GASIFICATION
(5 ECTS) *Compulsory*

Responsible person:
Dr hab. inż. Marek Ściążko, prof. , Institute of Chemical Processing of Coal IChPW, Zabrze

Learning outcomes:

The course is aimed at:

- getting students acquainted with the major coal and biomass gasification technologies, coal and biomass preparation for the process, gasification media production, gas conversion and purification and quality parameters of gasification products, syngas utilization, basic synthesis of fuels and chemicals from syngas.
- developing understanding of chemical reactions involved in coal conversion, particularly by gasification, enhancing modelling skill of gasification providing basic knowledge of gasification thermodynamics and kinetics.
- enabling students to prepare the process design of coal and biomass gasification (gasification island: coal preparation unit, steam preparation and air separation unit, gasifier, gas conversion and purification unit; co- and poly-generation processes) as well as to prepare mass and energy balance of the gasification processes.

Course main content:

The course is built of two parts: lectures (30 h) and project (30 h)

Lectures:

Lectures will dwell on the most important gasification technologies as the way of solid fuels (lignite, coal, biomass) conversion to refined gas (synthetic gas, methane, hydrogen), liquid fuels and energy (IGCC).

The content of lectures:
World balance of primary energy sources; General characteristics of solid fuel conversion processes, status and perspective of gasification technologies (1)
Solid fuels for gasification processes: characteristics, classification and methods of fuel analysis (2)
Fundamentals of biomass and coal gasification: mechanism and reactions of gasification, coal and biomass pyrolysis, thermodynamic and kinetic aspects of gasification, bed types, feed systems, process classification, process selection, gasification criteria (3)
Overview of industrial gasification technologies of coal gasification: BLG, Shell, Texaco, Siemens, PWR etc. (4)
Coal upgrading for gasification reactors; Steam and oxygen production for coal gasification (1)
Syngas upgrading: gas impurities, gas quality requirements for chemical syntheses and IGCC, cooling processes, removal of acid gases, gas conditioning, side processes i.e. acid gas recovery and compression of carbon dioxide (4)
Integrated Gasification Combined Cycle (IGCC) with Carbon Capture and Storage (3),
Gas from coal gasification for chemical applications; Hydrogen production by coal gasification; Gas to Liquids Processes GTL (4)
UCG - Underground coal gasification (2)
Biomass gasification: kind of fuel, fuel input, application, feedstock related problems; Overview of commercial gasification technologies of biomass gasification and co-gasification of coal and biomass: PRENFLO, CHOREN etc (4)
Nuclear cogeneration: employment of HTR for coal and biomass gasification (1)
Utilization of by-products and waste treatment; Environmental performance of coal gasification; Techno-economic assessment of coal gasification processes (1)

***Projects*:** each student will be provided with research papers and books as well technical data concerned with particular gasification processes and units. Students are then required to prepare and present the process design and/or mass and energy balance for a selected process of coal or biomass gasification and syngas upgrading.

Projects – content:

1. Development of the process concepts and process chains of coal/biomass gasification technology for different applications:
- Generation of chemical products (NH_3, H_2, SNG, MeOH, liquid fuels)
- Co-generation process (heat and electricity production)
- Poly-generation process (heat, electricity and chemical production)
- IGCC without and with CCS
2. Drawing up of mass and energy balances for selected coal/biomass gasification systems
3. Evaluation of the techno- and eco-efficiency of gasification processes
4. Process modelling of coal or biomass pyrolysis and gasification including thermodynamics laws and chemical reactions principles.

Admission requirements:

None

Literature:

1. C. Higman, M. van der Burgt: Gasification, Elsevier, 2008,
2. J. Rezaiyan, N.P. Cheremisinoff: Gasification Technologies, CRC, 2005,
3. Speight J-G.: Synthetic Fuels Handbook: properties, process and performance, Mc Graw-Hill 2008,
4. L. Douglas Smoot, P.J. Smith: Coal Combustion and Gasification, Plenum Press, New York and London, 1985,
5. P. Arendt et al.: Die Verendlung und Umwandlung von Kohle, Deutsche Wissenschaftliche Gesellschaft für Erdöl, Erdgas und Kohle e.V., Hamburg 2008,
6. M. Sciążko, H. Zieliński: Termochemiczne przetwórstwo węgla i biomasy, Wyd. IChPW, Zabrze 2003,
7. B. Białecka: Podziemne zgazowanie węgla, Wyd. GIG, Katowice 2008,
8. T. Borowiecki et al.: Czysta energia, produkty chemiczne i paliwa z węgla – ocena potencjału rozwojowego, Wyd. IChPW, Zabrze 2003,
9. M. Sciazko: Modele klasyfikacji węgla w ujęciu termodynamicznym i kinetycznym, Wyd. AGH, Krakow 2011.

Assessment:

Lecture: final course grade (from 2/fail to 5/very good)

Project: grade (from 2/fail to 5/very good)

Rules of final credit: The final course grade is based on the result of the exam (50 %) and the passing grade from the project (50 %).