KH1231 Chemical Engineering and Technology 2 21.0 credits

Kemiteknik 2

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for KH1231 valid from Autumn 2011

Grading scale

A, B, C, D, E, FX, F

Education cycle

First cycle

Main field of study

Chemistry and Chemical Engineering,Technology

Specific prerequisites

Completed upper secondary education including documented proficiency in Swedish corresponding to Swedish B, and English corresponding to English A. For students who received/will receive their final school grades after 31 December 2009, there is an additional entry for mathematics as follows:
documented proficiency in mathematics corresponding to Mathematics A.
And the specific requirements of mathematics, physics and chemistry corresponding to Mathematics D, Physics B and Chemistry A.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The main gole of the course is that the student should be able to dimension and analyse chemical reactors, separation equipment and process systems and to make aware decisions on choise of equipment and process paths.

Part 1,Unit operations:

When you have passed the course part you will be able to:

- formulateand solve mass balances and energy balances for unit operations of evaporation, distillation, extraction, leaching and humidification operations
- calculate enthalpy for pure substances, mixtures and water vapor at various conditions
- calculate the driving force for heat transfer and heat transfer area on evaporation
- take the boiling point elevation into account and describe its impact on evaporation
- describe the operating modes and properties for forward, backward, mixed and parallel feed of multiple-effect evaporators
- describe common types of evaporators, equipment for extracting and leaching, plates and packings
- apply boiling and equilibrium diagrams for mixtures of two components in distillation
- describe design and features of a continuous fractionating column
- set up material balances of operating lines for two-component systems of distillation and absorption
- calculate the number of ideal stages numerically and graphically for a given separation by distillation and absorption
- calculate the actual height of a column by using plate efficiencies
- describe core principles of separation by adsorption, extraction and leaching
- apply the equilibrium equation of gas-liquid in absorption, liquid-liquid during extraction and solid-liquid during leaching
- calculate mass transfer within and between phases by applying two-film theory
- explain and calculate common definitions of moist air, such as humidity, relative humidity, wet-bulb temperature and adiabatic saturation temperature
- apply humidity chart, Mollier diagram, for moist air
- use graphical methods for setting up mass balances for extraction and leaching
- estimate the number of ideal stages in separation by extraction and leaching

Part 2, Chemical reaction engineering:

When you have passed the course part you will be able to:

- formulate and solve material balances and energy balances for systems with chemical reaction and explain the meaning of the therms
- calculate the composition and quantity of flows
- calculate temperatures of streams and the need for heating och cooling in different process steps
- describe the caracthericics of the batch reactor, the continous-stirred tank reactor, the tubular reactor and the packed bed reactor and to compare the reactors and to suggest reaction conditions for dofferent casees
- dimension isothermal reactors by using the rate of reaction equation and/or experimental data
- write a heat balance for a nonisothermal chemical reactor and explain the meaning of the therms and how to calculate them
- give examples of industrial reactor design for different reaction systems and desribe how the heat transfer can be arranged
- describe the rate of reaction equation for irreversible and reversible reaction and to explain the therms reaction order, rate limiting step, reaction mechanism and elementary reaction
- calculate reaction order and heat constant by using experimental data
- describe the connection between material transfer (diffusion) and chemical reaction and how the reaction ressistance is influenced under different conditions
- describe how process calculations are performed and how different variables and equations are used
- plan, carry out and evaluate studies of a chemical process in laboratory scale and to present the result in a thecnical report
- describe and characterise the structure of the European chemical industry and its most important raw materials
- outline some important large scale processes, including oil refining and production of petrochemical products
- describe production and use of industrial catalysts

Part 3 Tecnical thermodynamics:

When you have passed the course part you will be able to:

- formulate energy balances for open and closed systems
- describe and use the first and second law of thermodynamics
- describe the conditions for transformation between different types of energy and how the transformation can take place
- describe and calculate theoretical energy transformation processes such as Carnot, Rankine and Brayton cycles and their tecnical equivalences in steam turbine and gas turbine processes
- describe and carry out calualations on cooling mashines and heat pumps

Part 4, Calculation exercise:

When you have passed the course part you will be able to:

- draw a simple flow sheet for a given process and to ”set up” the equations needed to solve a given problem

Part 5, Role play, ethics:

When you have passed the course part you will:

- have knowledge of basic ethical concepts and to use them for applications in chemical engineering

Course contents

Part 1 – Unit operations. Fundamentaltheoryofheatand mass transferwithapplicationtoevaporation,moistair,distillation,absorption,leachingandextraction.

Part 2 – Chemical reaction engineering.
General problems in process chemistry. Chemical processes. Material and energy balances. Chemical reaction engineering including choice of and operating conditions for chemical reactors, derivation of equations for the reactors. Laboratory work in project form.

Part 3 – Tecnical thermodynamics.
The basic laws of thermodynamics. Applied thermodynamics for ”kretsprocesser inom ång- och kylteknik” and heat pumps

Course literature

McCabe, W. L., Smith, J. C. and Harriott, P., Unit Operations of Chemical Engineering, 7th ed., McGraw-Hill, New York, 2005. Simonsson, D.,
Kemisk reaktionsteknik, KTH, eller Fogler, H. S., Elements of Chemical Reaction Engineering, 4th ed, Prentice-Hall International, 2005, Gevert, B., Järås, S., Kemisk Teknologi / Teknisk kemi, KTH, övningsexempel m.m. Moran, M. J. and Shapiro, H. N., Fundamentals of Engineering Thermodynamics, John Wiley & Sons.

Examination

- LAB1 - Examination, 1.5 credits, grading scale: P, F
- LAB2 - Examination, 4.5 credits, grading scale: P, F
- TEN1 - Written examination, 4.5 credits, grading scale: P, F
- TEN2 - Written examination, 6.0 credits, grading scale: P, F
- TEN3 - Written examination, 3.0 credits, grading scale: P, F
- ÖVN1 - Exercises, 1.5 credits, grading scale: P, F
- ÖVN2 - Exercises, - credits, grading scale: P, F

Based on recommendation from KTH’s coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

Passed examination, Separation processes (TEN1; 4.5 credits)
Passed examination, Chemical reaction engineering (TEN2; 6.0 credits)
Passed examination, Technical thermodynamics (TEN3; 3.0 credits)
Laboratory work, Separation processes (LAB1; 1.5 credits)
Laboratory work, Chemical reaction engineering (LAB2; 4.5 credits)
Exercises, (ÖVN1; 1.5 credits)
Exercises, (ÖVN2; 0 credits).

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.