Contents 2014

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I consider myself very lucky to work at a department where the research carried out is so relevant for many of the problems our world face today. We have researchers working with waste-water treatment, how to avoid flooding of cities during extreme rainfall, creating biofuels and chemicals from renewable sources, improving carbon capture systems, optimizing industrial processes to reduce costs and environmental footprints, creating mathematical models of preparative chromatography processes to make it possible economically to optimize these systems, investigating the efficiency and fouling of different filters in membrane filtration, etc. etc.

Do I hear you ask how all these totally different things can be connected in any way? Well, we believe they are and with the new design of our yearly report and our redesigned web we hope and believe that we have become a little better at explaining what we do and how it is all connected.

Mattias Alveteg
Head of Department
Chemical Engineering, Lund University
Research

Research at the department is focused mainly on resource-efficient technologies for sustainable development, and is carried out in collaboration with other national and international research groups and companies. Scientists at our department have long experience of pretreatment methods, as well as biotechnological and thermochemical reactions, separation processes and the design of processes for the production of chemicals, fuels and other materials from biomass. Other important areas of research include the modelling and simulation of processes in order to increase their efficiency, and environmental issues such as carbon dioxide removal and water and wastewater treatment.

GREEN CHEMICAL ENGINEERING

A great deal of practical research is carried out in the laboratory with the aim of utilizing bio-based resources instead of, or as a complement to, fossil-based processes. Examples of the raw materials used in these processes are raw biomass from forestry or agriculture, and by-products and waste from traditional biomass-based industries, such as the pulp and paper industry.

Chemicals from biomass

Research has been carried out at the department for many years on the production of chemicals from biomass. This research is spurred on by the needs and desire of society to reduce the use of fossil-based raw materials and energy. Oil is used mainly as transportation fuel, while coal and natural gas are used for heat and power production. However, considerable amounts are also used in the production of chemicals. Whereas other kinds of raw materials can be used in the energy sector, the production of chemicals often requires a carbon source.

Various kinds of biomass are used in our research for the production of chemicals, mainly lignocellulose from trees. These chemicals can be produced by both thermochemical and biochemical processes. Our research is aimed at improving processes for the production of platform chemicals, which in turn can be used as the starting materials for a wide range of final products. An example of this is succinic acid, which can be produced microbially from sugar. Succinic acid is already used in industry today, but it is predicted that it will become increasingly important in several value chains if can be produced more cost-effectively. Another example is the use of glycerol and ethanol for the synthesis of the industrially important olefins ethylene and propene, which are used in the production of common plastics such as polyethylene and polypropylene.

Fuel from biomass

The department has long been involved in research on the production of fuels from biomass, mainly lignocellulose-rich materials, such as the by-products of forestry and agriculture, as these do not compete with the production of food. The main incentive for producing transportation fuel from biomass is the need to reduce carbon dioxide emissions. This can be achieved by a combination of measures, such as more energy-efficient vehicles, reducing the need for transportation, and introducing biomass-based fuels. The production of ethanol, biogas and biohydrogen from lignocellulose, and the production of green LPG from the by-product glycerol are the main areas of research. Scientists at the department have been involved in the transformation of the Swedish energy system since the oil crisis in the 1970s, mainly by investigating the production of fuel, mainly ethanol, from biomass. The focus of this research has
changed as a result of the advancements made and the results obtained. The most important stages in bioethanol production, as well as in other energy carriers, are the pretreatment and hydrolysis of the biomass to produce fermentable sugars, the fermentation of complex sugar solutions, and the purification of the products. Process design and techno-economic analysis in which complete production processes are modelled are important elements in steering new research in the right direction. The department is also host to a national process development unit where pretreatment and fermentation can be studied on pilot scale for both batch and continuous processes.

Materials from biomass
We also have considerable experience in the purification and concentration of macromolecules such as lignin and hemicellulose, for conversion into various products. These macromolecules may originate from industrial processes, such as pulp and paper production, or can be produced at the department by acid or alkali hydrolysis of biomass in one of our pretreatment reactors. The main aim of this research is to develop resource-efficient separation and fractionation processes that can be implemented in existing and future biorefineries.

