



National Technical University of
Ukraine "Igor Sikorsky Kyiv
Polytechnic Institute"



Department of machines and
devices of chemical and oil
refining industries

NAME OF THE COURSE

Computerized methods of construction and calculation of technological pipelines

Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	First (bachelor's)
Field of knowledge	13 Mechanical engineering
Specialty	133 Industrial mechanical engineering
Educational program	Industrial Mechanical Engineering
Discipline status	Selective
Form of study	full-time
Year of training, semester	4 course, spring semester
Scope of discipline	4 (120)
Semester control/ control measures	Test
Lessons schedule	https://rozklad.kpi.ua/ https://ecampus.kpi.ua/ 3 hours per week (1 hours of lectures and 2 hours of practical classes)
Language of teaching	Ukrainian
Information about head of the course / teachers	Lecturer: Ph.D., Assoc. Andreiev I. A. Practical/Seminar: Ph.D., Assoc. Andreiev I. A. che@kpi.ua
Placement of the course	https://ecampus.kpi.ua/ , http://ci.kpi.ua

Program of educational discipline

1. Description of the educational discipline, its purpose, subject of study and learning outcomes *Description of the educational discipline.*

The course covers the basics of designing technological pipelines, their application, theoretical information on the basics of engineering calculations, modern standard calculation formulas, normative calculation methods.

The subject of the academic discipline.

Discipline "Computerized methods of construction and calculation of technological pipelines" is taught as a selective component of training qualified specialists in the field of mechanical engineering, resource conservation, ecology and computer-integrated technologies.

Mastering the methods of design and calculation involves not just mastering certain rules, but rather the development of a unique style of thinking, focused on the creation of modern technology in the field of chemical and oil refining engineering.

The purpose of the educational discipline.

The purpose of studying this discipline is the formation of students of a complex of knowledge, skills, and abilities necessary for qualified design and calculation of typical equipment of the chemical industry. According to the goal, the training of bachelors requires the formation of the following abilities:

- use and application in professional activity of normative methods of calculation of technological pipelines,

- using knowledge of design and construction of typical equipment,
- mastering the method of determining the loads that occur during installation, testing and in working conditions,
- receiving information about the current state of equipment elements during operation,
- improvement of technological pipeline equipment,
- use of the method of calculating stresses and deformations that occur during the operation of technological pipelines.

1.2. The main tasks of the credit module.

According to the requirements of the educational and professional program, after mastering the academic discipline, students must demonstrate the following learning outcomes:

knowledge:

- basic constructions of technological pipelines, typical nodes and details and requirements for them;
- materials used in manufacturing process pipelines and their properties;
- calculation parameters and rules for their determination;
- conditions of strength, stiffness, stability, tightness;
- calculation models of technological pipelines;
- determination of stresses, stress state analysis, permissible and limit loads;
- normative methods of calculation of technological pipelines;
- development of a structurally perfected product.

skill:

- based on the features of the technological process, determine the initial and limiting conditions and load scheme for the structure,
- on the basis of working conditions, determine the stress-strain state of the structure under static and dynamic thermoforce loads,
- based on the knowledge of theoretical training, using reference books and standards, choose structural materials and seal materials,
- using reference materials, perform calculations regarding the strength of technological pipelines,
- perform parametric calculations of technological pipelines using known analytical dependencies and reference information,
- take into account the need for assembly, disassembly, transportation and installation of the product,
- on the basis of the acquired knowledge, perform calculations on stiffness, stability, strength and develop design documentation,
- create constructions of technological pipelines that are safe in operation.

experience:

- design development of technological pipelines;
- ensuring strength, stability, rigidity, tightness, corrosion resistance, structural integrity and other requirements for elements of technological pipelines.

2. Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

Mastering the discipline "Computerized methods of construction and calculation of technological pipelines" is based on the principles of integration of the complex of knowledge received by students during the bachelor's education when studying the disciplines of natural and engineering-technical direction in the field of "Mechanical Engineering". To successfully master this discipline, it is necessary

to have basic knowledge in the field of higher mathematics, physics, resistance of materials, hydraulics, processes and equipment of chemical industries, to be able to use a computer to provide the necessary calculations, to have skills in the field of applied programming, mathematical modeling of processes and systems.

As a result of mastering the discipline, the student will be ready to use fundamental and natural scientific knowledge and methods to solve complex scientific and technical problems in the field of professional and research and innovation activities.

3. Content of the academic discipline "Computerized methods of construction and calculation of technological pipelines"

Topic 1. Technological pipelines. General requirements.

Topic 2. Details of pipelines.

Topic 3. Normative parameters and permissible stresses.

Topic 4. Calculation of steel pipelines.

Topic 5. Calculation of the thickness of the walls of taps.

Topic 6. Calculation of the thickness of the transition walls.

