Department of Chemical Engineering

Annual Report 2010

NTNU
Norwegian University of Science and Technology

DEPARTMENT OF CHEMICAL ENGINEERING, NTNU

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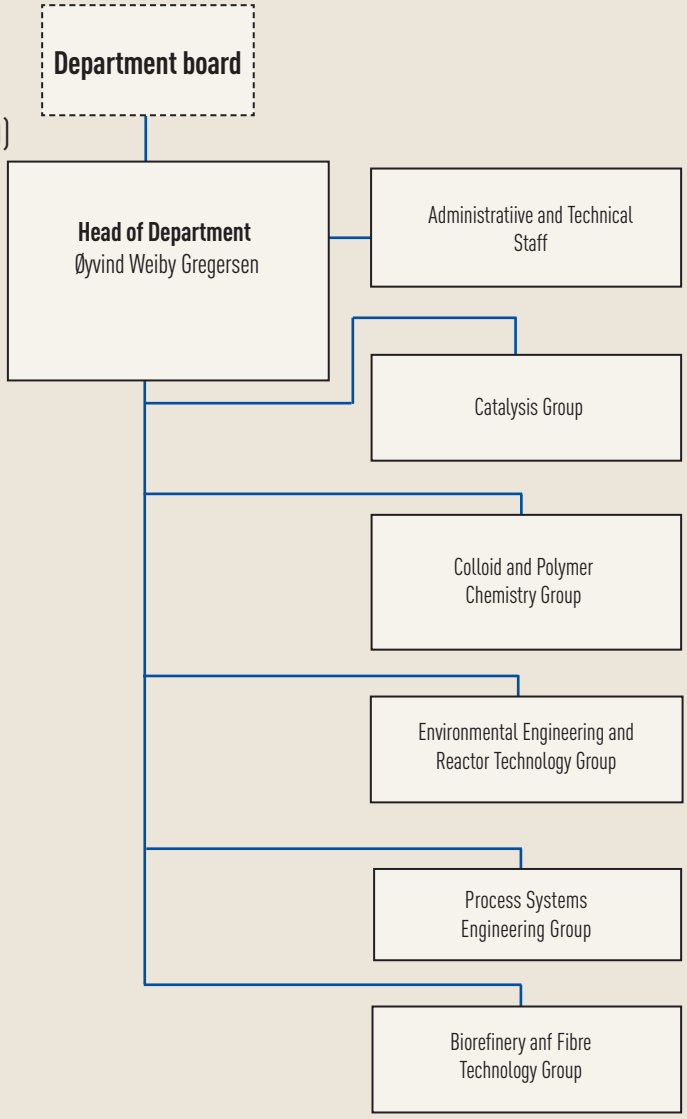
Head of Department:
Professor Øyvind Weiby Gregersen

Deputy Head of Department:
Associated Professor Jens-Petter Andreassen (from 01.07.2010)
Professor Edd A. Blekkan (until 30.06.2010)
Professor Sigurd Skogestad (from 01.07.2010)

Department advisory committee
External members:
Heidi Mediaas, Head of Energy and Environment
Statoil TNE R&D Research
Centre Trondheim
Deputy member, Arne Grislingås, Chief Scientist
Statoil TNE R&D Research
Centre Trondheim
Philip Reme, Director PFI
Deputy member, Ole Wærnes, Research Director
SINTEF Materials and Chemistry

Internal members:
Associate Professor Jens-Petter Andreassen
Higher Executive Officer Torgrim Mathisen
Ph.D. Inger-Lise Alsvik
Student Anna Elise Leithe
Student Rebecca Williams



Staff
Academic staff, see the individual research groups

Technical and administrative staff:
Head of Administration Tom Helmersen

Administrative staff:
Higher Executive Officer Hege Johannessen (from 06.04.2010)
Higher Executive Officer Jørn Olav Løkken (until 31.03.2010)
Executive Officer Tove Barø
Higher Executive Officer Torgrim Mathisen
Higher Executive Officer Lisbeth B. Roel

Technical staff:
Engineer Harry Brun
Principal Engineer Andrea A. Mingot
Principal Engineer Geir Finnøy
Principal Engineer May Grete Sætran
Principal Engineer Signe Håkonsen
Senior Engineer Berit Borthen
Principal Engineer Caterina Lesaint
Principal Engineer Karin W. Dragsten
Engineer Frode Sundseth
Engineer Odd Ivar Hovin
Principal Engineer Iva Královà
Principal Engineer Camilla I. Dagsgård
Principal Engineer Jan Morten Roel
Engineer Arne Fossum
Senior Engineer Asbjørn Øye

DEPARTMENT OF CHEMICAL ENGINEERING, NTNU

www.ntnu.edu/chemeng

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COVER-PAGE: Photo by Tom Helmersen.
During 2009-2010 the K-IV building has been totally renovated. New ventilation and a new gas distribution system is installed improving the HES standard of the building.

Printed April 2011
Prepared and edited by Lisbeth Blekkan Roel, Tom Helmersen, Øyvind Gregersen.

CHAPTER 1: INTRODUCTION

Introduction to Annual Report 2010

By Øyvind Weiby Gregersen (Head of Department)

This report aims at summing up the activity in 2010 as well as providing more general information about the department. We hope you find it useful!

During 2010 the department has continued the trends from the last years delivering excellent research and being highly international. The last point is illustrated by our 18 students in the international master program and Ph.D. candidates from more than 27 nations. Further 8 of our Norwegian students spent at least one semester abroad, and we had 32 visiting students. This is a desired development, which will serve a more international industry structure well. However, an important challenge in the years to come will be to recruit sufficient numbers of Norwegian Ph.D. candidates to cover our needs for teaching assistance in the three first years of the Chemical engineering program where all teaching is given in Norwegian.

In 2010, the research output, as expressed by the number of graduated Ph.D. candidates and publications, was the best ever! The number of credited publications in international journals was 126(2010) whereas it in the five previous years were 76 (2005), 74 (2006), 109 (2007), 84 (2008) and 109 (2009).

Furthermore, 16 Ph.D. candidates graduated in 2010, is also a new record. Since the average time to complete a PhD is about 4-5 years (including leaves of absence), we can infer from the Table on the next page that the PhD production will increase further the coming years, because of the record number of 38 new PhD students in employed in 2008.

The Department has over the last years got a low number of students in the *Chemical Engineering and Biotechnology* program, but in 2010 the situation improved as we got 45 new 3rd year students. To attract as many good students as possible, we are working actively on recruiting and improving the quality of our study program. The student laboratories are upgraded, and in 2011 we will introduce a new subject in modeling and programming. The teaching of basic subjects shall be rotated among the faculty and each subject shall have a group of at least two faculty members who can step in at short notice. The use of Ph.D. candidates for teaching is also being revised so that each candidate who are teaching shall have a 4 year plan for the teaching where he/she teach a few courses for several consecutive years. The goal of the department is to recruit at least 50% of the students in the Chemical Engineering and Biotechnology program and this goal was reached in 2010.

In terms of plans and for recruitment of faculty, we have made a new strategic plan in 2010 for the 2010-2015 period. In 2009 a new faculty position focusing on CO_2 absorption was announced and in 2010 a new position in CO2 separation using membranes was announced. Both positions are expected to be filled during 2011and will represent a much needed capacity in research fields of global importance where our department has an internationally leading position. The next academic position will be one in applied computational chemistry to be announced early in 2011. To support teaching, research quality and our expanding laboratory and pilot scale research we are also hoping to get three new engineers during the next years.

The Department is located in chemistry buildings K4 and K5, experimental halls C and D and in the PFI-building. Our chemistry buildings date back to 1957/58 (K5/Exp. Halls) and 1965 (K4). A complete renovation of K4 (1st to 4th floor) was completed during 2010 and officially opened by the Minister of Research Tora Åsland on May 18th. The renovation of the K4 cellar pilot hall and hall D is will finish during 2011. To continue the renovation of the chemistry experimental hall, we received 40 mill NOK in 2010 from the government, which will be used to renovate hall C. Plans are made to renovate chemistry building K5 and the rest of the chemistry halls to upgrade the standard, and create good research facilities for the European CO_2 Capture and Storage Laboratory (ECCSEL), however this renovation require additional funding.

In 2009 the Department received the evaluation report from the Research Council as part of an evaluation of all Chemistry Research in Norway. The evaluation was very positive for the Department, and the committee writes: *"The Committee was very favourably impressed by the research in this department, and further believes that the close interactions with SINTEF and other research entities are highly beneficial. The Committee can therefore make no major general recommendations for changes, other than that the Committee is in favour of maintaining current directions and plans."* Since then we have increased both the number of graduated PhDs and the number of international journal publications. However, to maintain this high activity and quality we must keep a high focus on doing high quality research that is useful to the industry, build networks to industry and research partners and write excellent research applications.

FACTS ABOUT THE DEPARTMENT OF CHEMICAL ENGINEERING

The Department of Chemical Engineering is located at the Gløshaugen campus of the Norwegian University of Science and Technology (NTNU) in Trondheim. NTNU is the only university in Norway that awards engineering degrees in all areas.

The Department offers a 5 year program leading to the degree of *sivilingeniør* (M.Sc.) in Chemical Engineering. Most of the students start at NTNU in their first year, but about 10 to 20% enter in the fourth year based on a 3-year engineering Bachelor degree. On top of this we offer a 3 year doctoral program leading to a Ph.D. degree in Chemical Engineering. In addition, we offer a 2 year International Master Program in Chemical Engineering.

The Department can trace its roots back to 1910 when the Norwegian Institute of Technology (NTH) started up in Trondheim with engineering chemistry as one of the seven majors. After the Second World War, three applied Departments were formed, Pulp and Paper Chemistry (*Treforedlingskjem*i, 1946), Chemical Engineering (*Kjemiteknikk*, 1949) and Industrial Chemistry (*Industriell kjemi,* 1949). These were merged to the present Department of Chemical Engineering (*Kjemisk prosessteknologi*) in 1999.

The objectives of the Department are:

1. *Education.* Offer a Master Degree in Chemical Engineering which is internationally recognized and makes the candidates attractive on the labour marked.
2. *Research*. Research shall be on an international level, and in some areas internationally leading.
3. The Department shall be attractive in order to recruit the best candidates, including academic faculty, PhD students and undergraduate students. The social environment shall be very good so that everyone feels welcome.

The permanent staff in 2010 included:

- 20 technical/administrative
- 19 academic, incl.14 Professors and 5 Associate Professors (*Førsteamanuensis*)

The non-permanent staff in 2010 included

- 4 technical
- 4 Adjunct Professors (*Professor II*) (20% *position)*
- 85 PhD students
- 30 Post docs. and researchers

The Department also houses 6 Professor emeritus, several visitors in addition to a large SINTEF group.

Student production

Year	MSc	PhD
1995	79	2
1996	57	5
1997	67	9
1998	46	13
1999	81	8
2000	69	10
2001	18(*)	11
2002	75	12
2003	44	7
2004	30	10
2005	25	13
2006	19	15
2007	31	15
2008	31	13
2009	35	14
2010	31	16

(*) Transition from 4.5 to 5 year program.

MSc students 2010/11

5th year	42 (incl. 9 International Master and 6 exchange students)
4th year	45 (incl.9 International Master and 4 exchange students)
3rd year	45

New PhD students (exchange students not included)

2003	20
2004	10
2005	9
2006	18
2007	15
2008	38
2009	18
2010	17

New Post docs./Scientists

2006	10
2007	25
2008	28
2009	6
2010	6

CHAPTER 2: RESEARCH

CATALYSIS GROUP

Academic staff
Professor Anders Holmen
Professor Edd A. Blekkan
Professor De Chen
Professor Magnus Rønning
Professor Hilde J. Venvik
Adjunct professor Kjell Moljord
Adjunct professor Erling Rytter

Post.docs.
Bjørn Christian Enger (from 01.02.2010)
Nina Hammer (from 04.01.2010)
Li He (until 30.06.2010)
Ingeborg-Helene Svenum
Espen Standal Wangen
Estelle Vanhaecke
Hongmin Wang (until 30.04.2010)
Tiejun Zhao
Jun Zhu

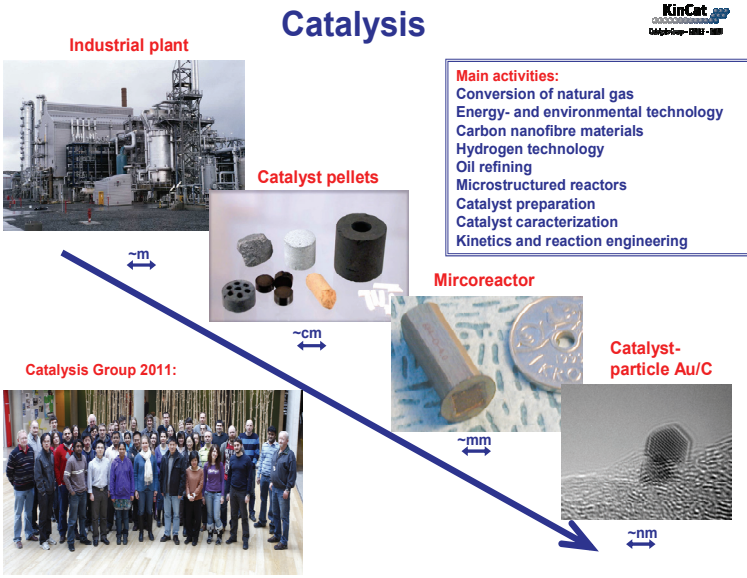
PhD. candidates
Alexey Voronov
Andreas H. Lillebø (from 01.09.2010)
Andrey Volynkin (from 16.08.2010)
Anh Hoang Dam
Asmira Delic
Charitha Udani (from 04.01.2010)
Daham Sanjaya Gunawardana
Eleni Patanou
Fan Huang
Fatemeh Hayer
Fengliu Lou (from 18.06.2010)
Georg Voß (from 16.08.2010)
Hamidreza Bakhtiary Davijany (until 21.11.2010)
Hassan Jamil Dar
Ilya Gorelkin
Ingvild Tronstad
Jia Yang
Miroslav Surma
Navaneethan Mutuswamy
Nicla Vicinanza (from 19.02.2010)
Nikolaos Tsakoumis
Oana Mihai
Paul Radstake
Saima Sultana Kazi
Sara Boullosa Eiras (until 31.10.2010)
Shreyas Pandurang Rane
Tayyaba Noor
Xuyen Kim Phan

Technical staff
Karin Wiggen Dragsten

Guests
Javier Fermoso Dominguez, Spanish Council for Scientific Research (CSIC)
Juam Maria Gonzalez Garballo, Instituto de Catalysis y x Petroquimic, Madrid

KinCat
Catalyst Group – SINTEF – NTNU

The Organization
The research and teaching in catalysis, petrochemistry and related subjects (including surface science, adsorption and physical studies of porous materials, reaction kinetics and process engineering) is organised in the Catalysis Group, a joint effort where NTNU, and the research company SINTEF share laboratories and equipment.



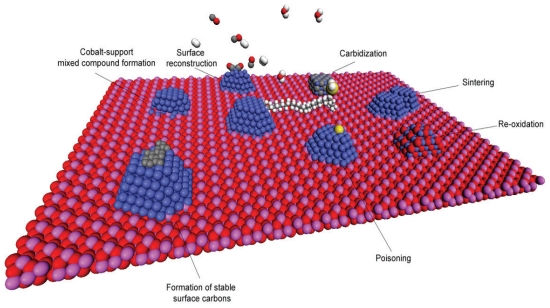
Personnel from the two organisations work together and participate in teaching and research. About 10-15 students graduate each year (M.Sc.). The group participates extensively in international networks, research programs etc., and cooperates closely with a number of universities and research groups inside and outside the EU.

The group and the laboratories
At present the group comprises about 50 people: 5 Professors, 2 Adjunct professors, about 10 fulltime research scientists holding Ph.D's, 5-10 Post.doc's and 28 PhD students. The laboratories and equipment include a large number of microreactors for catalyst studies, several small pilot plants, all the necessary equipment for catalyst and material characterization (chemisorption, physical adsorption, Temperature Programmed techniques (TPR, TPD, thermal analysis), XPS, Auger spectroscopy, STM, FTIR and others). Recently, *in situ* IR/Raman and the TEOM-technique (Tapered Element Oscillating Microbalance) have been introduced in the laboratory, and we were the first group in Europe to utilize the TEOM technique in catalyst studies. Cooperation with the Departments of Physics (TEM and surface science), and Materials Science and Engineering, the other groups at the department of Chemical Engineering (all aspects of chemical and process engineering, particularly reactor engineering and colloid and polymer chemistry) and other departments ensures a wide scope and a high

quality of the work. The research is funded by the Norwegian Research Council, EU, Norwegian and international industry and and other sources, and spans from fundamental studies of ideal surfaces to studies of real catalysts and process development work in small pilot plans.

The projects
A description of the Group as well as further details of all the projects, are given in our Annual Report.

Natural Gas Conversion
Natural gas is an abundant hydrocarbon fuel and chemical feedstock, and utilizing this resource with minimum environmental impact is a major challenge to catalysis. It is the main goal of the present programme to study catalytic processes for conversion of natural gas to chemicals and fuels including hydrogen. The programme includes production of synthesis gas, Fischer-Tropsch synthesis, and dehydrogenation of C_2-C_4 alkanes. The work is carried out in close collaboration with Norwegian industry and SINTEF. The group also participates in a Centre for Research-based Innovation (SFI-inGAP) focusing on the use of natural gas.

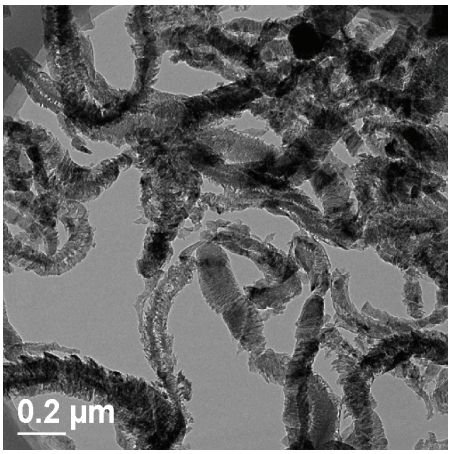


Deactivation mechanisms in Fischer Trosch catalysts: From N.E. Tsakoumis, M. Rønning, Ø. Borg, E. Rytter, A. Holmen, Deactivation of cobalt based Fischer-Tropsch catalysts: A review, Catal. Today, 154 (2010), 162-182

Hydrogen Technology
Particular attention is directed towards hydrogen technology: Catalysis is important in the production of hydrogen from hydrocarbons. Natural gas in an important source of hydrogen, and research is thus linked to syngas issues. In addition, the conversion of "transportable" hydrogen carriers such as propane, methanol and (bio) ethanol is studied. Of particular relevance is the integration of CO_2 separation technologies in hydrogen production processes, and this is targeted through sorption enhanced reactions and membrane reactors (see below). The group is also involved in development of improved fuel cell catalysts based on carbon nanofibers (also below). Collaborations include SINTEF as well as Norwegian industry. Hydrogen technology is also part of the MIT-NTNU cooperation.

