THE RECOVERY OF NICKEL, MANGANESE, COBALT, AND LITHIUM FROM SPENT LITHIUM-ION BATTERIES BY CHEMICAL PRECIPITATION

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ABSTRACT

Lithium-ion batteries (LIBs) have increased interest due to their high potential for efficient energy storage and environmental sustainability. Recovering valuable metals from spent Li-ion Batteries has significant environmental and economic benefits and has become an urgent area of research worldwide. This study reports on the recovery of valuable metal composites and compounds using a chemical precipitation process for the recovery of Li-ion batteries, which uses lithium-nickel-manganese-cobalt oxide as the cathode material. The overall recovery efficiency for Ni, Mn, and Co was found to be 96.1%, 95.7%, and 97.1%, respectively. 98% of the Ni, Co and Mn were precipitated in hydroxide form with <1 % impurities. 96% of Li can be recovered respectively in the form of Li2CO3 with <1 % of contaminants.

INTRODUCTION

Li-ion batteries have recently gained widespread recognition as the best power source for vehicles that use alternative fuels, including completely electric battery-powered vehicles. Recycling major components from spent Li-ion batteries is a beneficial way to prevent environmental pollution and alleviate resource shortage and depletion. Recovery of valuable metals is crucial to recycling and sustainability. Chemical precipitation method is one of the techniques used to recover valuable metals from lithium-ion batteries. It involves the formation of solid metal compounds through chemical reactions, which are then separated and further processed to obtain the desired metal-rich materials.

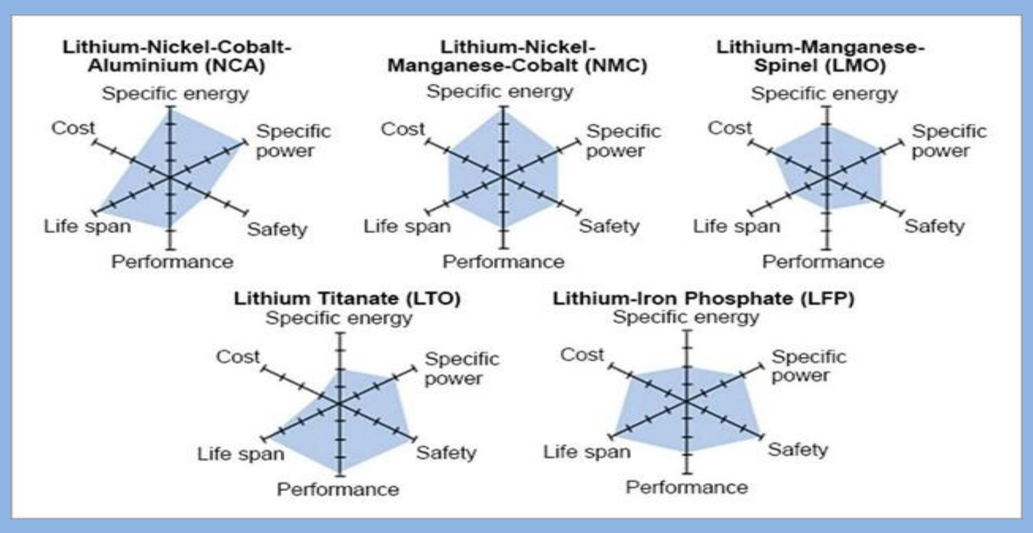
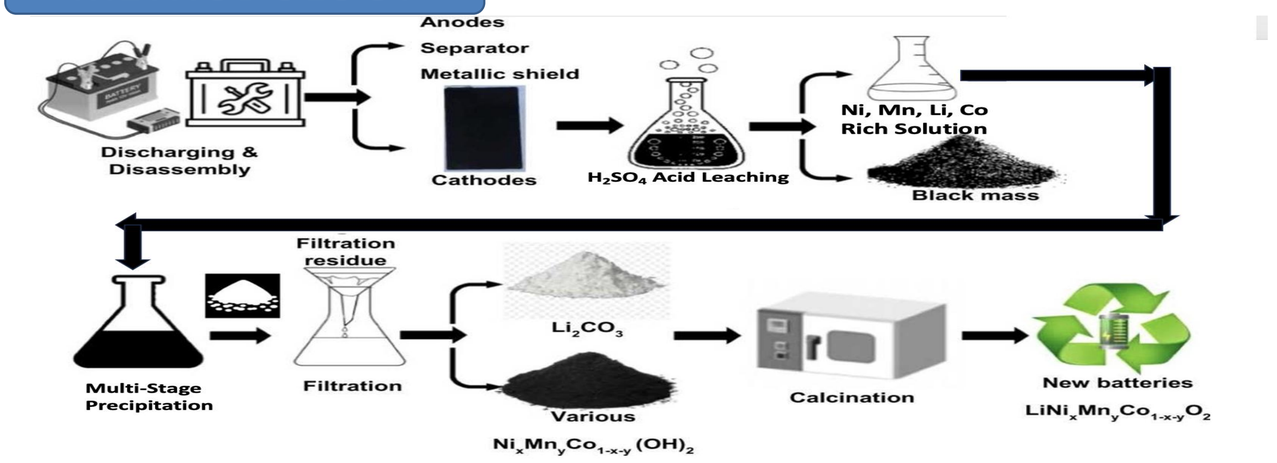