SUSTAINABLE PROCESS ENGINEERING
The aim of the research carried out in this field is to make each step of the process and the whole process more efficient. Process modelling of various kinds is used in many projects to create a comprehensive picture of the process being studied, including the separate steps. The process can then be optimized to obtain the most efficient use of raw materials and energy, to improve runnability and reduce production cost.

Resource-efficient production
The efficient use of resources is one of the most important factors in the process industry to ensure competitiveness in the global market. This means maximum utilization of raw materials, minimal loss through by-products, cost-efficient treatment of waste and the rational use of energy. It is also important to maintain resource efficiency during changes in production, such as changes in the quality and amount of product, and as a result of unforeseen events that can affect operation.

Resource-efficient production often involves complex processes, with many steps, the recirculation of material streams and energy-recovery systems. Research at the department is focused on the evaluation, optimization and design of complex processes, and is pursued exclusively with the aid of process modelling and simulation.

The effects of the choice of, and changes in, operational conditions during continuous processes, and the choice of dynamic conditions in batch processes are also studied. The aim of this research is to evaluate the flexibility and robustness of a process to changes in production, and will provide a competitive advantage by minimizing the amount of product that has to be stored at the plant, while maximizing the amount that can be delivered to the customer. Evaluation, optimization and the design of dynamic conditions in batch separation processes for the production of pharmaceuticals is an especially active area of research at the department.

Process intensification
Process intensification involves the development of equipment and production methods for more efficient conversion. This may mean redesigning equipment, or the integration of two or more steps to achieve higher efficiency.
Integration and automation of batch process steps is one of the areas of research at the department. Examples include studies on the integration of separation steps in pharmaceutical production, and integrated hydrolysis and fermentation in the production of biofuels and chemicals. The time required to isolate and purify a protein, from the time it is expressed in a bioreactor until its final form in a pharmaceutical, can be significantly reduced. Studies are also being carried out on the integration of reaction and separation in the chemical modification of pharmaceuticals.

Model based process engineering
Mathematical models offer a means of formulating and presenting knowledge that can be used to solve technical problems. This is called model-based process engineering. This approach is applied to all chemical engineering processes, but in research it means the development of advanced process models and the solution of complicated problems. The field is characterized by the use of mathematical models, computational methods for simulation, optimization and statistical analysis, engineering programming, computational tools and simulation software.

Today, predictions of the performance of a process system are almost entirely made by simulations with mathematical models. The development of models with the ability to provide physical explanations with sufficiently broad ranges of validity is central to many research projects. In order to be able to make reliable predictions, the parameters of the model must be verified against experimental data. Research is being carried out on both general methods for model adaptation and specific areas of application.

The evaluation of the robustness of a process step involves studying how various disturbances in operation affect the performance of that step and the quality of the product. This is an active area of research, and several studies are in progress in the fields of pharmaceuticals and special metals. Both deterministic worst-case scenario analysis and stochastic probability analysis are used.

The optimization of process conditions is a very active area of research. Optimization studies are carried out on both whole processes and single steps, often based on multiple objective functions. Special attention has been devoted to the optimization of dynamic processes, especially in industrial chromatographic separation of proteins, but also in changes in production in chemical processes and power plants.

ENVIRONMENTAL ENGINEERING
Research in environmental engineering includes measures that can lead to direct improvements in the environment, both locally and globally. The main areas include the absorption of carbon dioxide, and processes for the treatment of water and waste from both industry and society.

Water treatment
The wastewater treatment plants of the future will be expected to meet new demands on the release of phosphorus and nitrogen, as well as compounds that are not easily degradable, such as excreted pharmaceuticals and other kinds of organic compounds. Efforts must also be directed towards more energy-efficient treatment methods and reductions in the emission of other greenhouse gases. During recent years, waste water has come to be regarded as a resource rather than waste, as it is possible to recover nutrients, energy and useable water. The water supply and sewage industry is thus facing considerable challenges in developing new systems for surface water and waste water that can meet future demands on both purity and resource efficiency. Compact solutions are often
demanded which further increases system complexity.

Applied research is being carried out at the department in several areas, often in close collaboration with industry. Projects in progress are associated with urban water infrastructure, focusing on energy efficiency and compact process solutions. Anaerobic digestion, the removal of recalcitrant substances and the handling and treatment of surface water are other key areas.

