



**Geology and Oil-gas Business Institute named after K. Turyssov
Department of Chemical and Biochemical Engineering**

EDUCATION PROGRAM

**8D07116 CHEMICAL TECHNOLOGY OF ORGANIC SUBSTANCES AND
MATERIALS**

Code and classification of the field of education: **8D07** «Engineering,
manufacturing and construction industries»

Code and classification of areas of study: **8D071** «Engineering and Engineering»

Group of educational programs: **D097** «Chemical engineering and processes»

Уровень по НРК: 8

Уровень по ОРК: 8

Year of study: 3

Credits: 180

Almaty 2025

The educational program 8D07116 " Chemical technology of organic substances and materials" was approved at the meeting of the Scientific Council of KazNTU named after K.I.Satpayev

Protocol №10 from «06» 03 2025y

Reviewed and recommended for approval at a meeting of the Educational and Methodological Council of K.I.Satpayev KazNTU

Protocol №3 from «20» 12 2024y

The educational program D07116 "Chemical technology of organic substances and materials" was developed by the academic committee in the direction D097 «Chemical engineering and processes»

Name	Academic degree/ academic	Post	Place of work	
Chairman of the Academic Committee:				
Selenova Bagadat Samatovna	Doctor of Chemical Sciences	Professor	Kazakh National Research Technical University named after K.I.Satpayev	
Teaching staff:				
Mangazbaeva Rauash Amantaevna	Candidate of Chemical Sciences	Associate Professor	Kazakh National Research Technical University named after K.I.Satpayev	
Aitkalieva Gulzat Slyashevna	Doctor PhD	Associate Professor	Kazakh National Research Technical University named after K.I.Satpayev	
Employers				
Seitenova Gaini Zhumagalievna	Candidate of Chemical Sciences, Associate Professor	Head of the Project Office	Petro Gas Chemical Association,	
Students:				
Bogdanova Violetta	-	Student	Kazakh National Research Technical University named after K.I.Satpayev	

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List of abbreviations and designations

EP – Educational program
CC – Communicative competence
LO – Learning Outcomes
NJSC - Non-profit joint stock company

1. Description of educational program

The educational program is a set of documents developed by the academic committee of the Kazakh National Research Technical University named after K.I. Satpayev.

The EP considers the needs of the regional labor market, the requirements of government agencies and relevant industry requirements. The branch of organic and petrochemical synthesis, which uses oil, gas, coal as raw materials, is the leading one and determines the progress of the chemical industry - an important link in the economy of Kazakhstan. Products of organic and petrochemical synthesis, having valuable chemical and physico-chemical properties, are semi-products in the production of polymers, medicinal substances, plant protection products and other synthetic materials. And since the industry of organic and petrochemical synthesis provides raw materials for all other sub-sectors of the chemical industry that produce synthetic materials, it must develop at a faster pace.

The EP is based on the state educational standard for higher professional education in the relevant field.

The EP defines program educational goals, student learning outcomes, necessary conditions, content and technologies for the implementation of the educational process, assessment and analysis of the quality of students during training and after graduation.

The EP includes the curriculum, the content of disciplines and learning outcomes and other materials to ensure a quality education for students.

2. Purpose and objectives of the educational program

The purpose of the EP:

Training highly qualified specialists with profound knowledge, methodological competencies, and research skills in the field of chemical technology of organic substances and their processing, capable of developing and implementing innovative and environmentally safe technologies for sustainable development and successfully competing in national and international labor markets.

The objectives of this EP are:

- social, humanitarian and professional training of bachelors in the field of

chemical engineering in accordance with the development of science and production, as well as with the needs of oil and gas chemical clusters in Kazakhstan, national research centers, master's and doctoral studies of higher educational institutions;

- training of bachelors - technologists who know the raw material base, methods of analytical quality control of raw materials and commercial products, production technologies and areas of consumption of organic substances and materials with fundamental training in physics, mathematics, chemistry, physical and chemical foundations of technologies for obtaining the most important classes of organic substances, production of chemical reagents (additives, surfactants, polymers) used in the production of fuels and petroleum oils, in the processes of extraction, preparation and transportation of hydrocarbon raw materials.