Design and Preparation of New Catalysts and Supports
The catalytically active material is the key to any catalytic process, and the preparation of these, highly specalized functional materials is an important industry. Understanding the processes involved in the preparation, and developing improved methods are therefore a central research areas. We work with new methods for the preparation of supports and catalysts such as flame spray pyrolysis and spray drying, as well as the preparation and use of structured, mesoporous supports. Other areas include core-shell particles and size and shape-control of metal particles.

Carbon Nanofibres
Carbon nanofibres (CNF) have several interesting properties such as high resistance to strong acids and bases, high electric conductivity (similar to graphite), relatively high surface area and high mechanical strength. These unique properties lead to a large number of applications, such as catalyst supports, selective sorption agents, energy storage, composite materials, nano-electric and nano-mechanical devices, as well as field emission devices. The programme includes synthesis of carbon nanofibres and nanotubes of different morphology and the use of CNF/CNT in applications such as heterogeneous catalysis, fuel cells and conversion and storage of energy. This is done in collaboration with other groups at NTNU, SINTEF and Norwegian Industry



Carbon Nanofibres (TEM image)

New reactor concepts and structured supports
Emerging reactor technologies such as microstructured reactors and (catalytic) membrane reactors are being developed and tested. The use of structured supports such as monoliths and foams is being studied, particularly for short contact time reaction systems like partial oxidation and oxidative dehydrogenation. The work on microstructured reactors, where channels with micrometer dimensions (1-1000µm) and up-scaling by parallelization is applied to enable new properties and possibilities, is performed in collaboration with Karlsruhe Institute of Technology (KIT) in Germany. Membrane reaction concepts based on novel Pd thin film technology are being developed together with

SINTEF, and a partnership with MIT and Statoil is directed towards the use of high-temperature proton-conducting membranes in hydrogen production with CO_2 capture.

Oil Refining
Upgrading of crude oil and oil fractions is an important subject of research, especially due to new environmental legislation demanding more efficient processes. The programme includes catalytic reforming, isomerization, hydrotreating/ hydrocracking and heavy oil upgrading. The work is carried out in close cooperation with SINTEF and the industry.

Photocatalysis
Accelerated environmental pollution on a global scale has drawn attention to the need for totally new environmentally friendly and clean chemical technologies. The application of photocatalysis to reduce toxic agents in air and water by developing catalysts that can utilise clean and abundant solar energy and convert it into useful chemical energy is a promising challenge. Photocatalysts that can operate at ambient temperature without producing harmful by-products are ideal as environmentally sound catalysts. For such systems to be considered in large-scale applications, photocatalytic systems that are able to operate effectively and efficiently using sunlight must be established. Hydrogen can be produced by photoinduced reforming of organic compounds, including methane and alcohols. Furthermore, the photoreduction of carbon dioxide into useful chemicals is a desirable prospect. It is essential to convert CO_2 into useful substances that are common feedstocks for the production of other chemicals (C_2-C_{3+}, alcohols, etc.). The photocatalysis work is carried out in close collaboration with other European universities and the Department of Materials Technology.

Biofuels
The research is focused on catalytic aspects of thermochemical conversion, such as syngas cleaning and composition adjustment, residual hydrocarbon reforming and Fischer-Tropsch synthesis.

The Güssing 10 MW biomass gasification reactor, a hub for biofuel research in Europe

Fundamental Studies in Heterogeneous Catalysis
Several experimental techniques are used to study the details of solid catalysts. We are working together with Department of Physics on the use of Transmission Electron Microscopy and Scanning Tunneling Microscopy. We focus on characterisation of catalysts at working conditions and for this purpose we are using the European Synchrotron Radiation Facility in Grenoble and together with the Ugelstad Laboratory we have recently purchased new facilities for IR and Raman spectroscopy. The TEOM (Tapered Element Oscillating Microbalance) is also a powerful technique for studying important phenomena like catalyst deactivation, diffusion in porous materials and adsorption, absorption and desorption.

Catalysis Group

First row:	*Edd, Fengliu, Hassan Jamil, Daham, Jun, Saima, Hilde, De, Xuyen, Nicla, Nikolaos, Karin, Asbjørn*
Second row:	*Magnus, Hilde, Fan, Espen, Shreyas, Tayyaba, Tiejun, Estelle, Fatemeh, Oana, Sara, Jia, Eleni,,Javier, Rune L.,*
	Asmira, Håkon, Rune, Navaneethan
Third row:	*Andrey, Camilla, Anders, Merete, Andreas, Nina, Torbjørn, Ingeborg-Helene, Georg, Miroslav, Paul, Anna, Alexey, Svatopluk, Ilya, Rune M.*

COLLOID- AND POLYMER CHEMISTRY GROUP (UGELSTAD LABORATORY)

Academic staff
Professor Johan Sjöblom
Professor Gisle Øye
Associate professor Wilhelm R. Glomm
Professor emeritus Arvid Berge
Professor emeritus Preben C. Mørk
Professor II emeritus Per Stenius
Martin Foss

Post docs
Bartolomiej Gawel
Brian A. Grimes
Cedric M. Lesaint
Kristofer Paso
Sebastien Simon
Serkan Kelesoglu (from 21.12.2010)
Sondre Volden

PhD candidates
Andreas Lyng Nenningsland
Asal Amiri (defended 07.10.2010)
Divina Kaombe
Karina Kovalchuk
Klodian Xhanari (defended 28.01.2011)
Mehdi Benmekhbi
Mona Eftekhardadkhan (from 29.06.2010)
Nils van der Tuuk Opedal
Serkan Keleşoğlu (defended 20.12.2010)
Sina Maria Lystvet
Umer Farooq (defended 30.09.2010)

Laboratory Manager
Iva Kralova

Technical staff
Bicheng Gao (from 01.07.2010)
Camilla I. Dagsgård
Caterina Lesaint
Christian Reisen (from 01.09.2010)
May Grete Sætran (until 15.05.2010)
Signe Håkonsen

Guests
Jan L. Eilertsen (visiting researcher)
Baptiste Billot (master student from Université de Franche-Comté)

Overview:
The Ugelstad Laboratory was founded in honour of Professor John Ugelstad at the Norwegian University of Science and Technology in January 2002 (Department of Chemical Engineering). The laboratory specializes in surfactant chemistry and its technical applications, emulsions and emulsion technology, preparation of polymers and polymer particles and their technical applications, plasma chemical modification of surfaces and silica-based chemistry. Applications include crude oil production and processing, pulp and paper, biomedicine, catalysis and materials science.
The main purpose is to raise the national level of colloidal science by establishing a modern educational, research and development laboratory within the field of colloid, polymer and surface chemistry.

Diploma and Ph.D. studies are offered within these topics, often in close collaboration with industrial companies. The aim is to educate highly qualified candidates for industrial positions. In order to attract the best and most motivated students and researchers, the laboratory has invested in new and modern instrumentation. The laboratory also participates in international exchange programmes, and hosts internationally renowned guest researchers and lecturers.

The Ugelstad Laboratory is sponsored by industrial companies, the Research Council of Norway (NFR), research institutes and NTNU. All the members are annually invited to a presentation of the recent research activities at the laboratory. This is combined with the Ugelstad Lecture, where invited scientists lecture within the field of colloid, polymer and surface chemistry.

Research Activities:
In the following paragraphs, selected ongoing research programs for 2010 are briefly described. For a complete description of the research activities at the Ugelstad Laboratory, please visit our web page: www.chemeng.ntnu.no/research/polymer/ugelstadlab/

Improved Oil recovery by Low Salinity Waterflooding: Surface Chemistry and SCAL Studies (VISTA 2007 – 2010)
The project focuses on how the surface chemistry of reservoir surfaces can contribute to improved oil recovery by low salinity waterflooding. The project was finalized in September 2010. Interactions between solid surfaces and surface active components in crude oils and characterization of solid-liquid and liquid-liquid interfaces were studied to improve the understanding of low salinity water flooding as an enhanced oil recovery method. The results have been summarized in 5 papers to be published in international journals.

The project is a collaboration with Department of Petroleum Technology and Applied Geophysics.

Multiphase Flow Assurance Innovation Centre (FACE) – Centre for Research-Based Innovation (SFI) 2006-2014
An increasing fraction of hydrocarbon reserves are difficult or impossible to produce and process today mainly due to the complexity of the fluids. Production of these reserves will require new and innovative technologies. FACE will develop the knowledge base for the new predictive tools that will be essential in order to develop the new, innovative production solutions. It is

expected that new SMB's will be generated based on knowledge and technology from the centre as well as development of new or improved products in existing companies. The research is focused on transport and separation aspects of three thematic topics, i.e. heavy crude oils, dispersed systems (emulsions), and solid particulate suspensions (hydrates, wax, sand and fines). We will use existing laboratories to perform both small-scale and high-pressure, large-scale flow experiments in pipes and separators.

Collaborative effort between NTNU, SINTEF, IFE and UiO.

Shut-in and Restart of Waxy Crude Pipelines: Software Module Development (KMB with NFR 2010 – 2013)

Waxy crude oil is commonly found on the Norwegian Continental Shelf and elsewhere. The waxy production fluids will then tend to form a structured gel-like plug inside the pipeline. It is therefore essential to design and operate the pipeline such that restart is possible in a safe and timely fashion. It has been observed that when the inlet pressure is increased it can take days or weeks for the gel to start moving. Detailed rheological measurements will be performed on gelled oil properties and on the removal of gelled oil a pipelines. A model will be developed to encapsulate a physical understanding of the gel-breakage process into a useful simulation tool. The model will account for chemicals injected to reduce wax formation, and thus enable optimal dosaging. In addition, a large thrust of the project will be to develop more effective pour point depressants (PPDs) and yield point depressants (YPDs) in conjuction with chemical manufacturers and chemical suppliers.

This project is a collaborative effort between the Ugelstad laboratory, the Institute for Energy Technology (IFE) and industrial partners.

Increased Energy Savings in Water-Oil Separation Through Advanced Fundamental Emulsion Paradigms (JIP1 2011 – 2013)

The goal of the project is to advance fundamental knowledge of the water-oil separation process in order to make it more energy efficient and energy saving. The focus will be on accelerating the processing of high volumes of water and viscous oil by speeding-up the sub-processes of creaming and sedimentation of existing emulsions in the first stage. The second stage involves the treatment of concentrated w/o or o/w emulsions. This program is a continuation of two previous JIP projects run in the past 6 years which were focused on an improvement of understanding of the stabilizing and destabilizing mechanisms of water-in crude oil emulsions based on heavy and particle-rich crude oils and also on the modelling (start-up, rheology and separation).

This project is a collaborative effort between the Ugelstad laboratory, University of Alberta, University of Bergen, IFE and several international partners.

Prediction of Ca-Naphthenate Deposition in Water-Oil Systems (JIP2:4 2011 – 2013)

During the past years, extensive work has focused towards naphthenate precipitation from acidic crude oil. Due to a rise in crude pH, the naphthenic acids dissociate and react with divalent cations, especially calcium. These compounds accumulate at the oil/water interface and might cause costly shutdowns. This program is a continuation of two previous JIP projects run in the past 6 years. Several key elements about calcium naphthenate were identified. Procedures and methods were developed as well which give the JIP members a technological lead in the naphthenate treatment. The continuation of the project, JIP2-4, was developed towards the establishment of a model predicting calcium naphthenate deposition in oil/water system based on interfacial conditions together with advanced techniques to detect calcium naphthenate formation in an early stage (on a nanogram scale). We intend to establish critical conditions for gel formation.

This project is a collaborative effort between the Ugelstad laboratory and several international partners.

An Integrated Approach to Interfacial/Surface Processes in Crude Oil Systems (NFR PETROMAKS)

In crude oil production and processing heterogeneous systems play an important role in the whole value chain, starting from oil recovery from the reservoir and ending with crude oil refining in the refineries. A rational definition of heterogeneous systems is systems with either interfaces or surfaces or both. A brief survey of such systems and processes reveal wettability of the mineral surfaces in the reservoir as extremely important in the recovery of oil, chemical composition of the interface between water and oil as important for the separation process (and droplet-droplet coalescence) with consequences for both oil and waste water quality, corrosion inhibition of steel surfaces to prevent corrosion to deteriorate pipelines and the contamination of solid surfaces to poison catalysts. A general problem including most of the sub-processes in the exploitation of crude oil is a proper lack of instrumentation and competence to undertake a proper characterization of surface structures and concentrations in order to improve the understanding of oil recovery and especially enhanced oil recovery,

separation technology and maintenance of pipeline integrity and transport.

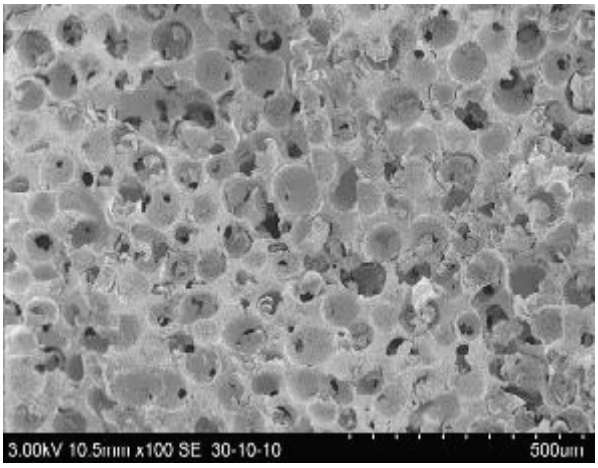
Produce Water Management. Fundamental understanding of the fluids (JIP 2010 – 2014)

The project focuses on understanding the interactions between dispersed components (oil/gas/solids) in produced water. The studies include interfacial characterization, dispersion behaviour and up scaled tests. The project is currently supported by 4 industrial sponsors.

Electrocoalescence II - Criteria for an efficient process in real crude oil systems (KMB - NFR 2006-2010)

The fundamental mechanism active in the electrocoalescence process has been identified as a formation of an electrohydrodynamical surface instability. Hydrodynamic models for drop movement have been established and verified experimentally in model systems. This far, coalescence has ben studied using transparent model oils. The challenge is to link this knowledge to realistic conditions and water-in-oil emulsions. The objective of this programme was to establish know-how for design and operation of electrocoalescers for realistic water-in-crude-oil emulsions, verify new drop-drop coalescence model for practical oils (e.g. heavy crudes, asphaltenes, etc.), build model oil/water emulsion tester, establish methods for quantifying electrocoalescence efficiency criteria for crude oils and contribute to increased production in reservoirs with high water content by efficient oil water separation.

Development of nanostructured microreactor-based reaction technologies for continuous in situ production of food and drug intermediates from renewable resources. (Polish-Norwegian Research Fund) 2008-2010
The project aims at developing novel family of high performance technologies for the in situ production of valuable chemicals – natural intermediates for food and pharmaceuticals synthesized from renewable resources, e.g. cellulose materials.T porous monoliths with hierarchal pore structures were developed in the project, and functionalized materials were tested in continuous flow-through oxidation of glucose to gluconic acid. The results have been summarized in 6 papers to be published in international journals.



SEM image of cross-section of monolith with hierarchicalpore structure (Image: Dr.B.Gawel)

Thermoresponsive Polymer Brushes on Nanoparticles and Surfaces (NFR FRINAT 2007-2011)
An interesting category of amphiphilic polymer systems are those who undergo phase transitions in response to environmental stimuli such as temperature and pH. These have been widely investigated for drug delivery, separations and diagnostics applications. The aim of this project is to develop an understanding - both mechanistic and applied - of different thermo-responsive polymers adsorbed to planar surfaces and particle substrates. Changes in structural and dynamic properties of the systems under various conditions will be examined.

This project is a collaborative effort between the Ugelstad laboratory and Dept. of Chemistry, UiO, with several international partners.

Nanosized cellulose fibrils as stabilizers of emulsions
The project is collaboration with the Paper and Fibre Institute (PFI) and focuses on using MFC as stabilisers in emulsions.