**Carbon dioxide capture**
Carbon dioxide is absorbed in many processes, for different reasons. In the production of biogas or synthetic natural gas (SNG) from biomass, it is necessary to upgrade the gas produced by removing carbon dioxide, in order to obtain a product of sufficient purity for use as transportation fuel or for injection into a natural gas network. In the chemical industry, it is often necessary to remove CO2 from gas streams, for example, in oil refineries and in the production of ethylene oxide. Carbon dioxide may also be removed for carbon capture and storage (CCS).

The absorption of carbon dioxide is an energy-demanding process. The greatest energy requirement is in the regeneration of the absorption solution, which often takes place at high temperature (>120°C). A number of processes could thus be made more energy- and cost-effective by reducing the energy demand of the absorption process.

Research on the absorption of carbon dioxide at the department focuses on the development of new systems in which the absorption solution can be regenerated at lower temperatures (70-90°C), thus reducing the energy demand. This also makes it possible to use excess heat from the process, which reduces the energy demand even further. Research is also being carried out on existing CO2 absorption systems with the aim of developing the process so that it is less energy-demanding.
Publications

The number of publications in scientific journals 2014 was 40 which is a normal annual production at the department.


B. Palmqvist, G. Lidén: Combining the effects of process design and pH for improved xylose conversion in high solid ethanol production from Arundo donax. *AMB Express*, 4, 2014.


The Department of Chemical Engineering is deeply involved in the engineering programs for Chemical Engineering, Biotechnology, and Environmental Engineering (abbreviated K, B and W, respectively). The Department gives eight compulsory courses at the basic level for these programs. There is also an involvement in the Civil Engineering program (V), both at the basic level and at the advanced level.

The Department is responsible for fifteen optional advanced courses in five engineering programs, apart from the four programs already mentioned. Students from the Applied Mathematics program (π) the Nano Science program (N) and the Risk Management program (RH) often participate in courses at the Department. Lecturers at the Department also participate in a number of courses headed by other Departments.

Two new courses were introduced this year: KETA05 Introduction to Chemical Engineering and KETN15 Resource Efficient Process Design, and one was given for the last time: KETA01 Chemical Engineering.

Table 3.1. Courses at basic level given by the Department during 2014. Colored squares indicate which study period the course is given.

<table>
<thead>
<tr>
<th>Title</th>
<th>Code</th>
<th>Program</th>
<th>ECTS points</th>
<th>No of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering (Kemiteknik)</td>
<td>KETA01</td>
<td>K</td>
<td>21</td>
<td>52</td>
</tr>
<tr>
<td>Introduction to Chemical Engineering (Introduktion till kemiteknik)</td>
<td>KETA05</td>
<td>K</td>
<td>7.5</td>
<td>54</td>
</tr>
<tr>
<td>Transport Phenomena (Transportprocesser)</td>
<td>KETF01</td>
<td>B, K</td>
<td>9</td>
<td>95</td>
</tr>
<tr>
<td>Reaction Engineering (Reaktionsteknik)</td>
<td>KETF25</td>
<td>B, K</td>
<td>7.5</td>
<td>120</td>
</tr>
<tr>
<td>Chemical Engineering, Project Laboratory Projektlaboration i kemiteknik</td>
<td>KETF05</td>
<td>K</td>
<td>7.5</td>
<td>44</td>
</tr>
<tr>
<td>Mass Transfer Processes in Environmental Engineering (Masstransport i tekniska och naturliga system)</td>
<td>KTE170</td>
<td>W</td>
<td>15</td>
<td>49</td>
</tr>
<tr>
<td>Heat Engineering (Energiteknik)</td>
<td>KET030</td>
<td>K</td>
<td>7.5</td>
<td>47</td>
</tr>
<tr>
<td>Separation Processes, Basic Course (Separationsprocesser)</td>
<td>KETF10</td>
<td>B, K</td>
<td>7.5</td>
<td>90</td>
</tr>
</tbody>
</table>
### Table 3.2. Advanced courses given by the Department during 2014. Colored squares indicate which study period the course is given.