- providing knowledge, skills and abilities that allow analyzing problems in the field of chemical engineering and finding ways to solve them, solve engineering problems in the design of production of organic substances and materials, conduct research work in the field of synthesis and study of the properties of new chemical compounds and materials using information technologies and methods of mathematical planning of experiment.

- preparation of students for professional activities in the conditions of existing production, the formation of skills and abilities to maintain the required level of labor and production discipline; on conducting a technical and economic analysis of production; on the adoption and implementation of management decisions in the face of different opinions.

3. Requirements for evaluating the learning outcomes of an educational program

The educational program was developed by the academic committee in accordance with the State Mandatory Standards of Higher and Postgraduate Education of the Republic of Kazakhstan dated July 20, 2022 No. 2 and reflects the learning outcomes on the basis of which curricula (working curricula, individual curricula of students) and working curricula in disciplines (syllabuses) are developed. Formed learning outcomes: applies knowledge of natural science, socio-economic and profile disciplines of biotechnology to solve practical and professional tasks of the biotechnology industry.

Formed learning outcomes: applies knowledge of natural science, socio-economic and profile disciplines of chemical technology to solve practical and professional tasks of the technological industry.

Evaluation of learning outcomes is carried out according to the developed test tasks within the educational program in accordance with the requirements of the state mandatory standard of higher and postgraduate education.

When evaluating learning outcomes, uniform conditions and equal opportunities are created for students to demonstrate their knowledge, skills and abilities. To use modern information technologies for the collection, processing and

dissemination of scientific information in the field of production of organic substances, processing of oil, gas, coal and polymers, elastomers, paints and varnishes.

4. Passport of the educational program

4.1. General information

№	Field name	Note
1	Code and classification of the field of education	8D07 «Engineering, manufacturing and construction industries»
1	Code and classification of areas of study	8D071 «Engineering and Engineering» (0710)
3	Group of educational programs	D097 Chemical Engineering and Processes"
4	Name of the educational program	8D07116 " Chemical technology of organic substances and materials"
5	Brief description of the educational program	The educational program (hereinafter EP) is a set of documents developed by the Kazakh National Research Technical University named after K.I. Satpayev and approved by the Ministry of Education and Science of the Republic of Kazakhstan. The EP considers the needs of the regional labor market, the requirements of government agencies and relevant industry requirements.
6	Purpose of the OP	Training of specialists with key and professional competencies in the field of production of organic substances, processing of oil, gas, coal and polymers, elastomers, paints and varnishes.
7	OP type	new
8	NQF level	8
9	ORC level	8
10	Distinctive features of the OP	The EP was developed considering the Atlas of new professions and competencies of Kazakhstan in the field of chemical technology of organic substances.
11	List of competencies of the educational program:	KK1.Communication - Fluent monolingual oral, written and communication skills - The ability to use communicative communication in various situations KK 2. Basic literacy in natural science disciplines - basic understanding of the scientific picture of the world with an understanding of the essence of the basic laws of science KK3.General engineering competencies - basic general engineering skills and knowledge, the ability to solve general engineering tasks and problems KK4.Professional competencies - a wide range of theoretical and practical knowledge in the professional field; - the ability to carry out the technological process in accordance with the regulations and use technical means to measure the main parameters of the technological process, the composition and properties of raw materials and finished products; KK5. Engineering and computer competencies - basic skills of using computer programs and software systems to solve