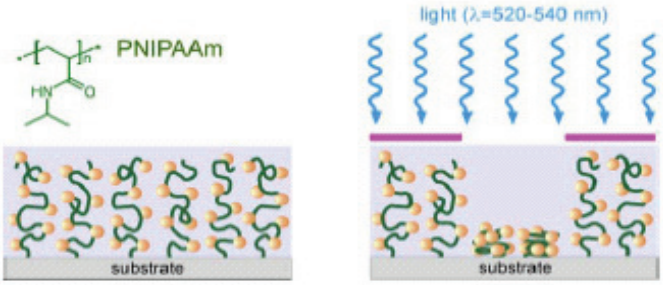
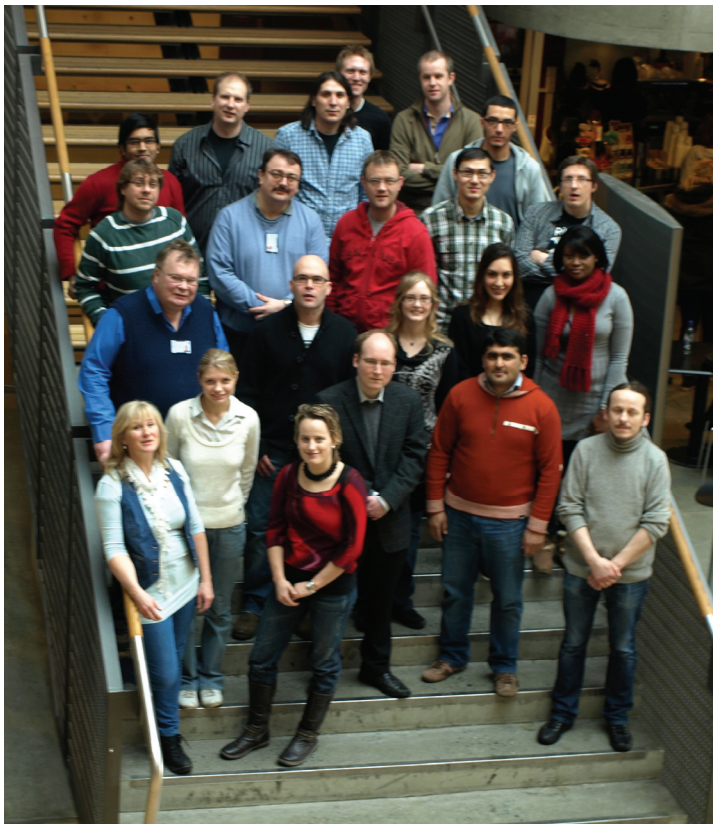


Figure 1: Schematic illustration of the "T-jump" modulated conformational transitions in surface-anchored PNIPAAm brushes. Gold nanoparticles will be loaded inside the brush and will attach to the NIPAAm monomers via H-bonds. Light having a wavelength close to the plasmon band of Au will be used to locally heat the particles, which in turn will cause collapse of the PNIPAAm chains. Through employment of a mask placed between the light course and the polymer, the PNIPAm collapse can be spatially modulated

Colloid- and Polymer Group



From right
First row: *Bartlomiej, Rafiq, Kristofer, Iva, Karina and Signe*
Second row: *Divina, Mona, Sina, Sondre and Johan*
Third row: *Cédric, Bicheng, Gisle, Sebastien and Brian*
Fourth row: *Mehdi, Nils, Andreas, Serkan, Wilhelm and Sulalit*

PROCESS SYSTEMS ENGINEERING GROUP

Academic staff
Professor Sigurd Skogestad
Professor Heinz A. Preisig
Associate professor Tore Haug-Warberg
Associate professor Nadi S. Bar
Professor emeritus Terje Hertzberg

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Henrik Manum (until 31.07.2010)
Håkon Dahl-Olsen
Jens Petter Strandberg
Johannes Jäschke
Jørgen Skancke
Magnus Glosli Jacobsen
Maryam Ghadrdan
Mehdi Panahi
Olaf Trygve Berglihn (until 30.06.2010)
Ramprasad Yelchuru
Ivan Dones (until 30.04.2010)

Guests
Weiwei Qiu (PhD student from Petroleum University of China, Beijing, until 15.10.2010)
Vana Zdenek, (PhD student from … Praha) 9.3-9. August
Jakub Kubecek (PhD student from …Praha) 9.3-9.6
Mikulas Huba and Jatarina Zakarova (Kvasnica (visiting faculty from Bratislava), 9/5-26/5
Miroslav Fikar and Michal Kvasnica (visiting faculty from Bratislava), 26/7 – 6/8
Radoslav Paulen (PhD student from Slovak Tech, Univ.Bratilslava, 24/5-19/6)
Andreas Psaltis (PhD student from Univ. Patras), 1/3-21/5
Allahyar Montazeri (From Faunhofer Institutue, Irminau) 20/9 – 30/9
Julio Dutra (PhD student from Univ. Fed. Rio de Janeiro)
Salvador Alcantra Cano (visiting PhD student from Univ. Autonoma de Barcelona), 1/10-1/12

Profile:
Process systems engineering deals with the overall system behaviour, and how the individual units should be combined to achieve optimal overall performance. Important topics are process modelling on all scales, operation and control, design and synthesis, and simulation, statistics and optimization. The group closely cooperates with other systems-oriented departments at the university, including Engineering Cybernetics, Energy and Process Engineering, and Industrial Ecology, and also with SINTEF. The process systems engineering activity at NTNU (PROST) holds high international standards and was already in 1994 recognized as a strong-point centre, both by NTNU and SINTEF. At present, the main activities in the group are within process control and process modelling including efficient thermodynamic calculations. A new interdisciplinary branch focusing on systems biology has recenetly been initiated (Nadi Bar) enriching the NTNU biology effort with a systems component.

Control Activities:
Industrial use of advanced process control increases rapidly, and candidates who combine process knowledge and control expertise are in high demand in industry. Control is an enabling technology, thus basic for any industry-based society. The use of advanced control is transforming industries previously regarded as "low-tech" into "high-tech". In process control (Sigurd Skogestad and Heinz Preisig), the objective of the research is to develop simple yet rigorous tools to solve problems significant to industrial applications.

Up to now, the design of the overall "plant-wide" control structure has been based on engineering experience and intuition, whilst the aim has been to develop rigorous techniques. The concept of "self-optimizing control" provides a basis for linking economic optimization and control (Sigurd Skogestad). For example, for a marathon runner, the heart rate may be a good "self-optimizing" variable that may be kept constant in spite of uncertainty. Control is done in a hierarchical construct. At the bottom of the hierarchy, the main issue is to "stabilize" the operation and follow the setpoints provided by the layer above. Further up in the hierarchy one finds optimising control co-ordinating the control of units and plants. A special case is sequential control, which is used to implement recipes in batch operations but also is the basics of handling start-up and shut-down as well as all fault and emergency handling. Another important concept is controllability, which links control and design. Here the main focus is on applications, which currently include reactor and recycle processes, distillation columns, gas processing plants, cooling cycles including liquefied natural gas (LNG) plants, low-temperature polymer fuel cells and anti-slug control. Small-scale experimental rigs have been built to study anti-slug control and novel distillation arrangements. In most cases, control is an "add-on" to enable and improve operation, but the anti-slug rig demonstrates how control in some cases can be used to operate the system in a completely different manner.

Modelling Behaviours:
The centre piece of process systems engineering is the model. Modelling is generally seen as a difficult and time consuming operation. The step-wise approach developed in this group has transformed the art of

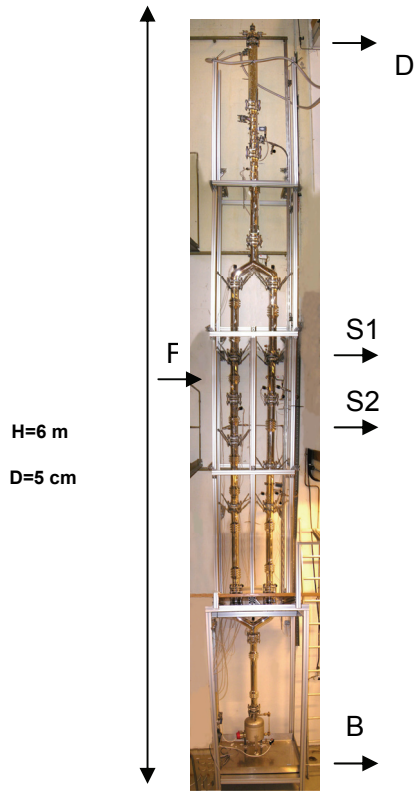
modelling into a nearly procedural operation, which has been captured in a program environment (Preisig). The modelling operation is thereby lifted up from writing equations to choosing concepts and mechanisms. The equations are then generated and assembled automatically taking the applicable equations from a data base that has built applying mechanistic descriptions where ever applicable. Multi-scale modelling is supported by enabling order-of-magnitude assumptions, which automatically induce model reduction thereby eliminating structure-related mathematical problems. The overall objective in the group is to develop efficient object-oriented software tools that implement this method and assist in developing consistent and structurally solvable process models on different scales that match the particular application. The technology is physics-based with extensions to allow for grey-box modelling. It aims at replacing various graphical interfaces to simulators and generates code for the major chemical engineering simulators such as gProms, Matlab, Modelica etc. but will also be able to generate stand alone, application-tailored simulators. The fourth generation of a high-level modelling tool (Preisig) incorporates object-oriented tools for efficient thermodynamic modelling, which extend into the efficient computation of thermodynamic information. Rather than a traditional implementation of activity or fugacity coefficients, emphasis is put on the use of structured equation sets governed by thermodynamic consistency rules (Haug-Warberg).

The thermodynamic models are implemented in symbolic form with automatic differentiation capabilities and serves as the basis of several industrial strength simulations (YASIM, CADAS) and energy accounting tools (HERE) in co-operation with StatoilHydro and Yara (Haug-Warberg). A primary aspect of thermodynamic (and other physics) modelling is the required consistency of physical units. We have a procedure to obtain self-consistent models, including automatic generation of gradients. This technique has so far been tested up to sixth order gradients, which are needed for higher-order critical point calculations.
In cooperation with Yara AS we have implemented a thermodynamic stream calculator “Yasim”. It has a gentle learning curve using the familiar Excel worksheet interface whilst using state-of-the-art thermodynamic methods. All model information including mass balances, energy balances, chemical and phase equilibrium relations are defined in symbolic form. Differentiations are done in symbolic form. These properties add unsurpassed flexibility to Yasim that is not found in any other software of its kind. The ease of use should make it ideally suited for training and use in an industrial environment.

Model-Process Interface:
The model generally needs to be fitted to experimental data, and the group has always has a strong focus on statistical methods and experimental design (Hertzberg). Although Professor Hertzberg retired in 2007, he is still active in this area, and in particular, in teaching.

Equipment:
The Kaibel distillation column (see picture) is 6 meter high and 5 cm in diameter and can be used to study "thermally coupled" columns, including the three-product Petlyuk column and the four-product Kaibel column. Dr. Ivar Halvorsen from SINTEF and Sigurd Skogestad manage this integrated distillation project. The group also has an automatic drink robot, which is used for demonstration purposes and to study sequence control based on automata theory (Heinz Preisig). The group also has a control teaching laboratory, which currently includes three thermal/air flow processes, a pseudo flash and a mixing process.

Funding Resources:
Funding comes from the Norwegian Research Council, the Gas Technology Centre at NTNU and SINTEF, from industry (StatoilHydro, Gassco) and from the EU (ProMatch program).



Kaibel Distillation column.

Back *Matteo, Deeptanshu, Julio, Naresh, Maryam, Alejandro, Sigurd, Magnus, Mehdi, Ramprasad, Esmaeil, Nadi, Johannes, Heinz*
Front *Anders, Knut Åge, Chriss, Daniel, Anette, Silje*

Photo taken in the group library in the 2nd floor of the completely renovated K4 building

ENVIRONMENTAL ENGINEERING AND REACTOR TECHNOLOGY GROUP

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Adjunct professor Jon Samseth
Professor emeritus Olav Erga
Professor emeritus Gunnar Thorsen

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Erik Troøien Hessen (from 22.06-31.12.2010)
Farshid Owrang (from 01.02.2010)
Qiang Yu
Taek-Joong Kim
Tom-Nils Nilsen

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Arshad Hussain
Hélène Lepaumier (until 31.10.2010)
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Liyuan Deng
Marius Sandru
Ralf Beck
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Ali Zakeri
Anastasia Trollebø
Arlinda Çiftja
Diego Di Domenico Pinto (from 24.11.2010)
Divina D. Kaombe (from 08.11.2010)
Eddie Setekleiv
Ellen M. Flaten (until 15.03.2010)
Erik Troøien Hessen (until 21.06.2010)
Federico Sporleder
Hamid Mehdizadeh
Hans Kristian Rusten (until 07.05.2010)
Inger Lise Alsvik
Ingvild Eide-Haugmo
Jamil Ahmad
Jannike Solsvik
Juliana Monteiro (from 24.11.2010)
Kalim Deshmukh (until 28.02.2010)
Kando Kalifa Janga
Karen Nessler Seglem (from 23.08.2010)
Kumar Ranjan Rout
Lijuan Wang
Luciano Patruno (until 30.06.2010)
Mayuri Gupta (from 04.01.2010)
Mehdi Karimi
Mohammad Washim Uddin
Nuria Tavera Valero (from 23.08.2010)
Pablo Dupuy (until 28.06.2010)
Paul A. M. Ystad (from 01.08.- 31.12.2010)
Paris Klimantos
Peter Bruder
Solrun Johanne Vevelstad
Shahla Gondal (from 16.08.2010)
Tone Borge (until 19.02.2010)
Ugochukwu Edwin Aronu
Vajiheh Nafisi (from 28.06.2010)
Xiao Luo
Xiaoguang Ma (from 20.09.2010)
Xuezhong He
Zhongxi Chao
Zsolt Borka
Øystein Jonassen (from 01.11.2010)

Technical staff
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Geir Finnøy (from 12.04.2010)
Yulia Flid (from 30.08.2010)

Guests
Jinzhao Liu (PhD student from Tsinghua University, China)

Environmental engineering and reactor technology is the largest research group in the department covering interests in the fields of chemical reactor research, process design, acid gas absorption, membrane research, and crystallization and particle design. Our group is involved in research projects for the capture of CO_2, like in the BIGCCS – International CCS Research Centre which is one of eight centres established by the Norwegian Research Council under the scheme of Environmentally Friendly Research Centres (CEER). The BIGCCS Centre focuses on sustainable power generation from fossil fuels based on cost-effective CO_2 capture, safe transport, and underground storage of CO_2. The members of the environmental and reactor technology group are involved in topics like separation of CO_2 with polymer membranes, capture of CO_2 in systems with simultaneous crystallization of solids, dynamic modelling of absorption processes, and modelling and simulation of sorption enhanced steam methane reforming operated in fixed and circulating fluidized bed reactors.

First row: ***Hallvard, Ardi, Diego, Xuezhong, Liyuan, Mauyri, Anastasia, Yulia, Vajiheh, Qiang***
Second row: ***Xiaoguang, Juliana, Solrun, Nina, Karen, Ingvild, May-Britt, Ahmad***
Third row: ***Federico, Ugochukwu, Mehdi, Washim, Marius, Jinzhao, Peter, Emmanuel, Zhongxi***
Fourth row: ***Magne, Hugo, Jens-Petter, Ralf, Zsolt, Paris***

Chemical Reactor Research

The activity on reactor engineering has been concentrated in fields directly supporting the design and development of chemical reactors and reactive separations. The most important research areas are:

- Mathematical modeling of chemical reactors.
- Multiphase flow modeling.
- Design of novel solution methods and algorithms.
- Experimental analyses of fluid flow, fluid particle coalescence and breakage, CO_2 sorption by adsorbents and heat- and mass transfer in chemical reactors.
- Experimental validation of numerical models.
- Analysis and design of reactors for environmentally friendly chemical processes.

The research in these fields comprises both experimental and theoretical studies ,, but emphasis is placed on modeling, development of numerical methods and in-house software for multi-phase reactor simulations.

The simplest models considered are normally implemented in the programming language Matlab, whereas the computationally demanding models are implemented in FORTRAN 90 and C++. Application areas are special chemicals reactors, polymer production, sorption enhanced steam methane reforming, conventional synthesis gas and methanol synthesis, membrane reactors, wood gasification and chemical looping combustion.

A stirred tank used for studies of heat transfer and flow phenomena.

Educationally the main objective of our group is to educate MSc for the Norwegian industry and to raise the national scientific competence in our field of research through PhD studies.

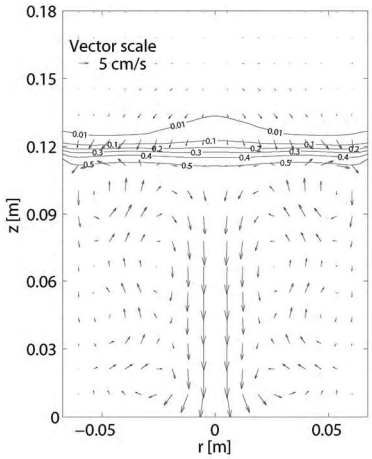
Research activities

The most important research projects are described in the following paragraphs. For a more comprehensive description, see: (http://www.chemeng.ntnu.no/research/reactmod/).

Modeling of multi-phase reactors

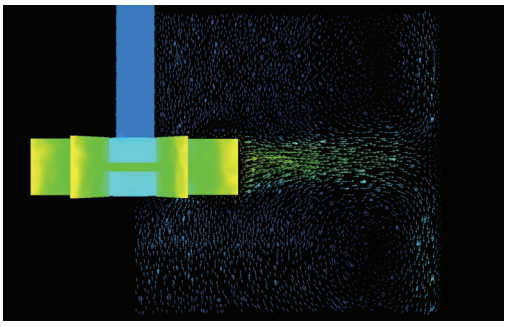
We have for more than 20 years been developing in-house CFD codes for simulating multiphase flows in chemical reactors. Lately, our main focus has been put

on developing modules for bubble/droplet break-up and coalescence within the population balance equation (PBE) framework.
The PBEs are solved accurately by efficient spectral and spectral-element methods designed for this particular purpose.



Flow pattern in a bubbling fluidized bed.

We are also investigating the performance of chemical reactive systems like fluidized beds, fixed bed reactors and agitated tanks. At present we are working with the design of suitable reactors for sorption enhanced reaction processes (SERP) like steam reforming with absorbents for CO_2.



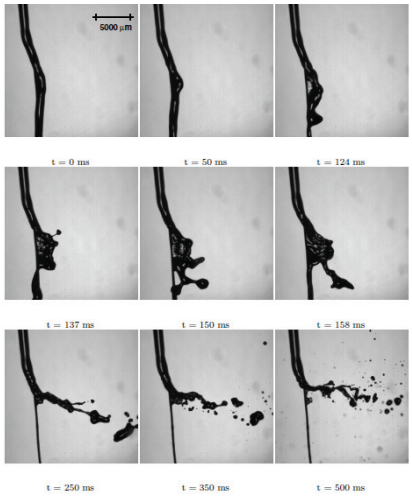
Simulation of the flow pattern from a turbine impeller.

The conventional 1D and 2D steady-state reactor models are normally run on standard PCs whereas the more computationally demanding dynamic 2D and 3D single and multiphase flow simulations are run on the national super-computers located at the university.

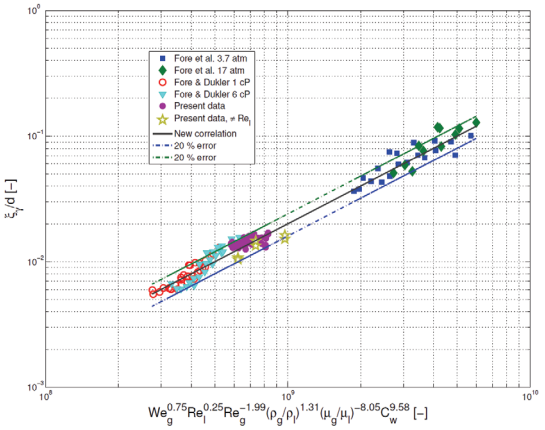
Advanced Modeling and Simulation of Chemical Reactors
The activity in this area is mainly founded by the Norwegian Research Council through the GassMaks program. The work in this project is focused on modeling of chemical reactors like fixed packed bed-, bubble column-, and fluidized bed reactors by the complete multifluid model containing a population balance equation for the fluid particle size distribution for the multiphase reactors. The model equations are solved by the modern least squares spectral element method. In the next phase of the project the novel in-house codes will be applied analyzing the chemical reactor processes utilizing natural gas as feedstock.

