



UNIWERSYTET PRZYRODNICZY WE WROCŁAWIU

Operation and optimization of agricultural biogas plants Educational subject description sheet

Basic information

Field of study Renewable energy sources and waste management		Education cycle 2022/23	
Speciality -		Subject code PD000000POZS.I10B.3028.22	
Organizational unit The Faculty of Life Sciences and Technology		Lecture languages english	
Study level First-cycle (engineer) programme		Mandatory optional	
Study form Full-time		Block major subjects	
Education profile General academic		Disciplines Environmental engineering, mining and energy, Agriculture and horticulture	
		Subject related to scientific research No	
		Subject shaping practical skills Tak	
Teacher responsible for the subject	Małgorzata Fugol		
Other teachers conducting classes	Małgorzata Fugol		
Period Semester 5	Examination exam	Number of ECTS points 5.0	
	Activities and hours lecture: 30 laboratory classes: 30		

Goals

C1	As part of the course, the student learns about the process of anaerobic (methane) fermentation and biogas plants. During the course the student learns about the process of anaerobic (methane) fermentation, structure and functioning of the installation, technologies, substrates, digestate management. The student learns the issues to the operation and optimization of biogas plant operation, process disruptions and prevention methods. Also the student becomes acquainted with the standards and laboratory and empirical manufacturing methods biogas. And also has the opportunity to learn about the functioning of an existing biogas plant.
----	---

Subject's learning outcomes

Code	Outcomes in terms of	Effects	Examination methods
Knowledge - Student knows and understands:			
W1	The student has knowledge of chemistry, biochemistry, and biology necessary to understand the processes occurring during the production of biofuels gaseous products and precipitation of origin vegetable and animal fermentation anaerobic (methane).	OZ_P6S_WG03	written exam, written credit
W2	The student has knowledge of the processes conversion of solid biomass into gaseous biofuels, including from waste biomass of agricultural origin and animal.	OZ_P6S_WG04	written exam, written credit
W3	The student has knowledge of the biosphere and processes chemical and physical in nature when obtaining energy from renewable sources, including biomass of agricultural origin and animal. The student has a general knowledge of the systems, technologies, techniques, devices and tools used in the production of energy from sources renewable energy, especially for biogas plants and biogas.	OZ_P6S_WG07, OZ_P6S_WG09	written exam, written credit
Skills - Student can:			
U1	The student is able to obtain information from literature, databases data and other sources; is able to integrate the obtained information, interpret them, and draw conclusions as well as formulate and substantiate opinions regarding gaseous biofuels.	OZ_P6S_UW01	active participation
U2	The student is able to solve based on the standard engineering activities production problems and operating in the field of biofuel production gas from renewable energy sources, taking into account the related requirements at the same time with care for the natural environment.	OZ_P6S_UW06	active participation
U3	The student is able to perform simple tasks under supervision research and design in the area of renewable energy sources	OZ_P6S_UW07	active participation
Social competences - Student is ready to:			
K1	The student is aware of the importance and responsibility and the effects of the engineer's activity towards renewable energy sources and waste management in aspect responsibility for people's quality of life and condition the natural environment.	OZ_P6S_KO03, OZ_P6S_KO04, OZ_P6S_KR06	active participation

Balance of ECTS points

Activity form	Activity hours*	
lecture	30	
laboratory classes	30	
exam participation	2	
exam / credit preparation	40	
collecting and studying literature	5	
lesson preparation	20	
consultations	3	
conducting research	5	
class preparation	15	
Student workload	Hours 150	ECTS 5.0
Workload involving teacher	Hours 65	ECTS 2.3
Practical workload	Hours 35	ECTS 1.2

* hour means 45 minutes

Study content

No.	Course content	Activities

1.	<p>1. Introduction to gas biofuels.</p> <p>2. The potential of biogas production in Poland and in the world. The condition of the existing biogas plants in the country and in the world. Trends. Legal regulations. Advantages and disadvantages of installation biogas plant.</p> <p>3. Laboratory tests related to the functioning of biogas plants (substrates, charge, digestate). Laboratory methods and standards concerning the production potential biogas and methane by stationary and flow-through methods. Empirical methods on the production potential of biogas and methane.</p> <p>4. Anaerobic fermentation as a biotechnological process. Factors and parameters influencing the course of fermentation. Phase of the fermentation process - biochemical aspects of the process.</p> <p>5. Biogas installations - classification, characteristics. Construction of a biogas plant. Legal and environmental constraints on construction.</p> <p>6. Substrates for biogas production. Types of biogas substrates - classification, characteristic.</p> <p>7. Technologies of biogas production - wet fermentation.</p> <p>8. Technologies of biogas production - dry fermentation.</p> <p>9. Processes accompanying the production of biogas; biogas purification, treatment thermal of substrates.</p> <p>10. Digestate - composition, management methods. Digestate - fertilizer or waste. Legal norms. Equipment for processing (separation), transport and deposit in the field.</p> <p>11. Selected issues related to the destabilization of the fermentation process anaerobic - causes, solutions.</p> <p>12. Selected issues related to the destabilization of the fermentation process anaerobic - causes, solutions - continued</p> <p>13, 14. Biogas from sewage treatment plants</p> <p>15. Ways of converting biogas into energy. Cogeneration engines.</p>	lecture
----	---	---------

