GAS PHASE EXTRACTION OF VANADIUM FROM SPENT VANADIUM CATALYST AND TANTALUM FROM TANTALUM OXIDE

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ABSTRACT

Gas phase extraction of metals using volatile organic reagents can be applied to metal bearing sources such as metal oxides, iron ore fines and fly ash. The process has the potential of having a smaller environmental impact compared with conventional extraction processes and the possibility also exists to recover and recycle the extractant. The research was directed to extend the application of gas phase extraction to two new metal systems, namely spent vanadium catalysts and a synthetic low grade tantalum oxide “ore”.

A literature review revealed that acetylacetone, trifluoro-acetylacetone and hexafluoro-acetylacetone were suitable extractants for vanadium and tantalum in a gas phase process. Due to safety considerations the fluorinated acetylacetone derivatives were not applied in the process and acetylacetone was the only extractant under investigation. The influence of the process parameters, temperature, particle size, acetylacetone flowrate and bed weight of the solid, on the extraction extent was studied for each system.

The sulphuric acid spent catalyst contained 49.03 mg vanadium/ g catalyst and the process was capable of extracting up to 60.3% of vanadium after contacting 15 g of catalyst (particle size +250µm to -500µm) with 7 mL/min of acetylacetone at a reaction temperature of 190 °C after 7 hours. It was also found that the reaction temperature, acetylacetone flowrate, and the interaction effects between particle size, ligand flowrate and catalyst bed loading, had a significant influence on the extraction degree of vanadium at 95% confidence level. Furthermore, a kinetic analysis revealed that the gas phase extraction was either mixed controlled or diffusion controlled.

The preliminary tantalum extraction study conducted here shows that gas phase extraction can be successfully applied to a synthetic tantalum oxide-silica sand mixture. The highest tantalum extraction of 93.4% was achieved at 150 °C after 5 hours of extraction at an acetylacetone flowrate of 7 mL/min for a 15 g bed (2 wt% Ta_2O_5). The solid-gas reaction between tantalum oxide and acetylacetone fluidised bed reactor were significantly influenced by the joint interaction effect of tantalum oxide concentration, acetylacetone flowrate and bed weight of the synthetic tantalum oxide mixture at 95% confidence level. The kinetic study showed that the gas phase extraction reaction of tantalum was governed by diffusion.