Course syllabus 2019

KETN20 Sustainable Process Design

Staff

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Literature

Smith: Chemical Process Design and Integration. John Wiley & Sons, 2016, ISBN: 978-1-119-99014-7. 2nd edition, ***abbreviated CP***

Al-Malah: Aspen Plus - Chemical Engineering Applications, John Wiley & Sons, 2017, ISBN: 978-1-119-29362-0 (epub), ***abbreviated CEA***

ULLMANN'S Encyclopedia of Industrial Chemistry, John Wiley and Sons, Online ISBN: 978-3-527-30673-2, ***abbreviated Ullmann***

Karlsson, Svensson: Absorption with chemical reaction

Lecture notes

Content

The aim of the course is to give the student the tools needed to combine multiple unit operations in an industrial process and to study the dependence between unit operations and how the total resource is affected when key parameters are varied.

The course is structured around a number of themes. The course covers design of industrial processes using flowsheeting programs and contains in-depth sections on phase equilibria, distillation, physical transport processes and energy conversion, multi-component distillation, absorption and evaporation. Energy and environmental aspects are illustrated by the section on energy, energy production, water and waste management, as well as gas purification. Also included is optimization of industrial processes with respect to energy efficiency and environmental impact.

The course setup is depicted below, where themes, study visits, project and calculation tasks are shown.

KETN20 Sustainable Process Design

HT1

Week	36	37	38	39	40	41	42	43	44
Theme	Process design Aspen Plus	Physical properties	Reactors	Separation processes Hom. mix CO_2 capture		Evaporation	Distillation	Repetition	Exam
Study visits									
Project, PDP				Contract					
Calculation tasks				PM	Evaporation		Distillation		

HT2

Week	45	46	47	48	49	50	51	52	1	2	3
Theme	Separation processes Het. mix	Pinch analysis	Process integration	Industrial energy conversion	Flue gas cleaning	Water system design	Repetition				Exam
Study visits			Industry								
Project, PDP	Start project		Consultation	Report	Consultation	Deadline	Presenting				
Calculation tasks				Heat pump							

Lectures

The material covered on each lecture is listed in the in the corresponding modules and calendar. Read the course material before each lecture. This is to ensure that you are able to get the most out of every lecture and to facilitate more discussion during the lecture. The purpose of the lecture is thus to provide you with enough opportunity to discuss and reflect on the course material covered so that you may achieve the learning outcomes specified in the course syllabus.

Lecture notes (i.e. ppt-presentation) will be available before each lecture. Note that all the content covered in the lecture might not be included in the lecture notes as you are expected to take notes yourself during the lecture.

Exercises and computer labs

The exercises to solve on the computer labs and exercises are listed in the corresponding modules and calendar. If course material is listed in the lesson plan for the exercise this should be read before the exercise.

The solutions to the exercises will be available at the exercises if you wish to consult them for tips on alternative solutions. This is to ensure that you try and solve all exercises yourself before you turn to the solutions for guidance. The teaching assistants are available on all computer labs and exercises for consultation. Contact the teaching assistant at the exercise if you want to look at a solution. Solutions on exercises are available on the scheduled exercises.

Group assignments

There are four group assignments in the course. They consist of three smaller calculation tasks and one larger process design project. You will be divided into groups of two at the start of the course, in which you will work on both the calculation tasks and the process design project. All group assignment reports should be written in English.

The three calculation tasks are connected to three of the course themes as listed below:

- Evaporation, deadline 4/10
- Distillation, deadline 22/10
- Heat pumps, deadline 3/12

The calculation tasks should be reported in a short summary, maximum 1 page, according to the instructions given in each assignment. The template used for assessment of the calculation tasks is available on Canvas.

