Syllabus
Course Program

Biosphere Protection Equipment

Specialty
E2 – Ecology

Institute
Institute of mechanical engineering and transport

Specialization
-

Department
Chemical engineering and industrial ecology (154)

Educational program
Engineering ecology

Course type
Selective

Level of education
Second (master's level)

Form of study
Full-time, part-time, distance learning

Semester
2

Language of instruction
Ukrainian, English

Lecturers and course developers

Nataliia Samoilenko
Nataliia.Samoilenko@khpi.edu.ua

Candidate of Technical Sciences, Professor of the Department of Chemical Engineering and Industrial Ecology at NTU "KhPI".
Author and co-author of more than 230 scientific and methodological publications.
General information, number of publications, main courses, etc.
More about the lecturer on the department's website

General information

Summary

The discipline is aimed at developing students' theoretical and applied knowledge on modern equipment used to protect the biosphere, proficiency in creating innovations in the area of technical means of environmental protection, principles of apparatus design and calculation, polluted gas emissions and wastewater treatment plants used to develop and update environmental technologies.

Course objectives and goals

Formation of students' systematic knowledge of modern treatment equipment, its design features and principle of operation, ability to substantiate ways to improve equipment and facilities characteristics, develop and design the most effective technical means of protecting elements of the biosphere to improve the environmental safety of industrial and non-industrial facilities.

Format of classes

Lectures, practical classes, calculated task, consultations, self-study. Final assessment in the form of differentiated grading.

Competencies

Knowledge of the latest engineering achievements and innovations in the field of technical means targeted on biosphere protection, ability to design and calculate equipment and apparatus for gas emissions and wastewater treatment, determination of the most effective technical means for use in the development of new nature conservation technologies.

Learning outcomes

Ability to identify the most effective technical means of protecting the biosphere, knowledge and justification of ways to improve environmental protection equipment, ability to develop, design, and modernise equipment for technological lines and treatment facilities, ability to carry out basic engineering calculations of environmental equipment in the system of developing new environmental technologies.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures – 32 hours, ppractical studies – 16 hours, self-study – 72 hours.

Course prerequisites

To successfully complete the course student must have knowledge and practical skills obtained in the previous disciplines "Eco-innovations in the Development of New Technologies", "Equipment and basics of designing environmentally safe technologies using CAD"

Features of the course, teaching and learning methods, and technologies

Lectures are conducted interactively with the use of multimedia technologies. The traditional teaching approach and the form of lectures-visualizations are used. In practical classes, the method of reproductive learning is used, which contributes to the development of students' skills and abilities regarding the acquired knowledge. The calculation task is aimed at deepening theoretical knowledge and developing the ability to perform calculations for professional tasks.

Program of the course

Academic classes

Lectures

Topics of the lectures	Hours
Topic 1. Sources of air pollution and characteristics of emissions. Sectoral structure of emissions of harmful substances and primary sources of their formation.	2
Topic 2. Equipment for dry purification of emissions from dust. Classification of methods and equipment for dry purification of emissions. Dust settling chambers. Vortex and louver dust collectors. Varieties of cyclones and their application. Emission purification using filters. Designs of bag filters and electrostatic precipitators.	4
Topic 3. Purification equipment for the wet method of dust collection. Characteristics of the method of wet purification of dusty streams and classification of apparatuses. Hollow scrubbers. Centrifugal gas washers. Foam dust collectors. Impact-inertial dust collection. Nozzle gas washers. Design and technological features of Venturi scrubbers	4
Topic 4. Equipment for the treatment of emissions from vapour and gaseous pollutants.	4

Features of emission purification from vapour and gaseous pollutants. Classification and characteristics of treatment methods. Types and designs of absorbers. Characteristics and design of adsorbers. Contact apparatuses with different types of catalysts.	
Topic 5. Settling and filtration of wastewater. General characteristics of mechanical wastewater purification. Sand traps. Designs of various types of sedimentation tanks. Classification and general characteristics of filters. Drum filters. Filters with granular load. Other types of filters.	4
Topic 6. Equipment for removing colloidal dispersed systems and emulsions from wastewater. Equipment for coagulation and flocculation. Characteristics of plants and flotators for wastewater treatment. Flotation-coagulators	4
Topic 7. Wastewater treatment apparatuses for removing dissolved impurities. Wastewater treatment in adsorbers. Ion exchange wastewater treatment using different types of apparatuses. Membrane water treatment systems and their design.	4
Topic 8. Electrochemical and chemical methods of wastewater treatment. General characteristics of treatment apparatuses. Designs of electroflotators and electrocoagulators. Characteristics of electrodialyzers and their designs. Features of chemical wastewater treatment.	2
Topic 9. Biological wastewater treatment systems. Technologies for biological treatment of industrial and domestic water. Structures and devices for biological wastewater treatment in artificial conditions. Design of aerators.	4
Total hours	**32**

