Basics of industrial emissions treatment processes for dust

Work program of the academic discipline (Syllabus)

Details of the discipline

Level of higher education	*First (educational and professional)*
Field of expertise	*10 Natural sciences*
Speciality	*101 Ecology*
Educational program	*Environmental safety*
Status of the discipline	*Selective*
Form of study	*full-time/distance/mixed*
Year of study, semester	*2nd year / fall semester*
Scope of the discipline	*4 ECTS credits (120 hours)*
Semester control / control measures	*Test*
Class schedule	*4 hours per week (2 hours of lectures and 1 hour of laboratory classes, 1 hour of practical classes)*
Language of instruction	*Ukrainian*
Information about course leader / teachers	Lecturer: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/ivanenko-olena-ivanivna.html Practical: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/ivanenko-olena-ivanivna.html Laboratory: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/ivanenko-olena-ivanivna.html
Placement of the course	*https://do.ipo.kpi.ua/course/view.php?id=5236*

Program of the discipline

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

In order to prevent the negative effects of human activity and improve the state of the air in terms of particulate matter, it is necessary to constantly improve air protection technologies. It is only with the help of knowledge of cleaning gas emissions from dust, as well as setting up work with atmospheric air quality assessment devices, that it is possible to protect the environment from the negative anthropogenic impact on the planet's airspace.

The subject of the discipline "Basics of industrial emissions treatment processes for dust" *is one of the main areas of implementation of environmental technologies aimed at protecting the atmosphere, and it is the removal of gaseous waste from dust before it is released into the atmosphere.*

To a large extent, the solution to this problem will be determined by the level of training of specialists working in the field of environmental protection, including institutions of state environmental safety management, scientific institutions and organizations, and enterprises.

To successfully solve the problems of protecting and preserving the atmosphere, specialists must be fluent in information and be able to solve complex problems of air protection from pollution at a high professional level.

Objective of the discipline "Basics of industrial emissions treatment processes for dust"

The purpose of this discipline is to develop students' knowledge in the field of modern methods of gas purification, a set of skills and abilities necessary for conducting research in this area, for creating modern gas purification technologies and for qualified management of existing technological processes. In accordance with the goal, the training of bachelors requires strengthening the competencies formed by students:

- *Ability to assess the impact of technological processes on the environment and identify environmental risks associated with production activities*
- *Ability to master international and domestic experience in solving regional and transboundary environmental problems*
- *Ability to develop design and working technical documentation in the field of environmental technologies, draw up structural diagrams with elements of equipment and industrial buildings, draw up completed design and engineering developments*
- *Ability to improve, design, implement and operate technologies and equipment for the treatment and processing of exhaust gases, wastewater and solid waste*
- *Ability to apply modern methods and means of monitoring the state of atmospheric air, natural waters, soils and biota, determine the level of contamination of natural and industrial materials with radioactive elements, master methods of assessing the impact of adverse factors on living organisms, determine the adaptive capabilities of the human body in the environment*
- *Ability to distinguish between technological processes of production, identify sources and ways of entering the environment of harmful components, assess their impact on human health and environmental quality*

*In accordance with the requirements of the program of the discipline "**Basics of industrial emissions treatment processes for dust**" students must demonstrate the following program learning outcomes after completing it:*

- *Solve problems in the field of environmental protection using generally accepted and/or standard approaches and international and national experience*
- *Be able to search for information using appropriate sources to make informed decisions*
- *Conduct laboratory tests using modern instruments, ensure sufficient measurement accuracy and reliability of results, and process the results*
- *Apply methodologies and technologies for the design, implementation and implementation of environmental technologies and equipment, carry out design and development activities*
- *To assess the state of the environment, determine the level of impact of the enterprise (production) on the environment, identify the main environmental pollutants of the enterprise (production)*
- *To develop technologies, use processes and devices that ensure effective separation, concentration, extraction, destruction of harmful impurities in water systems and gas environments, waste treatment and utilization*

2. **Prerequisites and post-requisites of the discipline (place in the structural and logical scheme of study in the relevant educational program)**

*The study of the discipline "**Basics of industrial emissions treatment processes for dust**" is based on the principles of integrating the various knowledge gained by students during their bachelor's degree in natural and engineering disciplines: General Ecology, Special Sections of Biogeochemistry, Chemistry with the Basics of Biogeochemistry.*

*The discipline "**Basics of industrial emissions treatment processes for dust**" is the fundamental basis for the study of the following disciplines: Environmental Monitoring, Modeling and Forecasting of the State of the Environment, Normalization of the Anthropogenic Load on the Environment,* *Environmental and Natural and Technogenic Safety, Technoecology, and provides for the implementation of a bachelor's project.*

3. Content of the discipline *"Basics of industrial emissions treatment processes from dust"*

Chapter 1. Current state, directions and prospects for the development of air pollution protection.

