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

Ecology and Technology of Plant Polymers

FUNDAMENTALS OF BIOCHEMICAL AND PHYSICAL CONVERSION OF LIGNOCELLULOSE MATERIALS

Working program of the discipline (Syllabus)

Details of the discipline

Level of higher education	***First (Bachelor)***
Branch of knowledge	*16 Chemical and bioengineering*
Speciality	*161 Chemical technology and engineering*
Educational program	*Industrial ecology and resource-efficient clean technologies*
Status of discipline	*Optional educational components*
Form of training	*full-time/remote/mixed*
Year of preparation, semester	*3rd year, spring semester*
Volume of discipline	*4 credits (120 h)*
Semester control/ control measures	*Test*
Schedule of classes	*3 hours per week (2 hours of lectures and 1 hour of practical classes)*
Language of instruction	*Ukrainian*
Information about thecourse /teachers	Lecturer: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky/galish-vita-vasilivna.html* Practical /Seminary: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky/galish-vita-vasilivna.html*
Course placement	*https://do.ipo.kpi.ua/*

Program of discipline

1. Description of the discipline, its purpose, subject of study and learning results

Global population growth leads to an increase in demand for energy resources, and therefore the use of oil is growing every year. Oil belongs to non-renewable raw materials, so it is important to develop new alternative energy sources, for example, biofuels from renewable plant materials. Biofuels such as bioethanol, biovuhillia, biogas can be obtained from different types of plant raw materials through thermal, thermocatalytic and biochemical transformation. Physical and biochemical transformations are widely used in technological processes aimed at solving important and urgent problems of finding and using new alternative raw materials for obtaining chemicals and energy, developing progressive methods for the disposal of plant waste. The use of successive stages of physical, chemical and biological processing from plant raw materials can be obtained, in addition to biofuels, a number of valuable products such as sugars, multiatomic alcohols, organic acids, furfurol, amino acids, low molecular weight lignin, etc.

Today, the bioconversion of renewable plant raw materials is considered as one of the key areas of chemical technology and ecology.

***The subject of the discipline "Fundamentals of biochemical and physical conversion of lignocellulose materials"** is the implementation of approaches to the physical and biochemical modification of plant raw materials that will ensure highly effective processing of plant biomass with a wide range of products, namely fuel, sugars, ethyl alcohol, organic acids, aromatic compounds, etc.*

The purpose of the discipline "Fundamentals of biochemical and physical conversion of lignocellulosic materials"

The purpose of studying the discipline is the professional training and formation of students' complex of knowledge necessary to manage the existing technological processes of processing plant raw materials and improve these processes and create new, more efficient, environmentally friendly industries that allow rational use of raw materials, biomass resources, energy resources, as well as those that reduce environmental pollution by various production wastes. In accordance with the purpose of training students in this specialty requires strengthening the competencies formed in students:

- *The ability to use methods of observation, description, identification, classification of objects of chemical technology and industrial products;*
- *The ability to determine the directions of use of plant raw materials and fibrous semi-finished products, to design and implement technologies for their processing;*
- *The ability to use the theoretical fundamentals of ecology, environmental protection and sustainable nature management, the basic principles and components of environmental management.*

*In accordance with the requirements of the program of the discipline "**Fundamentals of biochemical and physical conversion of lignocellulosic materials**", students after its assimilation must demonstrate the following programmatic learning results:*

- *To understand the basic properties of structural materials, principles and limitations of their use in chemical engineering;*
- *To substantiate the choice of technological schemes of production on the basis of rational use of raw materials, energy, obtaining quality products, achieving high productivity while solving environmental issues, calculate material and thermal balances of processes, based on them to find costs of raw materials and energy resources;*
- *To participate in the development and implementation of projects aimed at optimal management and treatment of industrial waste.*

2. Prerequisit and requisition disciplines (place in the structural and logical scheme of training according to the relevant educational program)

*The study of the discipline "**Fundamentals of biochemical and physical conversion of lignocellulose materials**" is based on the principles of integration of various knowledge gained by students during the bachelor's degree in the study of the disciplines of the cycle of general and professional training. The discipline "**Fundamentals of biochemical and physical conversion of lignocellulosic materials**" ensures the implementation of the bachelor's project.*

3. Contents of the discipline

Section 1. General characteristics of bioenergy.