Practical studies

Topics for practical studies	Hours	Weighting coefficients *a*
Topic 1. Calculation of industrial cyclones Industrial cyclones and features of their calculation. Methodology and example of cyclone calculation.	2	0,2
Topic 2. Determination of the main characteristics of the apparatuses for thin dust removal from emissions. Theoretical provisions. Calculation of bag filters. Calculation and selection of an electrostatic precipitator.	4	0,2
Topic 3. Apparatuses for wet gas treatment from dust and their calculation. Calculation of a hollow scrubber for the purification and cooling of contaminated emissions. Determination of the main parameters of a Venturi scrubber.	4	0,2
Topic 4. Calculation of mechanical wastewater treatment facilities. Wastewater treatment in sand and oil traps. Calculation of the main dimensions of a vertical settling tank.	4	0,2
Topic 5. Calculation of an electrocoagulator for wastewater treatment Theoretical aspects of the use of apparatuses in wastewater treatment technology. Determination of the main characteristics of the electrocoagulator	2	0,2

Total hours	**16**	$\sum_{i=1}^{n} a_i$

Laboratory classes

Laboratory work within the discipline is not provided

Control works

The control work is conducted in the form of testing on the Office 365 platform.

Topics for control works	Weighting coefficients b
Control work No.1.	1
Total	$\sum_{i=1}^{m} b_i$=1

Self-study

Work on theoretical materials

Topics for self-study	Hours
Topic 1. Complex of technological and engineering solutions for environmental protection	4
Topic 2.Basic mechanisms of dust collection	4
Topic 3. Designs of inertial dust collectors and features of their application	4
Topic 4. Biological treatment of emissions	4
Topic 5. Innovative developments in the technique of emissions treatment from carbon dioxide and its useful use	6
Topic 6. Apparatuses for wastewater treatment from suspended solids in the field of centrifugal forces	2
Topic 7. Extraction treatment of wastewater.	4
Topic 8. Treatment and neutralisation of sewage sludge.	4
Topic 9. The use of oxyfilters and biological filters for wastewater treatment.	4
Topic 10. Application of artificial intelligence to optimise emissions and wastewater treatment processes	6
Total hours	**42**

Topics for individual assignments

The individual assignment involves the calculation of the most common apparatuses and structures for treating polluted emissions and wastewater. It is aimed at deepening knowledge and gaining practical skills in the expected learning outcomes of this discipline. The student is asked to determine the equipment's main technological and design characteristics and structures according to an individual variant. The task is completed during the academic weeks and submitted for examination before the exam.

Topic 1. Calculation of the main characteristics of treatment equipment Determination of the main technological and design characteristics of polluted emission treatment apparatuses. Calculation of wastewater treatment apparatuses and facilities.	
Total hours	**30**

Non-formal education

The elements of non-formal education recommended in the syllabus can be credited under a simplified procedure without additional validation of the results (creation of a subject commission). If the topic matches, it can be counted instead of practical work the publication of an abstract of a scientific or scientific-practical conference, an article in a professional publication, or successful completion of a course or webinar may be credited with maximum marks instead of practical work. The recommended courses and webinars list is formed based on relevant information published by their developers during the academic year

Literature, training materials, and information resources

Main literature

1. Vasylenko I.A., Skyba M.I., Pivovarov O.A., Vorobiova V.I. Teoretychni osnovy okhorony navkolyshnoho seredovyshcha. Dnipro: Aktsent PP, 2017. 204 s.
2. Zatserkliannyi M.M., Zatserkliannyi O.M., Stolevych T.B. Protsesy zakhystu navkolyshnoho seredovyshcha: pidruchnyk. Odesa : Feniks, 2017. 454 s.
3. Krusir H. V., Madani M.M., Harkovych O.L. Tekhnika ta tekhnolohii ochyshchennia hazovykh vykydiv [Elektronnyi resurs] : navch. posib. Odesa : ONAKhT, 2017. Elektron. tekst. dani. 207 s. URL: https://card-file.ontu.edu.ua/handle/123456789/6498
4. Suchasni tekhnolohii zakhystu atmosfery: navch. posib. dlia studentiv vyshchykh navchalnykh zakladiv ekolohichnoho profiliu /Ukl. Martynenko S.A. Kropyvnytskyi: TsNTU, 2019. 155 s.
5. Doroshchenko V.V., Kotsiuba I.H., Yelnikova T.O., Uvaieva O.I. Vodopidhotovka: navch. posib. Zhytomyr: Derzhavnyi universytet «Zhytomyrska politekhnika», 2020. 153 s.
6.Inzhenerna ekolohiia : pidruchnyk / V. M. Isaienko, K. O. Babikova, Yu. M. Satalkin, M. S. Romanov ; za zah. red. prof. V. M. Isaienka. 2-e vyd., aktualizovane na pryntsypakh spryiannia stalomu innovatsiinomu rozvytku ta zasadakh synerhetychnoho i kompetentnisnoho pidkhodiv. Kyiv :NAU, 2019. 452 s.
7. Herasymov O.I. Teoretychni osnovy tekhnolohii zakhystu navkolyshnoho seredovyshcha: navch.pos. Odesk.derzh.ekol.un-t. Odesa:TES, 2018. 228 s.