Topic 1: *Composition, structure, properties and functions of the atmosphere.*

Topic 2. *Characterization of air pollutants and classification of pollution sources.*

Topic 3. *Standardization of atmospheric air quality.*

Topic 4. *Main sources of air pollutant emissions by industry sectors*

Topic 5. *Transformation of impurities in the atmosphere.*

Topic 6. *Dispersion of pollutants in the atmosphere.*

Section 2: Cleaning the exhaust gases from dust.

Topic 1: *Basic properties of dust.*

Topic 2. *Dust collection. Parameters of the dust collection process.*

Section 3. Dry mechanical gas purification devices.

Topic 1: *Dust settling chambers and inertial dust collectors.*

Topic 2. *Blinds and cyclones.*

Topic 3: *Vortex dust collectors.*

Section 4. Wet mechanical gas purification devices.

Topic 1: Nozzle *scrubber, nozzle scrubber, scrubber with a moving nozzle.*

Topic 2. *Centrifugal scrubber, venturi scrubber, impactor, bubbling-foam apparatus.*

Section 5. Apparatus for gas purification by filtration.

Topic 1: *Fiber and granular filters.*

Topic 2. *Fabric filters.*

Chapter 6. Apparatus for purification of gases in an electric field.

Topic 1: *Classification of electrostatic precipitators and their structural elements.*

Topic 2. *Dry and wet electrostatic precipitators.*

Training materials and resources

Basic literature

1. Beketov V.E., Yevtukhova G.P. Sources and processes of atmospheric pollution. Kharkiv: A. N. Beketov Kharkiv National University of Oil and Gas Industry, 2019. 113 c.

2. Sarapina M.V. Processes and devices of dust and gas purification: a course of lectures. Kharkiv: NUCSU, 2018. 125 c.

3. Krusir G.V., Madani M.M., Garkovich O.L. Techniques and technologies of gas emissions treatment. Odesa: ONAHT-Odesa, 2017. 207 c.

4. Methods of calculation of complex dust and gas cleaning systems. Monograph / M.I. Shilyaev, E.M. Khromova. M: DIA Publishing House, 2018. 196 c.

5. Fundamentals of industrial emissions cleaning processes from dust. Laboratory workshop: a textbook for students majoring in 101 Ecology, 161 Chemical Technology and Engineering / Igor Sikorsky Kyiv Polytechnic Institute; compiled by Ivanenko O.I., Overchenko T.A., Nosachova Y.V., Tverdokhlib M.M. - Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2021. 34 p.

6. Fundamentals of industrial emissions purification processes from vapors and gases. Laboratory workshop: a study guide for students majoring in 101 Ecology, 161 Chemical Technology and Engineering / Igor Sikorsky Kyiv Polytechnic Institute; compiled by Ivanenko O.I., Overchenko T.A., Nosachova Y.V., Tverdokhlib M.M. - Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2021. 34 p.

Additional literature

7. Industrial technologies and purification of technological and ventilation emissions: a textbook / Yurkevych Y. S., Voznyak O. T., Zhelykh V. M.; Ministry of MES of Ukraine, Lviv Polytechnic National University. 2012. 120 c.
8. Severin L. I., Petruk V. G., Bezvoziuk I. I., Vasylkivsky I. V. Environmental technologies (protection of the atmosphere) / Part I: Study guide. Vinnytsia: Universum-Vinnytsia, 2010.
9. Ratushniak G.S., Lyalyuk O.G. Means of gas emissions purification. Study guide. Vinnytsia: Universum-Vinnytsia, 2008. 207 c.
10. Ecology and environmental protection: a textbook. Kyiv: Znannya, 2007. 422 c.
11. KD 52.9.4.01-09. Guidelines for forecasting meteorological conditions for the formation of air pollution levels in Ukrainian cities. Kyiv: State Hydrometeorological Service, 2010. 78 c.
12. Ryzhkov S.S. Apparatus for air purification from pollution: methodical instructions / S.S. Ryzhkov, Y.M. Kharitonov, V.V. Blagodatny. - Mykolaiv : UDMTU, 2002. - 36 c.
Information resources on the Internet
13. Ministry of Environmental Protection and Natural Resources of Ukraine / [Electronic resource]. - Access mode: https://mepr.gov.ua/.
14. Industrial ecology. Community of environmentalists / [Electronic resource]. - Access mode: http://www.eco.com.ua/.
15. Professional Association of Ecologists of Ukraine / [Electronic resource] - Access mode: https://paeu.com.ua/.
16. Denysenko Scientific and Technical Library / [Electronic resource] - Access mode: https://library.kpi.ua.
17. Vernadsky National Library / [Electronic resource] - Access mode: http://www.nbuv.gov.ua/.
18. Electronic archive of scientific and educational materials of Igor Sikorsky Kyiv Polytechnic Institute / [Electronic resource] - Access mode: https://ela.kpi.ua/.