Topic 1. The need for bioenergy.

Topic 2. Current state and prospects for the development of bioenergy in Ukraine and the world.

Section 2. General characteristics of biomass and biofuels.

Topic 3. Types of biomass for energy needs.

Topic 4. Assessment of energy resources of lignocellulose biomass.

Topic 5. Look at the biofuels.

Topic 6. Solid biofuels.

Topic 7. Liquid biofuels.

Topic 8. Gaseous biofuels.

Section 3. Basics of physical conversion of lignocellulose.

Topic 9. Thermochemical conversion of lignocellulose raw materials.

Topic 10. Fundamentals of biomass gasification.

Topic 11. Practical basis for biomass gasification.

Section 4. Basics of biochemical conversion of lignocellulose materials.

Topic 12. Enzyme hydrolysis of lignocellulose.

Topic 13. Preliminary treatment of lignocellulose raw materials.
Topic 14. Enzymes for biochemical conversion of lignocellulose materials.

4. Educational materials and resources

Basic literature

1. *Bioenergy projects: from idea to implementation. Practical manual / Generally edited by Tormosov R.Y. – K.: Polygraph Plus LLC – 2015. – 208 p.*
2. *Innovative technologies of plant resource saving / Barbash V.A. Teaching. manual, Kyiv: Karavela, 2016.- 288 p.*
3. *Organization and economics of bioresources use: textbook: 2nd edition, revised and supplemented – Vinnytsia: Druk LLC, 2020. – 372 p.*
4. *Bioconversion of organic waste: theory and practice / M. S. Slobodyanyk, K. O. Chebotko, L. V. Voitenko, V. A. Kopylevych, V. V. Zhirnov, V. E. Kosmaty. – Nizhyn: Publisher PE Lysenko M.M., 2015. – 208 p.*

Additional literature

5. *V.A. Barbash, I.M. Deykun Chemistry of plant polymers. Tutorial. 2nd edition of the reworking. and complement. – Kyiv.: Karavela, 2018. – 440 p.*
6. *O.P. Gupalo, O.P. Tushnytskyi. Chemistry of wood. – Lviv. – 1979. – 228 s.Gomel M. D., Shabliy T. O., Radovenchik Y.V. Physical and chemical bases of water purification processes: textbook. – K.: Condor-Publishing House, 2019. – 256 p.*
7. *Kulyk M.I. Energy crops: textbook / M.I. Kulyk. – Poltava: "Astraya", 2016. – 110 p.*

Information resources on the Internet

8. *Biomass, Biofuels, Biochemicals. BIOFUELS: Alternative feedstocks and conversion processes for the production of liquid and gaseous biofuels. 2nd edition / edited by A. Pandey, C. Larroche, C.-G. Dussap et al. – Elsevire. Academic Press. – 2019. – 869 c. (https://books.google.com.ua/books?hl=uk&lr=&id=2vabDwAAQBAJ&oi=fnd&pg=PP1&dq=Biomass,+Biofuels,+Biochemicals&ots=hTJh0PlE0o&sig=F6lYwBg14mSUzzqea4xvya1_fIE&redir_esc=y#v=onepage&q=Biomass%2C%20Biofuels%2C%20Biochemicals&f=false)*
9. *Heiderich S., Muller M., Foscolo P.U. ADVANCED BIOMASS GASIFICATION: New concept for the efficiency increase and product flexibility. – Elsevire. Academic Press. – 2016. – 135 c. (https://books.google.com.ua/books?hl=uk&lr=&id=XwNKCgAAQBAJ&oi=fnd&pg=PP1&dq=Advanced+Biomass+Gasification&ots=RpxoQsfTIX&sig=FnIcGNjJaC3NFBCtLlhchnitB3I&redir_esc=y#v=onepage&q=Advanced%20Biomass%20Gasification&f=false)*
10. *Biomass, Biofuels, Biochemicals. Advance in enzyme technology. 1nd edition / edited by R.S. Singh, R.R. Singhania, A. Pandey, C. Larroche. – Elsevire. Academic Press. – 2019. – 511 c. (https://books.google.com.ua/books?hl=uk&lr=&id=cg2GDwAAQBAJ&oi=fnd&pg=PP1&dq=Biomass,+Biofuels,+Biochemicals&ots=yGhgPH2jFA&sig=dRIYbLStvV3BqVPiuX0ublVe5mc&redir_esc=y#v=onepage&q=Biomass%2C%20Biofuels%2C%20Biochemicals&f=false)*
11. *Biofuels production / edited by V. Babu, A. Thapliyal, G.K. Patel. – Wiley. Scrivener Publishing. – 2013. – 250 c. (https://books.google.com.ua/books?hl=uk&lr=&id=iezBAAAAQBAJ&oi=fnd&pg=PT11&dq=Biofuels+production+vikash+babu&ots=oeaxE7k9eX&sig=54yNNIHvaYHHphhgMG0kV-M2Rd0&redir_esc=y#v=onepage&q=Biofuels%20production%20vikash%20babu&f=false)*
12. *Ministry of Energy of Ukraine – http://mpe.kmu.gov.ua/minugol/control/uk/publish/article?art_id=245614698&cat_id=245183225*

