Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Machines and Apparatus of Chemical and Oil Refining Production

"Industrial mixing"

The syllabus of the discipline

Details of the discipline	
Level of higher education	**First (bachelor's) degree**
Field of expertise	13 - Mechanical engineering
Specialty.	133 - Industrial machinery engineering
Educational program	"Industrial Engineering"
Status of the educational component	Selective
Scope of the discipline	120 hours/ 4 ECTS credits
Year of study, semester	4th year of study, fall semester
Form of study	Full-time (daytime)
Class schedule	1 lecture every two weeks and 1 practical lesson per week
Semester control / control measures	Credit / 1 ICR, WGR.
Language of instruction	English
Information about the course leader / teachers	phD, Associate Professor, Seminsky Oleksandr Olehovych, forstd@ukr.net , @mahnv_kpi
Placement of the course	http://ci.kpi.ua

Program of the discipline

1. Description of the discipline, its purpose, subject matter and learning outcomes

Mixing is one of the most common technological processes used to produce multicomponent systems, improve product quality, intensify chemical reactions and heat and mass transfer processes. Understanding the laws of mixing and the rational choice of mixing equipment allows for greater efficiency and technological excellence in production.

Within the framework of the educational and professional program "Computer-integrated technologies of equipment design in chemical engineering", the discipline "Industrial mixing" complements the professional component of training in terms of the peculiarities of processes in fluid media and the peculiarities of choosing the design of special equipment.

The purpose of the discipline is to develop an understanding of the mixing process and its practical application.

The discipline develops the following ***competencies***:

- apply knowledge in practical situations;
- to learn and master modern knowledge;
- ability to think systematically;
- the ability to use knowledge of the physical fundamentals of hydromechanical, thermal and mass transfer processes in solving professionally oriented problems;

- ability to determine the parameters of chemical and technological processes and to make a rational choice of equipment for their implementation and determine its operating modes under given production conditions.

The ***program learning outcomes*** after studying the discipline include:

- knowledge and understanding of the principles, approaches and methods of chemical and related technologies equipment engineering and prospects for their development, be able to analyze engineering objects, processes and methods;
- ability to select and use equipment, tools and methods necessary for solving engineering problems.

2. Prerequisites and post-requisites of the discipline

The discipline is based on the educational components of the program: "Fundamentals of Chemical Engineering" and "Transfer Processes in Continuous Media", and complements the discipline "Processes and Equipment of Chemical Technology".

3. Content of the discipline

The discipline deals with the issues of mixing using mainly mechanical mixing devices, namely: hydrodynamics of mixing, peculiarities of the process in obtaining dispersed systems, chemical reactions, processing of non-Newtonian liquids; peculiarities of calculating process parameters and selecting equipment for its implementation.

4. Training materials and resources

Basic literature:

1. Processes and equipment of chemical technology / Y.M. Kornienko, Y.Y. Lukach, I.O. Mikulonok, B.L. Rakytsky, G.L. Ryabtsev. K.: NTUU "KPI", 2011. - [P. 1. - 300 p.; P. 2.-416 p.].
2. Processes and apparatus of chemical technologies. Part II. Hydromechanical processes. Mixing / Y.M. Khanyk, A.I. Dubynin, O.V. Stanislavchuk, L.Z. Biletska - Lviv: Lviv Polytechnic Publishing House, 2006. - 180 c.
3. Processes and apparatus of chemical technology: Textbook / Edited by L.L. Tovazhnyansky - Kharkiv: NTU "KhPI." - 1016 p.