Educational content

5. Methods of mastering the discipline

Lecture classes

Lecture classes are aimed at:

- *providing modern, holistic, interdependent knowledge in the discipline "**Basics of industrial emissions treatment processes for dust**", the level of which is determined by the target setting for each specific topic;*
- *ensuring that students work together with the teacher during the lecture;*
- *fostering students' professional and business skills 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 scientific development in the field of modern methods and processes of gas purification, forecasting development for the coming years;*
- *displaying the methodological processing of the material (highlighting the main points, conclusions, recommendations, their clear and adequate formulation);*
- *use of visual materials for demonstration, combining them, if possible, with the demonstration of results and samples;*
- *presenting the research materials in clear and high-quality language, observing structural and logical connections, explaining all newly introduced terms and concepts;*
- *accessibility to the audience.*

No. s/n	Title of the lecture topic and a list of main issues (list of didactic tools, references to literature and assignments for IWS)	Hours
1	**Current state, directions and prospects for the development of air basin protection against pollution** Composition, structure, properties and functions of the atmosphere. Anthropogenic impact on the state of the atmosphere. Literature: [1, 10] Tasks for the IWS. Directions and goals of creating low-waste industries. Literature: [8].	2
2	**Current state, directions and prospects for the development of air pollution protection** Characterization of air pollutants from industrial enterprises and classification of pollution sources. Literature: [1, 10] Tasks for the IWS. Air pollution from mobile sources of road transport. Literature: [1].	2
3	**Current state, directions and prospects for the development of air basin protection against pollution** Air quality regulation. Literature: [1, 8]. Task for the IWS. Ukrainian cities with the highest emissions of harmful substances into the atmosphere and the distribution of pollution by source. Literature: [8].	2
4	**Current state, directions and prospects for the development of air basin protection against pollution** Main sources of air pollutant emissions by industry sectors Literature: [1]. Tasks for the IWS. Transboundary transfer of pollutants. Literature: [1].	2
5	**Current state, directions and prospects for the development of air basin protection against pollution** Transformation of impurities in the atmosphere. Literature: [1, 8] Tasks for the IWS. Physical pollutants of the atmosphere. Literature: [1].	2
6	**Current state, directions and prospects for the development of air pollution protection** Dispersion of pollutants in the atmosphere. Literature: [1, 11]. Task for the IWS. The content and fluctuations in the concentration of harmful impurities in urban air depending on factors such as precipitation and fog. Literature: [11].	2
7	**Cleaning the exhaust gases from dust** The main properties of dust. References: [1, 2, 3, 8]. Tasks for IWS. Basic properties of gases. Literature: [8].	2
8	**Cleaning the exhaust gases from dust** Dust collection. Dust collection process parameters. Literature: [4, 8, 9].	2