<table>
<thead>
<tr>
<th>Title</th>
<th>Code</th>
<th>Program</th>
<th>ECTS points</th>
<th>No of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Separation Processes (Industriella separationsprocesser)</td>
<td>KETN05</td>
<td>K, W</td>
<td>7.5</td>
<td>35</td>
</tr>
<tr>
<td>Chemical Engineering Processes (Kemitekniska processer)</td>
<td>KETF20</td>
<td>K, W</td>
<td>7.5</td>
<td>31</td>
</tr>
<tr>
<td>Biochemical Reaction Engineering (Biokemisk reaktionsteknik)</td>
<td>KTE071</td>
<td>B, K, W</td>
<td>7.5</td>
<td>31</td>
</tr>
<tr>
<td>Urban Water (Urbana vatten)</td>
<td>VVA030</td>
<td>V, W</td>
<td>15</td>
<td>37</td>
</tr>
<tr>
<td>Project course in water and wastewater treatment, part I&amp;II (Projektkurs i vattenförsörjnings- och avloppsteknik, del I&amp;II)</td>
<td>VVA910</td>
<td>V, W</td>
<td>7.5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>VVA920</td>
<td>V, W</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Energy and Environment (Energi och Miljö)</td>
<td>KET010</td>
<td>K, W</td>
<td>7.5</td>
<td>36</td>
</tr>
<tr>
<td>Applied Transport Phenomena (Tillämpade transportprocesser)</td>
<td>KETN10</td>
<td>B, K, W</td>
<td>7.5</td>
<td>36</td>
</tr>
<tr>
<td>Resource Efficient Process Design (Resurseffektiv processdesign)</td>
<td>KETN15</td>
<td>B, K, W</td>
<td>7.5</td>
<td>31</td>
</tr>
<tr>
<td>Loss Prevention (Processriskanalys)</td>
<td>KTE131</td>
<td>B, K, RH, W</td>
<td>7.5</td>
<td>59</td>
</tr>
<tr>
<td>Process Simulation (Processsimulering)</td>
<td>KETN01</td>
<td>B, K, Pi, W</td>
<td>7.5</td>
<td>24</td>
</tr>
<tr>
<td>Feasibility Studies on Industrial Plants (Projektering)</td>
<td>KET050</td>
<td>K, W</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>Decentralized Water and Wastewater Treatment (Decentraliserad vatten- och</td>
<td>VVAN01</td>
<td>W</td>
<td>7.5</td>
<td>27</td>
</tr>
</tbody>
</table>
### Table 3.3. Other courses where staff from the Department took part during 2014. Colored squares indicate which study period the course is given.

<table>
<thead>
<tr>
<th>Title</th>
<th>Code</th>
<th>Program</th>
<th>Autumn term</th>
<th>Spring term</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1    2</td>
<td>3    4</td>
</tr>
<tr>
<td>Teaching and Learning (Förståelse och lärande) – 85%</td>
<td>GEMA4</td>
<td>All</td>
<td>3    12</td>
<td></td>
</tr>
<tr>
<td>Infrastructure Technique (Infrastrukturtteknik) – 30%</td>
<td>VTVA01</td>
<td>L</td>
<td>12   54</td>
<td></td>
</tr>
<tr>
<td>Environmental Chemistry (Miljökemi) – 50%</td>
<td>KOK032</td>
<td>K, B</td>
<td>7.5  68</td>
<td></td>
</tr>
<tr>
<td>Applied Aquatic Chemistry (Tillämpad vattenkemi) – 30%</td>
<td>KOOF01</td>
<td>W</td>
<td>5    64</td>
<td></td>
</tr>
<tr>
<td>Environmental Science, especially Environmental Chemistry (Miljövetenskap med miljökemisk profil) – 20%</td>
<td>FMI031</td>
<td>V</td>
<td>6    84</td>
<td></td>
</tr>
</tbody>
</table>
MASTER THERSES
An important part in the training of engineers is the Degree Project (“examensarbete”) which is finished by a Master thesis. By tradition the Department has always been very active in arranging and supervising Degree Projects, primarily due to good contacts with the industry. 30 Master theses were presented during 2014.