Additional reading:

1. Oldshue J.Y. Fluid Mixing Technology / J.Y. Oldshue. - Mcgraw-Hill, 1983. - 574 p.
2. Harnby N. Mixing in the Process Industries / N Harnby, M.F. Edwards, A.W. Nienow. - Butterworth-Heinemann, 1997. - 432 p.
3. Paul E.L., Atiemo-Obeng V.A. and Kresta S.M. Handbook of Industrial Mixing: Scince and Practice / E.L. Paul, V.A. Atiemo-Obeng and S.M. Kresta (eds.) - Hoboken, NJ, USA: Wiley, 2003. - 1432 p.
4. Kresta S.M., Etchells A.W., Dickey D.S. and Atiemo-Obeng V.A. Advances in Industrial Mixing: A Companion to the Handbook of Industrial Mixing / S.M. Kresta, A.W. Etchells, D.S. Dickey and V.A. Atiemo-Obeng (eds.). - USA^ Wiley, 2015. - 1040 p.
5. Nagata S. Mixing Principles and Applications / S. Nagata. - USA: Halsted Press, 1975. - 458 p.

Educational content

5. Methods of mastering the discipline

Calendar and thematic plan

Week	*The content of the training work*	*SRS (66 hours according to the curriculum)*
1, I week	**Lecture 1.** Scope of application of mixing. Classification of equipment for mixing. Basic designs of devices with mechanical stirrers.	Study the topic of the class. Work with the recommended literature.
2, I week	**Practical lesson 1:** Hydrodynamic calculation of a device without internal devices.	Preparing for the lesson.
3, II week	**Practical lesson 2:** Hydrodynamic calculation of the apparatus with reflectors.	Preparing for the lesson.
4, I week	**Lecture 2**. Hydrodynamics of mechanical mixing. Modified similarity criteria. Efficiency of mixing. Fundamentals of calculation of mechanical mixers.	Study the topic of the class. Work with the recommended literature.
5, I week	**Practical lesson 3:** Hydrodynamic calculation of the apparatus with internal devices.	Preparing for the lesson.
6, II week	**Practical lesson 4.** Calculation of an apparatus with several mixers.	Preparing for the lesson.
7, I week	**Lecture 3**. Technological features of the organization of mixing. Determination of residence time in a separate apparatus and in a cascade.	Study the topic of the class. Work with the recommended literature.
8, I week	**Practical lesson 5.** Thermal calculation of a device without internal devices with a shell.	Preparing for the lesson.
9, II week	**Practical lesson 6.** Calculation of heat transfer from a coil in an apparatus with reflectors.	Preparing for the lesson.
10, I week	**Lecture 4**. Heat transfer in devices with stirrers.	Study the topic of the class. Work with the recommended literature.
11, I week	**Practical lesson 7.** Calculation of the parameters of a half-pipe shell.	Preparing for the lesson.
12, II week	**Practical lesson 8.** Thermal calculation of the apparatus with reflectors and a shell made of half-tubes.	Preparing for the lesson.
13, I week	**Lecture 5**. Reactors with stirrers.	Study the topic of the class. Work with the recommended literature.
14, I week	**Practical lesson 9.** Calculation of the maximum temperature drop for a flow apparatus without internal devices.	Preparing for the lesson.
15, II week	**Practical lesson 10.** Calculation of an apparatus for mixing in a liquid-solid system.	Preparing for the lesson.
16, I week	**Lecture 6**. Peculiarities of obtaining dispersed systems (suspension, emulsification) in apparatus with mechanical stirrers.	Study the topic of the class. Work with the recommended literature.
17, I week	**Practical lesson 11.** Calculation of an apparatus for mixing in a liquid-liquid system.	Preparing for the lesson.
18, II week	**Practical lesson 12.** Calculation of the apparatus for mass transfer in the liquid-gas system during mixing.	Preparing for the lesson.

