

PRINCE OF SONGKLA UNIVERSITY  
FACULTY OF ENGINEERING

Final Examination: Semester II

Academic Year: 2007

Date: February 29, 2008

Time: 9:00-12:00

Subject: 230-592 Special topics (Catalysts)

Room: A401

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ไม่อนุญาตให้นำเอกสารและเครื่องคำนวณทุกชนิดเข้าห้องสอบ  
ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริต  
และพักการศึกษา 1 ภาคการศึกษา

Please do all 5 questions. Show all your work to receive full or partial credit.  
Final score is 190. (Total page = 9, including first page)

Question #	Total Score	Score
1	30	
2	80	
3	30	
4	20	
5	30	
<b>Total</b>	190	
	25%	

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สุกฤทธิรา รัตนวิไล

ผู้ออกข้อสอบ

1. Find the technical terms that match the following definitions.  
(3 scores/each word, total 30 scores)

1.1 ..... A process in which the catalyst is preferentially poisoned to minimized unwanted cracking and coking.

1.2 ..... The measurement of physical and chemical properties of catalyst.

1.3 ..... A catalyst which use for controlling of vehicle engine emissions and reduction of HC, VOCs and NO<sub>x</sub>.

1.4 ..... Activity loss is caused by irreversilde chemisorption of an impurity.

1.5 ..... Species causing activity loss does not participate in the main reaction.

1.6 ..... Process that re-dispersion of sintered by using Pt/Al<sub>2</sub>O<sub>3</sub>; start with introduce HCl or CCl<sub>4</sub> at 450-550°C in O<sub>2</sub>/N<sub>2</sub> 1-4 hrs then adsorb O<sub>2</sub>, Cl<sub>2</sub> on surface of crystal to form AlCl<sub>3</sub> and PtCl<sub>2</sub>(AlCl<sub>3</sub>)<sub>2</sub>.

1.7 ..... An inorganic chemical reaction in which water and carbon monoxide react to form carbon dioxide and hydroge 1.

1.8 ..... Breaking up large hydrocarbon molecules into smaller and more useful bits.

1.9 ..... A substance that can cause a change in the rate of a chemical reaction without itself being consumed.

1.10 ..... A technique used to characterize the structures of surfaces and gave 2 dimensional structures of well-defined single crystal surfaces.

2. Find the answer of each question. (10 scores/each, total 80 scores)

2.1 Explain the following sentence in term of catalyst. “An ounce of prevention is worth a pound of cure”

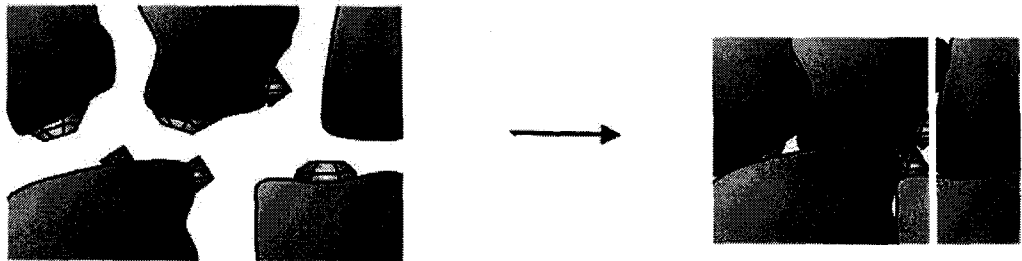
2.2 Explain the process how to regeneration of sulfur-poisoned.

2.3 Explain figure A and B?

A)



B)



2.4 What is “three-way catalyst”?

2.5 Explain the process of synthesis gas: Fisher-Tropsch.

2.6 What is in your view the greatest catalyst for Benzene hydrogenation and why?

2.7 How does zeolite play a role in the processing petroleum; catalytic cracking?

2.8 In a process with constant flow, mixed/batch reactor with independent deactivation, first order for main reaction and first order in activity for deactivation reaction. The rate express are

$$-r_A = kC_A a \quad (1)$$

$$-da/dt = k_d a \quad (2)$$

The performance equation for a mixed/batch reactor with rate based on catalyst mass is

$$W/F_{AO} = X_A / kC_A a \quad (3)$$

$a$  = activity

$W$  = weight of catalyst

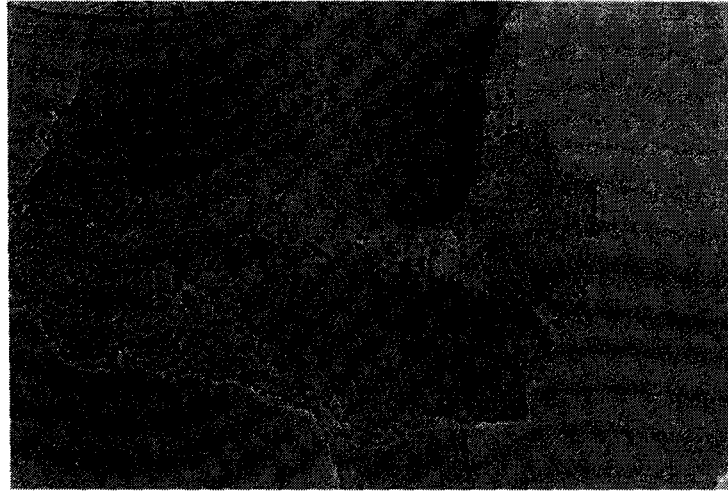
$F_{AO}$  = volumetric flow rate

$X_A$  = A conversion

Derive equation (3).

3. Imagine yourself the newly appointment manager of catalysis group consisting of 12 professionals and 9 technicians at a large chemical and catalysis company. Suppose that your management has offered to provide 20 million baht for the purchase of new equipment for catalyst characterization, since you presently have none. Write a proposal listing the equipment, short justification for purchasing each equipment and how would you put this equipment to use. (30 scores)

4. The following figure show a cobalt catalyst (darker spots) supported on coal carbonized at high temperature. Could you suggest which catalyst characterization equipment would provide this result? (20 scores)





5. A graduate student name "Dam" decided to study the kinetic of catalytic reforming of pentane into isopentane and  $H_2$  over  $Pt/Al_2O_3$  at  $500\text{ }^\circ\text{C}$ . He used a feedstock containing 7 psi  $H_2$ , 7 psi of Helium (as inert) and 0.7 psi of pentane. He was unable to study the kinetics because the catalyst deactivated too rapidly. After speaking with his advisor, he changed the feedstock to 14 psi  $H_2$ , and 0.7 psi of pentane and was able to obtain rate data. Explain why the catalyst deactivated under the original conditions and list the possible cause of deactivation. (30 scores)