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

Department Ecology and
Plant polymers technology

WATER SUPPLY AND WATER DISPOSAL OF THE MOST WATER-INTENSIVE ENTERPRISES

Educational component work program (Syllabus)

Educational component details	
Level of higher education	***The first (bachelor)***
Discipline	*16 Chemical engineering and bioengineering*
Specialty	*161 Chemical technology and engineering*
Educational program	*Industrial ecology and resource-efficient clean technologies*
Status of the educational component	*Selective*
Form of study	*Correspondence*
Year of training, semester	*4th year/8th semester*
The scope of the educational component	*4 ECTS credits (120 hours)*
Semester control/control measures	*Test*
Class schedule	*2 hours of lecture classes, 2 hours of practical classes and 6 hours of laboratory classes*
Language of instruction	*Ukrainian*
Information about the course leader / teachers	Lecturer: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/tverdokhlib-mariya-mikolajivna.html* *Laboratory classes: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/tverdokhlib-mariya-mikolajivna.html*
Course placement	*https://do.ipo.kpi.ua/course/view.php?id=7227*

Educational component program

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

Today, in conditions of water resource scarcity, rational use of water is one of the most necessary conditions for economic activity. At the same time, not only the volume of water taken from the environment, but also the volume of polluted wastewater discharged into the environment is of extremely important importance for the state of the hydrosphere. Therefore, timely assessment of the state of water supply systems and the implementation of safe, modern wastewater systems guarantee the conditions for sustainable development of mankind, and the study of relevant disciplines in this area is even necessary. Modern water-consuming enterprises consume huge volumes of water. Rational use of these resources is an extremely important task. Water management of each industrial enterprise has specific features of water use, its own sources of its pollution and, therefore, requires the development and implementation of specific technological solutions to the problem of water purification for the purpose of its reuse.

The purpose of the educational component is to form in students a complex of knowledge related to the organization of water supply and wastewater systems of industrial facilities for qualified management of technological processes.

In accordance with the goal, the training of bachelors in this specialty requires the formation of the following competencies in students :

- *the ability to use the theoretical fundamentals of ecology, environmental protection and sustainable nature management, the basic principles and components of environmental management;*
- *the ability to distinguish the technological processes of production, to determine the sources and ways of entering the natural environment of harmful components, to assess their impact on human health and the quality of the environment;*
- *the ability to design and implement technologies for purification and processing of exhaust gases, wastewater and solid waste.*

According to the requirements of the educational component program ***"Water supply and water disposal of the most water-intensive enterprises"****, after mastering it, students must demonstrate the following program learning outcomes:*

- *to understand the basic environmental laws, rules and principles of environmental protection and nature management;*
- *to select and use appropriate equipment, tools and methods to solve complex problems of chemical engineering, control and management of technological processes of chemical production;*
- *to develop and implement projects related to chemical production technologies and equipment, taking into account objectives, resources, existing constraints, social and economic aspects and risks.*

2. Prerequisites and postrequisites of the educational component (place in the structural and logical scheme of training according to the relevant educational program)

The study of the educational component ***"Water supply and water disposal of the most water-intensive enterprises"*** *is based on the principles of integrating various knowledge obtained by students during the three years of the bachelor's degree when studying natural sciences and engineering disciplines. The educational component* ***"Water supply and water disposal of the most water-intensive enterprises"*** *is a fundamental basis that should provide solutions to complex problems in the field of hydrosphere protection, rational use of water resources and is aimed at a deep rethinking of existing and the creation of new holistic knowledge and professional practice. The educational component* ***"Water supply and water disposal of the most water-intensive enterprises"*** *ensures the implementation of the bachelor's project.*

3. Content of the educational component

Section 1. Water supply in industry and water quality improvement.

Topic 1 Features of water use in industrial production.

Topic 2. Industrial water supply systems and schemes.

Section 2. Water drainage and wastewater treatment.

Topic 3. Industrial wastewater. Drainage systems of industrial enterprises.

