

Article

Recovery of Platinum from Spent Petroleum Catalysts: Optimization Using Response Surface Methodology

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1. Changes of spent catalysts at different calcination temperatures

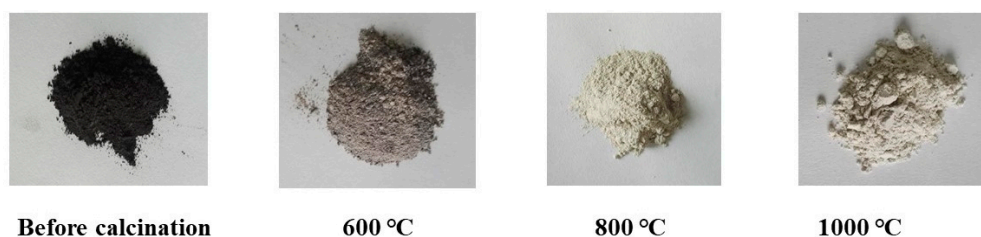
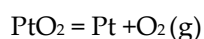


Figure S2. Color changes of spent catalysts at different calcination temperatures.

2. Thermomechanical analysis of PtO₂ decomposition



The Gibbs free energy was calculated by HSC 6.0, as shown below.

Table S1. The Gibbs free energy of the decomposition of PtO₂.

T/°C	100	200	300	400	500	600	700	800	900	1000
$\Delta G(\text{kJ/mol})$	16.156	11.948	7.779	3.653	-0.074	-3.435	-6.729	-9.964	-13.148	-16.288

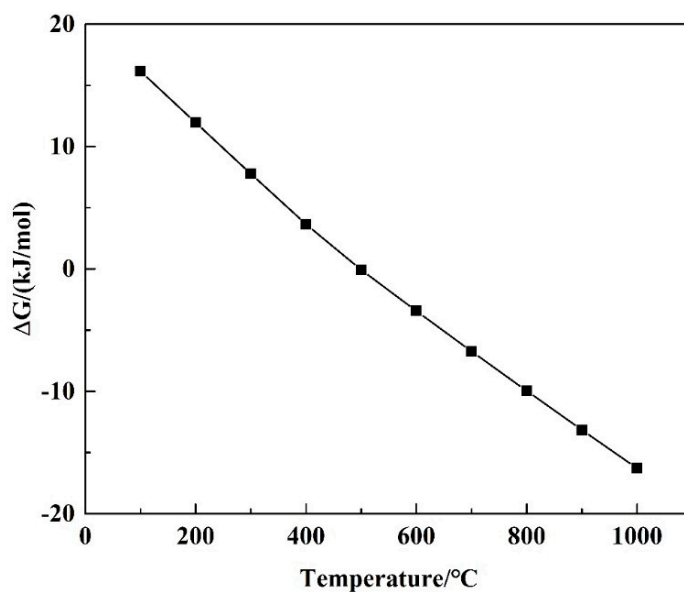


Figure S3. The relationship between Gibbs free energy of the decomposition of PtO₂ and temperature.

3. DTG curve of spent catalysts

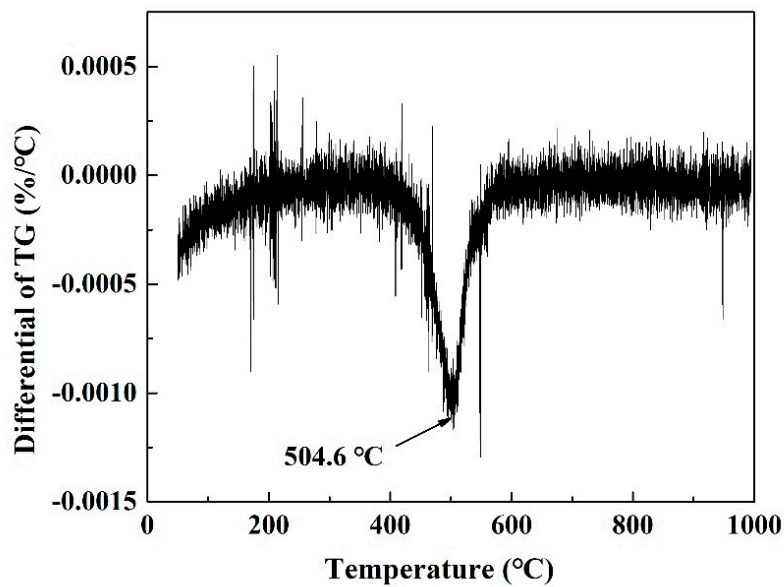


Figure S1. The DTG curve of spent petrochemical catalysts.