13. *State Agency of Forest Resources of Ukraine - https://forest.gov.ua/napryamki-diyalnosti/lisi-ukrayini/zagalna-harakteristika-lisiv-ukrayini*
14. *State Agency for Energy Efficiency and Energy Saving of Ukraine – https://saee.gov.ua/uk/ae/bioenergy*
15. *State Statistics Service of Ukraine - http://www.ukrstat.gov.ua/*

Educational content

5. Methods of mastering the discipline (educational component)

Lecture classes

Lectures are aimed at:

- *provision of modern knowledge in the discipline "**Fundamentals of biochemical and physical conversion of lignocellulose materials**", the level of which is determined by the target installation for each specific topic;*
- *providing in the process of lecturing the student's creative work together with the teacher;*
- *display of methodological processing of the material (allocation of the main provisions, conclusions, recommendations, clear and adequate to their formulations);*
- *formation of the necessary interest in students and providing direction for independent work;*
- *use for demonstration of visual materials, combining, if possible, them with the demonstration of results and samples;*
- *teaching materialin a clear and high-quality language in compliance with structural and logical relations, explanation of all newly introduced terms and concepts;*
- *accessibility for perception by this audience.*

No s/p	The name of the lecture topic and the list of main issues (list of didactic means, references to literature and tasks on the IWS)	Hours
1	***The need for bioenergy.*** *Development of world energy consumption. world development of bioenergy.* *Literature: [1, 2, 3, 6].* *Tasks at the IWS:* *Integrated use of wood and non-wood raw materials for the needs of the energy industry.*	1
2	***Current state and prospects for the development of bioenergy in Ukraine and the world.*** *Energy resources of Ukraine. State of bioenergy. Problems of industry development.* *Literature: [1, 2, 8, 10].* *Tasks at the IWS:* *Obstacles in the development of bioenergy and ways to overcome them.*	1

3	***Types of biomass for energy needs.*** *What is biomass? Biomass sources: Biomass potential in Ukraine.* *Literature: [1, 2, 3, 4].* *Tasks at the IWS:* *Forest reserves of Ukraine.*	1
4	***Assessment of energy resources of lignocellulose biomass.*** *Structure of lignocellulose biomass. Biomass supply. Use of energy crops.* *Literature: [2, 5, 6, 7].* *Tasks at the IWS:* *Organizational and technical solutions for the supply of biomass. Harvesting of agricultural biomass. Transportation of biomass.*	1
5	***Look at the biofuels.*** *Solid, liquid and carbonate biofuels. biofuels of the first generation. biofuels of the second generation. biofuels of the third generation .* *Literature: [2, 6].* *Tasks at the IWS:* *The effect of the humidity of lignocellulose raw materials on the heat of combustion.*	4
6	***Solid biofuels.*** *Elemental composition of biofuels. chemical and physical properties of biofuels. Technical, financial and environmental restrictions when using solid biofuels. Economic aspects of the use of various types of biomass. Commodity forms of solid biofuels.* *Literature: [1, 3].* *Tasks at the IWS:* *Determination of the cost of bale straw. Determination of the cost of wood chips. Formation of the cost of fuel pellets.*	4
7	***Liquid biofuels.*** *Bioethanol. Biomethanol. Biobutanol. Biodiesel. Biomaslo.* *Literature: [1, 5].* *Tasks at the IWS:* *Technical, economic and environmental aspects of liquid biofuel production.*	4
8	***Gaseous biofuels.*** *Biogas. Biomethane. Biovoden.* *Literature: [1, 3, 5].* *Tasks at the IWS:* *Technical, economic and environmental aspects of liquid biofuel production.*	2
9	***Thermochemical conversion of lignocellulose raw materials.*** *Technology of pyrolysis of plant raw materials. Pyrolysis scheme.* *Literature: [3].* *Tasks at the IWS:* *Classification of retort.*	4
10	***Fundamentals of biomass gasification.*** *Chemistry of gasification. Composition of gas. Generalekhnology of gasification.* *Literature: [3].* *Tasks at the IWS:* *Preparation of raw materials for gasification: washing, drying, grinding.*	2