		general engineering tasks KK6.Engineering and working competencies - skills and abilities of using technical means and experimental devices to solve general engineering tasks KK7. Socio-economic competencies - Critical understanding and cognitive ability to reason on contemporary social and economic issues KK8. Specially-professional competencies for the perception of information, setting goals and choosing ways to achieve it; - the ability to independently organize the work of performers, find and make management decisions in the field of labor organization and implementation of environmental measures; - knowledge of the principles of management, control and correction of activities in the context of teamwork, improving managerial and executive professionalism.
12	Learning outcomes of the educational program:	PO1 Critically evaluate contemporary scientific concepts, methods, and approaches in the chemical technology of organic substances and polymeric materials, as well as in sustainable development. PO2 Apply the principles of sustainable chemistry and environmental safety in the design of technological processes. PO3 To develop optimized processes for the processing of hydrocarbon and polymer raw materials using digital and mathematical models. PO4 To develop new materials and polymers with specified properties for priority sectors of the economy. RO5 To use scientometric and information resources to justify the relevance and novelty of scientific developments and to conduct professional communication, including the preparation of publications, patents, and reports. RO6 Plan and conduct applied and fundamental research in the field of chemical technology of organic substances.
13	Form of study	Full-time
14	Training period	3 years
15	Volume of loans	180
16	Languages of instruction	Kaz, Russian and English
17	Awarded Academic Degree	Doctor of Engineering (Industry)
18	Developer(s) and authors:	Selenova B.S., Mangazbaeva R.A., Aitkalieva G.S.

4.2. The relationship between the achievability of the formed learning outcomes in the educational program and academic disciplines

№	Name of discipline	Brief description of discipline	Number of credits	Formed learning outcomes (codes)					
				PO1	PO2	PO3	PO4	PO5	PO6
CYCLE OF BASIC DISCIPLINES university component									
1	Academic writing	Purpose: To form the system competencies of doctoral students and young researchers in the field of academic writing as a key tool for scientific communication and publication activities. Content: Scientific discourse and academic communication; Typology of scientific texts: from dissertation to publication; Creation of original scientific content; Scientific text: structure and logic of construction; Comparative analysis of sources and preparation of a literary review; Work with metadata and scientometric tools; Preparation of articles for international peer-reviewed journals; Work with reviews and the scientific community; Academic mobility and grant support for research; Annotations, patents, reports: science beyond the article; Planning of publication strategy and research career; English language of scientific communication.	5	v				v	
2	Methods of scientific research	Purpose: It consists in mastering knowledge about the laws, principles, concepts, terminology, content, specific features of the organization and management of scientific research using modern methods of scientometry. Contents: structure of	5	v					

		technical sciences, application of general scientific, philosophical and special methods of scientific research, principles of organization of scientific research, methodological features of modern science, ways of development of science and scientific research, the role of technical sciences, computer science and engineering research in theory and practice.							
3	Sustainability Science	Objective: to develop a deep understanding among doctoral students of the interactions between natural and social systems, as well as to develop skills for identifying and developing strategies for sustainable development that promote long-term human well-being and environmental preservation. Content: complex interconnections between ecosystems and societies. An analysis of sustainability issues at local, national, and international levels.	5	v					
CYCLE OF BASIC DISCIPLINES component of choice									
4	Complex processing of hydrocarbon raw materials	Course Objective develop doctoral students' ability to independently forecast, design, and implement innovative approaches to hydrocarbon feedstock processing that ensure optimization of technological processes, taking into account feedstock composition and properties, sustainable development requirements, and environmental safety. Content: Current trends in hydrocarbon feedstock processing in the context of the energy transition; integrated technological schemes and process	5	v	v			v	

		integration; modelling and optimization in Aspen HYSYS; greening production (reducing the carbon footprint, utilizing by-products); patent search and techno-economic justification of innovations; pilot and industrial testing. Final assessment - exam, defense of a project or research paper.							
5	Simulation and optimization of chemical engineering processes	Course Objective develop doctoral students' ability to design, adapt, and implement innovative methods of computer modelling and optimization of processes in chemical technology of organic substances and materials, ensuring sustainable, resource-efficient, and environmentally safe production. Content: mathematical modelling (dynamic, steady-state, multiphase, reaction-diffusion models); integration of experimental data; modelling synthesis and processing of hydrocarbon and polymer feedstock; optimization of technological schemes (gradient, evolutionary, multi-criteria methods); sensitivity analysis, forecasting, and risk management; use of Aspen Plus, COMSOL, MATLAB, ANSYS Fluent; digital twins. Final assessment - exam, defense of a project or research paper.	5			v			v
CYCLE OF PROFILE DISCIPLINES COMPONENT OF CHOICE									
6	Green chemistry in the production of chemicals and materials	Course Objective develop doctoral students' ability to design and implement innovative, resource-efficient, and environmentally safe chemical-technological processes and materials based on the principles of green chemistry, applying advanced	5		v				v

