GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Thermal waste treatment and recycling, PG_00069299		
Field of study	Chemical Technology		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Energy Conversion and Storage -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Katarzyna Januszewicz	
	Teachers		

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	0.0	15.0	45

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	5.0	25.0	75

Subject objectives

The aim of the course is to familiarize students with modern technologies of thermal waste treatment, such as incineration, pyrolysis and gasification, as well as processes enabling the recovery of energy and raw materials (e.g. hydrogen) from waste. Students will gain knowledge about the types of waste that can be thermally treated (including waste biomass and plastics) and will learn about material recovery processes (including regranulation). The course emphasizes practical aspects through laboratories and developing skills in analysis and presentation of technologies during seminars.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_K01] critically evaluates the content of cognitive and practical problems	K7_K01 critically evaluates content related to cognitive and practical problems	[SK5] Assessment of ability to solve problems that arise in practice [SK4] Assessment of communication skills, including language correctness
[K7_U05] uses instrumental methods applied in technology and related fields	K7_U05 uses instrumental methods used in technology and related fields	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task [SU3] Assessment of ability to use knowledge gained from the subject
[K7_U04] predicts the properties of the materials obtained and the course of processes involving them, based on knowledge of technology and related fields and computer methods of data analysis, modelling and simulation	K7_U02 conducts experiments using appropriately selected techniques and equipment, taking advantage of new achievements in technology and related fields	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU5] Assessment of ability to present the results of task
[K7_W02] selects appropriate apparatus and materials for the manufacture and processing of consumer goods	K7_W02 selects appropriate equipment and materials for the production and processing of consumer goods	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects

Subject contents	**Introduction:** • Classification of waste materials intended for thermal processing • The role of thermal recycling in waste management and the circular economy **Waste Combustion:** • Mechanisms of the combustion process • Technologies for municipal and industrial waste incineration, incineration plants • Combustion products: flue gases, ashes and their further utilization, flue gas treatment systems **Waste Pyrolysis:** • Pyrolysis mechanism: degradation under anaerobic conditions • Types of pyrolysis reactors • Pyrolysis products: bio-oils, pyrolytic gases, solid coke (biochar) • Applications of pyrolysis products in industry and energy • Hydrogen production from pyrolysis gases steam and autothermal reforming technologies **Waste Gasification:** • Mechanisms and technologies of gasification • Composition of synthesis gas (syngas) and its potential applications (energy, chemical production) • Gasification of waste biomass and plastics **Waste Materials for Thermal Recycling:** • Waste biomass: characteristics, preparation for thermal processes • Plastics: thermal degradation potential and raw material recovery • Plastic regranulation processes material recovery before thermal treatment **Environmental and Energy Aspects of the Processes:** • Emissions from thermal processes: control, minimization, and legal standards • Energy balance of combustion, pyrolysis, and gasification processes • Environmental impact of thermal processes and mitigation options

Seminars:
Presentations and discussions on recycling methods

Laboratory Classes:
Experimental analysis of thermal waste conversion processes and characterization of products.
Analysis of pyrolysis and combustion processes (small-scale experiments).
Characterization of thermal degradation products: gas composition, analysis of solids (coke, ash).
Testing the properties of bio-oil and syngas.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
	50.0%	40.0%
	50.0%	40.0%
	50.0%	20.0%

Recommended reading

Basic literature

1. Czerwińska J., Wielgosiński G., 2019, Spalarnie odpadów komunalnych w Polsce, Nowa Energia, 4.
2. Gaja K., Kuropka J. (red.), 2016, Powietrze atmosferyczne. Jakość, zagrożenia, ochrona, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław.
3. Namiecińska O., Wielgosiński G., 2016, Spalarnie odpadów komunalnych perspektywa roku 2020, Nowa Energia, 2.
4. Rajca P., Zajemska M., 2018, Ocena możliwości wykorzystania paliwa RDF na cele energetyczne, Rynek Energii, 4.
5. Wieczorek A., Siekierski M., 2021, Gospodarka odpadami. Instalacje i urządzenia do przetwarzania odpadów, MAZOWSZE Studia Regionalne, 36, Mazowieckie Biuro Planowania Regionalnego, Warszawa, s. 31-44.
6. Wielgosiński G. 2020.Termiczne przekształcanie odpadów. Nowa Energia, Racibórz.
7. Wielgosiński G, Czerwińska J., Szufa Sz. 2021.Municipal Solid Waste Mass Balance as a Tool for Calculation of the Possibility of Implementing the Circular Economy Concept.Energies (14)181

Supplementary literature

EU Legal Acts:

- **Directive 94/62/EC** of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste (OJ L 365, 31.12.1994, p. 10, as amended).
- **Directive 2000/76/EC** of the European Parliament and of the Council of 4 December 2000 on the incineration of waste (published in the Official Journal of the European Union on 28 December 2000).
- **Directive 2008/98/EC** of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance) (published in the Official Journal of the European Union on 22 November 2008).
- **Directive 2009/128/EC** of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides (OJ L 309, 24.11.2009, p. 71).
- **Regulation (EU) 2019/2088** of the European Parliament and of the Council of 27 November 2019 on sustainabilityrelated disclosures in the financial services sector (Text with EEA relevance) (published in the Official Journal of the European Union on 9 December 2019).
- **Regulation (EU) 2020/852** of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (Text with EEA relevance).

eResources addresses

Example issues/ example questions/ tasks being completed	• **What are the main categories of waste eligible for thermal treatment?** • **What is the difference between material recycling and thermal recycling?** • **How does thermal waste treatment fit into the circular economy model?** • **What are the main products of pyrolysis, and what factors determine their composition?** • **Which parameters determine the suitability of waste biomass for pyrolysis?**
Work placement	Not applicable

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