4. Shrinking-core models

(1) Surface chemical control model

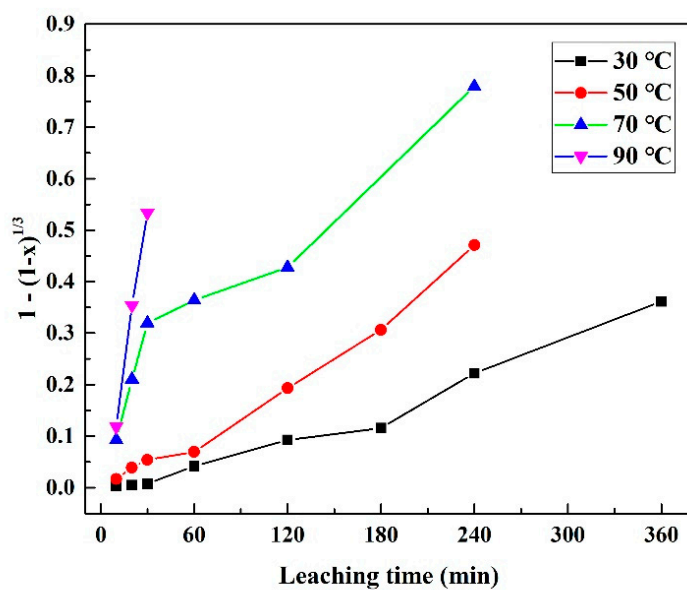


Figure S4. Plots of $1-(1-x)^{1/3}$ vs. time under different leaching temperatures.

(2) Ash layer diffusion model

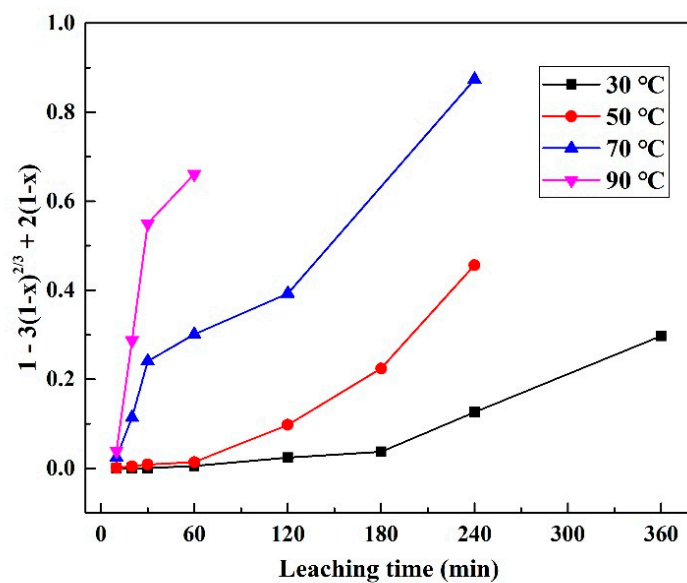


Figure S5. Plots of $1-3(1-x)^{2/3} + 2(1-x)$ vs. time under different leaching temperatures.

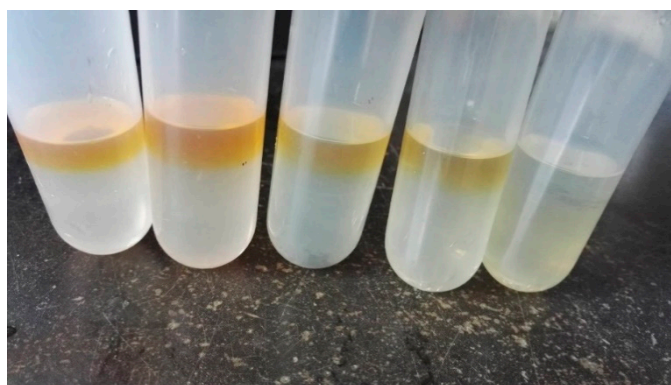


Figure S6. The color changes in ethyl acetate phase with different usage of Fe.

5. The XRF analysis of spent catalysts (before calcination).

Table S2. The XRF analysis of spent catalysts in form of oxides.

Elements	Al ₂ O ₃	Fe ₂ O ₃	MoO ₃	Cl	SiO ₂	SnO ₂	P ₂ O ₅	CaO
Content (%)	89.965	2.86	1.74	1.27	0.965	0.585	0.395	0.40
Elements	Na ₂ O	NiO	Eu ₂ O ₃	ZrO ₂	TiO ₂	CeO ₂		
Content (%)	0.39	0.33	0.28	0.26	0.16	0.059		

6. The information of leaching solution before reduction

Table S3. The volume of leaching solution and concentration of Pt.

Initial S/L ratio (g/ml)	Initial concentration of c(H ⁺) (mol/L)	V (ml)	c(Pt) (mg/L)
1:5	1	405	300.5
	2	339	319.7
	4	377	287.6
	6	312	351.5
1:10	1	771	158.3
	2	692	166.2
	4	604	184.1
	6	618	202.4
1:20	1	1510	25.0
	2	1232	87.71
	4	1452	86.68
	6	1281	95.34