	Tasks for the IWS. Methods and devices for monitoring the concentration of dust impurities in the atmosphere and industrial emissions. *Literature: [8].*	
9	***Dry mechanical gas cleaning devices*** *Dust collecting chambers and inertial dust collectors.* *Literature: [2, 3, 4].* *Tasks for the IWS. Irrigation flues.* *Literature: [2, 3, 4].*	*2*
10	***Dry mechanical gas cleaning devices*** *Blinds, cyclones.* *Literature: [2, 3, 4].* *Tasks for the IWS. Rotary dust collectors.* *Literature: [12].*	*2*
11	***Dry mechanical gas cleaning devices*** *Vortex dust collectors.* *Literature: [2, 3, 4].* *Tasks for the IWS. Dynamic dust collectors.* *Literature: [8].*	*2*
12	***Wet mechanical gas cleaning devices*** *Nozzle scrubber, nozzle scrubber, scrubber with moving nozzle.* *Literature: [2, 3, 4].* *Tasks for the IWS. Mechanical disk scrubber.* *Literature: [12].*	*2*
13	***Wet mechanical gas cleaning devices*** *Centrifugal scrubber, venturi scrubber, impact and inertial type device, bubbling and foaming device.* *Literature: [2, 3, 4].* *Tasks for the IWS. Doyle's high-speed scrubber.* *Literature: [12].*	*2*
14	***Apparatus for gas purification by filtration.*** *Fiber and granular filters.* *Literature: [2, 3, 4].* *Tasks for the IWS. Ceramic and metal-ceramic filters.* *Literature: [8].*	*2*
15	***Apparatus for gas purification by filtration*** *Fabric filters.* *Literature: [2, 3, 4].* *Tasks for the IWS. Filter mist eliminators.* *Literature: [12].*	*2*
16	***Apparatus for gas purification in an electric field*** *Classification of electrostatic precipitators and their structural elements.* *Literature: [2, 3, 4].* *Tasks for IWS. Magnetic purification of gases.* *Literature: [7, 8].*	*2*
17	***Apparatus for gas purification in an electric field*** *Dry and wet electrostatic precipitators.* *Literature: [2, 3, 4].* *Tasks for the IWS. Recovery of captured dust.* *Literature: [7, 8].*	*2*
18	***MCT***	*2*

	Total	***36***

Laboratory classes

In the system of professional training of students, laboratory classes take up 25% of the classroom *load. As a supplement to the lecture course, they lay the foundation and form the basis of the bachelor's degree in ecology. The purpose of laboratory classes is to develop students' experimental skills, research approach to the* subject, and consolidate theoretical material.

No. s/n	*Name of the laboratory work*	*Number of classroom hours*
1	*Introduction. Safety briefing, familiarization with the program of laboratory work, issuance of methodological literature*	*1*
2	*Determining the amount of dust in the air*	*3*
3	*Determination of dust radioactivity in the air*	*3*
4	*Determination of physical properties of industrial dust*	*3*
5	*Determination of dust cleaning efficiency in cyclones*	*3*
6	*Determining the efficiency of dust cleaning in bag filters*	*3*
7	*Test*	*2*
Total hours		*18*

Practical classes

In the system of professional training of bachelors in this discipline, practical classes take up 25% of the class load. Being a supplement to the lecture course, they lay down and form the basis of a bachelor's qualification in the field of ecology, namely the protection of the atmosphere from anthropogenic impact. The content of these classes and the methodology of their conduct should ensure the development of creative activity of the individual. They develop scientific thinking and the ability to use special terminology, allow you to test your knowledge, so this type of work is an important means of prompt feedback. Practical classes should perform not only cognitive and educational functions, but also contribute to the growth of bachelors as creative workers in the field of environmental protection.

The main tasks of the cycle of practical classes:

- *to help bachelors systematize, consolidate and deepen their theoretical knowledge in the field of fundamental methods and technologies of air purification;*
- *to teach bachelors methods of solving practical problems, to promote the acquisition of skills and abilities to perform calculations, graphic and other tasks;*
- *teach them how to work with scientific and reference literature and diagrams;*
- *to develop the ability to learn independently, i.e. to master the methods, ways and techniques of self-study, self-development and self-control.*

No. s/n	***Name of the topic of the practical lesson and a list of key issues (list of didactic support, references to literature and assignments for IWS)***	***Hours***
1	***Calculation of the material balance**.* *Literature: [4].*	***2***
2	***Calculation of a dry gravity type dust collector using a simplified method**.* *Literature: [4].*	***2***

3	***Calculation of a gravity-type dry dust collector using a complicated methodology***. *Literature: [4].*	***3***
4	***Calculation of a dry centrifugal dust collector***. *Literature: [4].*	***3***
5	***Calculation of a nozzleless scrubber.*** *Literature: [4].*	***2***
6	***Calculation of a fabric bag filter.*** *Literature: [4].*	***3***
7	***Calculation of an electrostatic precipitator.*** *Literature: [4].*	***3***
	Total	***18***

6. Independent work of the student

Independent work takes up 40% of the credit module study time, including preparation for the test. The main task of students' independent work is to master scientific knowledge in areas that are not included in the list of lecture topics through personal search for information, the formation of an active interest in a creative approach to academic work. In the process of independent work within the educational component, students should learn to analyze in-depth modern approaches to the development and implementation of the latest technologies for the treatment of polluted waste gases, based on the concentrations of pollutants and emission standards for the gas mixture. The student should be able to create the most effective methods for cleaning contaminated gases.