11	***Practical basis for biomass gasification.*** *Types of gasgenerators. Gasification schemes. Reactor of gasification of plant raw materials in the downstream flow of gas. Reactor of gasification of plant raw materials in the transverse flow of gas. Reactor of gasification of plant raw materials in the transverse flow of gas. Gasification reactor with bubbling boiling layer* of *raw materials. Gasification reactor with circulating boiling layer of raw materials.* *Literature: [3].* *Tasks at the IWS:* *By-products of gasification. Plasma gasification of biomass.*	*2*
12	***Enzyme hydrolysis of lignocellulose.*** *General technology of biochemical conversion of lignocellulose materials. General structure of cellulose, hemicelulose, lignin. Dependence of the rate of enzyme hydrolysis of cellulose substrates on their composition.* *Literature: [4, 5].* *Tasks at the IWS:* *Effect of biomass resistance during enzyme hydrolysis.*	*4*
13	***Preliminary treatment of lignocellulose materials.*** *Acid treatment. Alkaline treatment. Organosolventfor processing. Autohydrolysis.* *Literature: [4, 5].* *Tasks at the IWS:* *The effect of machining on the effectiveness of enzyme hydrolysis of lignocellulose materials.*	*2*
14	***Enzymes for biochemical conversion of lignocellulose materials.*** *Cellulase. Endoglucanase. Celobiohydrolaza. Exoglucosidase. Glucosidase. Adsorption of enzymes on cellulose.* *Literature: [4, 5].* *Tasks at the IWS:* *The nature of synergism in the action of enzymes of the cellulase complex. Methods of cultivation of enzyme complexes.*	*4*
15	***Total***	***36***

Practical classes

In the system of professional training of bachelors in this discipline, practical classes occupy 50% of the classroom load. Dany type of work is an important means of operational feedback.

The main tasks of the cycle of practical classes:

- to help students systematize, consolidate and deepen knowledge of a theoretical nature in the field of technologies for complex wood processing;

- teach them to work with scientific and reference literature, documentation and technological schemes;

- to form the ability to learn independently, that is, to master the methods, methods and techniques of self-learning, self-development and self-control.

No s/p	*Theme Title*	*Hours*
1	*Assessment of energy resources of lignocellulose biomass*	*2*
2	*Liquid biofuels*	*2*
3	*Thermochemical conversion of lignocellulose raw materials*	*2*

4	*Fundamentals of biomass gasification*	*3*
5	*Enzyme hydrolysis of lignocellulose*	*3*
6	*Ina speech with a report on the chosen topic*	*3*
7	*Performing modular control work*	*1*
8	*Test*	*2*
Tortal		*18*

6. Independent work of a student/postgraduate student

Independent work takes 55% of the time to study the credit module, including preparation for the credit module