Topic 4. Water supply and wastewater disposal of enterprises that are the largest consumers of water.

4. Educational materials and resources

Basic literature

1. *Shablii T.O., Radovenchyk V.M., Gomelya M.D. Application of new reagents and technologies in industrial water consumption. K. Infodruk , 2014. – 327 p.*
2. *Trus I.M., Galysh V.V., Skyba M.I., Radovenchyk Ya.V., Gomelya M.D. New highly effective methods of purification from soluble and insoluble pollutants : monograph. / – K.: Kondor-Publishing House , 2020. – 272 p.*
3. *Shadura V.O., Kravchenko N.V. Water supply and wastewater disposal: a textbook.- Rivne : NUVGP, 2018.-343 p.*
4. *Pruttskov D.V., Sokolnik V.I., Dobrovolska O.G., Kolyada V.P., Vasylenko T.G., Chyganov S.L., Svitlychna V.B. Water supply and wastewater disposal of industrial enterprises: Textbook. – Zaporizhzhia: Publishing house ZGIA, 2018. – 194 p.*

Additional literature

5. *Hayrapetyan T. S., Lukashenko S. V. Industrial water treatment : lecture notes. – Kharkiv: KhNUMG named after O. M. Beketov , 2024. – 181 p.*
6. *Technology and equipment for obtaining drinking and technical water: Workshop (Part 2). [Electronic resource]: a textbook for students of specialty 161 "Chemical technologies and engineering", specialization "Chemical technologies of inorganic substances and water purification" / N.M. Tolstopalova , M.I. Litynska , T.I. Obushenko , I.M. Astrelin , O.V. Sanginova; Igor Sikorsky Kyiv Polytechnic Institute – Electronic text data (1 file: 8.12 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2020. – 181 p.*
7. *Khilchevsky V.K., Zabokrytska M.R., Stelmakh V.Yu. Hydroecological aspects of water supply and wastewater disposal: a manual. – K.: DIA, 2023. - 228 p.*
8. *Stepova O. V., Trokhymenko G. G. Technologies for protecting the aquatic environment: a teaching and methodological manual for specialties 101 "Ecology", 183 "Technologies for protecting the environment" of all forms of study. Poltava: National University "Poltava Polytechnic named after Yuri Kondratyuk"; Mykolaiv: Admiral Makarov National University of Shipbuilding, 2022. – 306 p.*
9. *Moshel M.V., Shevchenko O.O. Rational use and protection of water resources: Textbook. – Chernihiv: ChDIEU, 2021. – 365 p.*
10. *Epoyan S. M., Hayrapetyan T. S. Reverse and non-drainage water use systems of industrial enterprises – Kharkiv: O. M. Beketov KhNUMG, 2022. – 113 p.*
11. *Tseytlin M. A., Rayko V. F., Shestopalov O. V. Engineering systems of water supply and drainage of settlements and enterprises: a manual . – Kharkiv: FOP Panov A. M., 2022. – 118 p.*
12. *Petruk V. G., Vasylkivsk-ky I. V., Petruk R. V., Sakalova G. V. and others. Environmental protection technologies. Part 2. Wastewater treatment methods: textbook. – Kherson: Oldi-plus , 2019. – 298 p.*
13. *Trus I. M. Creation of scientific foundations of resource-efficient and environmentally safe technologies of water use in industry: dissertation … Doctor of Technical Sciences: 21.06.01 – Environmental Safety / Trus Inna Mykolaivna. – Kyiv, 2023. – 499 p.*
14. *Galish V. V. Complex resource-efficient technologies for water purification of paper production: dissertation ... Doctor of Technical Sciences: 05.17.21 - Water purification technology / Galish Vita Vasylivna. - Kyiv, 2023. - 417 p.*