		digital and analytical tools aimed at minimizing environmental impact and increasing product sustainability in the context of the Sustainable Development Goals (SDGs). Content: Concept and principles of green chemistry: 12 principles and their role in industrial chemistry. Environmental assessment of technologies: LCA (Life Cycle Assessment) and LCC (Life Cycle Cost) methodologies. Green reagents and solvents: designing safe alternatives. Innovative catalytic processes with low energy consumption. Biotechnological and enzymatic processes in chemical production. International environmental safety and sustainability standards and regulations (REACH, ISO 14000). Case studies: successful implementation of green technologies in polymer production, petrochemicals, and pharmaceuticals. Final assessment - exam, defense of a project or research paper.							
7	Polymers with a complex of special properties	Course Objective develop doctoral students' competencies in scientifically grounded design, forecasting, and optimization of technologies for producing polymer composite materials (PCMs) with a complex of special properties, including the ability to create innovative materials with specified characteristics for priority sectors of the economy, integrating principles of sustainable development and environmental safety. Content: The course prepares specialists capable of independently designing,	5	v	v		v		

		conducting research, and implementing in production the technologies for manufacturing PCMs with unique performance characteristics: high strength, thermal stability, chemical resistance, biocompatibility, etc. Topics include: modern classifications and requirements for PCMs with special properties; relationships between molecular structure, supramolecular organization, and performance; technological processes of PCM synthesis and processing; principles of selecting polymer binders and fillers considering sustainability and environmental safety; innovative directions: smart polymers, self-healing materials, biodegradable composites; methods for assessing durability and reliability of PCMs under real operating conditions; case studies from aerospace, medical, oil and gas, and energy industries. Final assessment - exam, defense of a project or research paper.							
8	Modern catalytic methods for the synthesis of polymers	Course Objective develop doctoral students' ability to design and optimize innovative catalytic processes for polymer synthesis with specified properties, considering sustainable development, resource efficiency, and environmental safety. Content: Current trends in catalytic polymer synthesis; homogeneous, heterogeneous, metallocene, and post-metallocene catalysts; polymerization mechanisms (coordination, radical, cationic, anionic); influence of	5	v	v	v	v		

		monomer structure and synthesis conditions on polymer structure and properties; methods of modification and functionalization; synthesis of biopolymers and polymers from renewable feedstock; environmentally friendly and resource-saving approaches; modelling and optimization of catalytic processes using specialized software. Final assessment - exam, defense of a project or research paper.							
9	GTL technologies	Course Objective develop doctoral students' ability to design, forecast, implement, and optimize innovative technologies for producing synthetic liquid fuels from natural and liquefied petroleum gases (Gas-to-Liquids, GTL), based on advanced scientific achievements in chemistry, catalysis, kinetics, and process engineering. Special attention is given to sustainability, energy efficiency, and environmental safety, as well as the integration of digital models and modern design tools. GTL technologies are a key direction in producing environmentally clean fuels, diversifying energy sources, and increasing national energy independence. The course builds competencies required for the development and implementation of advanced gas processing technologies, which is particularly relevant for Kazakhstan in the context of the global transition to a low-carbon economy. Final assessment - exam, defense of a project or research paper.	5	v	v	v			

Curriculum of educational program



«APPROVED»
Decision of the Academic Council
NPJSC «KazNRTU
named after K.Satbayev»
dated 06.03.2025 Minutes № 10