Topic 7. Tee connections.

Topic 8. Calculation of the strength of high-pressure steel pipelines.

Topic 9. Calculation of non-linear high-pressure pipes, which are designed to work at elevated temperatures.

Topic 10. Calculation of curved elements of high-pressure pipelines.

Topic 11. Calculation of conical transitions of high pressure pipelines.

Topic 12. Plugs of technological pipelines.

Topic 13. Calculation of hole reinforcement.

4. Educational materials and resources

Basic literature

1 ДБН Д.2.3–12–99. Технологічні трубопроводи. [Чинний від 2000-01-01]. Вид. офіц. Київ: Держбуд, 2000. 226 с.

2 Штонда Ю. Н., Барвин А. И., Табунщиков В. Г. Методические указания к расчету на прочность технологических стальных трубопроводов на P_y до 10 МПа. Северодонецк: ТИ, 2009. 112 с. URL: https://ohpkaf.at.ua/k_raschetu_na_prochnost_tekhnologicheskikh.pdf.

3 НПАОП 0.00–1.73–14. Правила охорони праці та безпечної експлуатації технологічних трубопроводів. [Чинний від 2014-11-12]. Вид. офіц. Київ: ДНАОП, 2015. URL: https://dnaop.com/html/54573/doc-%D0%9D%D0%9F%D0%90%D0%9E%D0%9F_0.00-1.73-14.

4 СОУ МПП 71.120-217:2009. Посудини та апарати сталеві зварні. Загальні технічні умови. [Чинний від 2009–07–07]. Вид. офіц. Київ: Міністерство промислової політики України, 2009. 339 с.

5 Андреев Игорь. Розрахунок технологічних трубопроводів: навч. посіб. для студ. спеціальності 133 «Галузеве машинобудування». Київ: КПІ ім. Ігоря Сікорського, 2023. 104 с. URL: <https://ela.kpi.ua/handle/123456789/52475>.

6 Андреев I. A. Конструювання і розрахунок основних елементів посудин та апаратів: підруч. для здобувачів ступеня бакалавра за спец. 133 Галузеве машинобудування. Київ: КПІ ім. Ігоря Сікорського, 2024. 428 с. URL: <https://ela.kpi.ua/handle/123456789/65136>.

7 Андреев I. A. Конструювання і розрахунок типового устаткування хімічних виробництв. Основні положення. Елементи тонкостінних посудин, навантажених внутрішнім тиском: навч. посіб. Київ: "Видавництво «Політехніка»", 2011. 272 с.

Additional literature

8 Андреев І. А., Мікульонок І. О. Розрахунок, конструювання і надійність обладнання хімічних виробництв: термінологічний словник. Київ: ІВЦ "Видавництво «Політехніка»", 2002. 216 с.

9 Андреев І.А., Зубрій О.Г. Конструювання та розрахунок апаратів високого тиску: навч. посіб. Київ: ІЗМН, 1999. 144 с.

10 Андреев І. А., Зубрій О. Г., Мікульонок І. О. Застосування матеріалів у хімічному машинобудуванні. Сталі й чавуни: навч. посіб. Київ: ІЗМН, 1999. 148 с.

11 Андреев Ігор. Укріплення отворів в посудинах та апаратах: навч. посіб. Київ: КПІ ім. Ігоря Сікорського, 2021. 72 с. URL: <https://ela.kpi.ua/handle/123456789/42254>.

5. Methods of mastering an educational discipline (educational component)

Lecture classes (taking into account individual classes).

Lectures are aimed at providing modern, comprehensive knowledge of the discipline "Computerized methods of construction and calculation of technological pipelines", definitions at the modern level of scientific development in the area of calculation and design of machines and devices; ensuring fruitful work of students during the lecture; application of effective methods of teaching, presentation of material and its assimilation; education of students' professional qualities and development of creative thinking; formation of their scientific and practical interest in mastering the course material, the desire for independent work.

№№№	The name of the topic of the lecture, a list of main questions, references to the literature, and assignments for students' homework	Hour (taking into account individual classes)
1	Technological pipelines. General requirements. Details of pipelines. Normative parameters and permissible stresses. Literature: [1–11]	2
2	Calculation of steel process pipelines under pressure up to 10 MPa. Literature: [1, 2, 5–8]	2
3	Calculation of the thickness of the walls of taps. Literature: [1, 2, 5–8]	2
4	Calculation of the thickness of the walls of transitions and tee connections. Literature: [1, 2, 5–8]	2
5	Calculation of the strength of high-pressure steel pipelines. Literature: [1, 2, 5–9]	2
6	Calculation of non-linear high-pressure pipes, which are designed to work at elevated temperatures. Literature: [1, 2, 5–8]	2
7	Calculation of curved elements of high-pressure pipelines. Calculation of conical transitions of high pressure pipelines. Literature: [1, 2, 5–8]	2
8	Plugs of technological pipelines. Literature: [1, 2, 5–8]	2
9	Calculation of hole reinforcement. Literature: [1, 2, 5–8, 11]	2
Total hours (including individual classes)		18