Figure 1: Types of Li-ion battery chemistries.

METHODOLOGY



RESULTS

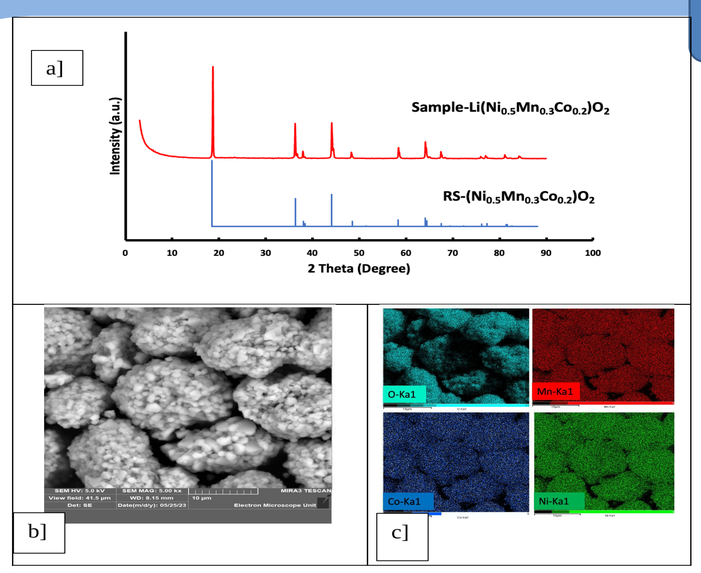


Figure 1: (a) The X-ray diffraction (XRD) pattern of waste lithium nickel manganese cobalt oxide (NMC 532) cathode materials. (b) The scanning electron microscopy (SEM) analysis of cathode materials; (c) the energy-dispersive X-ray spectroscopy (EDS) analysis of NMC cathode materials

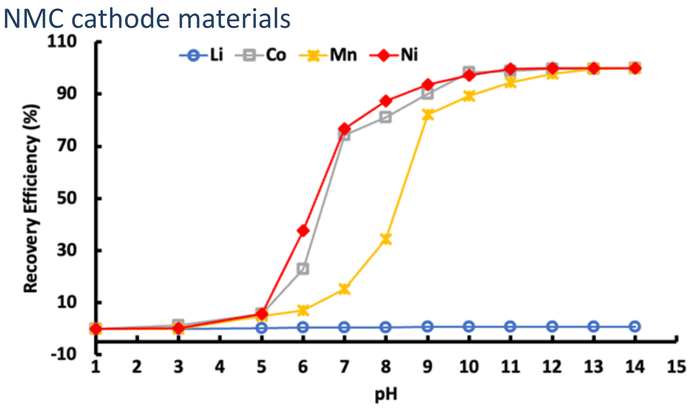


Figure 2: Recovery efficiency of NMC metals, at different pH levels (Temp=20°C).