Information resources on the Internet

15. *Interactive map of river pollution in Ukraine – https://texty.org.ua/water/*
16. *State Agency of Water Resources of Ukraine – https://www.davr.gov.ua/*
17. *National Library named after V.I. Vernadsky – http://www.nbuv.gov.ua/*
18. *Scientific and Technical Library named after G.I. Denysenko of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" https://www.library.kpi.ua/*
19. *Electronic archive educational materials of Igor Sikorsky Kyiv Polytechnic Institute – https://ela.kpi.ua/*

Educational content

5. Methodology for mastering the educational component

Lecture classes

Lectures are aimed at:

- *providing modern, holistic, interdependent knowledge from* the educational component ***"Water supply and water disposal of the most water-intensive enterprises"****, the level of which is determined by the target setting for each specific topic;*
- *ensuring creative work of students together with the teacher during the lecture;*
- *fostering professional and business qualities in students and developing their independent creative thinking;*
- *developing the necessary interest in students and determining the direction for independent work;*
- *determination of the current level of development of science in the field of modern methods and processes of water treatment , forecasting development for the coming years;*
- *reflection of the methodological processing of the material (highlighting the main provisions, conclusions, recommendations, their clear and adequate formulation)*
- *use of visual materials for demonstration, combining them, if possible, with the demonstration of results and samples;*
- *teaching research materials in clear and high-quality language, observing structural and logical connections, explaining all newly introduced terms and concepts;*
- *accessibility for perception by a given audience.*

The name of the lecture topic and the list of main issues (list of didactic means, references to literature and tasks at the IWS)	***Hours***
Section 1. Industrial water supply and water quality improvement	
Topic 1. Features of water use in industrial production. *Water supply and water use in the world and Ukraine. Main directions of water use in industry. Requirements for the quality of water used in industry.* *Literature: [3]; [4]; [6]; [8]; [10].* *Tasks on the IWS: Main indicators of water resource use by enterprises of various industries in Ukraine.*	***0.5***
Topic 2. Industrial water supply systems and schemes. *Water supply schemes for settlements. Water supply schemes for industrial facilities. Rational use of water at industrial enterprises. Selection and feasibility study of a production water supply system.* *Literature: [3]; [4]; [9] ; [12]* *Tasks on the IWS: Sources of water supply for industrial enterprises and their characteristics.*	***0.5***
Section 2. Water drainage and wastewater treatment	
Topic 3. Industrial wastewater. Drainage systems of industrial enterprises. *Classification of wastewater discharged from industrial enterprises. Composition of pollutants and properties of industrial wastewater. Features of wastewater disposal systems of industrial enterprises. Conditions for acceptance into the city sewer system and conditions for wastewater discharge into water bodies.* *Literature: [4]; [9]; [12] .* *Tasks on the IWS: Leads surface stormwater runoff from territories industrial enterprises .*	***0.5***
Topic 4. Water supply and wastewater disposal of enterprises that are the largest consumers of water. *Features of water supply and wastewater disposal of heat and power enterprises. Water supply and wastewater treatment of electroplating production. Water supply and wastewater treatment of pulp and paper production.* *Literature: [2]; [5]; [6]; [7], [14], [15].* *Tasks on the IWS: Wastewater treatment of ion exchange filters for water reuse.*	***0.5***
Total hours	***2***

Laboratory classes

In the system of professional training of higher education students, laboratory classes occupy 60 % of the classroom load. Being a supplement to the lecture course, they lay and form the foundations of the qualification of an organizer of environmental management. The purpose of laboratory and practical classes is to develop experimental skills, a research approach to studying the subject, and consolidate theoretical material in students.

The name of the laboratory work	***Hours***
Introduction. Safety briefing, introduction to the laboratory work program, issuance of methodological literature.	***1***
Determination of the corrosion rate of metals in various environments by the massometric method.	***1***
scale inhibitors in water stabilization treatment.	***1***
Processing iron-containing used etching solution in.	***1***
Extraction of copper from spent electrolytes by cementation.	***1***
Utilization of zinc-containing solutions to obtain zinc whites.	***1***
Total hours	***6***

Practical classes

In the system professional preparation applicants higher education on this subject educational component practical occupation They take up 20% of the classroom load. Being a supplement to the lecture course, they lay and shape foundations Bachelor's degree in ecology, namely protection reservoir from anthropogenic impact. Change these classes and their methodology carrying out must provide development creative activities personality. They develop scientific thinking and ability use special terminology, allow verify knowledge.

