BIOREFINERY:
Application of Chemical Engineering Principles
(Course code: 416511, 5 s.p.)

For:	PhD & MSc students
Lectures:	20-22 March & 25-26 March 2013
Lecture times:	Generally 9:15-17:00 (see detailed lecture schedule)
Location:	Glaset on 4th floor Axelia II (Piispankatu 8)
To register*:	email Nikolai DeMartini (nmartini@abo.fi)
	or ÅAU students can register in Moodle 2 or MinPlan
Registration deadline:	8 March 2013

For non-ÅAU students:

Website:	https://moodle2.vasa.abo.fi/login/index.php
Coordinator:	Nikolai DeMartini (nmartini@abo.fi); +358 (0)2 215 4762

* PhD-students from Finnish universities other than ÅAU, need to fill out a JOO-application (www.joopas.fi) it can be filed electronically or sent to:
Studiekansliet vid Åbo Akademi/Kerstin Fagerström
Tavastgatan 13
20500 Åbo

Lecturers:

Anna Sundberg, ÅAU
Dmitry Murzin, ÅAU
Johan Bobacka, ÅAU
Jan Gustafsson, ÅAU
Jyri-Pekka Mikkola, Umeå & ÅAU
Mikko Hupa, ÅAU
Nikolai DeMartini, ÅAU
Pedro Fardim, ÅAU
Stefan Willför, ÅAU
Tapio Salmi, ÅAU
Tuomo Sainio, LUT

Laboratories:

Analytical Chemistry
Fibre and Cellulose Technology
Industrial Chem. and Rxn Engineering
Inorganic Chemistry
Wood and Paper Chemistry

Åbo Akademi University
BIOREGS
GSCE
PROCESS CHEMISTRY CENTRE

Description

Biorefinery concepts are leading to new industries and new ideas within old industries. They involve biomass instead of fossil feedstocks. There are unique challenges to utilizing the carbon and hydrogen in biomass to make fuels and chemicals. While there was a significant push in the 70's and early 80's, in most cases there was not the economic incentives necessary to result in the consistent development required to bring about mature industries. There are both technical and economic uncertainties in most concepts. The objective of this course is to provide an introduction to biorefinery concepts and challenges for cellulosic biomass. Lectures will provide some background to biomass and its conversion to energy, fuels and chemicals. Examples will be given of the application of chemical engineering principals to biorefinery concepts. Five laboratories in Chemical Engineering (Analytical Chemistry; Fibre and Cellulose Technology; Industrial Chemistry and Reaction Engineering; Inorganic Chemistry; and Wood and Paper Chemistry) have come together to teach this course.

The project is intended to let you explore a biorefinery concept you find interesting. The basis for the project presentation at the end of the course will be an intensive literature study and some basic mass and energy calculations. You will have the opportunity to do the project either individually or as a group and you will be able to choose your topic for the project with approval from the supervisor. More details about the project and the project timeline are given in the following pages.

Lecture Schedule

Wednesday 20 Mar 2013	Thursday 21 Mar 2013	Friday 22 Mar 2013	Monday 25 Mar 2013	Tuesday 26 Mar 2013
9:15-10:00 *Introduction (ND)* ***10:15-12:00*** *Building blocks and chemical bonds in biomass (AS)*	**9:15-12:00** Pre-treatment & Hydrolysis (PF)	**9:15-12:00** Chromatographic separation of monosaccharides (Tuomo Sainio, LUT)	**10:15-12:00** Conducting polymers for biofuel cells *(JB)*	**9:15-12:00** *Thermochemical Conversion of biomass (ND)*
12:00-13:15 Lunch	12:00-13:15 Lunch	12:00-13:15 Lunch	12:00-13:15 Lunch	12:00-13:15 Lunch
13:15-16:00 *Products from cellulose, hemicellulose, lignin & extractives (SW, JG)* **16:15–17:00** *Exercises (ND)*	**13:15-17:00** Biomass based chemical plant (TS & DM)	**13:15-15:00** *Ionic liquids for biomass fractionation* 15:00 Adjourn	**13:15-15:45** *Thermochemical Conversion of biomass (MH)* **16:00–16:45** Excercises (ND)	**13:15 – 15:00** *Review (ND) & Panel Discussion (ND + others)* **15:00** *Adjourn*

ND: Nikolai DeMartini; AS: Anna Sundberg; SW: Stefan Willför; JG: Jan Gustafsson; PF: Pedro Fardim; TS: Tapio Salmi; DM: Dmitry Murzin; J-PM: Jyri-Pekka Mikkola; JB: Johan Bobacka; MH: Mikko Hupa

Exam

Exact date to be set by Friday 22.3. The exam will cover the lecture material and any compendium material.

Project

Portion of your grade: The project grade counts for 25% of your final grade.

Group or Individual: You have the option of choosing to do this project individually or as part of a group of up to 3 people. You can choose the group you want to work in. The score your group gets will be the score you get for the project.

Topic Selection: You can propose a topic (subject to approval by the coordinator) or work with the coordinator to select a topic for the project. Please first approach project selection by trying to define a "problem". For example, Dow Chemicals wanted to make carpeting out of biomass derived fibers. They then established they could do this from PLA and then generated the PLA from corn. Another example would be to begin from a feedstock perspective. For example Denmark generates more straw than can be used in agriculture. For a long time they exported this, but eventually they began looking at co-combustion with coal and did the research needed to support that. Subsequently they have set up a demonstration plant to extract the sugars from the straw for ethanol production prior to combustion of the residues. The project concept can be small scale (such as development of a wood pyrolysis unit for home use), but you need to carry it through to what you will use it for. It can also be large scale (such as gasification for Fischer-Tropsch fuels). The concept can be novel or well established, but should be interesting to you as you will need to do a lot of reading for this project. While biomass combustion falls within the biorefinery concept, it should not be the primary concept in your project.

Project Description: Once you have defined your topic, your objective is to be able to present basic background for the evaluation of the concept. At the end of the course you will make a 20-25 minute presentation (~20 slides) of your concept with 5-10 minutes for a question and answer session with your peers. The basis for your presentation will be literature. Basic mass/energy balance calculations should be done to draw conclusions about scale, mass of biomass needed, etc. Alternatively, if you cannot be present to give a presentation, please make arrangements with Nikolai DeMartini to write a report.

Project timeline:

Wk 13 (27.3)	Decision about group/individual; description of topic + 1-2 articles
Wk 14 (3.4)	Data on biomass composition and properties
Wk 15 (10.4)	Chemical reactions/process steps
Wk 16 (17.4)	Basic mass/energy balance calculations for inputs/products
Wk 17 (24.4)	Scale and implications
Wk 18 (30.4)	Assessment of the impact of a change in feedstock
Wk 19 (8.5)	Research needs
Wk 20 (15.5)	Finalize presentations
Wk 21 (22.5?)	Group presentations (date to be finalized 20.3)

Each week during the project you should email the material to Nikolai DeMartini. Meetings (face to face or phone for students not in Turku) can be scheduled to discuss questions related to the project. This is a lot of information to pull together and as biorefinery concepts are still mostly in the developmental stage. They are still mostly under development (i.e. there are gaps in the knowledge). However, there is also a great deal of information published and being published so this is an opportunity to get familiar with a concept and resources available to obtain the current thinking on biorefinery topics.