No. s/n	*Name of the topic to be studied independently*	*Number of hours of IWS*
Chapter 1. Current state, directions and prospects of development of air basin protection from pollution		
1	*Topic 1: Composition, structure, properties and functions of the atmosphere. Anthropogenic impact on the state of the atmosphere.* *Composition, structure, properties and functions of the atmosphere. Anthropogenic impact on the state of the atmosphere.* *Tasks for the IWS. Directions and goals of creating low-waste industries. Literature: [8].* *Topic 2. Characterization of air pollutants from industrial enterprises and classification of pollution sources.* *Tasks for the IWS. Air pollution from mobile sources of road transport.* *Literature: [1].* *Topic 3. Standardization of atmospheric air quality.* *Task for the IWS. Ukrainian cities with the highest emissions of harmful substances into the atmosphere and the distribution of pollution by source.* *Literature: [8].* *Topic 4. Main sources of air pollutant emissions by industry sectors* *Tasks for the JRC. Transboundary transfer of pollutants.* *Literature: [1].* *Topic 5. Transformation of impurities in the atmosphere.* *Tasks for the IWS. Physical pollutants of the atmosphere.* *Literature: [1].* *Topic 6. Dispersion of pollutants in the atmosphere.*	*15*

	Task for the IWS. The content and fluctuations in the concentration of harmful impurities in urban air depending on factors such as precipitation and fog. *Literature: [11].*	
	Section 2: Cleaning the exhaust gases from dust	
2	*Topic 1: Basic properties of dust.* *Tasks for IWS. Basic properties of gases.* *Literature: [8].* *Topic 2. Dust collection. Parameters of the dust collection process.* *IWS assignment. Methods and devices for monitoring the concentration of dust impurities in the atmosphere and industrial emissions.* *Literature: [8].*	*5*
	Section 3. Dry mechanical gas purification devices	
3	*Topic 1: Dust settling chambers and inertial dust collectors.* *Tasks for the IWS. Irrigation flues.* *Literature: [2, 3, 4].* *Topic 2. Blinds and cyclones.* *Tasks for the IWS. Rotary dust collectors.* *Literature: [12].* *Topic 3: Vortex dust collectors.* *Tasks for the IWS. Dynamic dust collectors.* *Literature: [8].*	*8*
	Section 4. Wet mechanical gas cleaning devices	
4	*Topic 1: Nozzle scrubber, nozzle scrubber, scrubber with a moving nozzle.* *Tasks for the IWS. Mechanical disk scrubber.* *Literature: [12].* *Topic 2. Centrifugal scrubber, venturi scrubber, impactor, bubbling-foam apparatus.* *Tasks for the IWS. Doyle's high-speed scrubber.* *Literature: [12].*	*5*
5	***Section 5. Apparatus for gas purification by filtration***	
	Topic 1: Fiber and granular filters. *Tasks for the IWS. Ceramic and metal-ceramic filters.* *Literature: [8].* *Topic 2. Fabric filters.* *Tasks for the IWS. Filter mist eliminators.* *Literature: [12].*	*5*
6	***Chapter 6. Apparatus for gas purification in an electric field***	
	Topic 1: Classification of electrostatic precipitators and their structural elements. *Tasks for IWS. Magnetic purification of gases.* *Literature: [7, 8].* *Topic 2. Dry and wet electrostatic precipitators.* *Tasks for the IWS. Recovery of captured dust.* *Literature: [7, 8].*	*6*
	Preparing for the MCT	*2*
	Preparing for the test	*2*
	Total hours	*48*

Policy and control

7. Policy of the academic discipline

Rules of attendance and behavior in the classroom

Students are obliged to actively participate in the educational process, not to be late for classes and not to miss them without a valid reason, not to interfere with the teacher's classes, and not to be distracted by activities unrelated to the educational process.

Rules for awarding reward and penalty points

- *incentive points can be awarded by the teacher only for the performance of creative works in the discipline or additional online specialized courses with the receipt of a relevant certificate:*
  https:// www.coursera.org/learn/fire-effect
  https://www.coursera.org/learn/global-warming
  However, their total cannot exceed 10% of the rating scale.
- *no penalty points are provided for in the discipline.*

Policy of deadlines and retakes

In case of arrears in the discipline or any force majeure circumstances, students should contact the teacher through available (provided by the teacher) communication channels to resolve problematic issues and agree on an algorithm of actions for working out.