Basic Tasks of the practical training cycle:

- to teach students receptions solution practical tasks , to promote mastery skills and abilities implementation calculations , graphics and others species tasks ;

- to teach their work with scientific and reference material literature , documentation and diagrams;

- to form skill to study independently , that is to master methods, ways and techniques self-learning, self-development and self-control.

The name of the practical work	***Hours***
Practical work 1. Determining the value of irreversible water consumption in production. References: [11];	***0.5***
Practical work 2. Calculation of the water balance of circulating water supply systems. References: [11];	***0.5***
Practical work 3. Determining the required degree of purification of industrial wastewater. References: [11];	***0.5***
Practical work 4. Choosing a technological scheme for water purification. References: [11];	***0.5***
Total hours	***2***

6. Independent work of a higher education student

Independent work takes up 90% of the time of studying the educational component, including preparation for the test. The main task of independent work of higher education applicants is to master scientific knowledge in areas that are not included in the list of lecture questions through personal search for information, the formation of active interest in a creative approach to educational work. In the process of independent work within the educational component, the student must learn to deeply analyze modern approaches to the development and implementation of the latest technologies for water treatment and water purification based on the characteristics of water and requirements for the quality of purified water.

No. z/p	The name of the topic submitted for independent processing	Number of hours of IWS
Section 1. Industrial water supply and water quality improvement.		
1	*Organization of circulating water supply systems. Water losses, water and salt balance in circulating water supply cycles.* *Protection of water circulation systems from scale formation , corrosion and biofouling.* *Main indicators of water resource use by enterprises of various industries in Ukraine .* *Sources of water supply for industrial enterprises and their characteristics.* *Ensuring the required quality of purified water for its reuse in production processes.* *Criteria for assessing the efficiency of water use at enterprises.* ***Literature: [3]; [4]; [6]; [8] ; [9] ; [11] ; [12] .***	**50**
Chapter 2. Water drainage and wastewater treatment .		
2	*Methods of industrial wastewater treatment. Types of treatment facilities. Treatment and disposal of sludge from treatment facilities.* *Rating environmental and economic advantages implementation water reuse systems in industrial enterprise.* *Withdrawal surface stormwater runoff from territories industrial enterprises. Ways and methods cleaning surface runoff.* *Types of control and requirements for the quality of feed and boiler water, water of open and closed heat supply systems.* *Wastewater treatment ion exchange filters for water reuse.* *Modern technology reagent-free water lighting.* ***Literature: [2]; [5]; [6]; [7]; [10]; [14]; [15].***	**50**
3	***Preparation for a modular test***	**5**
4	***Preparation for the test***	**5**
	Total hours	**110**

Provision of program results by components of the educational component

Name EK	Lecture classes	Practical and laboratory classes, individual assignments
To understand the basic environmental laws, rules and principles of environmental protection and nature management.	*Lecture 1. Topic 1. Features of water use in industrial production.* *Lecture 2. Industrial water supply systems .*	*Practical work 1. Determining the amount of irreversible water consumption in production.* *Practical work 2.* *of circulating water supply systems in one balance.* *Practical work 3.* *Determining the required degree of purification of industrial wastewater.*
To develop and implement projects related to chemical production technologies and equipment, taking into account objectives, resources, existing constraints, social and economic aspects and risks.	*Lecture 3. Industrial wastewater. Industrial wastewater systems.* *Lecture 4. Water supply and wastewater disposal of enterprises that are the largest consumers of water.*	*Practical work 4.* *Choosing a water purification process scheme.*

