Recycling of Spent Mo-Co Catalyst for the Recovery of Molybdenum Using Cyphos IL 104

Authors : Harshit Mahandra, Rashmi Singh, Bina Gupta

Abstract : Molybdenum is widely used in thermocouples, anticathode of X-ray tubes and in the production of alloys of steels. Molybdenum compounds are extensively used as a catalyst in petroleum-refining industries for hydrodesulphurization. Activity of the catalysts decreases gradually with time and are dumped as hazardous waste due to contamination with toxic materials during the process. These spent catalysts can serve as a secondary source for metal recovery and help to sort out environmental and economical issues. In present study, extraction and separation of molybdenum from a Mo-Co spent catalyst leach liquor containing 0.870 g L^{-1} Mo, 0.341 g L^{-1} Co, 0.422 $\times 10^{-1}$ g L^{-1} Fe and 0.508 g L^{-1} Al in 3 mol L^{-1} HCl has been investigated using solvent extraction technique. The extracted molybdenum has been finally recovered as molybdenum trioxide. Leaching conditions used were- 3 mol L^{-1} HCl, 90°C temperature, solid to liquid ratio (w/v) of 1.25% and reaction time of 60 minutes. 96.45% molybdenum was leached under these conditions. For the extraction of molybdenum from leach liquor, Cyphos IL 104 [trihexyl(tetradecyl)phosphonium bis(2,4,4-trimethylpentyl)phosphinate] in toluene was used as an extractant. Around 91% molybdenum was extracted with 0.02 mol L^{-1} Cyphos IL 104, and 75% of molybdenum was stripped from the loaded organic phase with 2 mol L^{-1} HNO_3 at A/O=1/1. McCabe Thiele diagrams were drawn to determine the number of stages required for the extraction and stripping of molybdenum. According to McCabe Thiele plots, two stages are required for both extraction and stripping of molybdenum at A/O=1/1 which were also confirmed by countercurrent simulation studies. Around 98% molybdenum was extracted in two countercurrent extraction stages with no co-extraction of cobalt and aluminum. Iron was removed from the loaded organic phase by scrubbing with 0.01 mol L^{-1} HCl. Quantitative recovery of molybdenum is achieved in three countercurrent stripping stages at A/O=1/1. Trioxide of molybdenum was obtained from strip solution and was characterized by XRD, FE-SEM and EDX techniques. Molybdenum trioxide due to its distinctive electrochromic, thermochromic and photochromic properties is used as a smart material for sensors, lubricants, and Li-ion batteries. Molybdenum trioxide finds application in various processes such as methanol oxidation, metathesis, propane oxidation and in hydrodesulphurization. It can also be used as a precursor for the synthesis of MoS_2 and $MoSe_2$.

Keywords : Cyphos IL 104, molybdenum, spent Mo-Co catalyst, recovery
Conference Title : ICC 2018 : International Conference on Chemistry
Conference Location : London, United Kingdom
Conference Dates : March 15-16, 2018