WORKING CURRICULUM

Academic year	2025-2026 (Autumn, Spring)
Group of educational programs	D097 - "Chemical engineering and processes"
Educational program	8D07116 - "Chemical technology of organic substances and materials"
The awarded academic degree	Doctor of Engineering (Industry)
Form and duration of study	full time (professional track) - 3 years

Discipline code	Name of disciplines	Block	Cycle	Total ECTS credits	Total hours	lek/lab/pr Contact hours	in hours SIS (including TSIS)	Form of control	Allocation of face-to-face training based on courses and semesters						Prerequisite	
									1 course		2 course		3 course			
									1 sem	2 sem	3 sem	4 sem	5 sem	6 sem		
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)																
CYCLE OF BASIC DISCIPLINES (BD)																
M-1. Module of basic training (university component)																
MET322	Methods of scientific research		BD, UC	5	150	30/0/15	105	E	5							
LNG305	Academic writing		BD, UC	5	150	0/0/45	105	E	5							
MNG350	Sustainability Science	1	BD, UC	5	150	30/0/15	105	E	5							
BIO322	Simulation and optimization of chemical engineering processes	1	BD, CCH	5	150	30/0/15	105	E	5							
CHE310	Complex processing of hydrocarbon raw materials	1	BD, CCH	5	150	30/0/15	105	E	5							
CYCLE OF PROFILE DISCIPLINES (PD)																
M-5. Module of final attestation																
ECA325	Final examination (writing and defending a doctoral dissertation)		FA	12											12	
M-4. Experimental research module																
AAP372	Experimental research work of doctoral student, including internships and doctoral dissertations		ERWDS	5				R	5							
AAP376	Experimental research work of doctoral student, including internships and doctoral dissertations		ERWDS	10				R		10						
AAP374	Experimental research work of doctoral student, including internships and doctoral dissertations		ERWDS	30				R			30					
AAP374	Experimental research work of doctoral student, including internships and doctoral dissertations		ERWDS	30				R				30				
AAP374	Experimental research work of doctoral student, including internships and doctoral dissertations		ERWDS	30				R					30			
AAP375	Experimental research work of doctoral student, including internships and doctoral dissertations		ERWDS	18				R							18	
No module																
AAP371	Industrial internship		PD, UC	20				R		20						
M-2. Module of professional activity (component of choice)																
BIO323	Polymers with a complex of special properties	1	PD, CCH	5	150	30/0/15	105	E	5							
CHE314	GTL technologies	1	PD, CCH	5	150	30/0/15	105	E	5							
BIO324	Modern catalytic methods for the synthesis of polymers	2	PD, CCH	5	150	30/0/15	105	E	5							
CHE315	Green chemistry in the production of chemicals and materials	2	PD, CCH	5	150	30/0/15	105	E	5							
Total based on UNIVERSITY:										30	30	30	30	30	30	
										60	60	60	60	60	60	
Number of credits for the entire period of study																
Cycle code	Cycles of disciplines			Credits												
				Required component (RC)		University component (UC)		Component of choice (CCH)		Total						
GED	Cycle of general education disciplines			0		0		0		0		0		0		
BD	Cycle of basic disciplines			0		15		0		0		0		15		

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PD	Cycle of profile disciplines	0	20	10	30
Total for theoretical training:		0	35	10	45
RWDS	Research Work of Doctoral Student				0
ERWDS	Experimental Research Work of Doctoral Student				123
FA	Final attestation				12
TOTAL:					180

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Minutes № 3 dated 20.12.2024

Decision of the Academic Council of the Institute. Minutes № 3 dated 28.11.2024

Signed:

Governing Board member - Vice-Rector for Academic Affairs

Uskenbayeva R. K.

Approved:

Vice Provost on academic development

Kalpeyeva Z. B.

Head of Department - Department of Educational Program
Management and Academic-Methodological Work

Zhumagaliyeva A. S.

Director - Geology and Oil-gas Business Institute named after
K. Turyssov

Auyelkhan Y. .

Department Chair - Chemical and biochemical engineering

Mangazbayeva R. A.

Representative of the Academic Committee from Employers

Seytenova G. Z.

____Acknowledged____