To select and use appropriate equipment, tools and methods to solve complex problems of chemical engineering, control and management of technological processes of chemical production.		*Laboratory work 1. Determination of the corrosion rate of metals in various environments by the massometric method.* *Laboratory work 2. scale inhibitors in water stabilization treatment.* *Laboratory work 3. Processing of iron-containing spent pickling solutions.* *Laboratory work 4. Extraction of copper from spent electrolytes by cementation.* *Laboratory work 5. Utilization of zinc-containing solutions to obtain zinc whites.*

Policy and control

7. Educational component policy

Rules for class attendance and behavior in classes

Higher education students are required to take an active part in the educational process, not be late for classes or miss them without a good reason, not interfere with the teacher conducting classes, and not be distracted by actions unrelated to the educational process.

Rules for assigning incentive and penalty points

- *Incentive points can be awarded by the teacher exclusively for performing creative works in the discipline or for additional completion of online specialized courses with obtaining the appropriate certificate:*
  - *https://www.coursera.org/learn/water*
  - *https://www.coursera.org/learn/sustainable-urban-water-systems*
  - *https://www.coursera.org/learn/water-management*
  - *https://www.coursera.org/learn/new-paradigms-in-wastewater-management#about*

But their sum cannot exceed 10 % of the rating scale.

Enrollment of individual results obtained within the framework of non-formal education is carried out in accordance with the Regulations on the recognition of learning outcomes acquired in non-formal/ informal education at Igor Sikorsky Kyiv Polytechnic Institute https://osvita.kpi.ua/node/179

- *Penalty points are not provided within the framework of the academic discipline.*

Deadline and rescheduling policy

In the event of arrears for the educational component or any force majeure circumstances, higher education applicants must contact the teacher via available (provided by the teacher) communication channels to resolve problematic issues and agree on an algorithm of actions for work-out.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the lack of references when using printed and electronic materials, quotes, opinions of other authors. Hints and copying when writing tests, conducting classes are unacceptable; taking an exam for another student; copying materials protected by the copyright system without the permission of the author of the work.

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More details: https://kpi.ua/code

Academic Conduct and Ethics Policy

Higher education students should be tolerant, respect the opinions of others, formulate objections in a correct form, and provide constructive feedback in class.

The norms of ethical behavior of higher education students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More details: https://kpi.ua/code

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

Distribution of study time by types of classes and tasks from the educational component according to the working curriculum:

Semester	Study time		Distribution of study hours				Control measures		
	Credits	Acad. hours	Lectures	Practical	Lab work	IWS	MCT	HSW	Semester control
8	4	120	2	2	6	110	1	-	Test

A higher education applicant's rating for the educational component consists of the points he receives for: *writing modular test work, laboratory work and practical tasks. The semester test is a credit.*

Rating (weighting) points system and evaluation criteria

Performing laboratory work.

The weighted score for 1 laboratory work is 10 points. There are 5 laboratory works in total. The maximum number of points for completing laboratory works is:

10 points x 5 LR. = 50 points

Criteria for evaluating laboratory work performance

Completeness and signs of task completion	Points
The work was completed in full without errors, the protocol with the appropriate conclusions was correctly drawn up, the work was submitted for defense on time, the student demonstrates deep knowledge of the work, confidently and in detail answers the questions posed during the defense.	10
The work was completed in full with minor errors or inaccuracies with unclearly formulated conclusions, the work was submitted for defense on time, during the defense the student shows uncertainty, shows weak knowledge of the work, and does not always give comprehensive answers to questions.	8-9
The work was not completed in full, there are no conclusions in the work, the work was submitted for defense late, and during the defense, the student cannot answer any of the questions asked on the topic of the work.	7-6
The work was not done.	0

Work on practicals classes :

Weighted score for performance based on practical classes – 5 points. The maximum number points:

5 points x 4 PR = 20 points

Criteria evaluation implementation calculation

Completeness and characteristics of the answer	Points
Calculation fully completed without errors, conclusions are given.	5
Calculation fully completed, contains minor errors, conclusions are given .	4
Calculation not fully completed without errors, conclusions are given.	3
Practical work is not counted.	0