Practical classes (taking into account individual classes)

When studying a credit module, 2/3 of the classroom load is allocated to practical classes. A practical lesson on a separate topic of this discipline is aimed at consolidating the material presented in the lecture by considering specific examples, exercises and problems on this topic. This enables students to systematize and deepen their theoretical knowledge. The practical session is conducted in a dialogue mode with educational discussions. At the beginning of the class, a control survey of the students is conducted based on the materials of the previous lectures, their familiarization with literary sources on the subject of the discipline.

№№	Name of the subject of the practical session, list of main questions, references to the literature	Hour
1	Normative parameters and permissible stresses. Calculation of steel process pipelines under pressure up to 10 MPa. Literature: [1–8]	2
2	Calculation of the strength of high-pressure steel pipelines. Literature: [1, 2, 5–8]	2
3	Calculation of the thickness of the walls of taps. Literature: [1, 2, 5–8]	4
4	Calculation of the thickness of the transition walls. Literature: [1, 2, 5–8]	2
5	Calculation of the wall thickness of tee joints. Literature: [1, 2, 5–8]	2
6	Calculation of the strength of high-pressure steel pipes. Literature: [1, 2, 5–8]	2
7	Verification calculation of high-pressure pipes in case of simultaneous action of internal pressure and temperature stresses. Literature: [1, 2, 5–9]	2
8	Calculation of non-linear high-pressure pipes, which are designed to work at elevated temperatures. Literature: [1, 2, 5–8]	6
9	Calculation of curved elements of high-pressure pipelines. Literature: [1, 2, 5–8]	2
10	Calculation of conical transitions of high pressure pipelines. Literature: [1, 2, 5–8]	2
11	Plugs of technological pipelines. Literature: [1, 2, 5–8]	4
12	Calculation of hole reinforcement. Literature: [1, 2, 5–8, 11]	6
Total hours		36

6. Independent work of the student (taking into account individual classes)

When teaching the academic discipline "Computerized methods of construction and calculation of technological pipelines", the student's independent work takes up 55% of the time of studying the credit module, taking into account the preparation for the credit. Independent work of students includes preparation for classroom classes, execution of modular control and calculation-graphic works, study of sections of the program and topics that are not included in the list of lecture questions or require more detailed study. The acquisition of knowledge on these topics is carried out through a detailed study of the relevant sections of the recommended basic and additional literature and an independent scientific and informational search on one's own initiative. The preparation of the student for the next classroom classes involves mastering the material of the previous lectures in the process of independent work.

№№	Type of work and titles of topics submitted for independent study	Hour
1	Preparation for classroom classes.	10

2	Performance of individual practical tasks on the topic of the module.	20
Working out sections of the program and topics that are not taught in lectures		
3	Design and calculation of non-metallic technological pipelines. Literature: [1 – 11].	21
4	Preparation for the test	15
Total hours		66

Policy and control

7. Policy of academic discipline (educational component)

Rules for attending lectures and practical classes;

Attending lectures and practical classes is a mandatory component of studying the material. At the lecture, the teacher uses his own presentation material. Students are obliged to take an active part in the educational process, not to be late for classes and not to miss them without a good reason, not to be distracted by actions unrelated to the educational process.

Policy of deadlines, rescheduling and incentive rules;

Missed classes must be made up. The student independently prepares a synopsis of the missed lecture or practical session, answers control questions to the teacher on the materials of the topic of the missed session. Individual practical tasks should be performed carefully and in a precisely defined time. Fulfillment of these requirements ensures an increase in the rating assessment of the results of mastering the educational discipline.

Academic Integrity Policy;

The policy of the academic discipline is built taking into account the norms of Ukrainian legislation on academic integrity, the Code of Honor of NTTU "Ihor Sikorsky Kyiv Polytechnic Institute" and is determined by the system of requirements that the teacher presents to the student when studying the discipline (rules of behavior in classes, absences, retakes, etc.).

8. Types of control and the rating system for evaluating learning outcomes (RSO) (taking into account individual classes).

Distribution of study time by types of classes and tasks in the discipline according to the working study plan:

Training time		Distribution of study hours				Control measures		
Credits	Hours	Lectures	Practical	Laboratory	Independent work of students	Modular control work	Calculation and graphic work	Semester control
4	120	18	36	–	66	1	1	Test

Control of students' knowledge is carried out with the help of interviews during practical classes, the results of individual practical tasks.

During the evaluation, the following is taken into account:

1. Attending lectures and practical classes, fruitfulness of work during classroom classes.
2. Timely and accurate performance of control practical tasks for independent work.
3. Study of basic and auxiliary literature.