No s/p	*Name of the topic submitted for self-study*	*Number of hours of IWS*
	Section 1. General characteristics of bioenergy	
1	***The need for bioenergy.*** *Integrated use of wood and non-wood raw materials for the needs of the energy industry.* *Literature: [1, 2, 3, 6]*	*3*
2	***Current state and prospects for the development of bioenergy in Ukraine and the world.*** *Obstacles in the development of bioenergy and ways to overcome them.* *Literature: [1, 2, 8, 10].*	*3*
	Section 2. General characteristics of biomass and biofuels.	
3	***Types of biomass for energy needs.*** *Forest reserves of Ukraine.* *Literature: [10].*	*3*
4	***Assessment of energy resources of lignocellulose biomass.*** *Organizational and technical solutions for the supply of biomass. Harvesting of agricultural biomass. Transportation of biomass.* *Literature: [2, 5, 6, 7].*	*3*
5	***Look at the biofuels.*** *The effect of the humidity of lignocellulose raw materials on the heat of combustion.* *Literature: [2, 6].*	*3*
6	***Solid biofuels.*** *Determination of the cost of bale straw. Determination of the cost of wood chips. Formation of the cost of fuel pellets.* *Literature: [1, 3].*	*3*
7	***Liquid biofuels.*** *Technical, economic and environmental aspects of liquid biofuel production.* *Literature: [1, 5].*	*3*
8	***Gaseous biofuels.*** *Technical, economic and environmental aspects of liquid biofuel production.*	*3*

	Literature: [1, 3, 5].	
Section 3. Basics of physical conversion of lignocellulose		
9	***Thermochemical conversion of lignocellulose raw materials.*** *Classification of retort.* *Literature: [3].*	*3*
10	***Fundamentals of biomass gasification.*** *Preparation of raw materials for gasification: washing, drying, grinding.* *Literature: [3].*	*3*
11	***Practical basis for biomass gasification.*** *By-products of gasification. Plasma gasification of biomass.* *Literature: [3].*	*3*
Section 4. Basics of biochemical conversion of lignocellulosic materials		
12	***Enzyme hydrolysis of lignocellulose.*** *Effect of biomass resistance during enzyme hydrolysis.* *Literature: [4, 5].*	*3*
13	***Preliminary processing of lignocellulose materials*** *The effect of machining on the effectiveness of enzyme hydrolysis of lignocellulose materials. Literature: [4, 5]*	*3*
14	***Enzymes for biochemical conversion of lignocellulose materials.*** *The nature of synergism in the action of enzymes of the cellulase complex. Methods of cultivation of enzyme complexes.* *Literature: [4, 5].*	*3*
15	*Preparation for modular control work*	*2*
16	*Preparation of the report*	*10*
17	*HCW*	*10*
18	*Preparation for the test*	*2*
19	*Total hours*	*66*

Politics and control

7. Policy of discipline (educational component)

Rules for attending classes and behavior in classes

Attending classes is a mandatory component of assessment. 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 interfere with the teacher to conduct classes, not to be distracted by actions that are not related to the educational process.

Rules for assigning incentive and penalty points

- *encouraging points can be credited by the teacher solely for the performance of creative works in the discipline, as well as additional passage of online specialized courses with the receipt of the appropriate certificate.*
- *penalty points within the discipline are not provided.*

Polika deadlines and re-assemblys

In case of debts in the discipline or any force majeure circumstances, students should contact the teacher through accessible (provided by the teacher) communication channels to solve problematic issues and coordinate the 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, opinions of other authors. Invalid hints and write-offs when writing tests, conducting classes; passing the credit for another student; copying materials protected by the copyright system without the permission of the author of the work.
The policies 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". Read more: https://kpi.ua/code

Policy of academic behavior and ethics
Students should be tolerant, respect the opinion of others, object to formulate in the correct form, constructively maintain 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". Read more: https://kpi.ua/code

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

Distribution of educational time by types of classes and tasks in the discipline according to the working curriculum:

Semester	School time		Distribution of training hours				Control measures		
	Credits	acad. year.	Lecture	Practical	Labs	IWS	MCT	HSW	Semester control
5	4	120	36	18	–	66	1	1	Passed

The student's rating in the discipline consists of points that he receives for:

1) speeches with a report on the topic that is submitted for practical classes.

2) active participation in the work of practical classes – 3 marks

3) performing a modular control work.

Semester control is test.

System of rating (weight) points and evaluation criteria

1. *Work in practical classes*

1.1. Speech with a substantiated report:

Weight point – 30. The maximum number of points in all practical classes is 30 points × 1 = 30 points.

