UNIVERSITY OF BORÅS

Syllabus

Modeling of combustion processes – theory and application
Modellering av förbränningsprocesser – teori och tillämpning
7.5 credits
7.5 högskolepoäng

Ladok Code: A506TA
Version: 4.1
Established by: Committee for Education in Technology 2021-03-12
Valid from: Spring 2021

Education Cycle: Second cycle
Main Field of Study (Progressive Specialisation): Energy Technology (A1F)
Disciplinary Domain: Technology
Prerequisites: Fulfills the demand for admission to the master program Resource Recovery.
Subject Area: Energy Technology
Grading Scale: Seven-degree grading scale (A-F)

Content
Important aspects during combustion is how energy and material are transported in the equipment together with how fast the reactions proceed and what compounds that are formed. In this course, the students will repeat the fundamental theories in transport processes and then apply those. The main focus is heat transfer which includes conduction, convection and radiation. Also momentum transfer is included as the convection to a large extent depends on the flow. In addition, mass transfer regarding diffusion in boundary layers and in particles is introduced. Beside the transport processes, both chemical reactions, to determine the reaction rate, and chemical equilibrium, to determine which compounds that are formed, are included. The chemical equilibrium calculations are of great importance to estimate the chemical composition of the solid residue after combustion and to assess if there is risk of deposit formation, agglomeration and corrosion. To handle conditions closer to real processes, numerical calculations of differential equations are introduced and then applied in a software which enables calculations in different geometries with coupled transport equations and reaction kinetics.

Learning Outcomes
After completing this course, students must be able to:

Knowledge and understanding
1.1. Describe the driving force in different transport processes
1.2. Explain flow field around different objects and the origin of a boundary layer
1.3. Explain how to determine reaction kinetics of thermal processes such as pyrolysis, gasification and combustion
1.4. Explain the basics of numerical calculations of differential equations
1.5. Explain the basics of thermodynamics and chemical equilibrium

2. Skill and ability
2.1. Perform heat balances in one and more dimensions in both stationary and dynamic system
2.2. Perform calculation of coupled heat transport processes including conduction, convection and radiation
2.3. Use a commercial computer software with coupled transport processes
2.4. Determine the rate limiting step for the overall reaction rate in different thermal processes with respect to mass transfer, heat transfer and reaction kinetics.
2.5. Determine the main components and their concentration during gasification when residence times and temperatures change
2.6. Determine the fundamental reaction kinetics during pyrolysis and gasification from experimental data
2.7. Determine the combustion process for a single particle
2.8. Perform calculations of chemical equilibrium with a computer software and explain the results

3. Assessment and attitude
3.1. Select and justify the method for determining reaction kinetics during pyrolysis and gasification and explain its limitations.

Forms of Teaching

The teaching will be in the form of lectures and exercises together with hand-in assignments together with oral and written presentations.

The language of instruction is English.

Forms of Examination

The course is examined by the following examination

- Written exam
  Learning outcomes: 1.1-1.4, 2.1-2.2, 2.4, 2.6
  Credits: 3,5 hec
  Grading Scale: A-F
- Hand-in assignments
  Learning outcomes: 1,5, 2.1-2.8, 3.1
  Credits: 4,0 hec
  Grading Scale: Not passed (U) or Passed (G)

  The grade on the written exam will determine the grade on the whole course and will not be issued until all parts have been approved

  If the student has received a decision/recommendation regarding special pedagogical support from the University of Borås due to disability or special needs, the examiner has the right to make accommodations when it comes to examination. The examiner must, based on the objectives of the course syllabus, determine whether the examination can be adapted in accordance with the decision/recommendation.

Student rights and obligations at examination are in accordance with guidelines and rules for the University of Borås.

Literature and Other Teaching Materials

Literature:
Incropera, DeWitt, Bergman, Lavine: Incroprea's Principles of Heat and Mass Transfer

Distributed material in the learning platform

The course literature is in English.

Student Influence and Evaluation

The course is evaluated according to current guidelines for course evaluations at University of Borås where the view of the students are collected. The course evaluation report is published and feedback is given to the participants and the coming students according to previous mentioned guidelines, and will be the basis for future course and program developments. The course coordinator are responsible that the evaluation is performed in line with the above description.

Miscellaneous

The course is included in the Master program Resource Recovery.

The grade of the course is given by the grade on the written exam.

This syllabus is a translation from the Swedish original.