The process design project involves an implementation of a larger process in the flow sheeting software Aspen Plus. The project report will be subject to peer review, as described in the *Report Guidelines KETN20*. The deadlines for the process design project are listed below:

- Project report, deadline 12/12
- Peer review, deadline 16/12
- Revised report, deadline 20/12

The project report will be reviewed using Urkund. On the 18th, 19th and 20th of December oral presentation of the process design project will take place.

Written exams

There are two written exams in the course. The exams are scheduled 28/10, 8-13 in KC:H, KC:I, and 17/1, 8-17. The first exam will include questions on theory and calculation tasks on the topics covered in HT1. The second exam is a take home exam where you will be asked to solve a process design task and submit a short report, using previously distributed material. The exams will be in English.

Study visits

One study visit is planned in the course: 20/11, 8-17. Attendance is mandatory for this study visit.

Schedule

The schedule for the course is available in the calendar and also summarized below. Any changes to the schedule will be made directly in the calendar and posted under Announcements.

HT1

Date	Time	Location	Content	Literature/comment	Teacher
2/9	10-12	KC:A	Course introduction	Course syllabus	All
3/9	8-10	KC:C	Process design	CP: ch 1	OW
4/9	10-12	Platinum	Process design	Getting started: ch 1-4	MP/MG
6/9	10-12	Platinum	Process design	CEA: ch 1 (homework 1.3)	MP/MG
9/9	10-12	KC:A	Physical properties	CP: Appendix A	OW
10/9	8-10	KC:L	Exercise introduction	Problem solving CP: example A2, A4	OW/ HS/MP/MG
11/9	8-10	A:B	Physical properties	CP: Appendix A	OW
	13-15	Platinum	EndNote	English	Library staff
	15-17	Platinum	EndNote	Swedish	Library staff
12/9	8-10	KC:L	Physical properties	CP: A.1, A.2, A.5	MP
13/9	10-12	Platinum	Physical properties	CEA: ch 2 (homework 2.3)	MP/MG
16/9	10-12	KC:F	Reactors	CP: ch 4-6	HS
17/9	8-10	KC:L	Reactors	CP: 4.2, 4.3, 5.1	MP
18/9	10-12	Platinum	Reactors	Exercise on Three reactors CEA: ch 6.1-6.6, exercise 6.1 (ch 6.13)	MP/MG
20/9	10-12	KC:L	Reactors	CP: 5.4, 5.7, 6.3	MP
23/9	10-12	KC:F	Separation proc	CP: ch 9	HS/OW
	13-15	KC:L	Separation proc	CP: 9.4, 9.5, 9.7	MP
24/9	8-10	KC:C	Separation proc	CP: ch 9, Absorption columns	HS
25/9	8-10	Platinum	Separation proc	Absorption DEPG + MDEA	MP/MG
26/9	8-10	KC:L	Separation proc	CP: 9.1, Exercises Absorption columns	MP
	15-17	Conference room, -1	Project	Contract, writing PM	HS/OW/ MG/MP
27/9	10-12	KC:M	Separation proc	Exercises Absorption columns	MP
			Project	Hand in contract	
30/9	10-12	KC:F	Evaporation	Ullmann's ch Evaporation	HS
	13-15	KC:L	Evaporation	Exercises on Evaporation	MP
1/10	8-10	KC:L	Evaporation	Exercises on Evaporation	MP
2/10	10-12	Platinum	Calculation task	Evaporation Assignment	MP/MG
3/10	8-10	Platinum	Calculation task	Evaporation Assignment	MP/MG
4/10			Calculation task	Hand-in Evaporation	
7/10	10-12	KC:F	Distillation	CP: ch 8, 10	OW
8/10	8-10	KC:L	Distillation	CP: 8.9, 8.12, 10.1, 10.2	MP
9/10	10-12	KC:G	Distillation	CP: ch 11	OW
	13-15	KC:L	Distillation	CP: 11.1, 11.2, 11.3	MP
10/10	10-12	Platinum	Distillation	CEA: ch 4.5-7 (homework 4.1)	MP/MG
16/10	10-12	Platinum	Calculation task	Distillation Assignment	MP/MG
17/10	15-17	Platinum	Calculation task	Distillation Assignment	MP/MG
18/10	10-12	KC:L	Repetition	Consultation exercises	MP
22/10			Calculation task	Hand-in Distillation	

