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Selective Solvent Extraction of Co from Ni and Mn through Outer-Sphere Interactions

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Abstract : Due to the growing popularity of electric vehicles and the importance of cobalt as part of the cathode material for lithium-ion batteries, demand for this metal is on the rise. Recycling of the cathode materials by means of solvent extraction is an attractive means of recovering cobalt and easing the pressure on limited natural resources. In this study, a series of straight chain and macrocyclic diamine ligands were developed for the selective recovery of cobalt from the solution containing nickel and manganese by means of solvent extraction. This combination of metals is the major cathode material used in electric vehicle batteries. The ligands can be protonated and function as ion-pairing ligands targeting the anionic $[CoCl_4]^{2-}$, a species which is not observed for Ni or Mn. Selectivity for Co was found to be good at very high chloride concentrations and low pH. Longer chains or larger macrocycles were found to enhance selectivity, and linear chains on the amide side groups also resulted in greater selectivity over the branched groups. The cation of the chloride salt used for adjusting chloride concentrations seems to play a major role in extraction through salting-out effects. The ligands developed in this study show good selectivity for Co over Ni and Mn but require very high chloride concentrations to function. This research does, however, open the door for further investigations into using diamines as solvent extraction ligands for the recovery of cobalt from spent lithium-ion batteries.

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