	UNIVERSITY OF EAST SARAJEVO Faculty of Technology Zvornik	
	Study programme: *Chemical Engineering and Technology*	
	CYCLE I / YEAR III	

Course title	**CATALYSIS AND CATALYSTS**
Department	Department for Physical Chemistry, Electrochemical Engineering and Materials– Faculty of Technology Zvornik

Course code	**Course status**	**Semester**	**ECTS**
04-1-029-5	Compulsory	V	5

Teacher	Milorad Tomić, PhD, full professor
Teaching assistant	Marija Mitrović, PhD, assistant professor

Number of hours/ teaching workload (per week)			**Individual student workload (in hours per semester)**			**Student workload coefficient S_o**
Lectures	**Auditory exercises**	**Laboratory exercises**	**Lectures**	**Auditory exercises**	**Laboratory exercises**	**S_o**
2	0	2	45	0	90	1,5
2*15 + 0*15 +2*15 = 60hours			(2*15*1.5 + 0*15*1.5 + 2*15*1.5)=90 hours			
Total course workload 60 + 90 = 150 hours per semester						

Learning outcomes

After finishing the course, students will be able to:

1. understand the relationship between the structural and chemical properties of catalysts and their catalytic properties
2. demonstrate and utilize the theoretical and practical knowledge necessary for conducting and controlling the catalytic process
3. use experimental methods and tools for evaluating the quality of catalysts
4. improve the catalytic process and improve the quality of the product from the economic, engineering and environmental aspects.

Prerequisites

No prerequisites

Teaching methods

Lectures, laboratory classes, seminar paper.

Syllabus outline per week

List of teaching units per weeks

1. Introduction, the essence of the catalytic act, thermodynamic and kinetic aspects of catalysis, method catalyst action. Division of catalysis. Comparison of homogeneous and heterogeneous catalysis. Catalyst properties: activity, selectivity, stability
2. Chemistry and catalysis. Collision theory. Transition state theory.
3. Homogeneous catalysis. Acid-base catalysis: specific acid-base catalysis, general acid-base catalysis and acid-base catalysis in a non-aqueous environment.
4. Heterogeneous catalysis. Adsorption phenomena: criteria used to distinguish physical adsorption and chemisorption. Chemisorption, heat of adsorption, adsorption isotherms. Theory of heterogeneous catalysis: theory of formation of unstable intermediates, theory of active centers, geometric factors of heterogeneous catalysis and electronic factors of heterogeneous catalysis.
5. Composition and preparation of heterogeneous catalysts. Chemical composition of the catalyst. Catalyst carriers. Catalytically active substances: metals and alloys as active substances, semiconductors as active substances, insulators as active substances. Promoters.
6. Production of catalysts. Precipitation and coprecipitation. Impregnation. Alloying and leaching. Filtering and washing. Drying. Grinding and sowing. Shaping. Catalyst activation.
7. Mid-term test (Colloquium) I
8. Kinetics and mechanism of heterogeneous-catalytic reactions. Kinetic expressions for monomolecular reaction. Kinetic expressions for the bimolecular reaction: Langmuir–Hinshelwood mechanism, mechanism on two centers, Eley-Rideal mechanism, mechanism on one center. Effect of temperature on the rate of heterogeneous-catalytic reaction.
9. Total speed of heterogeneous catalytic reactions. Diffusion resistance through the boundary layer or resistance to interfacial diffusion. Interphase transfer of substance. Interphase mass transfer and chemical reaction. Effect of interphase transfer on catalyst efficiency.
10. Resistance to diffusion through the pore or resistance to intraphase diffusion. Intraphase mass transfer: molecular diffusion, Knudsen diffusion and surface diffusion. Intraphase transmission

	substances and chemical reaction. Intraphase efficiency factor: ideal pore model bounded by a roller mantle and a model of an ideal catalyst grain in the shape of a sphere. Transmission of heat between the fluid and the catalyst. 11. Catalyst activity. Experimental methods of determining reaction speed (activity of catalysts), experimental reactors: integral and differential reactor, PKR and reactor with recirculation. Calculation of the mass and energy transfer coefficient. 12. Criteria for assessing the influence of matter and energy transfer on the overall reaction rate: interphase, intraphase and reactor gradients. Influence of diffusion on the stability of catalytic process. Types of catalyst selectivity. Influence of chemical and physical properties of catalysts on selectivity. 13. Catalyst deactivation: contamination, poisoning, sintering or phase transformation of catalyst and loss of catalyst by evaporation. Catalyst deactivation mechanism. Catalyst deactivation kinetics. The way the poison acts on the surface of the catalyst. Effect of mass transfer on deactivation rate. 14. Prevention of catalyst deactivation and reactivation. Operational problem. Reactivation and catalyst regeneration. Reactivation of the contaminated catalyst. Reactivation poisoned catalyst. Reactivation of the sintered catalyst. 15. Mid-term test (Colloquium) II

Main literature

Author	Title, publisher	Year	Pages
Zrnčević, S.	Catalysis and catalysts, Hinus, Zagreb	2005	
Hagen, J.	Industrial Catalysis, Wiley-VCH, Weinheim	1999	
Chorkendorff I., Niemantsverdriet J. W.	Concepts of Modern Catalysis and Kinetics	2003	

Additional reading

Author	Title, publisher	Year	Pages
Nascimento, M.A.	Theoretical aspects of heterogeneous catalysis	2010	

	Type of student evaluation	Grade points	Percentage
Obligations, assessment methods and grading system	Pre-exam obligations		
	Attendance	6	6 %
	Seminar paper	10	10%
	Laboratory exercises	16	16 %
	Tests/colloquia	38	38 %
	Final examination (oral)	30	30 %
	Total	100	100 %
Web page	www.tfzv.ues.rs.ba		
Date	2023		