Modular test papers

Weighted score – 1 5 points. The maximum number of points for all tests is:

15 points x 2 works = 30 points

Criteria for evaluating test papers

Completeness and characteristics of the answer	*Points*
Complete answer (at least 90% of the required information), examples provided	*15*
Incomplete disclosure of one of the questions or a complete answer with minor inaccuracies	*12-13*
Incomplete answer (at least 60% of the required information) and minor errors	*11-9*
The test was not passed.	*0*

Thus, the semester rating scale for the educational component is:

$$R_c = 10\ 5 + 5\ 4 + 15\ 2 = 100 \text{ points}$$

The maximum amount of points is 100. To receive credit for the educational component "automatically", you must have a rating of at least 60 points. A prerequisite for admission to the credit is the enrollment of all types of work - practical, laboratory and MKR, while the rating must be at least 40% of the rating scale (R), i.e. 40 points.

Students who have scored less than 0.6 R during the semester, as well as those who want to increase their overall rating, take a credit test. In this case, all the points they received during the semester are canceled. The test tasks contain questions that relate to different sections of the credit module. The list of credit questions is given in Section 9. To obtain a credit score, the sum of all rating points R received during the semester is converted according to the table:

Number of points	***Rating***
9 5 ...100	*Perfectly*
8 5 ...9 4	*very good*
75...8 4	*Good*
6 5 ...74	*satisfactorily*
60...6 4	*enough*
RD <60	*unsatisfactorily*
Admission conditions not met	*not allowed*

9. Additional information on the educational component

Approximate list of questions submitted for semester control

1. *Water supply systems for industrial enterprises.*
2. *Types of water consumption in production.*
3. *Water supply standards.*
4. *What are the requirements for the quality of cooling water?*
5. *What are the requirements for the quality of water used in recirculating systems?*
6. *technical water supply.*
7. *Existing water use patterns at industrial enterprises.*
8. *Sequential-recirculating water supply systems. Their advantages over direct-flow systems.*
9. *What is the difference between closed water supply systems and circulating water systems?*
10. *What is the essence of rational use of water?*
11. *Water-salt balance equation.*
12. *Using the concentration coefficient of highly soluble salts for calculating the water chemical operating mode of circulating water supply systems.*
13. *Causes and types of fouling of pipes and heat exchangers.*
14. *The concept of water stability, carbon dioxide equilibrium equation.*
15. *. Water treatment methods to prevent carbonate deposits, corrosion of pipes and heat exchangers.*
16. *The main reasons for the violation of the water-chemical regime of the existing water supply and drainage systems of the PP.*
17. *Water stability and methods of ensuring it.*
18. *Name the main methods for preventing dense salt deposits in circulating water supply systems.*
19. *What methods are used to prevent salt deposits in water supply systems?*

20. *Main water consumers at thermal power plants.*
21. *Draw a diagram of a condensing power plant. Draw a diagram of water cooling at a thermal power plant.*
22. *Methods of industrial wastewater treatment.*
23. *Technological schemes for wastewater treatment for reuse in production.*
24. *List the requirements for the quality of water used in the manufacture of various types of paper.*
25. *Requirements for the quality of water used in electroplating production.*
26. *Main technological processes and structures used in water treatment at thermal power plants.*
27. *What does the choice of water treatment method depend on?*
28. *The task of pre-treatment of water.*
29. *Water preparation for the production of alcoholic and non-alcoholic beverages.*
30. *Wastewater from water treatment plants and their impact on the environment.*
31. *Local and plant-wide water purification facilities.*
32. *Non-dischargeable methods of cationic softening with recovery and reuse of wastewater.*

The working program of the educational component (syllabus):
Compiled *Associate Professor, Candidate of Technical Sciences, Tverdokhlib M. M.*

Approved *by the Department of E and PPT (protocol № 17 from 29.05.2025)*
Approved by *the Methodological Commission of the Faculty (protocol № 11 from 27.06.2025)*