An investigation on the pyrolysis, flotation and leaching for the recycling of spent lithium-ion batteries

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The recycling of lithium-ion batteries (LIBs) has become one of the main research areas in battery value chain to meet the increasing need for their raw materials. Pyrolysis and flotation are alternative pre-treatment processes to be used prior hydrometallurgical leaching and the consequent battery materials recovery. Nevertheless, the advantages and barriers of integrated utilization of pyrolysis and/or flotation have not been systematically investigated. In this experimental study, various scenarios of pyrolysis, flotation and leaching were combined for the treatment of industrially produced black mass retrieved from spent batteries. The results showed that pyrolysis improved the separation efficiency of graphite from lithium metal oxides by aiding the liberation of particles from the binder. The graphite purity in flotation concentrate increased from nearly 60% to 80% despite the negative impact in the recovery from 60 % to 50%. Moreover, pyrolysis also increased the leaching yields of the metals from 40% to more than 80%. In addition, application of flotation prior to leaching increased the leaching yields of Ni and Co approximately 5%. It was found that higher dissolution yields of metals from the black mass can be achieved with the combination of pyrolysis and flotation before leaching. This trend was not observed for Li, possibly due to its partial dissolution in process water during flotation. The current study shows that optimization and integration of new alternative pre-treatment processes may improve process efficiency and help to build the most efficient pre-treatment strategies for LIB recycling.