CO_2 capture and droplet removal

Removal of droplets from high pressure gases
An area of great importance for the Norwegian gas producing industry is the separating out of droplets from high pressure gases. Downstream process equipment e.g. compressors, separation processes or chemical reactors suffer disturbed operation or break-down if gases are not droplet free. Today's units are not good enough at high pressures, and robust and reliable solutions must be found in particular for sub-sea completions. The projects HiPGaS and now HiPGLS were established for studying the phenomena governing such separations. In collaboration with ten industrial partners separation rigs have been established for both low and high (<150 bar) pressures at NTNU and at the Statoil research center at Rotvoll. Tests within the projects have also been performed at semi-industrial scale at the K-lab facility at Kårstø. Results from the high pressure rigs are unique and form a basis for model validation. In an established laser laboratory we study droplet/droplet and droplet/surface collisions and the stability and break-up of liquid jets and surfaces leading to re-entrainment of droplets. There is a strong interaction between experiments and numerical models. Examples are shown below for the breakup of liquid film on a thread, typical of what happens on a mesh pad separator.

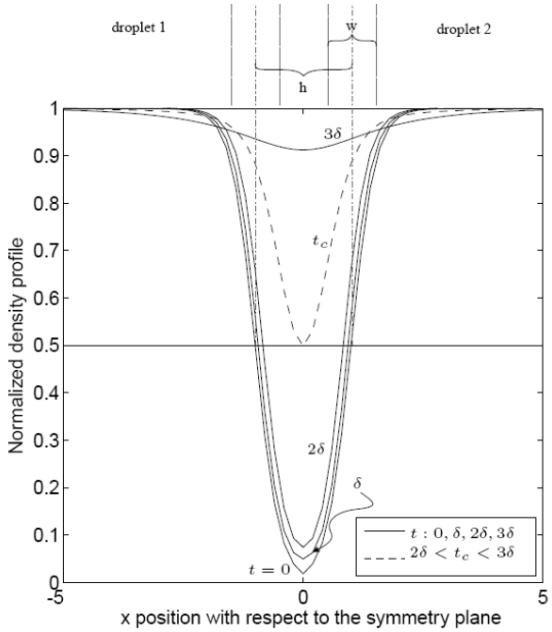


Effect on liquid film stability by increasing gas flow

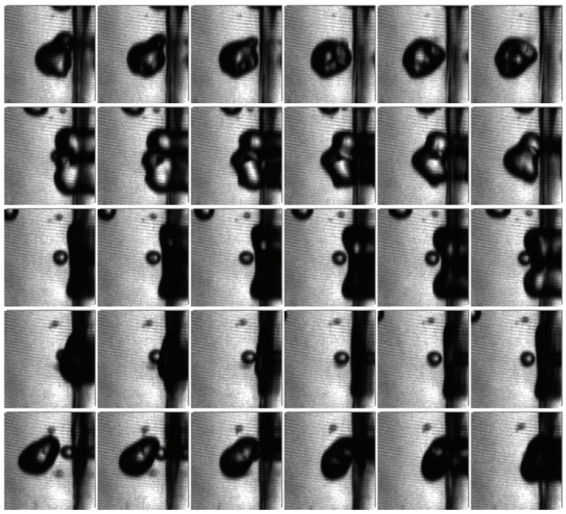


A new correlation for estimating entrained droplet size

A new and more general correlation for predicting droplet size distributions, valid for several geometries has been developed. In the area of droplet collision outcomes a more fundamental model has been developed based on lattice Boltzmann and a Cahn-Hilliard/free energy approach to treat the interface having a thickness depending on physical properties.



Interfacial coalescence using the Cahn-Hiliard model



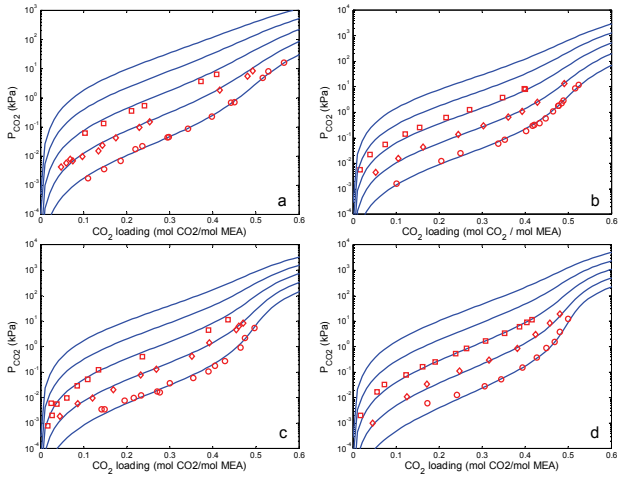
High speed video of partial deposition for the CO_2-CO_2 system at 70 bar

The model is extended for the particular case of multiscale simulations. Modelling real droplets with real interfaces is critical for predicting coalescence behaviour. Simulations for interface thickness to droplet radius ratios of more than two orders of magnitude were performed. The model is a first in its kind where coalescence and pinch off effects can be captured without adding additional closure laws, only through an energy description that takes into account non-uniform systems. Droplet deposition studies were performed at relatively high pressures(<70 bar) and the CO_2 system was found to provide a very good test system as interfacial tension down to 1 mN/m could be achieved. The figure above shows partial deposition in the CO_2 system.

Interfacial tension in high pressure hydrocarbon systems are measured with a pendant drop technique, and modelled using gradient theory for an inhomogeneous interface. Two PhDs graduated from this project in 2010.

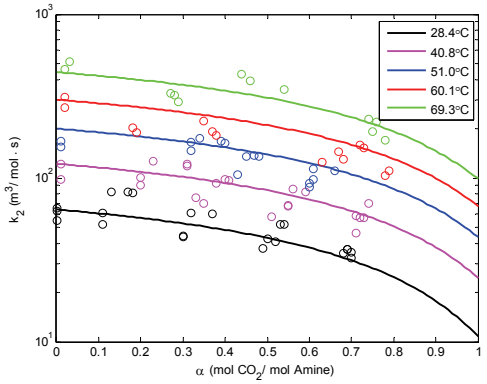
CO_2 capture from exhaust gases and natural gas. One of the most fundamental problems facing the earth today is global warming. The emissions of CO_2, the most important greenhouse gas must be reduced, e.g. by CO_2 Capture and Storage (CCS). We have many research projects in this area funded by the Research Council of Norway, the industry, and the European Union. Our work is concentrated along two axes, one studying CO_2 capture from off gases from fossil fueled power plants and from the iron and steel-making industry, and the other directed toward the removal of acid gases from natural gas. We were heavily involved the EU FP6 projects, e.g CASTOR and CAPRICE. This work continues in the EU FP7 CESAR project, and recently as coordinator of the EU FP7 iCap project. This work involves all the steps from theoretical screening by use of computational chemistry, through experimental screening, testing of environmental properties, characterization of equilibria, thermal properties, transport properties and kinetics, degradation and mechanisms, to testing in laboratory pilot plants.

In parallel we develop rigorous thermodynamic models, based on electrolyte NRTL and extended UNIQUAC model frameworks, see figure below.



Measured and modelled CO_2 partial pressures, UNIQUAC model

Improved models for combined mass and heat transfer are also under development. In addition we have developed a full rate based simulator for the whole absorption/desorption process, CO2SIM



Experimental and simulated rate constants for EDA in loaded solutions

Of the national projects on CO_2 capture, the largest is SOLVit, a JIP with Aker Clean Carbon (ACC). Other projects are VOCC, and REACT and the Research Council financed BIGCO2, now BIGCCS. In the CCERT project, a JIP with Research Council financing and four industrial partners, fundamental problems are addressed.

Process Design

A process design is to a large extent a consequence of developments on catalyst, choice of reaction routes, selection of solvent system, fluid type etc. At this level of development the structure of the chemical system and the kinetics are determined. Much research is focused on these topics because even incremental improvements may have large economical consequences. The next major step is to find a suitable reactor and process in which to deploy the system on a larger scale. The traditional way of doing design of new processes is by selecting reactor type and process configuration based on comparison to a similar known system. Design choices are often made on the basis of past experience or trial-and-error using laboratory tests and repeated simulations. These activities are necessary. However, it is not likely that the traditional way alone will lead to the best possible process configuration and design. Complementary tools and methods are needed to lead the design engineer onto the path of optimal design. Deviations from the optimal design will lead to unnecessary loss of product yield, unnecessary large volumes and loss of energy. Within the conceptual process design activity some of the most important choices are made, which have large consequences on the profitability and environmental loads of the final process technology. According to Douglas (1988)[1] the conceptual design of an integrated plant can be broken down into a hierachy of decisions and organized into different levels of activities. Among the levels of activities are reactor-separator-recycle structures, heat integration, and separation train sequence design. A method in focus here is a systematic procedure based on shortcut models. A path is a line of production on which basic operations or functions take place. Reactants pass through a series of functions or basic operations to form the desired products. The basic operations are represented by design functions on the volume path. The design functions are fluid mixing (dispersion), distribution of extra feed points, distribution of heat transfer area and coolant temperature, catalyst dilution distribution and more. The conceptual reactor design problem is solved as an optimal control problem. Parameterization of the design functions and the state variables are applied. The realization is a staged process string of multifunctional units.

Douglas, J. M., Conceptual Design of Chemical Processes, McGraw Hill, 1988.

Membrane Research

Membranes for gas separation and osmotic processes

(More information about the Memfo (Membrane Research activities): (www.chemeng.ntnu.no/memfo)

The membrane research programs have extensive activities both on basic membrane material development, as well as membrane gas separation processes, modelling and simulations. The main focus for the research is CO_2 capture by membranes (from flue gas, natural gas sweetening, biogas upgrading) and hydrogen recovery from various mixed gas streams. In addition to these energy focused gas applications, there is also ongoing research on membranes for other gas mixtures, chlorine separation included. The membrane materials in focus are various types of polymers, nano-composites, carbon membranes, and modified glass membranes.
The international network is extensive, with co-operation both within EU-projects, USA, Japan, the Nordic countries and Russia.

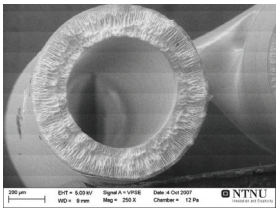
Brief description of sample gas separation projects

a) FSC-Membrane /Climit (Gassnova)/ Statoil: Membrane development for selective CO_2 capture
The membrane material being developed in this project contains a specific "carrier" which makes it selective for CO_2 while other gas components are being retained. The material is based on a polymer containing fixed amine groups as carriers. A significant progress was achieved during the previous KMB-project, and within the current FSC-project the membrane is being tested out on a small pilot scale to verify the good performance both with respect to CO_2-flux and selectivity compared to the other components in a mixed gas. The obtained results have drawn international attention. The membrane is patented, and there are big expectations for the upscaling taking place; for CO_2 capture from coal fired or gas fired power plants as well as other CO_2 containing gas streams. The project is divided in two phases, the first one ending in 2011. One research scientist and one Post doc are working on the project. Project partner is Statoil, and with funding from Climit- Gassnova. There is also interest from industry on other applications where CO_2 is present in the gas stream (natural gas sweetening, process industry, CO_2 removal from anaesthetic gas...)

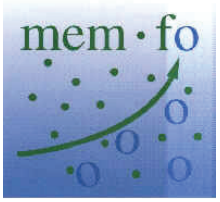
b) EU FP6 project NanoGloWa
(www.nanoglowa.com)
The project started November 2006 and is focusing on "Nano-structured membranes against Global Warming" (NanoGloWa). Memfo is a major partner in the project; task leader for two work packages focusing on development of carbon membranes and polymeric materials for CO_2 capture from coal fired power plants. The project also includes spinning of hollow fibres, module development and durability tests. The membrane has proved to be stable towards SO_2 over a longer period of time. One Post.doc. and one PhD student were attached to the project in 2010 – the project is going into its fianl year in 2011. The project coordinbator is KEMA in The Netherlands.

c) EU FP7 project DECARBit
The project is coordinated by Sintef and had kick-off in Feb 2008. The focus is pre-combustion separation of CO_2 and H_2 at high temperatures (>300°C). Carbon membranes are being tailored for this separation. The project also includes module development and durability tests. The project coordinator is SINTEF Energy

d) KMB GASSMAKS / NFR project RECCO2
The project started late 2007. The objective is CO_2 removal from high pressure natural gas streams using a polymeric blend membrane; using as one of the polymers in the blend the patented PVAm facilitated transport membrane – other materials suitable for high pressure applications are also considered. The project includes material development, pilot construction, durability tests and simulations. The main challenge in this project is the performance at high pressures (→100 bar). Advanced high pressure test rigs have been built, one for permeation tests and one for durability tests. Special restrictions for HMS is needed in this operating range. Industrial partner is Statoil.



SEM-picture showing a membrane. DO-DI: 1 -0.6 mm cut through a hollow fibre



Memfo = Membrane Forskning (Membrane Research)

Bundle of hollow fibre membranes in an industrial module–packing densities can be up to 30 000 m^2/m^3

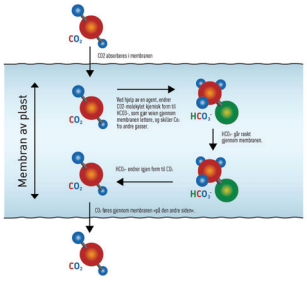


Illustration of the mechanism in the patented CO_2 facilitated transport membrane

e) KMB Petromaks / NFR A Green Sea
The project started in 2010, and Sintef Energy is the coordinator. The project has activities within four alternative technologies for natural gas sweetening. Memfo's activity within the project is development of a nanocomposite membrane material for a membrane contactor. The other technologies are development of sorbents, alternative absorbents and low temperature separation. Process integration is also an important activity. There is one PhD-student within Memfo working on the project.

Brief description of a sample liquid separation project

f) KMB NANOMAT / NFR project: Membranes for osmotic processes – POPMOP
Reverse osmosis is today one of the major methods for desalting ocean water into freshwater. Osmotic effects demands that a high pressure on the saltwater side of the membrane modules must be applied to override the osmotic pressure difference between sea water and freshwater. If the applied pressure in the cells is lower than the osmotic pressure the water flow is reversed and freshwater flows into the saltwater compartment, thus increasing the volume of moderately pressurized saltwater. This is the principle of Pressure Retarded Osmosis (PRO), which may be used to produce electric energy as the surplus water on the saltwater side may be run through turbines for power production. The potential for power production at the outlet of every river that flows into the ocean is very large.
Towards the end of 2007 Memfo was granted a KMB project from Nanomat/NFR supported by Aqualyng, Statkraft and Statoil. The project is aiming at studying and optimizing the synthesis of polymers for osmotic processes. This development includes both optimisation of the support membrane, as well as the thin film membrane itself. One PhD student and one research scientist have been working on the project in 2010, in addition to collaboration with Sintef.

***g)* VARIOUS PROJECTS ON NANOCOMPOSITES**
The group has additionally several smaller research projects focusing on development of hybrid materials; in 2010 three PhDs have been involved in this topic.

The Memfo researchers work very much as a team in addition to be dedicated to individual projects. Hence the simulation of processes is handled whenever needed by those who have the competence. Likewise; the concern for environmental issues, leads to the focus also on biogas upgrading to vehicle fuel quality (biomethane). Carbon membranes has proved to be suitable for upgrading of biogas; documented by experiments and discussed in publications.

A collaboration with University of Dar es Salaam (UDSM), Tanzania, has resulted in a project funded by NUFU. The focus is on bioenergy; with certain aspects of the production of bioethanol and biodiesel from local raw materials. There are 2 PhDs at UDSM and 1 at NTNU attached to this project.

There are several well equipped laboratories available for the membrane research; both for membrane material development as well as membrane characterization. The membrane research on CCS is especially strong, and completes the research on CCS activities in collaboration within the Environment and Reactor Group.

A spin-off company from the research on carbon molecular sieve membranes was established in 2008 with the support of the Technology Transfer Office (TTO) at NTNU. The name of the company is *MemfoACT* (= Membranes for Advanced Clean Technology, http://www.memfoact.no)
This company won 3 prizes for creativity and innovation in 2009/2010.

Crystallizaton and Particle Design

The research within crystallization is focused at kinetics of nucleation, crystal growth, and agglomeration in order to predict and control the particle size distribution and shape of crystalline particulate products for scale prevention, improved solid-liquid separation, CO_2-capture in precipitating systems, and for nano-particle production. The crystallization group also investigates fundamental mechanisms in the early formation of solid particles, mechanisms for growth of polycrystalline particles and interaction between biopolymers and mineral formation.

Improved Glycol Loop Operation – bulk precipitation and scaling of carbonates in natural gas processing.
The aim of the project is to develop a simulation tool for glycol loops in processing of natural gas. This necessitates a deep understanding of the precipitation and crystallisation behaviour of salts and scale-forming carbonates in ethylene glycol (MEG) and water mixtures. Kinetics of calcium carbonate precipitation, scaling on heated surfaces and separation of salts in the on-shore glycol reclamation systems will be the main research tasks. The project is in collaboration with Institute of Energy Technology, Norway (IFE) and financed by several international oil and gas companies and the Research Council of Norway (NFR). The first part of the project (from 2006) was finalized in 2010 and a new 3 year application was granted. So far the studies performed in the crystallization group have shown that MEG significantly affects the precipitation of calcium carbonate by lowering the growth rate and by shifting the polymorphic composition. Kinetic expressions have been developed to be implemented into computer simulator for particle formation control within glycol loops. The project is continuing (with 1 PhD and 1 postdoc at NTNU) by studies of surface scaling and bulk precipitation in presence of relevant impurities.