Academic integrity policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the absence of references when using printed and electronic materials, quotes, and opinions of other authors. Hints and cheating during tests and classes are unacceptable; passing a test for another student; copying materials protected by copyright 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". For more details: https://kpi.ua/code

Policy of academic behavior and ethics

Students should be tolerant, respect the opinions of others, formulate objections in the correct form, and provide constructive feedback in the classroom.
The norms of ethical behavior of 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". For more details: https://kpi.ua/code

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

Allocation of study time by type of class and assignments in the discipline according to the working curriculum:

Semester	Study time		Distribution of training hours				Control measures		
	Loans	Acad. H	Lectures	Practical	Lab.	IWS	MCT	PP	Semester control
3	4	120	36	18	18	48	1	-	Test

A student's rating in a discipline is made up of the points he or she receives for it:

A student's rating in a credit module is based on the points he or she receives for laboratory work, for writing a module test, and for the final test.

The semester control is a test.

Rating (weight) points system and evaluation criteria

Rating system and evaluation criteria:

Performing laboratory work.

The weighting score for laboratory work is 5 points. The maximum number of points for all laboratory works is equal:

5 points x 5 works = 25 points

Criteria for evaluating the performance of the laboratory task

Completeness and signs of task completion	Points.
The task has been completed in full	5
Minor deficiencies under item 1	4
Failure to complete a task on time	3
Late completion of the task, deficiencies under clause 1	2
Poor performance of the task	1
Failure to complete the task	0

Modular control tasks

The weighting score is 25 points. The maximum number of points for the test is equal to:

25 points x 1 paper = 25 points

Criteria for grading tests

Completeness and signs of response	Points.
Full answer.	22-25
A fairly complete answer with some inaccuracies	18-21
The answer does not include secondary or dependent on the main parameters (materials)	15-17
The answer does not include half of the main parameters and several minor parameters or materials	11-14
Superficial answer without analysis of parameters, conditions, materials, facts, incomplete conclusions	5-10
The test is not credited	0-4

Test work for credit

The task of the control work consists of 50 test questions from different sections of the work program of the discipline. Each question of the test is evaluated in 1 point.

A prerequisite for admission to the test is passing all laboratory work and writing a module test.

Thus, the semester rating scale in the discipline is as follows:

$$R = 5 \times 5 + 25 + 50 = 100 \text{ points}$$

Based on the results of the first 7 weeks, an "ideal student" should score 35 points (for 2 laboratory works and a module test). At the first assessment (week 8), a student receives a "pass" grade if their current rating is at least 15 points.

Based on the results of academic work over 13 weeks of study, an "ideal student" should score 45 points (for 4 laboratory works and a module test). At the second assessment (week 14), a student receives a "pass" grade if their current rating is at least 25 points.

The sum of the points for the control measures during the semester and for the final control work is converted to a final grade according to the table.

Number of points	Assessment.
95...100	excellent

85...94	*very well*
75...84	*well*
65...74	*satisfactorily*
60...64	*sufficiently*
RD<60	*unsatisfactorily*
The conditions for admission are not met	*not allowed*

9. Additional information on the discipline

List of tasks to be submitted for the module test

1. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:
volumetric gas flow rate V_r = 27000 m^3/h;

dust content of the gas flow C dust initial= 4.1 g/m^3;

Concentration in Ambient Air for dust = 10 mg/m^3;

efficiency of dust removal in an electrostatic precipitator η_1 =26.89%=0.2689;

dust removal efficiency on the fabric filter η_2 =99.67%=0.9967.

2. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:
volumetric gas flow rate V_r = 40000 m^3 /h;

dust content of the gas flow C dust initial= 2.1 g/m^3 ;

Concentration in Ambient Air for dust = 1.5 mg/m^3;

dust removal efficiency in the cyclone η_1 =73.89%=0.7389;

dust removal efficiency on the electrostatic precipitator η_2 =75.8 %=0.758.

3. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:
volumetric gas flow rate V_r = 50,000 m^3 /h;

dust content of the gas flow C dust initial= 5 g/m^3 ;

Concentration in Ambient Air for dust = 10 mg/m^3 ;

dust removal efficiency in the cyclone η_1 =82.8%=0.828;

dust removal efficiency on the electrostatic precipitator η_2 =92.4 %=0.924.

4. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:
volumetric gas flow rate V_r = 48000 m^3 /h;

dust content of the gas stream C dust initial= 4.4 g/m^3 ;

Concentration in Ambient Air for dust = 0.8 mg/m^3 ;

efficiency of dust removal in the cyclone $\eta_1 = 31\%$=0,31;

efficiency of dust removal on the electrostatic precipitator $\eta_2 = 78\%$=0,78.

5. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 17000 m^3 /h;

dust content of the gas stream C dust initial= 61 g/m^3 ;

Concentration in Ambient Air for dust = 1mg/m^3 ;

Dust removal efficiency of the bag filter η_1 = 98.36 % = 0.9836;

Dust removal efficiency on the scrubber η_2 = 63.3% = 0.633;

Dust removal efficiency on the electrostatic precipitator η_3 = 99.5 % = 0.995.

6. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 15000 m^3 /h;

dust content of the gas stream C dust initial= 100 g/m^3 ;

Concentration in Ambient Air for dust = 1 mg/m^3 ;

Dust removal efficiency in the cyclone η_1 = 86.25 % = 0.8625;

Dust removal efficiency on the electrostatic precipitator η_2 = 84.9 % = 0.849;

Dust removal efficiency on the bag filter η_3 = 52 % = 0.52.

7. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 20,000 m^3 /h;

dust content of the gas stream C dust initial= 25 g/m^3 ;

Concentration in Ambient Air for dust = 1.5 mg/m^3 ;

Dust removal efficiency in the dust collecting chamber $\eta_{пк}$ = 70.55%

Dust removal efficiency in the scrubber η_c = 90.67 %.

Dust removal efficiency in the electrostatic precipitator $\eta_ф$ = 99.799%.

8. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 450000 m^3 /h;

dust content of the gas stream C dust initial= 15.1 g/m^3 ;

Concentration in Ambient Air for dust = 1 mg/m^3 ;

Dust removal efficiency in the cyclone η_1 = 84.135% = 0.84235;

Dust removal efficiency on the electrostatic precipitator η_2 = 95.48% = 0.9548;

Dust removal efficiency of the bag filter η_3 = 90.9% = 0.909.

9. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 17000 m^3 /s;

dust content of the gas stream C dust initial= 1000 mg/m^3 ;

Concentration in Ambient Air for dust = 1 mg/m^3 ;

Dust removal efficiency in a cyclone η_1 = 60% = 0.6;

Dust removal efficiency on the electrostatic precipitator η_2 = 98.48% = 0.9848.

10. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:
Volumetric gas flow rate V_r = 50,000 m^3 /h;

dust content of the gas stream C dust initial= 40 g/m^3 ;

Concentration in Ambient Air for dust = 3 mg/m^3 ;

Dust removal efficiency in the cyclone η_1 = 38.27% = 0.3827;

Dust removal efficiency on the electrostatic precipitator η_2 = 99.99% = 0.9999.

11. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:
Volumetric gas flow rate V_r = 13000 m^3 /s;

dust content of the gas stream C dust initial= 7 g/m^3 ;

Concentration in Ambient Air for dust = 6 mg/m^3 ;

Dust removal efficiency in the cyclone η_1 = 31 % = 0.31;

Dust removal efficiency on the electrostatic precipitator η_2 = 99.89% = 0.9989.

12. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate V_r = 24500 m^3 /hour;

dust content of the gas stream C dust initial= 1.5 g/m^3 ;

Concentration in Ambient Air for dust = 0.5 mg/m^3 ;

Dust removal efficiency in the cyclone $\eta_ц$ = 59.5% = 0.595;

Dust removal efficiency on the electrostatic precipitator $\eta_ф$ = 99.96% = 0.9996.

13. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate V_r = 22000 m^3 /h;

dust content of the gas stream C dust initial= 3.3 g/m^3 ;

Concentration in Ambient Air for dust = 1.1 mg/m^3 ;

Dust removal efficiency in the cyclone $\eta_ц$ = 64.08 % = 0.6408;

Dust removal efficiency on the electrostatic precipitator $\eta_ф$ = 99.95% = 0.9995.

14. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate V_r = 120000 m^3 /h;

dust content of the gas stream C dust initial= 2.15 g/m^3 ;

Concentration in Ambient Air for dust = 6 mg/m^3 ;

Dust removal efficiency in the cyclone $\eta_ц$ = 45.28 % = 0.4528;

Dust removal efficiency on the electrostatic precipitator $\eta_ф$ = 99.996% = 0.99996.

15. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas consumption $V_г$ = 270000 m^3 /year;

dust content of the gas stream C dust initial= 6 g/m^3 ;

Concentration in Ambient Air for dust = 0.6 mg/m^3 ;

The efficiency of the dust collection chamber $\eta_п$ = 24.7%;

Cyclone efficiency $\eta_ц$ = 97.25%;

Electrostatic precipitator efficiency η_e = 99.99%.

16. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 20,000 m^3 /h;

dust content of the gas stream C dust initial= 70 g/m^3 ;

Concentration in Ambient Air for dust = 1 mg/m^3

Cyclone efficiency $\eta_ц$ = 92.5%;

Electrostatic precipitator efficiency η_e = 99.998%.

17. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 40000 m^3 /h;

dust content of the gas stream C dust initial= 50 g/m^3 ;

Concentration in Ambient Air for dust = 1 mg/m^3 ;

Cyclone efficiency $\eta_ц$ = 82.9 % = 0.829;

The efficiency of the electrostatic precipitator η_e = 99.99% = 0.9999.

18. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 5000 m^3 /s

dust content of the gas stream C dust initial= 20 g/m^3 ;

Concentration in Ambient Air for dust = 0.15 mg/m^3 ;

The efficiency of the dust collection chamber is $\eta_п$ = 77 %;

Cyclone efficiency $\eta_ц$ = 90%;

The efficiency of the fabric filter is $\eta_ф$ = 97%.

19. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 50,000 m^3 /h;

Dust content of the gas stream C dust initial = 60 g/m^3 ;

Concentration in Ambient Air for dust = 25 mg/m^3 ;

Cyclone efficiency $\eta_ц$ = 61.3%;

Electrostatic precipitator efficiency η_e = 99.99%.

20. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 15000 m^3 /h;

dust content of the gas stream C dust initial= 40 g/m^3 ;

Concentration in Ambient Air for dust = 20 mg/m^3 ;

The efficiency of the dust collection chamber is $\eta_п$ = 80%;

Cyclone efficiency $\eta_ц$ = 90.1%;

The efficiency of the fabric filter is $\eta_ф$ = 98%.

21. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 30000 m^3 /h;

Dust content of the gas stream C dust initial= 130 g/m^3 ;

Concentration in Ambient Air for dust = 5 mg/m^3 ;

Cyclone efficiency $\eta_ц$ = 63%;

Electrostatic precipitator efficiency η_e = 99.99%.

22. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

volumetric gas flow rate $V_г$ = 27000 m^3 /hour;

dust content of the gas stream C dust initial= 4.1 g/m^3 ;

Concentration in Ambient Air for dust = 10 mg/m^3 ;

efficiency of dust removal in an electrostatic precipitator η_1 =26.89%=0.2689;

dust removal efficiency on the fabric filter η_2 =99.67%=0.9967.

23. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

volumetric gas flow rate $V_г$ = 40000 m^3 /hour;

dust content of the gas stream C dust initial=44 g/m^3 ;

Concentration in Ambient Air for dust = 10 mg/m^3 ;

efficiency of dust removal in the cyclone $\eta_1 = 31\%$=0,31;

efficiency of dust removal on an electrostatic precipitator $\eta_2 = 78\%$=0,78;

dust removal efficiency on the bag filter $\eta_3 = 99,9\%$=0,999.

24. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 13000 m^3 /h;

dust content of the gas stream C dust initial = 7 g/m^3 ;

Concentration in Ambient Air for dust = 6 mg/m^3 ;

Dust removal efficiency in the cyclone η_1 = 31 % = 0.31;

Dust removal efficiency on the electrostatic precipitator η_2 = 99.89% = 0.9989.

25. Calculate the material balance and draw a block diagram of the dust treatment plant with the following input parameters:

Volumetric gas flow rate $V_г$ = 24500 m^3 /hour;

dust content of the gas stream C dust initial= 1.5 g/m^3 ;

Concentration in Ambient Air for dust = 1 mg/m^3 ;

Dust removal efficiency in the cyclone $\eta_ц$ = 59.5% = 0.595;

Dust removal efficiency on the electrostatic precipitator $\eta_ф$ = 99.96% = 0.9996.

Work program of the discipline (syllabus):

Compiled by *Doctor of Technical Sciences, Associate Professor Ivanenko O. I.*

Approved by *the Department of E and TPP (protocol № 14 from 8.06.2022).*

Approved by *the ICF Methodological Commission (protocol № 10 from 24.06.2022)*