Chemical Engineering
- André Bugge: Simulative investigation of a continuous chromatographic process
- Anja Essén: Energieräffektivisering på Boliden Bergsöe AB
- Pontus Ivarsson: Produktåtervinning från moderlut vid en av polyolfabrikerna på Site Perstorp
- Emil Lidman Olsson: Två-fas fermentation för förbättrad produktion i en GS-CHO cell-linje
- Johanna Linde: Reglering av löst syre i fermentationer
- Tobias Lindén: Reduktion av stoftutsläpp och energieräffektivisering av mesaugnarnas rötter vid södra cell Mörrum
- Mikael Nolin: Experimentell undersökning, modellgranskning och lösarvalidering av Vapor Lift Tube-distributören
- Patrik Norgren: Utveckling av VOC-fri färg
- Andreas Nygren: CFD simulerande av bubbelsäken
- Ferran Perez Serrano: Modelling and simulation of antibody purification
- Erik Persson Varelius: Optimering av reaktionsutnyttjandet av koldioxid i ett sockerraffinerad carbonatationsprocess
- Oskar Rudenius: Ozonblekning av barrsulfitmassa vid Stora Enso Nymölla
- Olof Runfors: Energiöptimering av extruderingsprocess på Kullaplast AB
- Daniel Sahlén: Reglering av löst syre i fermentationer

- Maria Sundqvist: Modellering och simulerande av en polyolprocess på Perstorper
- Martin Wannong: Steam consumption at a Chemical plant

Water and environmental engineering
- Sofie Andreasson: Utvärdering av potential för anaerob behandling av industriellt avloppsvatten vid ambient temperatur
- Nelly Dahl: Utvärdering av potential för anaerob behandling av industriellt avloppsvatten vid ambient temperatur
- Maja Ekblad: Stormwater treatment – Sorption of organic biocides from paints and renders
- Maria Fridolf: Dagvattendammars funktion-En studie av vägdayvantattenhammen Fredriksberg
- Rizwana Hamid: Anaerobic Treatment of Industrial Wastewaters
- Sara Johansson: Nitrifikationshämning i tvätterivapppsvatten
- Anna Olsson: Hantering av processvatten relaterat till certifierat avloppsvatten
- Helena Parment: Nitrifikationshämning i tvätterivapppsvatten
- Linnea Rudolfsson: Optimering av biogasproduktion och kapacitet genom utvärdering av olika driftsätt för rötthamarans på Källby ARV-en studie i pilotskala
- Anna Saarvanto: Optimerad slamhantering inom NSVA för ökad biogasproduktion
- Elin Sjöstedt: Konduktivitetsmätningar av tillskottsvatten i Staffanstorps kommun
- Dóra Stefansdottir: Manometriskt metod för utvärdering av anammoaktiviteten vid Sjölunda avloppsreningsverk
- Frida Stolt: Optimering av biogasproduktion och kapacitet genom-
utvärdering av olika driftsätt för rötkamrarna på Källby ARV-en studie i pilotskala

- Boris Trivic: Optimerad slamhantering inom NSVA för ökad biogasproduktion

3rd cycle education

PHD THESIS
Five PhD theses were successfully defended during 2014:

Niklas Andersson
Parallel computing in model-based process engineering

Stefano Macrelli
Ethanol from Sugarcane Lignocellulosic Residues - Opportunities for Process Improvement and Production Cost Reduction

Mark Max-Hansen
Modeling and Optimization of Rare Earth Element Chromatography

Benny Palmqvist
Processing Lignocellulosic Biomass into Ethanol - Implications of High Solid Loadings

Helena Svensson
Energy Efficient Processes for the Production of Gaseous Biofuels - Reforming and Gas Upgrading

LICENTIATE THESIS
One licentiate thesis were successfully defended during 2014:

J. Väänänen
Applying coagulation, flocculation and discfiltration in tertiary treatment
Personnel

In total 66 individuals were employed at the department during 2014, corresponding to slightly less than 60 man-years. The department had 9 professors, 3 adjunct professors 22-24 PhD-students and an additional 5 industrial PhD-students.

ADJUNCT PROFESSORS
A long-term goal at the department is to strengthen external activities and contacts with industrial partners, research institutes, organisations and high class universities. As a part of this strategy, the department recruits adjunct professors to work part time at the university and part time in another company or organisation. During 2014 three adjunct professors were working at the department in the following areas:

**Arne Staby**: Employed 20% at the department, the other part at Novo Nordisk in Denmark. Works with Prof. Bernt Nilsson in developing separation processes for enzymes.