1. The rating of the student from the credit module consists of the points he receives for work in practical classes, for the performance of control module and calculation-graphic works on the topic of the module, and according to the results of the semester control - exam.

2. Scoring criteria:

2.1. Work in practical classes:

- fruitful work - 4 points;
- untimely completed task - 2 points;
- passive work or absence from class - 0 points.

The maximum number of points for work during practical classes is 72.

2.2. Evaluation criteria for calculation and graphic work

- "excellent" - 15-18 points;
- "good" -- 9-14 points;
- "satisfactory" - 5-8 points;
- "unsatisfactory" - 0 points.

The maximum number of points for calculation and graphic work is 18.

2.3. Evaluation criteria for modular control work

- "excellent" - 10 points;
- "good" -- 8-9 points;
- "satisfactory" - 6-7 points;
- "unsatisfactory" - 0 points.

For 9 weeks of study, the maximum number of points that a student can score is 100 points based on the results of the educational work and the performance of the control module and calculation-graphic works.

To receive credit from the credit module "automatically", you need to have a rating of at least 60 points, as well as passed test papers.

Students who have a rating of less than 60 points at the end of the semester, as well as those who want to improve their grade in the rating points system, complete a credit test. The test task consists of three questions from different sections of the work program. An unsatisfactory answer to an additional question reduces the total score by 4 points.

Each test question (r1, r2 , r3) is evaluated at 33 points according to the evaluation system:

- "excellent", complete answer (at least 90% of the required information) - 33-30 points;
- "good", sufficiently complete answer (at least 75% of the required information or minor inaccuracies) - 29-25 points;
- "satisfactory", incomplete answer (at least 60% of the required information and some errors) - 24-20 points;
- "unsatisfactory", an unsatisfactory answer - 0 points.

The sum of the rating points received by the student after mastering the discipline and passing the exam is transferred to the final grade according to the table:

Scores	Rating
95...100	excellent
85...94	very good
75...84	good
65...74	satisfactory
60...64	enough
< 60	unsatisfactory
Admission conditions not met	not allowed

9. Additional information on the discipline (educational component)

Preliminary list of questions submitted for semester control.

1. Обґрунтувати призначення і класифікувати технологічні трубопроводи.
2. Навести склад технологічних трубопроводів.
3. Навести марки сталей, які застосовуються для виготовлення технологічних трубопроводів.
4. Навести нормативні параметри і допустимі напруження для технологічних трубопроводів.
5. Надати алгоритм розрахунку товщини стінки труб, які знаходяться під тиском до 10 МПа.

6. Надати алгоритм розрахунку товщини стінки гнутих відводів.
7. Надати алгоритм розрахунку товщини стінки безшовних відводів.
8. Надати алгоритм розрахунку товщини стінки секторних відводів.
9. Надати алгоритм розрахунку товщини стінки штампозварних відводів.
10. Обґрунтувати особливості розрахунку товщини стінки переходів.
11. Навести методику розрахунку трійникових з'єднань, що знаходяться під внутрішнім тиском до 10 МПа.
12. Навести конструкції зварних з'єднань трійників зі штуцером.
13. Обґрунтувати особливості розрахунку товщини стінки трійників з відбортованими отворами і врізною сідловиною.
14. Навести конструкції плоских круглих заглушок, які знаходяться під тиском до 10 МПа.
15. Навести методику розрахунку плоских круглих заглушок, які знаходяться під тиском до 10 МПа.
16. Навести методику розрахунку еліптичних заглушок, які знаходяться під тиском до 10 МПа.
17. Надати конструкції еліптичних заглушок з отворами.
18. Навести методику розрахунку еліптичних заглушок з отворами, які знаходяться під тиском до 10 МПа.
19. Навести нормативні параметри і допустимі напруження для технологічних трубопроводів високого тиску.
20. Надати алгоритм розрахунку товщини труби високого тиску.
21. Надати алгоритм перевірного розрахунку труб високого тиску у випадку сумісної дії внутрішнього тиску і температурних напружень.
22. Надати алгоритм розрахунку криволінійних елементів технологічних трубопроводів високого тиску.
23. Надати алгоритм розрахунку конічних переходів технологічних трубопроводів високого тиску.
24. Обґрунтувати принцип укріплення отворів технологічних трубопроводів.

Робочу програму навчальної дисципліни (силабус):

Складено доцент кафедри МАХНВ, к.т.н. Андрєєв Ігор Анатолійович

Ухвалено кафедрою машин та апаратів хімічних і нафтопереробних виробництв (протокол № 20 від 20.06.2024 р.)

Погоджено Методичною комісією інженерно-хімічного факультету (протокол № 11 від 28.06.2024 р.)