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A Hydrometallurgical Route for the Recovery of Molybdenum from Spent Mo-Co Catalyst

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Abstract : Molybdenum is a strategic metal and finds applications in petroleum refining, thermocouples, X-ray tubes and in making of steel alloy owing to its high melting temperature and tensile strength. The growing significance and economic value of molybdenum has increased interest in the development of efficient processes aiming its recovery from secondary sources. Main secondary sources of Mo are molybdenum catalysts which are used for hydrodesulphurisation process in petrochemical refineries. The activity of these catalysts gradually decreases with time during the desulphurisation process as the catalysts get contaminated with toxic material and are dumped as waste which leads to environmental issues. In this scenario, recovery of molybdenum from spent catalyst is significant from both economic and environmental point of view. Recently ionic liquids have gained prominence due to their low vapour pressure, high thermal stability, good extraction efficiency and recycling capacity. The present study reports recovery of molybdenum from Mo-Co spent leach liquor using Cyphos IL 102[trihexyl(tetradecyl)phosphonium bromide] as an extractant. Spent catalyst was leached with 3.0 mol/L HCl, and the leach liquor containing Mo-870 ppm, Co-341 ppm, Al-508 ppm and Fe-42 ppm was subjected to extraction step. The effect of extractant concentration on the leach liquor was investigated and almost 85% extraction of Mo was achieved with 0.05 mol/L Cyphos IL 102. Results of stripping studies revealed that 2.0 mol/L HNO3 can effectively strip 94% of the extracted Mo from the loaded organic phase. McCabe- Thiele diagrams were constructed to determine the number of stages required for quantitative extraction and stripping of molybdenum and were confirmed by countercurrent simulation studies. According to McCabe- Thiele extraction and stripping isotherms, two stages are required for quantitative extraction and stripping of molybdenum at A/O= 1:1. Around 95.4% extraction of molybdenum was achieved in two-stage counter current at A/O= 1:1 with the negligible extraction of Co and Al. However, iron was coextracted and removed from the loaded organic phase by scrubbing with 0.01 mol/L HCl. Quantitative stripping (~99.5 %) of molybdenum was achieved with 2.0 mol/L HNO_3 in two stages at O/A=1:1. Overall ~95.0% molybdenum with 99 % purity was recovered from Mo-Co spent catalyst. From the strip solution, MoO_3 was obtained by crystallization followed by thermal decomposition. The product obtained after thermal decomposition was characterized by XRD, FE-SEM and EDX techniques. XRD peaks of MoO_3 correspond to molybdite Syn-MoO_3 structure. FE-SEM depicts the rod-like morphology of synthesized MoO_3. EDX analysis of MoO_3 shows 1:3 atomic percentage of molybdenum and oxygen. The synthesised MoO_3 can find application in gas sensors, electrodes of batteries, display devices, smart windows, lubricants and as a catalyst.

Keywords : cyphos Il 102, extraction, spent mo-co catalyst, recovery
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