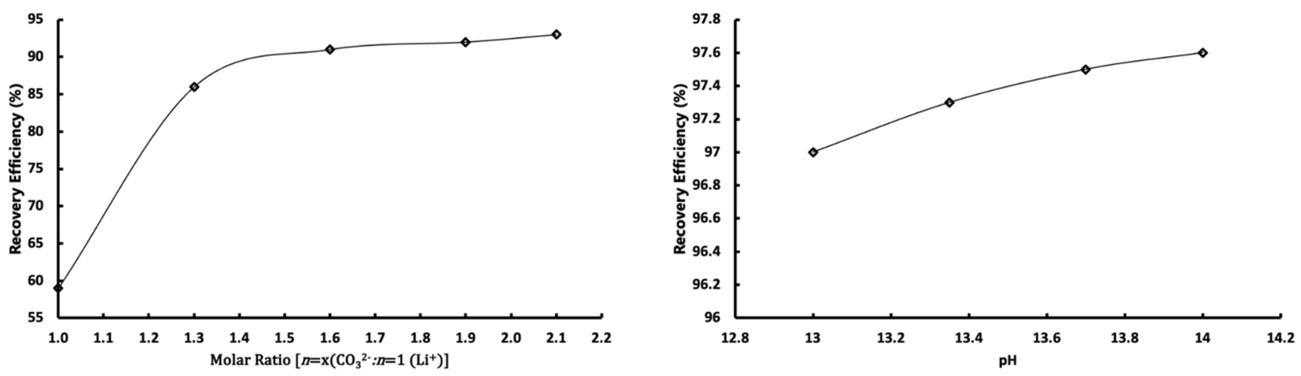


Figure 3: (a) (the effect of CO_2^{3-}: Li+ molar ratio (20°C and pH=13), and b)Recovery efficiency of Lithium, at different pH levels (Temp=20°C).

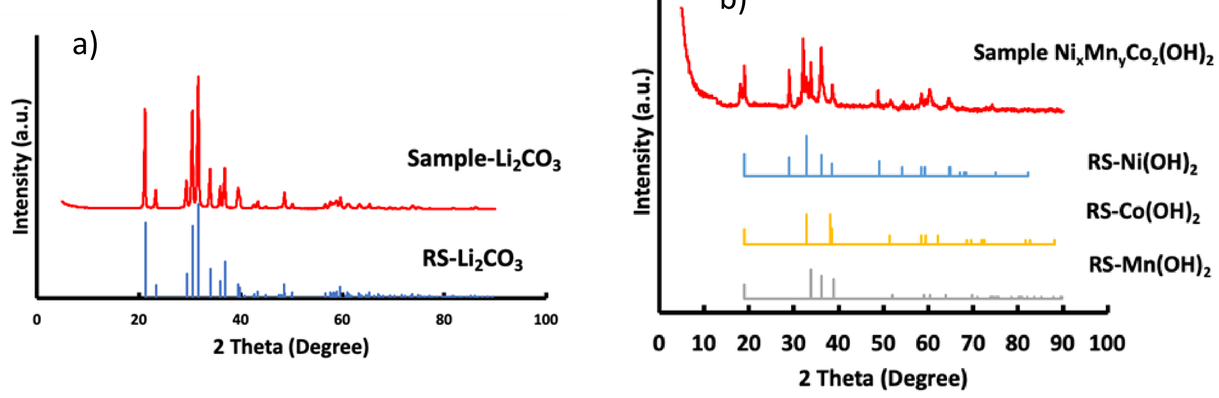


Figure 4: a) XRD pattern of (a) Li_2CO_3 and (b)NMC products obtained by precipitation.

CONCLUSION

Through the utilization of leachate solutions comprising 2M H_2SO_4 + 6 vol.% H_2O_2, and a 75 g/L S/L ratio and conducting leaching for 2h at a temperature of 20°C, peak leaching recovery efficiency of 98% for Li, 97.1% for Co, 96.1% for Ni, and 95.7% for Mn can be recovered. Through this precipitation process, 93% of Li can be recovered in the form of Li_2CO_3. The process exhibits great potential for recovery of valuable materials from spent Li-ion batteries.

REFERENCES

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- Jin, S., Mu, D., Lu, Z., Li, R., Liu, Z., Wang, Y., Tian, S. and Dai, C., 2022. A comprehensive review on the recycling of spent lithium-ion batteries: Urgent status and technology advances. Journal of Cleaner Production, 340, p.130535.

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