Course Description

There are a lot of industrial chemical processes all over the world. Every day chemists are finding new sorts of materials, medicines and fuels. Not all the inventions will be implemented in practice. The main reason of this it is a shortcoming of chemical reaction speed.

Nikolai Zelinsky, who found the first Petrochemical Academy in Russia, said that there are no unrealistic reactions and if the reaction does not realize it means the right catalyst has not been found. This genius concept underlies modern approaches to refinery and petrochemistry.

«Industrial catalysis» is an extensive course where overview of the modern integrated catalytic refinery processes will be analyzed. The course is aimed at providing students with basic knowledge of chemical kinetic and catalysis. The types of catalysts, surface structure of solid surface and the main catalytic industrial processes will be considered in this course. Topics are focused not only on classical catalytic scheme but provide information about perspective technologies.

Special Features of the Course

1. The course provides basic information about kinetic and catalysis. Students have an opportunity to renovate the knowledge in chemical catalysis or start from the beginning if they did not learn similar subject previously.

2. Course materials cover the basic refinery catalytic processes which have widespread internationally. Up to date scientific information is accompanied by practical illustration.

3. Modern view to connecting between a structure and property of catalysts are tightly integrated in the training on the course. Properties of catalysts are studied throw wide range of laboratory works. Students not only explore the industrial catalysts but also synthesize simple ones and find out there properties.

Course Aims

- To make clear the physicochemical basis of catalysis and kinetics.
- To explain how the catalysts work.
- To develop understanding and skills related to the recognition and interpretation of catalytic refining processes.
- To give broad information about industrial catalysts productions and principles of them fusion.
- To introduce environmental friendly philosophy of green chemistry.

Course Objectives

- To explain different types of chemical reaction kinetics which take a part in real industrial processes.
- To classify main industrial catalysts, methods of them testing, demands placed on the catalysts.
- To present students modern scientific methods of catalysts constructing and investigation.
- To make known schemes of refinery catalytic processes.

Learning Outcomes of the Course

By the end of the course, students will be able:

- to form kinetic equations of chemical reactions, to explain impact of different technological factors to the reactions rate;
- to analyze the relationship between catalysts composition and their properties;
- to issue opinions on suitability of different catalysts in industrial processes;
- to interpret schematic diagrams of catalytic refinery processes,
- to reflect methods of catalysts testing;
- to illustrate the properties of catalysts required for practical using in chemical technology.

Course Outline

Week	Lectures	Practice	Hours ¹
		session /	
		Assignments	
1	<u>Chemical kinetics</u> and catalysis	History	0.25
		Reaction rate and Extent	0.25
		of Conversion	0.20
		Activation energy and	0.25
		Heat of reaction	0.25
		catalysis and Catalytic reactions	0.25
		Catalysis and	0.25
		Thermodynamic	0.25
		The Selectivity and	0.20
		Activity	0.5
		Homogeneous Catalysis	
		Enzyme Catalysis	1
2	Types of catalysis	Heterogenous Catalysis	0.5
		Practical work No 1	4
		Lab Works No 1	3
3	<u>Heterogenious</u> <u>catalysis</u>	Adsorption	0.25
		Isotherms	0.25
		Physical Adsorbtion and	0.25
		Chemisorption	0.25
		Promoters and Catalyst	0.5
		Poisons	0.5
		Practical work No 2	3
		Lad Works NO 2	
	Catalysts (Part 1		
4	Structure of Metals, Oxides and Sulfides	Catalysts in industrial	0.25
		processes	
	and their Surfaces)		0.25
		ivietal Structures	0.25

¹ Hours designed for Classroom sessions, Web-sessions, Home Assignments etc. INDUSTRIAL CATALYSIS. Syllabus 3

		Oxides and Sulfides Lab Works No 3	0.25 3
5	<u>Catalysts (Part 2.</u> <u>Small Particles and</u> <u>Porous Material,</u> <u>Preparation of</u> <u>Catalysts</u>	Pore System Catalyst Supports Shaping of Catalyst Supports Zeolites Preparation of Supported Catalysts Practical work No 3 Lab Works No 4	0.25 0.25 0.25 0.25 1 4 3
6	<u>Catalysis in</u> refinery and petrochemistry	Oil Refining and Petrochemistry Hydrotreating Gasoline Production Reforming and Bifunctional Catalysis Alkylation Reactions of Small Olefins Quiz No 2 Practical work No 4 Lab Works No 5, 6, 7	1 1 1 1 1 1 1 4 13
7	Final Quiz (Attestation)		2
9	Final exam		2

Lecturer and Contact Information



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Assessment

Grade policy for both home assignments and the final exam is:

- A (excellent work) 91–100 points
- B (above average work) 81–90 points
- C (average work) 71–80 points
- D (below average work) 50–70 points
- F (failed work) < 50 points
- To pass the exam students have to do all course's assignments. The final exam consists of two parts : the final quiz and writing exam.

Attendance Policy

Students are expected to attend and participate in classes and should notify trainers of excused absences in advance, where possible. Students who have an excused absence are expected to make arrangements with instructors for alternative assignment.

Every topic has a home assignment work that should be done. The final mark will be made by the same grade policy as for a final exam.

Web page of the course

The webpage of the course <u>INDUSTRIAL CATALYSIS</u> is available through E-learning SibFU web site: <u>www.e.sfu-kras.ru</u>. You must be logged in to access this course. Course materials and required reading materials are available at the course web-page.

Core reading

The strongly recommended book for this course is <u>Handbook of Industrial Catalysts by</u> <u>Lawrie Lloyd</u> (Springer International Publishing, ISBN: 978-0-387-24682-6, 2011). It contains information about the most using industrial catalysts and main industrial catalytic processes. The book <u>Syntesis of Solid Catalyst by Krijn P. de Jong</u> (Wiley-VCH, ISBN: 978-3-527-32040-0, 2011) is also recommended. This manuscript familiarizes students with modern methods of catalysts producing.

The <u>Catalytic Kinetics by Dmitry Murzin and Tapio Salmi</u> (Elsevier, ISBN 0444516050, 2005) will be useful in order to understand the main kinetics and catalytic reaction mechanisms.

Although this list is not full without the book <u>Green Chemical Engineering by S. Suresh</u> (CRC Press, ISBN: 978-1-4665-5885-4, 2015). It provides a general information about principals of environmentally friendly chemistry.