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Recovery of Platinum Group Metals from Spent Catalysts
Final Report for the RRTTC 1996

Publication: 1996 - 079

Duane Bartak, Department of Chemistry, University of Northern Iowa

C. Woo, Department Chemistry, University of Northern Iowa

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RRTTC PROJECT: RECOVERY OF PLATINUM GROUP METALS FROM SPENT CATALYSTS.

PRINCIPAL INVESTIGATORS.

Drs. Duane E. Bartak and Ching S. Woo, Professors of Chemistry, Department of Chemistry, University of Northern Iowa, Cedar Falls, IA, 50614-0423.
Phone (319) 273-2438, Fax: (319) 273-7127

PROJECT SUMMARY.

The project focused on the recovery of platinum group metals from spent automotive catalytic converters. The research involved the use of a combination of separation steps and electrochemical techniques to recover the platinum group metals (PGMs), namely, platinum, palladium, and rhodium from spent catalyst materials. Electrochemical technologies were selected because they have the potential to recover and recycle metals at relatively low concentrations from a variety of sources including process streams. In addition, electrochemical techniques offer the possibility of an environmentally friendly technology for the transformation and recycling of materials because electricity can be used in place of toxic chemical reagents.

Platinum, palladium, and rhodium are the catalysts used in automotive catalytic converters at approximate concentrations of 800 ppm Pt, 100 ppm Pd, and 40 ppm Rh on a solid support. The goal of this work was to develop a simple and economically viable method for the recovery of these relatively low levels of PGMs from the catalyst support, which is a ceramic material consisting of oxides of silicon, aluminum, and magnesium. The PGMs were initially extracted from the ceramic support by the use of an acid/oxidant leaching solution consisting of 6M HCl with 10% HNO_3. The resultant leaching solution contained a mixture of PGMs and other metals (e.g., aluminum and magnesium) from the ceramic support material.

An electrochemical flow cell based upon a Pt/Ti cathode (area of 8 cm^2) and a dimensionally stabilized anode was developed. Centrifugal magnetic-drive pumps were used to cycle the leaching solution past the cathode and an anolyte solution past the anode, respectively, at nominal flow rates of 0.5 liters per minute. Controlled-current electrolysis experiments were carried out at current densities of 15 to 60 mA cm^{-2}. As a result, electrochemical reduction of the chloride complexes of the PGMs from the leachant solution was accomplished. Results indicate that greater than 80% of the Pt can be recovered in this manner from the spent catalyst. The electrochemical reduction was selective in terms of being capable of separation (i.e., deposition) of the platinum group metals from other metals in the leaching solution.

It was demonstrated that the acid solutions used for leaching the PGMs could be reused or recycled back through the leaching step after the electrochemical separation or deposition step. That is, the hydrochloric acid/nitric acid leachant solution can be reused to leach more spent catalyst material after the PGMs are removed by the electrochemical step. Thus, a process was developed which is environmentally friendly because the chemical reagents can be recycled and reused. Furthermore, the process is a continuous flow process rather than a batch process, which also makes it more practical. The PI is in the process of applying for a disclosure document from the US Patent and Trademark Office for the above work or invention. The PI plans to obtain a US Patent on the overall process including the leaching and electrochemical reduction of the PGMs using a flow system in which the chemical reagents can be reused and recycled.

Date: October 1, 1996. Written by Duane E. Bartak.

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