Industrial Crystallization and Filtration
The goal of this research is to relate solid/liquid separation characteristics to the underlying growth and agglomeration phenomena. It involves studies of inorganic salts and pharmaceuticals, and the primary target for the activity at NTNU is to link the parameters in the crystallisation process to the subsequent filtration

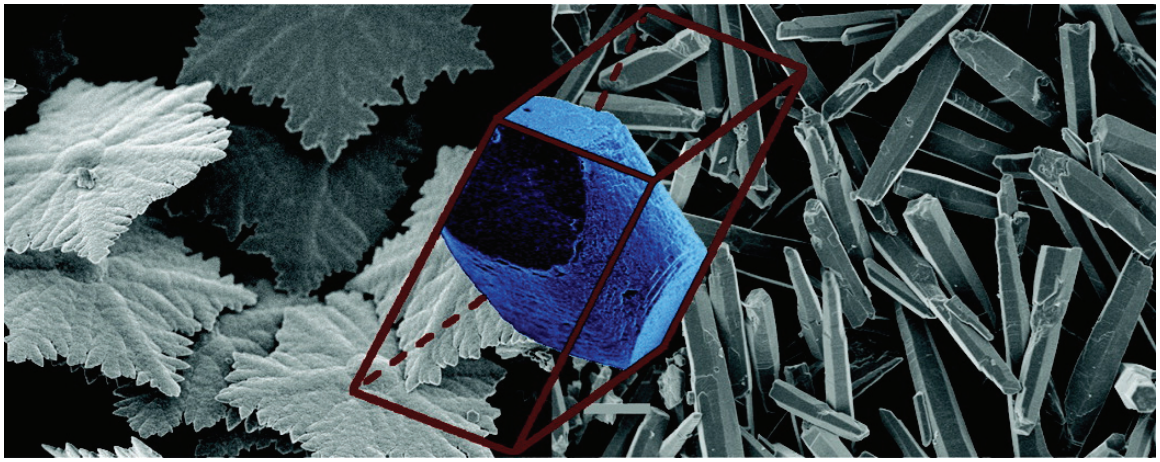
step by focusing on common mechanisms for these selected systems. A project in collaboration with POSTEC at Tel-Tek and is financed by the Research Council of Norway and Norwegian industry partners is now finalized. A general mechanism of crystal growth switching whereby the particle shape is dramatically altered for several systems differing widely in their chemical nature. This is illustrated for the precipitation of sodium glutamate by switching from the well-known needle crystals of β-glutamic acid to spherical particles of the same polymorph. Filtration resistance measurements as well as powder flow properties measured by uniaxial testing has shown that these spherical particles are unwanted, and in some cases the conditions can be met to avoid their formation. A new application has been filed to continue the work to improve industrial filtration processes.

Biomineralization

Structural biocomposites found in nature often have a well-defined organization on the nanometer scale. For mineralized materials, interactions between organic and inorganic phases are important for controlling crystal size, morphology, and spatial arrangement, which is a requirement when structural biomaterials are designed. In a joint project with department of biochemistry, lead by the physics department, we have been studying the formation of nanoparticles of calcium carbonate and calcium phosphate in polysacchraride (alginate) networks as model systems for bone formation. The mineral formation within alginate gel beads is a complex precipitation phenomenon resulting from diffusion of ions through the networks and simultaneous competition for calcium by the gelling process. However, as we have shown by crystal growth rate studies in presence of different alginate oligomers, these molecules are strong crystal growth modifiers overriding the effect of mixing and diffusion and thereby facilitating the production of very small crystals within the networks. Studies performed in 2010 have shown that these materials might template stem cell differentiation for bone regeneration purposes. The variation in the oligomer composition was also shown to have great effects on the polymorphic composition of calcium carbonate, results that beside their fundamental significance can provide insight into mineral scale mitigation strategies in industry as well as to design hybrid materials.

CO_2-capture in precipitating systems

A PhD was hired in 2010 to work with carbon dioxide absorption in systems where the crystallization processes during absorption and desorption can influence the kinetics and capacity of the capture process



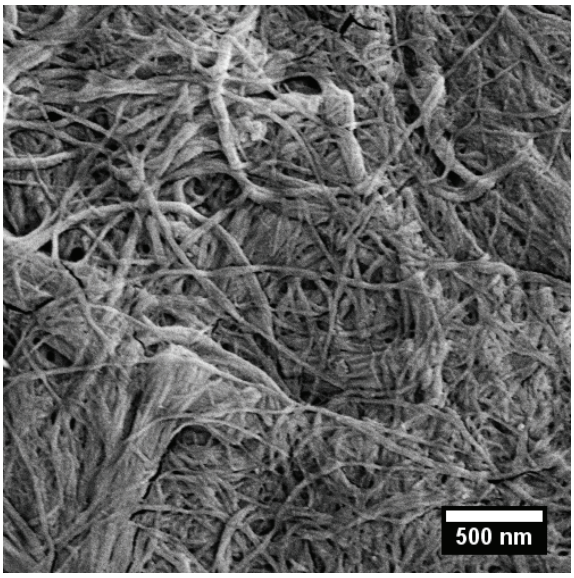
Certain alginate oligomers have the capacity to force the crystallization of calcium carbonate into exclusively calcite (in blue, only partly inhibited) by suppressing selectively the growth of the other polymorphs, snowflake shaped vaterite and needle type aragonite.

BIOREFINERY AND FIBRE TECHNOLOGY GROUP

Academic staff
Professor Øyvind W. Gregersen
Associate professor Størker Moe
Professor emeritus Torbjørn Helle

Post.docs.
Asuka Yamakawa (until 31.10.2010)
Marco Iotti (until 31.05.2010)
Sara Paunonen (from 01.11.2010)
Swarnima Agnihotri (from 15.03.2010)

PhD. candidates
Collin Ching Tyn Hii
Galina Rodionova
Marius Rusu
Mihaela Tanase
Sara Paunonen (until 31.10.2010)
Tuan-Anh Nguyen



FE-SEM image of a the surface of a microfibrillar cellulose film produced by homogenization (Syverud et al 2009)

Teaching

The Biorefinery and Fiber Technology group provides chemical engineers and PhDs for the Norwegian pulp and paper industry. The estimated need from the industry is 8-10 engineering graduates and about 2 PhD candidates per year. We have now developed the curriculum of our courses in the 4th and 5th year to include bioenergy and biorefinery concepts on an equal basis with pulp and paper. This reflects a similar change in our research focus and starting industrial development.

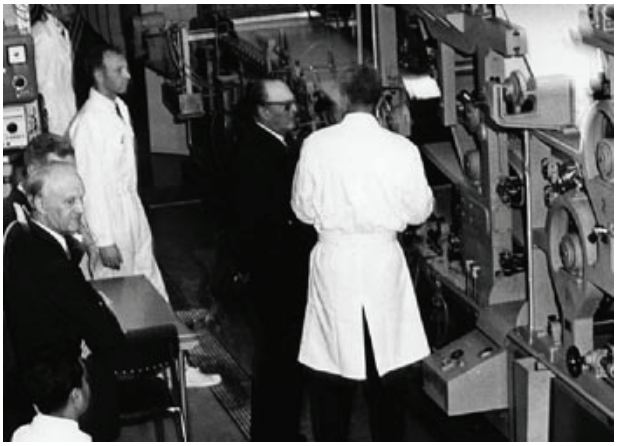
Partners

The Biorefinery and Fibre technology group, Paper and Fibre research Institute (PFI) and parts of the Ugelstad laboratory (colloid and surface chemistry) are located in the same building on the NTNU Gløshaugen campus and are working in close cooperation. In addition Sintef, Innventia (Stockholm), HUT (Helsinki) and MIUN (Sundsvall) are important research partners. We also cooperate closely with industry partners such as Norske Skog, Södra Cell, Borregaard, Peterson, Dynea, and Statoil.

Research
Our research is focused on bioenergy/biorefinery, improvements in the pulp and paper process and on improved end product quality. Our main research activity is done through PhD and Post Doc. fellows. Examples are:

- Pre-treatment and conditions for hydrolysis of wood for bioethanol production
- Better strength and surface properties of wood-containing paper by use of microfibrillated cellulose as an additive.
- Barrier properties of microfibrillated cellulose and chemically modified microfibrillated cellulose.
- Properties of adhesives containing microfibrillated cellulose.
- The relation between the mechanical properties and permeability of laminated board and the performance of heavy duty food transport boxes.
- Reduced energy consumption and/or better fibre properties of mechanical pulp through high intensity refining, co-refining of different raw materials or pre-treatment of wood chips.
- The effect of furnish composition and sheet structure on wet pressing efficiency.

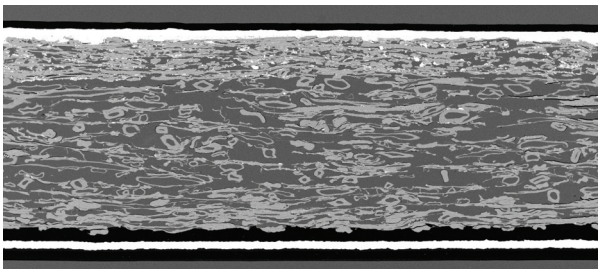
Moving the pilot plant
Due to the renovation of chemistry building KIV and the need for laboratories and pilot plants for CO_2 separation research, the pulp and paper pilot plant and paper machine has been removed. Most of the equipment (but not the paper machine) was installed in the pilot hall of the PFI building during 2010.



The paper machine which was opened by King Olav in 1965 had become technically obsolete and had to yield ground to a new pilot hall for CO_2 separation research.

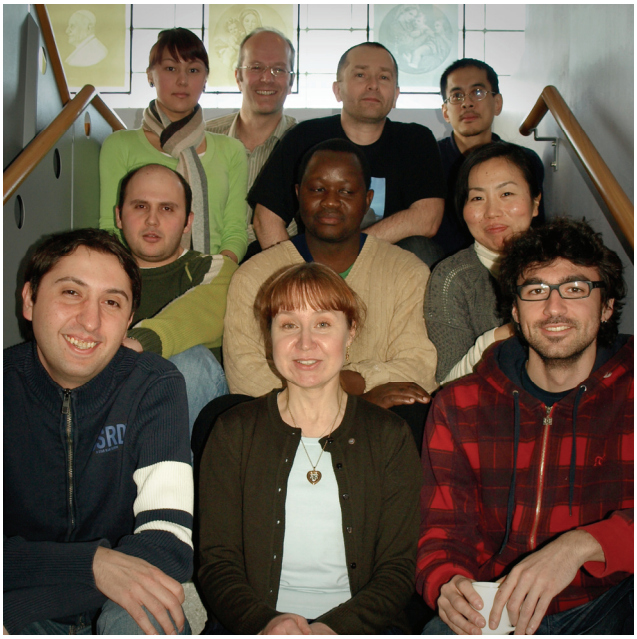
Trends

The last years a new activity on use of cellulose based particles in composite materials have started. Both better oxygen barrier and mechanical properties may be obtained by using cellulose fibres or fibrils as reinforcement in thermoplastic composites.
Together with PFI a new research activity on the use of wood based biofuel production have also started. The goal is cost effective production of biodiesel and ethanol from wood.
Further, energy effective production is one of the primary concerns of the pulp and paper industry and thus also an important research area now and in the future.



The mechanical and barrier properties of a paper material depend on the material choice and structure. The SEM image of the cross section of a liquid board shows (from top) a Polyethylene (PE), mineral coating, kraft pulp, CTMP, kraft pulp, PE, Aluminium layer and PE

BIOREFINERY AND FIBRE TECHNOLOGY GROUP



First row: Marius, Sara and Marco
Second row: Klodian, Kando and Asuka
Third row: Galina, Øyvind, Størker and Collin

CHAPTER 3: PUBLICATIONS

PUBLICATIONS IN REFEREED JOURNALS

1. **Andreassen, Jens-Petter; Flaten, Ellen Marie; Beck, Ralf; Lewis, Alison Emslie.**
Investigations of spherulitic growth in industrial crystallization. *Chemical engineering research & design* 2010 ;Volum 88.(9A) s. 1163-1168

2. **Aronu, Ugochukwu Edwin; Svendsen, Hallvard Fjøsne; Hoff, Karl Anders.**
Investigation of amine amino acid salts for carbon dioxide absorption. *International Journal of Greenhouse Gas Control* 2010 ;Volum 4.(5) s. 771-775

3. **Bakke, Morten; Johansen, Tor Arne; Skogestad, Sigurd.**
Effect of Varying Controller Parameters in Closed-Loop Subspace Identification,. *Elsevier IFAC Publications / IFAC Proceedings series* 2010

4. **Balonek, Christine M.; Lillebø, Andreas Helland; Rane, Shreyas Pandurang; Rytter, Erling; Schmidt, Lanny D.; Holmen, Anders.**
Effect of Alkali Metal Impurities on Co-Re Catalysts for Fischer-Tropsch Synthesis from Biomass-Derived Syngas. *Catalysis Letters* 2010 ;Volum 138. s. 8-13

5. **Beck, Ralf; Andreassen, Jens-Petter.**
Spherulitic Growth of Calcium Carbonate. *Crystal Growth & Design* 2010 ;Volum 10.(7) s. 2934-2947

6. **Beck, Ralf; Andreassen, Jens-Petter.**
The onset of spherulitic growth in crystallization of calcium carbonate. *Journal of Crystal Growth* 2010 ;Volum 312.(15) s. 2226-2238

7. **Beck, Ralf; Heskestad, Rita; Malthe-Sørenssen, Didrik; Häkkinen, Antti; Louhi-Kultanen, M.; Andreassen, Jens-Petter.**
Ageing of spherulites of an industrial relevant aromatic amine derivative. *Crystal research and technology (1981)* 2010 ;Volum 45.(2) s. 204-212

8. **Beck, Ralf; Malthe-Sørenssen, Didrik; Andreassen, Jens-Petter.**
Formation and ageing of L-glutamic acid spherulites. *Crystal research and technology (1981)* 2010 ;Volum 45.(7) s. 753-762

9. **Beck, Ralf; Nysæter, Trude O.; Enstad, G. G.; Malthe-Sørenssen, Didrik; Andreassen, Jens-Petter.**
Influence of Crystal Properties on Powder Flow Behavior of an Aromatic Amine and L-Glutamic Acid. *Particulate Science and Technology* 2010 ;Volum 28.(2) s. 146-160

10. **Beck, Ralf; Svinning, Ketil; Häkkinen, Antti; Malthe-Sørenssen, Didrik; Andreassen, Jens-Petter.**
Analysis of Filtration Characteristics for Compressible Polycrystalline Particles by Partial Least Squares Regression. *Separation science and technology (Print)* 2010 ;Volum 45.(9) s. 1196-1208

11. **Deng, Liyuan; Hägg, May-Britt.**
Swelling behavior and gas permeation performance of PVAm/PVA blend FSC membrane. *Journal of Membrane Science* 2010 ;Volum 363.(1-2) s. 295-301

12. **Deng, Liyuan; Hägg, May-Britt.**
Techno-economic evaluation of biogas upgrading process using CO2 facilitated transport membrane. *International Journal of Greenhouse Gas Control* 2010 ;Volum 4.(4) s. 638-646

13. **Dones, Ivan; Manenti, Flavio; Preisig, Heinz A.; Buzzi-Ferraris, Guido.**
Nonlinear Model Predictive Control: A Self-Adaptive Approach. *Industrial & Engineering Chemistry Research* 2010 ;Volum 49.(10) s. 4782-4791

14. **Dones, Ivan; Preisig, Heinz A.**
Model simplification and time-scale assumptions applied to distillation modelling. *Computers and Chemical Engineering* 2010 ;Volum 34.(5) s. 732-743

15. **Duan, XueZhi; Zhou, Jing-Hong; Qian, Gang; Li, Ping; Zhou, Xing-Gui; Chen, De.**
Carbon Nanofiber-Supported Ru Catalysts for Hydrogen Evolution by Ammonia Decomposition. *Cuihuà xuébào* 2010 ;Volum 31.(8) s. 979-986

16. **Dupuy, Pablo Matias; Fernandino, Maria; Jakobsen, Hugo Atle; Svendsen, Hallvard Fjøsne.**
Using Cahn–Hilliard mobility to simulate coalescence dynamics. *Computers and Mathematics with Applications* 2010 ;Volum 59.(7) s. 2246-2259

17. **Dupuy, Pablo Matías; Kleinohl, Nils; Fernandino, Maria; Jakobsen, Hugo Atle; Svendsen, Hallvard Fjøsne.**
Droplet-surface impact at high pressures. *Chemical Engineering Science* 2010 ;Volum 65.(19) s. 5320-5343

18. **Dupuy, Pablo Matías; Svendsen, Hallvard Fjøsne; Patruno, Luciano Emanuel; Jakobsen, Hugo Atle.**
Finite-difference stable stencils based on least-square quadric fitting. *Computer Physics Communications* 2010 ;Volum 181.(10) s. 1671-1681

19. **Enger, Bjørn Christian; Lødeng, Rune; Holmen, Anders.**
Effects of Noble Metal Promoters on In Situ Reduced Low Loading Ni Catalysts for Methane Activation. *Catalysis Letters* 2010 ;Volum 134.(1-2) s. 13-23

20. **Enger, Bjørn Christian; Lødeng, Rune; Walmsley, John C; Holmen, Anders.**
Inactive aluminate spinels as precursors for design of CPO and reforming catalysts. *Applied Catalysis A : General* 2010 ;Volum 383.(1-2) s. 119-127

21. **Fan, Yanru; Simon, Sebastien Charles; Sjøblom, Johan.**
Influence of Nonionic Surfactants on the Surface and Interfacial Film Properties of Asphaltenes Investigated by Langmuir Balance and Brewster Angle Microscopy. *Langmuir* 2010 ;Volum 26.(13) s. 10497-10505

22. **Fan, Yanru; Simon, Sebastien Charles; Sjøblom, Johan.**
Interfacial shear rheology of asphaltenes at oil-water interface and its relation to emulsion stability: Influence of concentration, solvent aromaticity and nonionic surfactant. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 2010 ;Volum 366.(1-3) s. 120-128

23. **Flaten, Ellen Marie; Seiersten, Marion; Andreassen, Jens-Petter.**
Growth of the calcium carbonate polymorph vaterite in mixtures of water and ethylene glycol at conditions of gas processing. *Journal of Crystal Growth* 2010 ;Volum 312.(7) s. 953-960

24. **Flaten, Ellen Marie; Seiersten, Marion; Andreassen, Jens-Petter.**
Induction time studies of calcium carbonate in ethylene glycol and water. *Chemical engineering research & design* 2010 ;Volum 88. s. 1659-1668

25. **Foss, Martin Smestad; Diplas, Spyros; Gulbrandsen, Egil.**
Mechanistic study of adsroption of cetyltrimethyl ammonium bromide on high purity iron using contact angle, polarization resistance and XPS. *Electrochimica Acta* 2010 ;Volum 55. s. 4851-4857

26. **Foss, Martin Smestad; Gulbrandsen, Egil; Sjøblom, Johan.**
Adsorption of Corrosion Inhibitors onto Iron Carbonate (FeCO3) Studied by Zetapotential Measurements. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(2) s. 200-208

27. **Foss, Martin Smestad; Gulbrandsen, Egil; Sjøblom, Johan.**
Measurements of Zeta Potential on Corroding, High-Purity Iron Particles: Influence of Corrosion Inhibitors. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(2) s. 233-240

