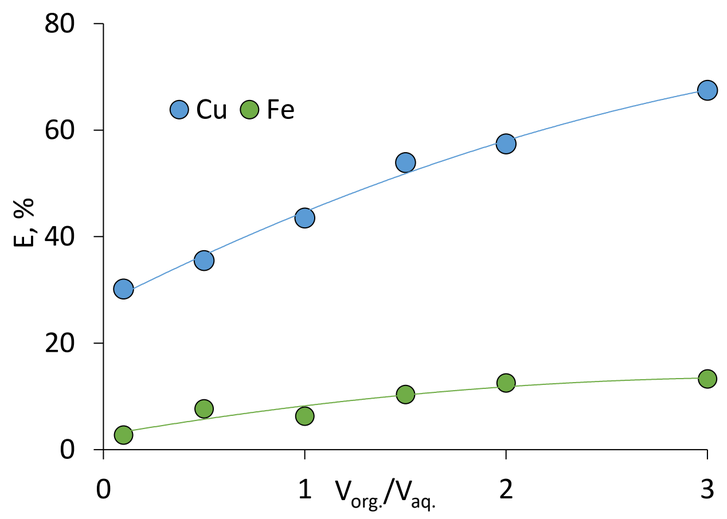
Extraction experiments were carried out at 25 °C and atmospheric pressure by stirring the aqueous and organic phases in a shaker at 45 rpm for 15 minutes. The methods for determining Fe(III) and Cu(II) ions are based on complexation with sulfosalicylic acid and pyridylazoresorcinol, respectively.



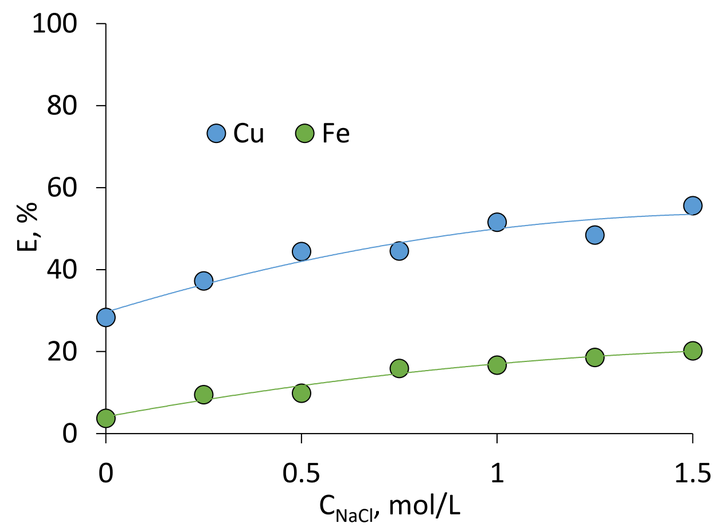
RESULTS & DISCUSSION



HES TIBPS/octanoic acid allows the separation of metal ions at both low and high concentrations of hydrochloric acid with high separation coefficients ($\beta_{Cu/Fe}$=31.97 at 5 M HCl and $\beta_{Fe/Cu}$=1061.92 at <1M HCl).



The separation of the Cu/Fe pair can be optimized by varying the volume ratio of the phases. The best results were obtained at an HCl concentration of 3.5 M with a phase ratio ($V_{org.}/V_{aq.}$) of 3.



The addition of chloride anions as a salting-out agent reduces the hydrochloric acid concentration required for effective metal extraction.

Cu(II) and Fe(III) can be stripped using aqueous solutions of 0.5 M $Na_2S_2O_3$ and 0.5 M H_2SO_4 with stripping efficiencies of >95.6% and >79.6%, respectively.

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CONCLUSION

The extraction behavior of Cu(II) and Fe(III) was investigated, enabling the identification of optimal conditions and hydrophobic eutectic solvent compositions for their separation.

These findings highlight the potential of the TIBPS/octanoic acid HES as a promising medium for hydrometallurgical Fe and Cu recovery.

FUTURE WORK / REFERENCES

Work on studying the extraction of other metals will be continued.

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