

# Recovery of Platinum from Chloride Leaching Solution of Spent Catalysts by Solvent Extraction

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Platinum was recovered from the leaching liquor of spent petroleum catalyst by solvent extraction. Most of platinum in the spent catalyst was leached by using a mixture of HCl and H<sub>2</sub>O<sub>2</sub> from the roasted spent catalyst. The effect of concentration of HCl/H<sub>2</sub>O<sub>2</sub> in the solution, reaction temperature and pulp density was investigated. Complete extraction of Pt and Fe from the leaching liquor was obtained by Aliquat 336 at an O/A ratio of 1 in 2 stages. High purity solutions containing Fe and Pt were obtained from the loaded Aliquat 336 by scrubbing with dilute HCl solution and stripping with HClO<sub>4</sub>, respectively. Finally, HCl in the raffinate was regenerated by extraction with TEHA (Tri (2-ethylhexyl) amine) and then by stripping with water. The purity of HCl in the stripped solution was high enough to be reused in the leaching of spent catalysts. The optimum conditions in leaching, extraction and stripping together with the mass balance of the constituents of the spent catalysts in the whole process are reported. [doi:10.2320/matertrans.M20122200]

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**Keywords:** platinum, iron, spent catalyst, leaching, solvent extraction

## 1. Introduction

Platinum group metals (PGMs) has wide range of applications due to their peculiar physical and chemical properties.<sup>1)</sup> Among PGMs, platinum is used as an alloying agent for other metal products, such as fine wires, medical instruments, and jewelry. Platinum together with palladium and rhodium are the main active components of car catalytic converters.<sup>2)</sup> Pt and Rh are indispensable in air-pollution control catalysts.<sup>3)</sup> Platinum metal and PtO<sub>2</sub> are also widely used as catalyst in a variety of reactions in chemical and petroleum industry.<sup>4,5)</sup>

The demand for PGMs in the manufacture of advanced materials with special function is increased with the development of industry. At the same time, considerable amounts of spent catalyst containing platinum and other precious metals are produced. The spent catalysts from automotive, chemical and petroleum industry are the secondary sources of the PGMs, in which the content of PGMs is about one thousand times of them in general platinum ores.<sup>6,7)</sup> Since the cost for the production of PGMs from the naturally occurring ores is high, it is important to develop a process for the recovery of PGMs from these secondary resources.

Hydrometallurgical method has advantage in selectively recovering metals from secondary sources compared with the pyrometallurgical processing.<sup>8)</sup> In hydrometallurgical method, PGMs are recovered by leaching with different lixivants from the spent catalysts,<sup>9–13)</sup> and PGMs can be separated from the leaching solution by ion exchange or by solvent extraction.<sup>14–18)</sup>

In this study, a hydrometallurgical process on the recovery of Pt from the spent petroleum catalyst was developed by leaching with hydrochloric acid and hydrogen peroxide followed by solvent extraction. An optimum leaching condition to maximize the dissolution of Pt from the spent catalysts was obtained from the experiments by varying

leaching conditions, such as roasting, the concentration of hydrochloric acid, the addition of oxidizing agent, the reaction temperature and pulp density. Large amount of Si in the leaching liquor was removed by filtration. Pt and hydrochloric acid was separated from the leaching solution. Fe was separated from the co-extracted organic containing Pt by scrubbing. Mass balance of the constituents in the spent catalysts was obtained. The purity and recovery percentage of Pt, Fe and HCl are reported.

## 2. Experimental

### 2.1 Catalyst

The spent catalyst pellets were crushed and homogenized by through mixing, and the particle size distribution was determined by standard sieve. The powders with a size distribution of 0.1–0.3 mm were employed in the leaching experiments. The chemical composition of the spent catalyst powder was determined by XRF and ICP-OES and the results are shown in Table 1.

In order to investigate the effect of roasting of the spent catalyst on the leaching of metals, the spent catalyst powders were roasted in a furnace in the temperature range from 700 to 900°C. During the roasting procedure, the temperature was increased at a rate of 10°C/min, and after the temperature was reached, the temperature was maintained constant for 5h. Then the roasted spent catalyst was cooled down in the furnace and was kept in a desiccator before experiments.

### 2.2 Leaching procedure

Leaching agents were prepared by diluting certain amount of acid or alkali in doubly distilled water. Reagent grades of

Table 1. The composition of the spent catalyst measured by XRF and ICP (Unit: mass%).

Element	Pt	Al	Si	Fe	Ni
	0.089	10.15	42	0.28	0.005

\*Micro elements: S, Cl, K, Ca, Sr, Zr, Na.

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