28. **Foss, Martin Smestad; Gulbrandsen, Egil; Sjøblom, Johan.**
Oil Wetting and Carbon Dioxide Corrosion Inhibition of Carbon Steel with Ferric Corrosion Products Deposits. *Corrosion* 2010 ;Volum 66.(2)

29. **Gawel, Bartlomiej; Gawel, Kamila; Øye, Gisle.**
Sol-Gel Synthesis of Non-Silica Monolithic Materials. *Materials* 2010 ;Volum 3. s. 2815-2833

30. **Grimes, Brian Arthur; Dorao, Carlos Alberto; Simon, Sebastien Charles; Nordgård, Erland; Sjøblom, Johan.**
Analysis of dynamic surfactant mass transfer and its relationship to the transient stabilization of coalescing liquid-liquid dispersions. *Journal of Colloid and Interface Science* 2010 ;Volum 348.(2) s. 479-490

31. **Gurandsrud, Karl J.; Gregersen, Øyvind Weiby.**
Fra sulfittmassekjemi til bioraffineri. *Kjemi* 2010 ;Volum 5. s. 12-13

32. **Halskau jr, Øyvind; Volden, Sondre; Calvo, Ana C; Martinez, Aurora; Glomm, Wilhelm.**
Adsorption and bioactivity of tyrosine hydroxylase on gold surfaces and nanoparticles. *Protein peptide letters* 2010 ;Volum 17.(11) s. 1376-1382

33. **Hammer, Nina; Zscherpe, Tina; Chen, De; Rønning, Magnus.**
Selective oxidation of CO on the Au-TiO2 catalysts on structured carbon support. *American Chemical Society Symposium Series (ACS)* 2010 ;Volum 55.(1) s. 102-103

34. **Hanneseth, Ann-Mari Dahl; Selsbak, Cecilie Mørk; Sjøblom, Johan.**
Behavior and Stability of Naphthenic Acid/Naphthenate Stabilized Emulsions. Mixed C80-Tetraacid and Stearic Acid Stabilization. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(6) s. 770-779

35. **He, Li; Berntsen, Helene; Chen, De.**
Approaching Sustainable H-2 Production: Sorption Enhanced Steam Reforming of Ethanol. *Journal of Physical Chemistry A* 2010 ;Volum 114.(11) s. 3834-3844

36. **He, Li; Chen, De.**
Single-Stage Production of Highly Concentrated Hydrogen from Biomass-Derived Syngas. *ChemSusChem* 2010 ;Volum 3.(10) s. 1169-1171

37. **He, Li; Parra, Jacobo Manuel Salamanca; Blekkan, Edd Anders; Chen, De.**
Towards efficient hydrogen production from glycerol by sorption enhanced steam reforming. *Energy & Environmental Science* 2010 ;Volum 3.(8) s. 1046-1056

38. **Helle, Torbjørn.**
Boktrykkingen - årtusenets viktigste oppfinnelse. *Adresseavisen* 2010

39. **Helle, Torbjørn.**
Lussekattene og safran. *Adresseavisen* 2010

40. **Helle, Torbjørn.**
Uka og ukedagene. *Adresseavisen* 2010

41. **Hessen, Erik Troøien; Haug-Warberg, Tore; Svendsen, Hallvard Fjøsne.**
The refined e-NRTL model applied to CO2-H2O-alkanolamine systems. *Chemical Engineering Science* 2010 ;Volum 65.(11) s. 3638-3648

42. **Hillestad, Magne.**
Systematic staging in chemical reactor design. *Chemical Engineering Science* 2010 ;Volum 65.(10) s. 3301-3312

43. **Huang, Fan; Vanhaecke, Estelle Marie M.; Chen, De.**
In situ polymerization and characterizations of polyaniline on MWCNT powders and aligned MWCNT films. *Catalysis Today* 2010 ;Volum 150.(1-2) s. 71-76

44. **Hult, Eva-Lena; Iotti, Marco; Lenes, Marianne.**
Efficient approach to high barrier packaging using microfibrillar cellulose and shellac. *Cellulose (London)* 2010 ;Volum 17.(3) s. 575-586

45. **Hussain, Arshad; Hägg, May-Britt.**
A feasibility study of CO2 capture from flue gas by a facilitated transport membrane. *Journal of Membrane Science* 2010 ;Volum 359.(1-2) s. 140-148

46. **Håkonsen, Silje Fosse; Walmsley, John C; Holmen, Anders.**
Ethene production by oxidative dehydrogenation of ethane at short contact times over Pt-Sn coated monoliths. *Applied Catalysis A : General* 2010 ;Volum 378.(1) s. 1-10

47. **Iotti, Marco; Gregersen, Øyvind Weiby; Moe, Størker; Lenes, Marianne.**
Rheological Studies of Microfibrillar Cellulose Water Dispersions. *Journal of polymers and the environment* 2010 ;Volum 18.(2) s.

48. **Jäschke, Johannes; Skogestad, Sigurd.**
Self-optimizing Control and NCO tracking in the Context of Real-Time Optimizaton. *Elsevier IFAC Publications / IFAC Proceedings series* 2010 s. 594-599

49. **Kim, Taek Joong; Uddin, Mohammad Washim; Sandru, Marius; Hägg, May-Britt.**
The Effect of Contaminants on the Composite Membranes for CO_2 Separation and Challenges in Up-Scaling of the Membranes. *Energy Procedia* 2010

50. **Knuutila, Hanna; Hessen, Erik Troøien; Kim, Inna; Haug-Warberg, Tore; Svendsen, Hallvard Fjøsne.**
Vapor-liquid equilibrium in the sodium carbonate-sodium bicarbonate-water-CO2-system. *Chemical Engineering Science* 2010 ;Volum 65.(6) s. 2218-2226

51. **Knuutila, Hanna; Juliussen, Olav; Svendsen, Hallvard Fjøsne.**
Density and N2O solubility of sodium and potassium carbonate solutions in the temperature range 25 to 80°C. *Chemical Engineering Science* 2010 ;Volum 65.(6) s. 2177-2182

52. **Knuutila, Hanna; Juliussen, Olav; Svendsen, Hallvard Fjøsne.**
Kinetics of the reaction of carbon dioxide with aqueous sodium and potassium carbonate solutions. *Chemical Engineering Science* 2010 ;Volum 65.(23) s. 6077-6088

53. **Kralova, Iva; Sjøblom, Johan.**
Biofuels-Renewable Energy Sources: A Review. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(3) s. 409-425

54. **Kralova, Iva; Sjøblom, Johan.**
Surfactants Used in Food Industry: A Review (vol 30, pg 1363 2009). *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(5) Suppl. 702

55. **Kvamsdal, Hanne M.; Hetland, Jens; Haugen, Geir; Svendsen, Hallvard Fjøsne; Major, F; Karstad, V; Tjellander, G.**
Maintaining a neutral water balance in a 450 MWe NGCC-CCS power system with post-combustion carbon dioxide capture aimed at offshore operation. *International Journal of Greenhouse Gas Control* 2010 ;Volum 4.(4) s. 613-622

56. **Kvande, Ingvar; Zhu, Jun; Zhao, Tiejun; Hammer, Nina; Rønning, Magnus; Raaen, Steinar; Walmsley, John C; Chen, De.**
Importance of Oxygen-Free Edge and Defect Sites for the Immobilization of Colloidal Pt Oxide Particles with Implications for the Preparation of CNF-Supported Catalysts. *The Journal of Physical Chemistry C* 2010 ;Volum 114.(4) s. 1752-1762

57. **Kvernland, Martin Krister; Halvorsen, Ivar J.; Skogestad, Sigurd.**
Model Predictive Control of a Kaibel Distillation Column. *Elsevier IFAC Publications / IFAC Proceedings series* 2010 s. 539-544

58. **Lesaint, Cedric Michel; Spets, Øyvind; Glomm, Wilhelm; Simon, Sebastien Charles; Sjøblom, Johan.**
Dielectric response as a function of viscosity for two crude oils with different conductivities. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 2010 ;Volum 369.(1-3) s. 20-26

59. **Less, Simone; Hannisdal, A; Sjøblom, Johan.**
Dehydration Efficiency of Water-in-Crude Oil Emulsions in Alternating Current Electrical Fields. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(3) s. 265-272

60. **Lind, Anna Maria; Myrstad, Rune; Eri, Sigrid; Skagseth, Torild Hulsund; Rytter, Erling; Holmen, Anders.**
Spray drying of porous alumina support for Fischer-Tropsch catalysis. *Studies in Surface Science and Catalysis* 2010 ;Volum 175. s. 685-688

61. **Linhart, Andreas; Skogestad, Sigurd.**
Reduced distillation models via stage aggregation. *Chemical Engineering Science* 2010 ;Volum 65.(11) s. 3439-3456

62. **Lögdberg, Sara; Lualdi, Matteo; Järås, Sven; Walmsley, John C; Blekkan, Edd Anders; Rytter, Erling; Holmen, Anders.**
On the selectivity of cobalt-based Fischer-Tropsch catalysts: Evidence for a common precursor for methane and long-chain hydrocarbons. *Journal of Catalysis* 2010 ;Volum 274.(1) s. 84-98

63. **Lou, FL; Sui, ZJ; Sun, JT; Li, P; Chen, De; Zhou, XG.**
Synthesis of carbon nanofibers/mica hybrids for antistatic coatings. *Materials letters (General ed.)* 2010 ;Volum 64.(6) s. 711-714

64. **Lu, Wen-Xin; Sui, Zhi-Jun; Zhou, Jing-Hong; Li, Ping; Chen, De; Zhou, Xing-Gui.**
Kinetically controlled synthesis of carbon nanofibers with different morphologies by catalytic CO disproportionation over iron catalyst. *Chemical Engineering Science* 2010 ;Volum 65.(1) s. 193-200

65. **Manum, Henrik; Skogestad, Sigurd.**
Bilevel programming for analysis of reduced models for use in model predictive control. *Journal of Systemics, Cybernetics and Informatics* 2010 ;Volum 9. s. 3-12

66. **Marchetti, Jorge Mario; Patruno, Luciano Emanuel; Jakobsen, Hugo Atle; Svendsen, Hallvard Fjøsne.**
Mathematical framework for higher order breakage scenarios. *Chemical Engineering Science* 2010 ;Volum 65.(22) s. 5881-5886

67. **Marchetti, Jorge Mario; Pedernera, M. N.; Schibib, N. S..**
Production of biodiesel from acid oil using sulfuric acid as catalysts: kinetics study. *International Journal of Low-Carbon Technologies* 2010 s. -

68. **Mejdell, Astrid Lervik; Chen, De; Peters, Thijs A.; Bredesen, Rune; Venvik, Hilde Johnsen.**
The effect of heat treatment in air on CO inhibition of a ~3μm Pd-Ag (23 wt.%) membrane. *Journal of Membrane Science* 2010 ;Volum 350.(1-2) s. 371-377

69. **Mihai, Oana; Chen, De; Holmen, Anders.**
Catalytic consequence of lattice oxygen of lanthanum ferrite perovskite in chemical looping reforming of methane. *Industrial & Engineering Chemistry Research* 2010

70. **Mulas, Michela; Brandao de Araújo, Antonio Carlos; Baratti, Roberto; Skogestad, Sigurd.**
Optimized Control Structure for a Wastewater Treatment Benchmark. *Elsevier IFAC Publications / IFAC Proceedings series* 2010 s. 647-652

71. **Nayak, Ameeya Kumar; Bhattacharyya, S.**
Combined Effect of Surface Roughness and Heterogeneity of Wall Potential on Electroosmosis in Microfluidic/Nanofuidic Channels.. *Journal of Fluids Engineering - Trancactions of The ASME* 2010 ;Volum 132.(4)

72. **Nenningsland, Andreas Lyng; Simon, Sebastien Charles; Sjøblom, Johan.**
Surface Properties of Basic Components Extracted from Petroleum Crude Oil. *Energy & Fuels* 2010 ;Volum 24.(12) s. 6501-6505

73. **Nordgård, Erland; Hanneseth, Ann-Mari Dahl; Sjøblom, Johan.**
Inhibition of Calcium Naphthenate. Experimental Methods to Study the Effect of Commercially Available Naphthenate Inhibitors. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(5) s. 668-675

74. **Nordgård, Erland; Sørland, Geir; Sjøblom, Johan.**
Behavior of Asphaltene Model Compounds at W/O Interfaces. *Langmuir* 2010 ;Volum 26.(4) s. 2352-2360

75. **Opedal, Mihaela Tanase; Stenius, Per Johan; Johansson, Lars; Hill, Jan; Sandberg, Christer.**
Mass balance of lipophilic extractives around impressafiner in mill and pilot scale. *Nordic Pulp & Paper Research Journal* 2010 ;Volum 25.(2) s. 162-169

76. **Opedal, Nils van der Tuuk; Sørland, Geir; Sjøblom, Johan.**
Emulsion Stability Studied by Nuclear Magnetic Resonance (NMR). *Energy & Fuels* 2010 ;Volum 24. s. 3628-3633

77. **Pamies, Ramon Francisco Porras; Volden, Sondre; Kjøniksen, Anna-Lena; Zhu, Kaizheng; Glomm, Wilhelm R; Nyström, Bo.**
Adsorption of Cationic Hydroxyethylcellulose Derivatives onto Planar and Curved Gold Surfaces. *Langmuir* 2010 ;Volum 26.(20) s. 15925-15932

78. **Pamies, Ramon Francisco Porras; Zhu, Kaizheng; Volden, Sondre; Kjøniksen, Anna-Lena; Karlsson, Göran; Glomm, Wilhelm; Nyström, Bo.**
Temperature-Induced Flocculation of Gold Particles with an Adsorbed Thermoresponsive Cationic Copolymer. *The Journal of Physical Chemistry C* 2010 ;Volum 114. s. 21960-21968

79. **Patruno, Luciano E; Marchetti, Jorge Mario; Dorao, Carlos Alberto; Svendsen, Hallvard Fjøsne; Jakobsen, Hugo Atle.**
Droplet size distribution after liquid entrainment in horizontal stratified two-phase three-field dispersed flow. *Chemical Engineering Science* 2010 ;Volum 65.(4) s. 1407-1414

80. **Patruno, Luciano Emanuel; Marchetti, Jorge Mario; Dorao, Carlos Alberto; Jakobsen, Hugo Atle; Svendsen, Hallvard Fjøsne; Tayebi, Davoud.** Scrubber Separation-Droplet Entrainment in High-Pressure Gas/Liquid Separation. *SPE Projects, Facilities & Construction* 2010 ;Volum 5.(4) s. 183-191

81. **Patruno, Luciano Emanuel; Ystad, Paul Andreas Marchioro; Jenssen, Carl Birger B.; Marchetti, Jorge Mario; Dorao, Carlos Alberto; Svendsen, Hallvard Fjøsne; Jakobsen, Hugo Atle.** Liquid entrainment-Droplet size distribution for a low surface tension mixture. *Chemical Engineering Science* 2010 ;Volum 65.(18) s. 5272-5284

82. **Patruno, Luciano Emanuel; Ystad, Paul Andreas Marchioro; Marchetti, Jorge Mario; Dorao, Carlos Alberto; Svendsen, Hallvard Fjøsne; Jakobsen, Hugo Atle.** Liquid entrainment from a wetted wire exposed to a high gas flow rate in cross flow. *Chemical Engineering Science* 2010 ;Volum 65. s. 6397-6406

83. **Paunonen, Sara Inkeri; Gregersen, Øyvind Weiby.** The Effect of Moisture Content on Compression Strength of Boxes Made of Solid Fiberboard with Polyethylene Coating—An Experimental Study. *Journal of Applied Packaging Research* 2010 ;Volum 4.(4) s. 221-240

84. **Paunonen, Sara Inkeri; Lenes, Marianne; Gregersen, Øyvind Weiby.** Modeled and measured bending stiffness of polyethylene coated solid fiberboard. *Nordic Pulp & Paper Research Journal* 2010 ;Volum 25.(3) s. 358-364

85. **Phan, Xuyen Kim; Bakhtiary, Hamidreza Davijany; Myrstad, Rune; Thormann, Janina; Pfeifer, Peter; Venvik, Hilde Johnsen; Holmen, Anders.** Preparation and Performance of a Catalyst-Coated Stacked Foil Microreactor for the Methanol Synthesis. *Industrial & Engineering Chemistry Research* 2010 ;Volum 49.(21) s. 10934-10941

86. **Preisig, Heinz A.** Constructing and maintaining proper process models. *Computers and Chemical Engineering* 2010 ;Volum 34. s. 1543-1555

87. **Qin, Feng; Wang, Shujuan; Hartono, Ardi; Svendsen, Hallvard Fjøsne; Chen, Changhe.** Kinetics of CO2 absorption in aqueous ammonia solution. *International Journal of Greenhouse Gas Control* 2010 ;Volum 4.(5) s. 729-738

88. **Qin, Feng; Wang, Shujuan; Kim, Inna; Svendsen, Hallvard Fjøsne; Chen, Changhe.** Study of the Heat of Absorption of CO2 in Aqueous Ammonia: Comparison between Experimental Data and Model Predictions. *Industrial & Engineering Chemistry Research* 2010 ;Volum 49.(8) s. 3776-3784

89. **Radde, Nicole; Bar, Nadav; Banaji, Murad.** Graphical Methods for analysing feedback in biological networks - A survey. *International Journal of Systems Science* 2010 ;Volum 41.(1) s. 35-46

90. **Ramachandran, Amutha; Tucho, Wakshum Mekonnen; Mejdell, Astrid Lervik; Stange, Marit; Venvik, Hilde Johnsen; Walmsley, John C; Holmestad, Randi; Bredesen, Rune; Borg, Anne.** Surface characterization of Pd/Ag23 wt% membranes after different thermal treatments. *Applied Surface Science* 2010 ;Volum 256.(20) s. 6121-6132

91. **Rane, Shreyas Pandurang; Borg, Øyvind; Yang, Jia; Rytter, Erling; Holmen, Anders.** Effect of alumina phases on hydrocarbon selectivity in Fischer-Tropsch synthesis. *Applied Catalysis A : General* 2010 ;Volum 388.(1-2) s. 160-167

92. **Rønning, Magnus; Tsakoumis, Nikolaos; Voronov, Alexey Sergeevich; Johnsen, Rune Esben; Norby, Poul; van Beek, Wouter; Borg, Øyvind; Rytter, Erling; Holmen, Anders.** Combined XRD and XANES studies of a Re-promoted Co/γ-Al2O3 catalyst at Fischer-Tropsch synthesis conditions. *Catalysis Today* 2010 ;Volum 155.(3-4) s. 289-295