Additional materials

1. Biekietov V. Ye., Yevtukhova H.P. Dzherela ta protsesy zabrudnennia atmosfery. Modul 1. Dzherela ta protsesy zabrudnennia atmosfery: konspekt lektsii dlia studentiv 3 kursu dennoi ta zaochnoi form navchannia spetsialnosti 101 – Ekolohiia. Kharkiv : KhNUMH im. O. N. Beketova, 2019. 113 s.
2. Cherniakova O.I. Metody zakhystu atmosfery : konspekt lektsii. Odesa: ODEKU, 2019. 89 s.
3. Innovation solutions to reduce environment pollution in air, soil, and water/ editor: Zeynep KARCIOĞLU KARAKAŞ. 2023. URL: https://iksadyayinevi.com/wp-content/uploads/2023/10/INNOVATIVE-SOLUTIONS-TO-REDUCE-ENVIRONMENTAL-POLLUTION.pdf
4. US EPA ARCHIVE DOCUMENT. URL: https://archive.epa.gov/region6/6pd/rcra_c/pd-o/web/pdf/a4a-apc-equipment.pdf

5.Metodychni vkazivky do vykonannia kursovoho proiektu z kursu "Obladnannia zakhystu biosfery" [Elektronnyi resurs]: dlia studentiv spets. 101 "Ekolohiia" ta 183 "Tekhnolohii zakhystu navkolyshnoho seredovyshcha" usikh form navchannia / uklad.: N. M. Samoilenko [ta in.] ; Nats. tekhn. un-t "Kharkiv. politekhn. in-t". Elektron. tekst. dani. Kharkiv, 2022. 44 s.

Information resources

1. OECD Webinar / The Future of Best Available Techniques in Industrial Pollution Prevention. https://youtu.be/vGxzeZN7F_w
2.Carbon capture, utilisation and storage. https://joint-research-centre.ec.europa.eu/projects-and-activities/carbon-capture-utilisation-and-storage_en

Grading system

The final grade for the educational component is determined by the lecturer and is based on topics, types of activities, etc., in accordance with the syllabus. It is an integrated assessment of the results of all types of student learning activities. The final grade should reflect all the grades for the different parts of the educational process, taking into account their weighting coefficients k:

Continuous assessment (during workshops, seminars, laboratory classes) k_1	Control works (if any), k_2	Individual assignment (if any), k_3	Final assessment (for courses with exams), k_4
0,25	0,35	0,30	0,10

The sum of the coefficients must be equal to one: $k_1 + k_2 + k_3 + k_4 = 1$. The weighting coefficients for the final assessment are decided by the course developer..
The final grade is calculated using the following formula:

$$G = C \cdot k_1 + K \cdot k_2 + \mathrm{I} \cdot k_3 + E \cdot k_4$$

where: C – weighted average score for the continuous assessment
I – individual assignment grade
K – weighted average score for the continuous assessment
E – final assessment (exam) grade

$$C = \frac{C_1 \cdot a_1 + C_2 \cdot a_2 + \ldots + C_n \cdot a_n}{\sum_{i=1}^{n} a_i}$$

де: a_i - weighting coefficient for each workshop (seminar) or laboratory class.

$$K = \frac{K_1 \cdot b_1 + K_2 \cdot b_2 + \ldots + K_m \cdot b_m}{\sum_{i=1}^{m} b_i}$$

де: b_i - weighting coefficient for each control work.

The assessments for each component (C, K, I, etc.) are based on a 100-point scale in line with the provisions of the "Criteria and System for Assessing Knowledge and Skills, and Rating of Higher Education Students" of the National Technical University "Kharkiv Polytechnic Institute."

The final grade is finalized as the calculated value of G, rounded up to the nearest integer.

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

Students must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by

30.08.2025 

Head of the department
Oleksii SHESTOPALOV

30.08.2025 

Guarantor of the educational program
Eugenia MANOILO