Evaluation criteria of the report:

Quality of the report and its protection	***Markets***
The topic of the report is fully disclosed; the student thoroughly explains all aspects of the relevant topic, draws the necessary conclusions and generalizations, and clearly answers the questions posed	*30*
The report does not provide enough facts and examples; no proper analysis was carried out; insufficiently clearly formulated conclusions; answers to questions are fuzzy or have some inaccuracies	*29... 26*
The topic of the report is not disclosed enough; no conclusions; no answers to individual questions	*25... 15*
The report does not correspond to the formulated topic; All questions asked went unanswered. The report is not counted	*0*

1.2. Participation in practical classes:

Weight point – 5. The maximum number of points in all practical classes is 5 points × 3 = 15 points.

Criteria for assessing students' knowledge:

Completeness and signs of response	***Markets***
Andactive participation in the discussion of all issues, the correctness and correctness of answers and the implementation of all tasks	*5*
Domitted some inconsequential errors in the performance of tasks or when discussing material	*3... 4*
This fuzzy answer; gross mistakes made; there is no specific wording of laws and terms	*1... 2*
The answer is not counted, there is no activity or preparedness for a practical lesson	*0*

2. *Home control work:*

Weight point – 15. The maximum number of points in all practical classes is 15 points × 1 = 15 points.

Evaluation criteria of the report:

Quality of the report and its protection	***Markets***
The topic of DKR is fully disclosed*; the student thoroughly explains all aspects of the relevant topic, draws the necessary conclusions and generalizations, and clearly answers the questions posed*	*15*
The SKR does not provide enough facts and examples; no proper analysis has been carried out; conclusions are not clearly formulated; the answers to questions are fuzzy or have some inaccuracies	*10... 14*
DKR is not disclosed enough; there are no conclusions; there are no answers to individual questions	*5... 9*
The DKR does not correspond to the formulated topic; all the questions posed remained unanswered. DKR is not counted	*0*

3. *Modular control work:*
Modular control work is carried out in the form of testing.
In total, students must answer 80 questions related to different sections and topics of the discipline.

The weight point for each correct answer is 0.5. Each of the answers is evaluated separately, after which the points received are summed up.

The maximum number of points for writing a modular control work is 0.5 points × 80 = 40 points.

Calculation of scale (R) rating

The discipline rating scale (R) is 100 points and is formed as the sum of all rating points received by the student based on the results of current control measures:

$$R = 30 \times 1 + 5 \times 3 + 15 \times 1 + 0.5 \times 80 = 100 \text{ балів.}$$

A prerequisite for admission to the standings is the enrollment of the reportand, the performance of home control work, the implementation of modular control work, as well as the starting rating of at least 40% of R, that is, 40 points.

Students who scored a rating of less than 0.6 R during the semester perform scoring control work. The task of the control work contains requests that belong to different sections of the program.

To obtain the student's scoring gradesand, the amount of all R rating points earned during the semester is transferred according to the table:

Score	***AboutTsinka***
95... 100	*Perfectly*
85... 94	*very good*
75...84	*well*
65... 74	*Satisfactory*
60...64	*enough*
RD 60<	*Disappointing*
Admission conditions not met	*is notallowed to*

9. Additional information on the discipline (educational component)

Approximate list of questions submitted to the MKR

1.Biomass of wood consists of three-base parts, namely:
a) crown, trunk and root system;
b) branch, crown, trunk;
c) crown, trunk, woody greens.
2.Which of these industries belong to the forestry:
(a) Cellulose;
b) hydrolysis;
c) furniture;
d) rosin-terpentine.
3.The main process on which hydrolysis production is based is:
a) catalytic transformation of natural polysaccharides into monosaccharides;
b) allocation of lignin;
c) hydrolysis of hexosans to hexosis.

Approximateand the task that I take outon the DKR

1. What is the theoretical yield and how many liters of alcohol (ρ=0.7893 g/cm^3) can be obtained from 100 kg of monosaccharide according to the reaction equation:

$$C_6N_{12}O_6 = 2S_2N_5OH + 2CO_2 + Q.$$

2. Calculate what mass of glucose must be taken to obtain 200 kg of alcohol. If the yield of the product is 83%.
3. Describe the technological scheme of obtaining bioethanol of the first generation.

Work program of the discipline (syllabus):

Warehouse *Assoc. Prof, PhD Vita Halysh*

Approved *by the Department of E and TRP (Protocol No. 14 from 08.06.2022)*

Approved *by the IHF Methodical Commission (Protocol No. 10 from 24.06.2022)*