

FULBRIGHT CHAIR IN ALTERNATIVE ENERGY

TEACHING ACCOMPLISHMENTS

During my Fulbright tenure at Chalmers University of Technology, I participated in several classes on alternative energy and the forest biorefinery, including:

KBT145: BIOREFINERY

- **Aim:** Within the next 50 years we will see a gradual transition from an oil based society to a biobased society. In this transition there will be a necessity to find new process routes to produce some of the materials used today as well as new materials that can replace some of the materials normally used today. The aim of this course is to give basic knowledge needed to understand how biomaterial can be used and how different biorefinery concepts can be developed based on both environmental and economical criteria.
- **Learning outcome:** After this course the students should have knowledge in: The chemical composition of the most common sources of biomaterial; methods of extracting components; the most important chemical reactions; the most common processes for extracting components and post treatment of extracted materials.
- **Content:** The course will shed light upon some general questions such as what type of biomaterial that are available, how these can be used as well as important reactions and how biomaterial can be processed. The course can be divided in the following parts:
 - Part I An overview: what biomaterial and biorefinery are; common types of biomaterial and where those can be found; finally, some common process routes will also be discussed
 - Part II This part will be dedicated to some basic items: the chemical composition and the structure of biomaterial will be discussed. Also some important reactions with different constituents in biomaterial is treated. A special emphasis will be on the most abundant biomaterial, the wood material.
 - Part III Process concepts: In this part different process concepts will be learned. Both hot methods (e.g. gasification) and wet methods (eg. pulping and ethanol production) will be treated.
 - Part IV Post treatment of components from biomaterial: In this part, examples of post treatment routes to products are discussed.

KBT130: CELLULOSE TECHNOLOGY

- **Aim:** The purpose of the course is to give the students knowledge of the different processes for paper pulp production from wood. Some important operations are highlighted in the laboratory sessions (kraft pulping, bleaching and mechanical pulp production). In a minor project work, the students are introduced to a flow-sheeting program.

- **Learning outcome:**
 - Describe the macroscopic and morphological structure of wood and give a basic description of the chemical structure of the wood constituents (cellulose, hemicelluloses, lignin and extractives)
 - Describe different processes related to mechanical pulp production (SGW, TMP and CTMP) and explain the mechanisms leading to fibre separation during mechanical pulp production processes as well as differences in resulting pulp properties
 - Describe and discuss the different events taking place during kraft pulping (steaming, impregnation and delignification) - chemical, physical and kinetic aspects should be covered
 - Describe batch and continuous kraft pulping processes (including both conventional and modified processes)
 - Describe how washing, sieving and drying of pulp are carried out and discuss different phenomena involved in these operations.
 - describe and discuss different bleaching sequences applied in the brightening of kraft pulp (including chemical and environmental aspects, different types of equipment, as well as pulp fibre properties)
 - Describe and discuss processes and phenomena involved in the chemical recovery in the kraft process (evaporation, combustion in the recovery boiler and white liquor preparation)
 - Give a basic description of the production of sulphite pulps and semi-chemical pulps
 - Use a flow-sheeting software (WinGEMS) for basic simulations of unit operations in the kraft process

Both courses were offered in the Chemical Engineering Department.

In addition, I presented teaching material to students at Forest Products Industry Research College (FPIRC).

1. Forest Biorefineries Bridge to Future: FPRIC Sweden (Aug., 2008).
2. US Perspective on Biorefinery, Forest Products Industry Research College (FPIRC), Royal Institute of Technology, Stockholm (Jan., 2009)