Week	*The content of the training work*	*SRS (66 hours according to the curriculum)*
19, I week	**Lecture 7**. Mixing and foaming. Features of homogenization in devices with mechanical stirrers.	Study the topic of the class. Work with the recommended literature.
20, I week	**Practical lesson 13.** Calculation of dissolution in a liquid-solid system.	Preparing for the lesson.
21, II week	**Practical lesson 14.** Experimental study of mixing.	Preparing for the lesson.
22, I week	**Lecture 8**. Features of mixing non-Newtonian fluids.	Study the topic of the class. Work with the recommended literature.
23, I week	**Practical lesson 15.** Experimental study of mixing.	Preparing for the lesson.
24, II week	**Practical lesson 16.** Defense of the results of experimental research.	Preparing for the lesson.
25, I week	**Lecture 9**. Mixing liquids without the use of mechanical stirrers.	Study the topic of the class. Work with the recommended literature.
26, I week	**Practical lesson 17.** Module control work	Preparing for a module test.
27, II week	**Practical session 18.** Defense of individual assignments (WGW). Announcement of the results of semester control.	Completion of the requirements of the silaBus to obtain a positive grade in the discipline.

6. Independent work of the student

The types of independent work are listed in the table in paragraph 5, according to the academic weeks and scheduled classes.

Policy and control

7. Policy of the academic discipline

A system of requirements for students:

- **rules for attending classes** - attendance at all types of classes is mandatory both in classrooms and in distance learning. In the latter case, classes are held in Zoom conferences and students "attend" them by connecting to the links provided by teachers;
- **rules of behavior in the classroom** - not to interfere with other students' listening to lectures or working in practical classes by unnecessary activities or conversations (including by phone). In the classroom and during distance learning at home, follow safety rules;
- **rules for crediting practical classes and awarding points for their completion** - the teacher evaluates the student's work during the class, the quality and timeliness of the presentation of the results of the assignment;
- **rules for awarding incentive and penalty points** - no incentive points are provided; 1 penalty point is awarded for absence from class without a valid reason or for late completion of practical assignments;
- **policy of deadlines and retakes**:
  1) all assignments are submitted and evaluated exclusively during classroom sessions;
  2) retakes are carried out according to the schedule established at the university level within the timeframe determined by the teacher and communicated to students when the rating scores are announced;
- **Policy on Academic Integrity** - students are required to comply with the provisions of the Honor Code and the requirements of academic integrity during the educational process.

8. Types of control and rating system for assessing learning outcomes

Current control: evaluation of work in practical classes (15 tasks, each of which is evaluated with a maximum of 4 points, the total score for all classes is 60 points), a module test and a calculation and graphic work are evaluated with a maximum of 20 points each.

Calendar control: is carried out twice a semester on weeks 7-8 and 14-15 as a monitoring of the current state of fulfillment of SilaBus requirements - a student receives "satisfactory" during the first and second calendar control if his/her current rating is at least 0.5 of the maximum number of points possible at the time of control.

Semester control is carried out in the form of a test, which is given at the last practical lesson based on the results of work in the semester in accordance with the student's rating in the discipline.

Conditions of admission to the semester control. Admission to the test is possible only if you complete and submit all practical assignments, submit a calculation and graphic work, write a module test and attend at least two-thirds of the lectures.

Table of correspondence between rating points and grades on the university scale:

Number of points	*Assessment.*
100-95	Excellent
94-85	Very good
84-75	Okay.
74-65	Satisfactory
64-60	Enough
Less than 60	Unsatisfactory
The conditions for admission are not met	Not allowed

9. Additional information on the discipline

The retake is conducted in the form of a test consisting of two parts: written and oral. The written part involves answering three questions selected using a random value generator (without repetition) from the list of control questions. The oral part consists of a survey on the course topics related to the questions in the ticket. Questions are worth a maximum of 15 points. Retakes are conducted according to a "soft" scheme (with the points gained during the semester). At the same time, 10 penalty points are awarded for each retake.

The syllabus of the discipline:

Compiled by Oleksandr Seminsky, Associate Professor of the Department of MAHNV, Candidate of Technical Sciences, Associate Professor.

Approved at the meeting of the Department of Machines and Apparatus of Chemical and Oil Refining Production (Protocole No. 20 of June 20, 2024).

Approved by the Methodological Commission of the Faculty of Engineering and Chemistry (Protocole No. 11 of June 28, 2024).