2.	<p>1. Opportunities and barriers to the development of biogas production installations in Poland - introduction, practical information, discussion.</p> <p>2, 3, 4. Departure to an agricultural biogas plant.</p> <p>5. Biogas laboratory - reactors for anaerobic (methane) fermentation carried out in a stationary and flow-like manner, devices related to fermentation process. Overview of the anaerobic digestion process, approximation laboratory work, research standards, research methodology, calculation of results, exemplary research substrates.</p> <p>6, 7. Biogas laboratory - basic analytical tests of substrates.</p> <p>8. Calculations for empirical methods of biogas production potential.</p> <p>9. Calculations for converting the results on the production potential biogas according to the test standard.</p> <p>10. Case study - calculations for estimating the substrate base to biogas production as well as electric and thermal power of biogas plants, energy production electricity and heat gross and net.</p> <p>11. Calculations for the operation of a biogas plant. Calculations for values of the digestate based on the physicochemical composition.</p> <p>12. Calculations for the purification of biogas.</p> <p>13. Calculations for converting biogas into energy.</p> <p>14, 15. Calculations related to the production of biogas from a sewage treatment plant.</p>	laboratory classes
----	---	--------------------

Course advanced

Teaching methods:

case analysis, presentation / demonstration, teamwork, discussion, participation in research, lecture, classes

Activities	Examination methods	Percentage in subject assessment
lecture	written exam	60%
laboratory classes	written credit, active participation	40%

Entry requirements

The student has knowledge of chemistry, biology, physics, issues related to gas biofuels, mainly biogas.

Literature

Obligatory

1. Podkówka W. i in. 2012. Biogaz rolniczy-odnawialne źródło energii. Teoria, praktyczne zastosowania.
2. Jędrzak A. 2008. Biologiczne przetwarzanie odpadów.
3. Głazczka i in. 2010. Technologie energii odnawialnej: Biogazownie rolnicze. Warszawa. ISBN 978-83-7073-432-9
4. Myczko A. i in., 2011. Budowa i eksploatacja biogazowni rolniczych. Poradnik dla inwestorów zainteresowanych budową biogazowni rolniczych.
5. Koziołek i in. 2017. Rozproszone systemy dystrybucji biogazu. Badania, projektowanie i rozwój. Wrocław. Oficyna Wydawnicza PWR.

Kierunkowe efekty uczenia się

Kod	Treść
OZ_P6S_KO03	Absolwent jest gotów do uznania szczególnej odpowiedzialności inżyniera zajmującego się odnawialnymi źródłami energii i gospodarką odpadami za jakość życia ludzi i stan środowiska naturalnego
OZ_P6S_KO04	Absolwent jest gotów do myślenia i działania w sposób przedsiębiorczy przynoszący korzyści gospodarce i społeczeństwu
OZ_P6S_KR06	Absolwent jest gotów do postępowania w sposób profesjonalny, przestrzegania zasad etyki zawodowej i poszanowania dobra ogółu
OZ_P6S_UW01	Absolwent potrafi pozyskiwać informacje z literatury, baz danych i innych źródeł; potrafi integrować uzyskane informacje, dokonywać ich interpretacji, a także wyciągać wnioski oraz formułować i uzasadniać opinie
OZ_P6S_UW06	Absolwent potrafi rozwiązywać, w oparciu o standardowe działania inżynierskie, problemy produkcyjne i eksploatacyjne w zakresie gospodarki odpadami oraz źródeł energii odnawialnej, uwzględniając jednocześnie wymogi związane z dbałością o środowisko naturalne
OZ_P6S_UW07	Absolwent potrafi planować i wykonywać zadania badawcze i projektowe dotyczące obszaru gospodarki odpadami oraz źródeł energii odnawialnej
OZ_P6S_WG03	Absolwent zna i rozumie w zawansowanym stopniu wybrane zagadnienia z zakresu chemii, biochemii i biologii niezbędne do zrozumienia procesów zachodzących w czasie pozyskiwania energii z produktów i opadów pochodzenia roślinnego i zwierzęcego, a także innych źródeł energii odnawialnej
OZ_P6S_WG04	Absolwent zna i rozumie w zawansowanym stopniu wybrane zagadnienia z zakresu wytwarzania biopaliw i wykorzystania biomasy, w tym biomasy odpadowej pochodzenia roślinnego i zwierzęcego
OZ_P6S_WG07	Absolwent zna i rozumie w zawansowanym stopniu wybrane zagadnienia z zakresu funkcjonowania biosfery, a szczególnie procesów chemicznych i fizycznych zachodzących w przyrodzie w czasie pozyskiwania energii ze źródeł odnawialnych, w tym z biomasy pochodzenia rolniczego i zwierzęcego
OZ_P6S_WG09	Absolwent zna i rozumie w zawansowanym stopniu wybrane zagadnienia z zakresu: systemów, technologii, technik, urządzeń i narzędzi stosowanych w produkcji energii ze źródeł odnawialnych