93. **Samseth, Jon.** Bygg kjernekraft i Bergens-området. *Teknisk Ukeblad* 2010 (24) s. 6-7

94. **Sandru, Marius; Haukebø, Siv Hustad; Hägg, May-Britt.** Composite hollow fiber membranes for CO2 capture. *Journal of Membrane Science* 2010 ;Volum 346.(1-2) s. 172-186

95. **Sanz-Navarro, Carlos; Åstrand, Per-Olof; Chen, De; Rønning, Magnus; van Duin, Adri C. T.; Goddard III, William A..** Molecular dynamics simulations of metal clusters supported on fishbone carbon nanofibers. *The Journal of Physical Chemistry C* 2010 ;Volum 114.(8) s. 3522-3530

96. **Setekleiv, Alf Eddie; Helsør, Thomas; Svendsen, Hallvard Fjøsne.** Liquid holdup in wire-mesh pads. *Chemical engineering research & design* 2010 ;Volum 88. s. 1523-1531

97. **Shamsuzzoha, Mohammad; Skogestad, Sigurd.** The setpoint overshoot method: A simple and fast closed-loop approach for PID tuning. *Journal of Process Control* 2010 ;Volum 20.(10) s. 1220-1234

98. **Shamsuzzoha, Mohammad; Skogestad, Sigurd; Halvorsen, Ivar J.** On-Line PI Controller tuning Using Closed-Loop Setpoint Response. *Elsevier IFAC Publications / IFAC Proceedings series* 2010 s. 497-502

99. **Silset, Anne; Flåten, Geir Rune; Helness, Herman; Melin, Esa; Øye, Gisle; Sjøblom, Johan.** A Multivariate Analysis on the Influence of Indigenous Crude Oil Components on the Quality of Produced Water. Comparison Between Bench and Rig Scale Experiments. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(3) s. 392-408

100. **Silset, Anne; Hannisdal, A; Hemmingsen, PV; Sjøblom, Johan.** Emulsions of Heavy Crude Oils. II. Viscous Responses and Their Influence on Emulsion Stability Measurements. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(10) s. 1432-1445

101. **Simon, Sebastien Charles; Nenningsland, Andreas Lyng; Herschbach, E; Sjøblom, Johan.** Extraction of Basic Components from Petroleum Crude Oil. *Energy & Fuels* 2010 ;Volum 24. s. 1043-1050

102. **Simon, Sebastien Charles; Theiler, Stefan; Knudsen, Agnethe; Øye, Gisle; Sjøblom, Johan.** Rheological Properties of Particle-Stabilized Emulsions. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(5) s. 632-640

103. **Sivertsen, Heidi; Alstad, Vidar; Skogestad, Sigurd.** Medium-Scale Experiments on Stabilizing Riser-Slug Flow. *Chemical engineering research & design* 2010 ;Volum 88. s. 156-170

104. **Sivertsen, Heidi; Storkaas, Espen; Skogestad, Sigurd.** Small-scale experiments on stabilizing riser slug flow. *Chemical engineering research & design* 2010 ;Volum 88.(2A) s. 213-228

105. **Sjøblom, Johan; Øvrevoll, Bodhild; Jentoft, Gunn Heidi; Lesaint, Caterina; Palermo, Thierry; Sinquin, Anne; Gateau, Patrick; Barre, Loic; Subramanian, Siva; Boxall, John; Dieker, Laura E.; Greaves, David; Lachance, Jason; Rensing, Patrick; Miller, Kelly; Sloan, E. Dendy; Koh, Carolyn A..** Investigation of the Hydrate Plugging and Non-Plugging Properties of Oils. *Journal of Dispersion Science and Technology* 2010 ;Volum 31.(8) s. 1100-1119

106. **Sporleder, Federico; Dorao, Carlos Alberto; Jakobsen, Hugo Atle.** Simulation of chemical reactors using the least-squares spectral element method. *Chemical Engineering Science* 2010 ;Volum 65.(18) s. 5146-5159

107. **Sundman, Ola; Nordgård, Erland; Grimes, Brian Arthur; Sjøblom, Johan.** Potentiometric Titrations of Five Synthetic Tetraacids as Models for Indigenous C-80 Tetraacids. *Langmuir* 2010 ;Volum 26.(3) s. 1619-1629

108. **Sundman, Ola; Simon, Sebastien Charles; Nordgård, Erland; Sjøblom, Johan.** Study of the Aqueous Chemical Interactions between a Synthetic Tetra-acid and Divalent Cations as a Model for the Formation of Metal Naphthenate Deposits. *Energy & Fuels* 2010 ;Volum 24.(11) s. 6054-6060

109. **Svenum, Ingeborg-Helene; Borck, Øyvind; Walle, Lars Erik; Schulte, Karina; Borg, Anne.** Adsorption of CO on Ni3Al(111) investigated using high-resolution photoemission spectroscopy and density functional theory. *Physical Review B. Condensed Matter and Materials Physics* 2010 ;Volum 81. s. -

110. **Syverud, K; Xhanari, Klodian; Chinga-Carrasco, G; Yu, Yingda; Stenius, Per Johan.** Films made of cellulose nanofibrils: surface modification by adsorption of a cationic surfactant and characterization by computer-assisted electron microscopy. *Journal of nanoparticle research* 2010

111. **Tonetto, Gabriella M.; Marchetti, Jorge Mario.** Transesterification of Soybean Oil Over Me/Al2O3 (Me = Na, Ba, Ca, and K) Catalysts and Monolith K/Al2O3-Cordierite. *Topics in catalysis* 2010

112. **Trinh, Loan T. T.; Volden, Sondre; Kjøniksen, Anna-Lena; Zhu, Kaizheng; Knudsen, Kenneth D.; Glomm, Wilhelm; Nyström, Bo.** Temperature-induced adsorption and optical properties of an amphiphilic diblock copolymer adsorbed onto flat and curved silver surfaces. *Journal of Colloid and Interface Science* 2010 ;Volum 342.(1) s. 142-146

113. **Tsakoumis, Nikolaos; Rønning, Magnus; Borg, Øyvind; Rytter, Erling; Holmen, Anders.** Deactivation of cobalt based Fischer-Tropsch catalysts: A review. *Catalysis Today* 2010 ;Volum 154.(3-4) s. 162-182

114. **Volden, Sondre; Kjøniksen, Anna-Lena; Zhu, Kaizheng; Genzer, Jan; Nyström, Bo; Nyström, Bo; Glomm, Wilhelm.** Temperature-Dependent Optical Properties of Gold Nanoparticles Coated with a Charged Diblock Copolymer and an Uncharged Triblock Copolymer. *ACS Nano* 2010 ;Volum 4.(2) s. 1187-1201

115. **Wang, Yuefa; Chao, Zhongxi; Jakobsen, Hugo Atle.** A Sensitivity Study of the Two-Fluid Model Closure Parameters (β, e) Determining the Main Gas-Solid Flow Pattern Characteristics. *Industrial & Engineering Chemistry Research* 2010 ;Volum 49.(7) s. 3433-3441

116. **Wang, Yuefa; Chao, Zhongxi; Jakobsen, Hugo Atle.** CFD modelling of CO_2 capture in the SE-SMR process in the fluidized bed reactors. *Chemical Engineering Transactions* 2010 ;Volum 21. s. 601-606

117. **Wang, Yuefa; Chao, Zhongxi; Jakobsen, Hugo Atle.**
3D Simulation of bubbling fluidized bed reactors for sorption enhanced steam methane reforming processes. *Journal of Natural Gas Science and Engineering* 2010 ;Volum 2. s. 105-113

118. **Xie, Minli; Olderøy, Magnus Østgård; Andreassen, Jens-Petter; Selbach, Sverre Magnus; Strand, Berit Løkensgard; Sikorski, Pawel.**
Alginate-controlled formation of nanoscale calcium carbonate and hydroxyapatite mineral phase within hydrogel networks. *Acta Biomaterialia* 2010 ;Volum 6.(9) s. 3665-3675

119. **Yang, Jia; Tveten, EZ; Chen, De; Holmen, Anders.**
Understanding the Effect of Cobalt Particle Size on Fischer-Tropsch Synthesis: Surface Species and Mechanistic Studies by SSITKA and Kinetic Isotope Effect. *Langmuir* 2010 ;Volum 26.(21) s. 16558-16567

120. **Yang, ML; Zhu, YA; Fan, C; Sui, ZJ; Chen, De; Zhou, XG.**
Density functional study of the chemisorption of C-1, C-2 and C-3 intermediates in propane dissociation on Pt(111). *Journal of Molecular Catalysis A: Chemical* 2010 ;Volum 321.(1-2) s. 42-49

121. **Yasuda, Masahiro; Goda, Takashi; Ogino, Hiroyasu; Glomm, Wilhelm; Takayanagi, Hiroaki.**
Preparation of uniform monomer droplets using packed column and continuous polymerization in tube reactor. *Journal of Colloid and Interface Science* 2010 ;Volum 349.(1) s. 392-401

JOURNALS

Johan Sjöblom, Editor-in-Chief:
Journal of Dispersion Science and Technology, Volume 28. New York: Taylor & Francis Books 2010. 8 issues in 2010

BOOKS

1. **Helle, Torbjørn.**
Papir - Det menneskevennlige materialet. Trondheim: Vitensenteret 2010 (ISBN 978-82-92088-43-2) 78 s.

122. **Yasuda, Masahiro; Kunieda, Hiroshi; Fujiwara, Maya; Takenaka, Hiroki; Glomm, Wilhelm; Ogino, Hiroyasu; Ishikawa, Haruo.**
Kinetics of the Polymerizable Azo Initiator 2,2'-Azobis[N-(2-propenyl)-2-methylpropionamide] and Its Application to Graft Copolymerization. *Journal of Applied Polymer Science* 2010 ;Volum 118.(4) s. 2425-2433

123. **Yasuda, Masahiro; Okamoto, Masayuki; Sugimoto, Kaori; Glomm, Wilhelm; Iwane, Kazuyoshi; Ogino, Hiroyasu; Ishimi, Kosaku; Ishikawa, Haruo.**
Kinetics of Solution Polymerization and Seed Polymerization of 2-p-(1,1,3,3-Tetramethyl-Butyl) Phenoxy-Polyethoxy] Ethyl Methacrylate Macromonomers. *Journal of chemical engineering of Japan* 2010 ;Volum 9. s. 767-776

124. **Yelchuru, Ramprasad; Skogestad, Sigurd; Manum, Henrik.**
MIQP formulation for Controlled Variable Selection in Self Optimizing Control. *Elsevier IFAC Publications / IFAC Proceedings series* 2010 s. 61-66

125. **Zhu, Yi-An; Chen, De; Zhou, Xing-Gui; Åstrand, Per Olof; Yuan, Wei-Kang.**
First-principles calculations of C diffusion through the surface and subsurface of Ag/Ni(1 0 0) and reconstructed Ag/Ni(1 0 0). *Surface Science* 2010 ;Volum 604.(2) s. 186-195

126. **Zhu, Zhengjie; Dorao, Carlos Alberto; Jakobsen, Hugo Atle.**
Mass Conservative Solution of the Population Balance Equation Using the Least-Squares Spectral Element Method. *Industrial & Engineering Chemistry Research* 2010 ;Volum 49.(13) s. 6204-6214

CHAPTERS IN BOOKS

1. **Aronu, Ugochukwu Edwin; Svendsen, Hallvard Fjøsne; Hoff, Karl Anders.**
CO_2 capture solvent selection by combined absorption-desorption analysis. I: *Conference proceedings Distillation Absorption 2010*. Eindhoven, The Netherlands: Eindhoven University of Technology 2010 ISBN 978-90-386-2215-6. s. 151-156

2. **Aronu, Ugochukwu Edwin; Svendsen, Hallvard Fjøsne; Hoff, Karl Anders; Knuutila, Hanna.**
Pilot plant study of 3-(methylamino) propylamine for post conbusiton CO_2 capture. I: *Proceedings of the 2nd Annual Gas Processing Symposium*. Elsevier 2010 ISBN 978-0-444-53588-7. s. 339-348

3. **Beck, Ralf; Andreassen, Jens-Petter.**
The influence of crystallization conditions on the growth of polycrystalline particles of L-glutamic acid, an aromatic amine derivative and calcium carbonate. I: *17th International Workshop on Industial Crystallization (BIWIC 2010)*. Halle-Wittenberg: Martin Luther-University Halle-Wittenberg 2010 ISBN 978-3-86955-428-0. s. 166-174

4. **Dejanović, Igor; Matijašević, Ljubica; Olujić, Žarko; Halvorsen, Ivar J.; Skogestad, Sigurd; Jansen, Helmut; Kaibel, Björn.**
Conceptual Design and Comparison of Four-Products Dividing Wall Columns for Separation of a Multicomponent Aromatics Mixture. I: *Conference proceedings Distillation Absorption 2010*. Eindhoven, The Netherlands: Eindhoven University of Technology 2010 ISBN 978-90-386-2215-6. s. 85-90

5. **Ghadrdan, Maryam; Halvorsen, Ivar J.; Skogestad, Sigurd.**
Optiomal operation of thermally-coupled Kaibel distillation columns. I: *Conference proceedings Distillation Absorption 2010*. Eindhoven, The Netherlands: Eindhoven University of Technology 2010 ISBN 978-90-386-2215-6. s. 563-568

6. **Halvorsen, Ivar J.; Dejanović, Igor; Matijašević, Ljubica; Olujić, Žarko; Skogestad, Sigurd.**
Establishing internal configuration of dividing wall column for separation of a multicoponent aromatics mixture. I: *Conference proceedings Distillation Absorption 2010*. Eindhoven, The Netherlands: Eindhoven University of Technology 2010 ISBN 978-90-386-2215-6. s. 91-96

7. **Jagtap, Rahul; Kaistha, Nitin; Skogestad, Sigurd.**
Plantwide Control for Economic Operaton of a Recycle Process. I: *20th European Symposium on Computer Aided Engineering - ESCAPE 20*. : ESCAPE 20 2010 ISBN 978-0-444-53569-6. s. 499-504

8. **Karimi, Mehdi; Hillestad, Magne; Svendsen, Hallvard Fjøsne.**
Capital costs and energy considerations of different alternative stripper configurations for post-combustion CO_2 capture. I: *Conference proceedings Distillation Absorption 2010*. Eindhoven, The Netherlands: Eindhoven University of Technology 2010 ISBN 978-90-386-2215-6. s. 193-198

9. **Panahi, Mehdi; Karimi, Mehdi; Skogestad, Sigurd; Hillestad, Magne; Svendsen, Hallvard Fjøsne.**
Self-Optimizing and Control Structure Design for a CO_2 Capturing Plant. I: *Proceedings of the 2nd Annual Gas Processing Symposium*. Elsevier 2010 ISBN 978-0-444-53588-7. s. 331-338

10. **Panahi, Mehdi; Karimi, Mehdi; Skogestad, Sigurd; Hillestad, Magne; Svendsen, Hallvard Fjøsne.**
Self-Optimizing and Control Stucture Design for a CO_2 Capturing Plant. I: *Proceedings of the 2nd Annual Gas Processing Symposium*. Elsevier 2010 ISBN 978-0-444-53588-7. s. 331-338

11. **Panahi, Mehdi; Skogestad, Sigurd; Yelchuru, Ramprasad.**
Steady State Simulation for Optimal Design and Operation of a GTL Process. I: *Proceedings of the 2nd Annual Gas Processing Symposium*. Elsevier 2010 ISBN 978-0-444-53588-7. s. 275-284

12. **Preisig, Heinz A.**
Parameter Estimation using Multi-Wavelets. I: *20th European Symposium on Computer Aided Engineering - ESCAPE 20*. : ESCAPE 20 2010 ISBN 978-0-444-53569-6. s. 367-372

13. **Shamsuzzoha, Mohammad; Skogestad, Sigurd; Halvorsen, Ivar J..**
A simple approach for on-line PI controller tuning using closed-loop setpont responses. I: *20th European Symposium on Computer Aided Engineering - ESCAPE 20*. : ESCAPE 20 2010 ISBN 978-0-444-53569-6. s. 619-624

14. **Strandberg, Jens; Skogestad, Sigurd; Halvorsen, Ivar J..**
Practical control of dividing-wall columns. I: *Conference proceedings Distillation Absorption 2010*. Eindhoven, The Netherlands: Eindhoven University of Technology 2010 ISBN 978-90-386-2215-6. s. 527-532

CONFERENCE CONTRIBUTIONS

1. **Ahmad, Jamil; Hägg, May-Britt.**
Development of nanocomposite membranes for gas separation. Membrane Activities in MEMFO; 2010-10-19

2. **Ahmad, Jamil; Hägg, May-Britt.**
Development of nanocomposite/Mixed Matrix membrane material for gas separation. CLIMIT PhD seminar; 2010-11-01 - 2010-11-02

3. **Alsvik, Inger Lise.**
Saltkraft - Ren energi for fremtiden. Forsker Grand Prix; 2010-11-10

4. **Alsvik, Inger Lise; Nilsen, Tom-Nils; Hägg, May-Britt.**
Thin film composite polyamide membranes for osmotic processes. Membranes in Drinking and Industrial Water Treatment; 2010-06-27 - 2010-06-30

5. **Alsvik, Inger Lise; Nilsen, Tom-Nils; Hägg, May-Britt.**
Thin film composite (TFC) polyamide membranes on a hydrophilic cellulose acetate (CA) support for pressure retarded osmosis (PRO). North American Membrane Society Conference (NAMS); 2010-07-17 - 2010-07-22

6. **Aronu, Ugochukwu Edwin.**
The BIGCO2 Project CO_2 equilibrium in amino acid based solvents. CLIMIT PhD seminar; 2010-11-01 - 2010-11-02

7. **Aronu, Ugochukwu Edwin; Hessen, Erik Troøien; Haug-Warberg, Tore; Hoff, Karl Anders; Svendsen, Hallvard Fjøsne.**
Equilibrium absorption of carbon dioxide by amino acid salt and amine amino acid salt solutions. the 10th International Conference on Greenhouse Gas Control Technologies (GHGT-10); 2010-09-19 - 2010-09-23

8. **Aronu, Ugochukwu Edwin; Svendsen, Hallvard Fjøsne; Hoff, Karl Anders.**
CO_2 capture solvent selection by combined absorption-desorption analysis. Distillation & Absorption (DA); 2010-09-12 - 2010-09-15

9. **Aronu, Ugochukwu Edwin; Svendsen, Hallvard Fjøsne; Hoff, Karl Anders.**
Vapour pressure and activity coefficient determination for amine amino acid salt solution. Innovation for Sustainable Production (i-SUP 2010); 2010-04-18 - 2010-04-21

