UNIVERSITY OF LJUBLJANA
Faculty of Mechanical Engineering

Chemical Energy Carriers (6006-M) 5 ECTS

Lecturer: **M. Mori, T. Seljak**

Lectures: 30h | Tutorials: 18h | Labs: 12h | Project: 0h | Lang. :

Objectives

- To know the basic physical and chemical properties of chemical energy carriers.
- To know the production and preparation of fossil fuels for use.
- To learn about renewable biofuels, their available potential and their interaction with food production.
- Know the procedures for extracting secondary fuels from waste materials.
- Understand the principles of energy storage, including energy conversion between transient energy forms and stored energy and including chemical, electrochemical and thermal storage principles.
- Understand the principles of designing and integrating energy storage systems into energy systems.

Programme

1. Fuel fundamentals: Physical and chemical properties of fuels, reactivity, thermal behaviour, ignition characteristics, and combustion-relevant parameters.
2. Chemical energy & thermodynamics: Energy carriers, chemical potential, reaction types, and thermodynamic principles governing fuel reactions.
3. Solid fuels & preparation: Wood, peat, coal, coal chemistry, storage, grinding, drying, and combustion methods with emission impacts.
4. Liquid fuels & processing: Oil extraction, refining, additives, storage, fuel preparation (atomization, gasification), and combustion emissions.
5. Gaseous fuels & utilization: Natural gas reserves, transport, liquefaction, evaporation, combustion technologies, and pollutant formation.
6. Alternative, waste-derived & synthetic fuels: Biofuels (1st–4th generation), secondary fuels from waste, synthetic fuels, production routes, economics, and environmental effects.
7. Advanced processing, storage & system integration: Gasification, liquefaction, plastic waste recovery, thermochemical/thermal energy storage, and integration of storage in flexible energy systems.

Prerequisites

In order to successfully achieve this course, the students must meet the enrolment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.

Learning outcomes

After attending this course, the student will acquire knowledge of the composition, generation and usage of chemical energy carriers - fuels and the approaches to their preparation for use. They will also acquire knowledge of renewable biofuels, synthetic fuels, waste materials and surplus energy storage from renewable energy sources, including waste conversion techniques.

Assessment

- Theory (lectures) – 40 %
- Practical coursework – 30 %
- Seminar work – 30 %

Literature

- Schorbert H., Chenistry of fossil fuels and biofuels, Cambridge University Press, 2013.
- Lecomte T. et al, Best Available Techniques (BAT) Reference Document for Large Combustion Plants.
- Industrial Emissions Directive 2010/75/EU Integrated Pollution Prevention and control, European IPPC Bureau, Evropska komisija, Bruselj, 2017.
- Barnes F. S. Large Energy Storage Sytems Handbook, CRC Press, 2011.
- Baukal C. E., Industral Burners Handbook, CRC Press, 2004.
- Rogoff M. J., Screve F., Waste-to-Energy: Technologies and Project Implementation, 3rd ed., Elsevier, 2019.