**Henrik Aspegren**: is since 2008 affiliated to VA Syd where he is head of R&D and the waste treatment division. Works 20% with the water and environmental engineering group at the department.

**Frank Lipnizki**: became adjunct professor at the department in January 2014. Since 2001 his affiliation is Alfa Laval where he is Business Manager, and Product Manager plus associated R&D manager and responsible for membrane training and education. He works 10% with Prof. Ann-Sofi Jönsson and the membrane group.

**RETIREMENTS**
Professor **Arne Andersson** retired after many years at the department and 15 years as professor. Arne is an internationally renowned researcher in catalysis whose brilliance resulted in many research grants from the Swedish funding agency Vetenskapsrådet and long term collaborations with industry. He was well appreciated by his PhD-students and his colleagues and continues to be active in the Nordic Catalysis society.

Professor **Jes la Cour Jansen** retired after 16 years as professor in water and environmental engineering. He started his career in Denmark and soon became an internationally renowned researcher. Through the breadth and depth of his knowledge he developed the water and environmental engineering group to what it is today, with its in-depth collaboration between academia, industry and the public sector. To our delight, Jes has agreed to continue working with us part-time over the next few years.
Department of Chemical Engineering 2014

Employed, industrial PhD-students and adjunct professors in alphabetical order.

Adnan K
Anders A
Anders Ax
Anders H
Andrée H
Ann-Sofi J
Anton S
Anne A
Anne N
Balázs F
Basel A
Benny P
Bertil N
Birgit J
Birgitta L
Borbála E
Christian H
Christian R
David G
Deniz K

Elin J
Elisabeth J
Filip N
Filip V
Frank L
Frank V
Fredric B
Fredrik N
Fredrik S
Frida O

Gertrud P
Guido Z
Gunnar L
Hans K
Hans-Kr K
Harald S
Helena S
Henrik A
Henrik Asp

Janne V
Jes LCJ
Johan T
Johanna O
Jonas B
Josedine H
Karin C
Karin J
Karolina J
Kristina K

Laura A
Laura M
Leif S
Lena N
Maja E
Maria M
Marja P
Mark M
Mats G
Mattias A

Meher S
Michael G
Misaghi M
Niklas A
Niklas B
Ola O
Ola W
Per W
Pia-Maria B
Salar H

Sara J
Stefano M
Stig S
Tobias H
Viveka L
Zaun A
Asa D
Economy

The total income for 2014 was 66.1 MSEK, a decrease by 2 MSEK (-2.9%) compared to 2013. We had a slight revenue increase in all funding parts except for external funding (researcher grants), where we had a decrease. The department has a similar type of economy over the years and it develops in small steps. External funding constitute 55% and undergraduate education 26% of the total revenue (See figure 1).

![Revenue by funding source 2014](image)

**Figure 1. Total revenue by funding source 2014 at the Department of Chemical Engineering.**

Salaries and other remunerations remains the main cost (55%) for the department while premises and buildings represent another 14% of the total expenditure (See figure 2). Indirect expenditure to higher levels lies at 20%.

![Expenditure by cost source 2014](image)

**Figure 2. Total expenditure by cost sources at the Department of Chemical Engineering 2014**
Contact details

Postal address:
Department of Chemical Engineering
Lund University
P O Box 124
SE-221 00 LUND, Sweden

Visiting address:
We remain located at the same place as before, but during 2015 the municipality of Lund decided to change our address from
Getingevägen 60, LUND
to
Naturvetarvägen 14, LUND

Delivery address:
We remain located at the same place as before, but during 2015 the municipality of Lund decided to change our address from
Getingevägen 60, LUND
to
Naturvetarvägen 16, LUND

Administration:
Education: Maria Messer
tel. +46 46 222 82 85
e-mail: maria.messer@chemeng.lth.se

Economy and personnel: Lena Nilsson
tel. +46 46 222 82 69
e-mail: lena.nilsson@chemeng.lth.se

Controller/Economist: Gity Yahoo
tel. +46 46 222 48 66
e-mail: gity.yahoo@energy.lth.se
Fax: +46 46 222 45 26
Website: http://www.chemeng.lth.se