23/10	10-12	KC:G	Repetition	Questions on Discussion Board	HS/OW
28/10	8-13	KC:H, KC:I	Exam		

HT2

Date	Time	Location	Content	Literature/comment	Teacher
4/11	10-12	A:C	Separation proc	CP: ch 7	HS/OW
5/11	10-12	KC:K	Separation proc	CP: 7.2, 7.5, 7.7	HK
6/11	10-12	Platinum	Separation proc	Separation with cyclone	HK/MG
7/11	10-12	Platinum	Project	Start project	HS/OW/ HK/MG
11/11	10-12	V:D	Pinch analysis	CP: ch 17	HS
12/11	10-12	KC:K	Pinch analysis	CP: 17.1, 17.3, 17.7 (17.5)	HK
13/11	10-12	KC:C	Pinch analysis	CP: ch 18	HS
	15-17	KC:L	Pinch analysis	CP: 18.5, 18.1a, 18.2ab, 18.4a	HK
14/11	10-12	Platinum	Energy Integration	Energy Integration	HK/MG
18/11	10-12	V:D	Process integration	CP: ch 20-22	HS/OW
19/11	10-12	KC:K	Process integration	CP: 21.2, 21.4ab, 22.1	HK
20/11	8-17	Industry	Study visit		HS/OW
22/11	13-15	Platinum	Project	Consultation	HS/OW/ HK/MG
25/11	10-12	V:D	Ind energy conv	CP: ch 23	OW
26/11	8-10	Conference room, -1	Project	Report writing	HS/OW/ HK/MG
	10-12	KC:L	Ind energy conv	CP: 23.2, 23.7, 23.10	HK
27/11	10-12	KC:G	Ind energy conv	CP: ch 24 (Applied Thermodynamics: ch 14)	OW
	13-15	KC:M	Ind energy conv	CP: 24.1, 24.6, AT: 14.10, 14.11	HK
28/11	10-12	Platinum	Calculation task	Heat Pump Assignment	HK/MG
29/11	13-15	Platinum	Calculation task	Heat Pump Assignment	HK/MG
2/12	10-12	V:D	Flue gas cleaning	CP: ch 25	HS
3/12	10-12	KC:K	Flue gas cleaning	CP: 25.1, 25.3ab	HK
			Calculation task	Hand-in Heat pump	
4/12	10-12	KC:K	Flue gas cleaning	CP: 25.4, 25.7	HK
5/12	10-12	Platinum	Project	Consultation	HK/MG/ OW/HS
	13-15	Platinum	Flue gas cleaning	Flue Gas Desulfurization	HK/MG
9/12	8-12	V:D	Water system design	CP: ch 26	FM
11/12	8-12	KC:K	Water system design	Exercises Water system design	HK
12/12			Project	Hand in report	
13/12	13-15	KC:P	Repetition	Consultation exercises	HK
16/12			Project	Hand-in peer review	

17/12	8-12	Conference room, -1	Project	Presentations	HS/OW/ HK/MG
18/12	8-12	Conference room, -1	Project	Presentations	HS/OW/ HK/MG
19/12	8-12	Conference room, -1	Project	Presentations	HS/OW/ HK/MG
20/12			Project	Hand-in revised report	
17/1	8-17		Exam		

Examination

The examination consists of several parts:

- Group assignments (7 hp)
- Written exam HT1 (5 hp)
- Written exam HT2 (3 hp)

Assessment through active participation in subprojects, showed in written and oral reports, as well as written exam and written take home exam. The final grade is based on the written exams. The exact credit levels for the different grades will be stated in the exam.