10. **Aronu, Ugochukwu Edwin; Svendsen, Hallvard Fjøsne; Hoff, Karl Anders; Knuutila, Hanna.**
Pilot Plant Study of 3-(methylamino) propylamine/sarcosine for post-combustion CO_2 capture. 2nd Annual Gas Processing Symposium; 2010-01-11 - 2010-01-14

11. **Bakhtiary, Hamidreza Davijany; Hayer, Fatemeh; Phan, Xuyen Kim; Myrstad, Rune; Pfeifer, Peter; Venvik, Hilde Johnsen; Holmen, Anders.**
Performance of a microstructured packed bed raactor in the synthesis of methanol. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

12. **Bakhtiary, Hamidreza Davijany; Hayer, Fatemeh; Phan, Xuyen Kim; Myrstad, Rune; Venvik, Hilde Johnsen; Pfeifer, Peter; Holmen, Anders.**
Reactor characteristics of an Integrated Micro Packed Reactor-Heat Excanger for methanol synthesis. 11th International Conference on Microreaction Technology (IMRET 11); 2010-03-08 - 2010-03-10

13. **Bakke, Morten; Johansen, Tor Arne; Skogestad, Sigurd.**
Effect of Varying Controller Parameters in Closed-Loop Subspace Identification. IFAC DYCOPS; 2010-07-05 - 2010-07-07

14. **Bar, Nadav.**
Aquaculture Nutrition research. Hebrew University, Rehovot; 2010-05-22 - 2010-05-23

15. **Bar, Nadav.**
Dynamic Modelling of Fish Growth. HAKI; 2010-06-24 - 2010-06-25

16. **Bar, Nadav.**
Introduction to System Biology. CSIC; 2010-01-21

17. **Bar, Nadav.**
Modelling approach to aquaculture research. Guelph University; 2010-09-06 - 2010-09-12

18. **Bar, Nadav.**
Multiscale dynamic model of fish growth. SIAMB; 2010-05-24 - 2010-05-25

19. **Bar, Nadav.**
Prediction of body composition in Aquaculture. Seminar University of Beograd; 2010-07-06

20. **Beck, Ralf; Andreassen, Jens-Petter.**
Pressure Filtration of three Industrially Important Substances and its Dependency on Crystallization Conditions, Size and Morphology. The 13th Nordic Filtration Symposium; 2010-06-10 - 2010-06-11

21. **Bitter, Johannes H.; den Breejen, Johan P.; Bezemer, G. Leendert; Macedo, A. L.; Mattos, L. V.; Noronha, F. B.; Radstake, Paul Bernard; Frøseth, Vidar; Holmen, Anders; de Jong, Krijn.**
Reaction dependent particle size effects in carbon supported cobalt catalysts. Carbon 2010 - From Nano to Macro; 2010-07-11 - 2010-07-16

22. **Blekkan, Edd Anders.**
Biodrivstoff. Løsning eller problem ?. Heimdal Rotary; 2010-02-15

23. **Blekkan, Edd Anders.**
Recent developments in the Fischer-Tropsch synthesis over supported cobalt catalysts. 9th Novel Gas Conversion Symposium; 2010-05-30 - 2010-06-04

24. **Borck, Øyvind; Svenum, Ingeborg-Helene; Walle, Lars Erik; Schulte, Karina; Borg, Anne.**
Adsorption of CO on Ni3Al(111): A combined theoretical and experimental study. CCP 2010, Conference on Computational Physics; 2010-06-23 - 2010-06-26

25. **Borg, Øyvind; Hammer, Nina; Enger, Bjørn Christian; Eri, Sigrid; Hulsund Skagseth, T.; Rytter, Erling.**
Effect of biomass derived synthesis gas impurities on TOF and hydrocarbon selectivity in cobalt Fischer-Trospch synthesis. 14th Nordic Symposium on catalysis; 2010-08-29 - 2010-08-30

26. **Borg, Øyvind; Yu, Zhixin; Rane, Shreyas Pandurang; Chen, De; Rytter, Erling; Holmen, Anders.**
Fischer-Tropsch Synthesis on Co Catalysts Supported on Caron Nanofibers. CarboCat IV - 4th International Symposium on Carbon for Catalysis; 2010-11-07 - 2010-11-10

27. **Chao, Zhongxi; Wang, Yuefa; Jakobsen, Jana P.; Fernandino, Maria; Jakobsen, Hugo Atle.**
A binary kinetic theory of granular flow model for fluidized bed. 7th International Conference on Multiphase Flow (ICMF 2010); 2010-05-30 - 2010-06-04

28. **Chen, De.**
Catalysis on surface edge-mediated nanoparticals supported on carbon nanofibers. The 3rd International Symposium on New Catalytic Materials; 2010-08-14 - 2010-08-19

29. **Chen, De.**
Properties and catalytic consequences of surface edge-mediated nanoparticals supported on carbon nanofibers. XIth Netherlands Catalysis and Chemistry Conference; 2010-03-01 - 2010-03-03

30. **Chen, De; Lødeng, Rune; Svendsen, Hallvard Fjøsne; Holmen, Anders.**
Hierarchical multiscale modeling of methane steam reforming reactions. International-Mexican Congress on Chemical Reaction Engineering (IMCCRE 2010); 2010-06-06 - 2010-06-10

31. **Ciftja, Arlinda Fejzo; Hartono, Ardi; Silva, Eirik Falck da; Svendsen, Hallvard Fjøsne.**
Study on Carbamate Stability in the AMP/CO_2/H_2O System from 13C-NMR Spectroscopy. GHGT10; 2010-09-19 - 2010-09-23

32. **Dam, Anh Hoang; Wang, Hongmin; Holmen, Anders; Chen, De.**
Steam methane reforming and carbon formation on Ni surface alloying. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

33. **Dehghan-Niri, Roya; Hansen, Thomas W.; Wagner, Jakob Birkedal; Holmen, Anders; Rytter, Erling; Borg, Øyvind; Holmestad, Randi; Walmsley, John.**
Using environmental transmission electron microscope to study the in-situ reduction of Co_3O4 supported on α-Al_2O_3. 17th International Microscopy Congress - IMC 2010; 2010-09-19 - 2010-09-24

34. **Dehghan-Niri, Roya; Hansen, Thomas Willum; Wagner, Jakob Birkedal; Holmen, Anders; Rytter, Erling; Borg, Øyvind; Walmsley, John C.**
In-situ reduction of cobalt oxide supported on alumina in an environmental transmission electron microscope. Sixth Tokyo Conference on Advanced Catalytic Science and Technology & Fifth Asia Paciific Congress on Catalysis (TOCAT6/APCAT5) "Innovation driven by catalysis"; 2010-07-18 - 2010-07-23

35. **Deng, Liyuan.**
Membranes for high pressure natural gas. Memfo seminar; 2010-10-19

36. **Eide-Haugmo, Ingvild; Lepaumier, Helene Marie; Einbu, Aslak; Vernstad, Kai; Silva, Eirik Falck da; Svendsen, Hallvard Fjøsne.**
Chemical stability and biodegradability of new solvents for CO_2 capture. GHGT-10 (10th International Conference on Greenhous Gas Control Technologies); 2010-09-19 - 2010-09-23

37. **Eide-Haugmo, Ingvild; Lepaumier, Helene Marie; Einbu, Aslak; Vernstad, Kai; Silva, Eirik Falck da; Svendsen, Hallvard Fjøsne.**
Screening model for the thermal degradation of solvents used for CO_2 -capture. The 2010 International Chemical Congress of Pacific Basin Societies (Pacifichem); 2010-12-15 - 2010-12-20

38. **Eiras, Sara Boullosa; Zhao, Tiejun; Vanhaecke, Estelle Marie M.; Chen, De; Holmen, Anders.**
CeO_2-ZrO_2-mixed oxide nanocommposites supported Rh: a promising catalyst for partial oxidation of methane to syngas. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

39. **Enger, Bjørn Christian; Lødeng, Rune; Holmen, Anders.**
UBI-QEP evaluation of Ni(100) and Ni(111) sites for syngas formation. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

40. **Gorelkin, Ilya; Blekkan, Edd Anders.**
Concepts and models of the catalytic dehydrogenation of propane. 12th Norwegian Catalysis Symposium; 2010-11-29 - 2010-11-30

41. **Gregersen, Øyvind Weiby.**
Fremtidens papirproduksjon i Norge, basert på skandinavisk råvare. Fremtidens produkter og produksjonsprosesser for norsk treforedlingsindustri; 2010-05-31

42. **Gupta, Mayuri.**
Computational study of pKa and carbamate stability constant values for amines important in post combustion CO_2 capture prosess. NKS Annual meeting in Computational Chemistry; 2010-11-22

43. **Gupta, Mayuri; Silva, Eirik Falck da; Svendsen, Hallvard Fjøsne.**
Study of Polyamines for Removal of Carbon Dioxide from Flue Gases. 60th Canadian Chemical Engineering Conference; 2010-10-24 - 2010-10-27

44. **Gupta, Mayuri; Silva, Eirik Falck da; Svendsen, Hallvard Fjøsne.**
Temperature Sensitivity of Piperazine and its Derivatives using Polarizable Continuum Solvation Model. 2010 2nd International Conference on Chemical, Biological and Environmental Engineering (ICBEE 2010); 2010-11-02 - 2010-11-04

45. **Hägg, May-Britt.**
Babijinoisutt nenbraber fir CO_2 separasjon. CLIMIT-dagene; 2010-10-12

46. **Hägg, May-Britt.**
Polymeric Membranes for CO_2 capture challenges on durability and process considerations. The Gordon Research Conference; 2010-07-11 - 2010-07-16

47. **Hägg, May-Britt; Deng, Liyuan; Kim, Taek Joong.**
Challenges related to optimized membrane modules for natural gas sweetening. GPA Conference; 2010-02-01 - 2010-02-03

48. **Hammer, Nina; Zscherpe, Tina; Chen, De; Rønning, Magnus.**
Selective oxidation of CO on Au-T_iO_2 catalysts on a structured carbon support. 239th National Meeting of the American Chemical Society. Division Fuel Chem; 2010-03-21 - 2010-03-25

49. **Hartono, Ardi; Aronu, Ugochukwu Edwin; Svendsen, Hallvard Fjøsne.**
Liquid Speciation Study in Amine Amino Acid Salts for CO_2 Absorbent with 13C-NMR. GHGT-10 (10th International Conference on Greenhous Gas Control Technologies); 2010-09-19 - 2010-09-23

50. **Hayer, Fatemeh; Bakhtiary, Hamidreza Davijany; Myrstad, Rune; Pfeifer, Peter; Holmen, Anders; Venvik, Hilde Johnsen.**
Synthesis of Dimethyl Ether from Syngas in a Fixed Bed Reactor - Simulation and Experimental study. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

51. **He, Li; Chen, De.**
Coupling CO_2 Capture in Catalytic reactions for the Conversion of Biomass to H2. The 9th edition of the Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

52. **He, Li; Chen, De.**
Highly efficient hydrogen production from biomass. 239th National Meeting of the American Chemical Society; 2010-03-21 - 2010-03-25

53. **He, Li; Zhao, Tiejun; Kazi, Saima Sultana; Rønning, Magnus; Chen, De.**
Progresses in carbonate looping process. 239th National Meeting of the American Chemical Society; 2010-03-21 - 2010-03-25

54. **He, Xuezhong; Hägg, May-Britt.**
Hollow Fiber Carbon Molecular Sieve Membranes for Gas Separation. NanoGloWa project meeting; 2010-11-15 - 2010-11-17

55. **He, Xuezhong; Hägg, May-Britt.**
Hollow Fibre Carbon Membranes: Investigations for CO_2 Capture. NAMS 2010; 2010-07-17 - 2010-07-22

56. **Helle, Torbjørn.**
Papir - trykking - tusenrets viktigste oppfinnelse. Gløshaugen Akademiske Klubb (GAK); 2010-10-28

57. **Helle, Torbjørn.**
Papir som informasjonsbærer gjennom tidene. Seminar; 2010-10-06

58. **Helle, Torbjørn.**
Uka - et tidsmål skapt av guder og mennesker. Gløshaugen Akademiske Klubb (GAK); 2010-05-20

59. **Holmen, Anders.**
Fischer-Tropsch synthesis. Jubileum ved Åbo Akademi; 2010-06-18

60. **Holmen, Anders.**
Supported Cobalt Catalysts for Fischer-Tropsch Synthesis. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

61. **Huang, Fan; Vanhaecke, Estelle Marie M.; Chen, De.**
Composite of Conducting Polymers and Aligned CNT for Energy Storage. 1st International Conference on Materials for Energy; 2010-07-04 - 2010-07-08

62. **Huang, Fan; Vanhaecke, Estelle Marie M.; Chen, De.**
Composites of Conducting Polymers and Carbon Nanostructures for Energy Storage. 1st International conference on materials for energy 2010; 2010-07-04 - 2010-07-08

63. **Huang, Fan; Vanhaecke, Estelle Marie M.; Chen, De.**
Composites of Conducting Polymers (Metal Oxides) and Carbon Nanostructures for Energy Storage. 5th Nanolab user meeting 2010; 2010-09-10

64. **Huang, Fan; Vanhaecke, Estelle Marie M.; Surma, Miroslav; Chen, De.**
Composite of conducting polymers semiconducting oxides and alignet CNT for energy storage. 14th Nordic symposium 2010; 2010-08-29 - 2010-08-31

65. **Karimi, Mehdi; Hillestad, Magne; Svendsen, Hallvard Fjøsne.**
Investigation of intercooling effect in CO_2 capture energy consumption. GHGT-10 (10th International Conference on Greenhous Gas Control Technologies); 2010-09-19 - 2010-09-23

66. **Kazi, Saima Sultana; He, Li; Zhao, Tiejun; Fagerbekk, Siri Albertsen; Lind, Anna Maria; Rønning, Magnus; Chen, De.**
New Calcium-based mixed oxide sorbents for CO_2 capture in sorption enhanced steam methane reforming. 9th Novel Gas Conversion Symposium; 2010-05-30 - 2010-06-03

67. **Kim, Taek Joong; Uddin, Mohammad Washim; Sandru, Marius; Hägg, May-Britt.**
The effect of contaminants on the composite membranes for CO_2 separation and challenges in up-scaling of the membranes. The Greenhouse Gas Control Technologies conference (GHGT); 2010-09-19 - 2010-09-23

68. **Kvamsdal, Hanne M.; Chikukwa, Actor; Hillestad, Magne; Zakeri, Ali; Einbu, Aslak.**
A comparison of different parameter correlation models and the validation of an MEA-based absorber model. The Greenhouse Gas Control Technologies (GHGT-10) conference; 2010-09-19 - 2010-09-23

69. **Kvamsdal, Hanne M.; Haugen, Geir; Svendsen, Hallvard Fjøsne; Tobiesen, Andrew Finn; Mangalapally, Hari; Hartono, Ardi; Mejdell, Thor.**
Modelling and simulation of the Esbjerg pilot plant using the Cesar 1 solvent. GHGT-10 (10th International Conference on Greenhous Gas Control Technologies); 2010-09-19 - 2010-09-23

70. **Kvande, Ingvar; Briskeby, S. T.; Hammer, Nina; Rønning, Magnus; Walmsley, John; Sunde, Svein; Chen, De.**
Direct evidence of strong interaction between PTO nanoparticles and carbon nanofibres. 14th Nordic Symposium on catalysis; 2010-08-29 - 2010-08-31

71. **Lögdberg, Sara; Lualdi, Matteo; Di Carlo, Gabriella; Järås, Sven; Boutonnet, Magali; Walmsley, John C; Blekkan, Edd Anders; Rytter, Erling; Holmen, Anders.**
On the selectivity of Cobalt-based Fischer-Tropsch catalysts. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

72. **Marchetti, Jorge Mario.**
Kinetic study of the esterification of free fatty acid and ethanol. Renewable Energy Research Conference 2010; 2010-06-07 - 2010-06-08

73. **Marchetti, Jorge Mario; Skjetne, Paal; Svendsen, Hallvard Fjøsne.**
Study of the Droplet-Wire System by using a VOF Technique. Fifth European Conference on Computational Fluid Dynamics (ECCOMAS CFD 2010); 2010-06-14 - 2010-06-17

74. **Mejdell, Thor; Vassbotn, Terje; Juliussen, Olav; Tobiesen, Finn Andrew; Einbu, Aslak; Knuutila, Hanna; Hoff, Karl Anders; Andersson, Vibeke; Svendsen, Hallvard Fjøsne.**
Novel full height pilot plant for solvent development and model validation. GHGT-10 (10th International Conference on Greenhous Gas Control Technologies); 2010-09-19 - 2010-09-23

75. **Mihai, Oana; Chen, De; Holmen, Anders.**
Catalytic consequence of lattice oxygen of lanthanum ferrite perovskite in chemical looping reforming of methane. International Mexican Congress on Chemical Reaction Wngineering (IMCCRE 2010); 2010-06-06 - 2010-06-10

76. **Mihai, Oana; Chen, De; Holmen, Anders.**
Experimental investigation of lanthanum ferrite perovskite catalyst using tartaric acid as complexing agent on the methane partial oxidation to syngas. International-Mexican Congress on Chemical Reaction Engineering (IMCCRE 2010); 2010-06-06 - 2010-06-10

77. **Mihai, Oana; Chen, De; Holmen, Anders.**
Methane partial oxidation by oxygen lattice of La FeO_3 perovskite catalysts. Gordon Research Conferences-Catalysis; 2010-06-27 - 2010-07-02

78. **Mihai, Oana; Chen, De; Holmen, Anders.**
The effect of crystal size of perovskites on methane partial oxidation. 9th Novel Gas Conversion Sympoosium (NGCS 9); 2010-05-30 - 2010-06-03

79. **Muthuswamy, Navaneethan; Gomez de la Fuente, Jose L.; Tsypkin, Mikhail; Zhao, Tiejun; Rønning, Magnus; Seland, Frode; Sunde, Svein; Chen, De.**
Platelet carbon nanofibers supported Pt nanoparticles for fuel cell application. 4th International symposium on carbon for catalysis; 2010-11-07 - 2010-11-10

80. **Nayak, Ameeya Kumar; Borka, Zsolt; Patruno, Luciano Emanuel; Sporleder, Federico; Dorao, Carlos Alberto; Jakobsen, Hugo Atle.**
A Combined Multifluid-Population Balance Model for Vertical Gas-Liquid Bubble Driven Flows. 4th International Conference on Population Balance (PBM2010); 2010-09-15 - 2010-09-17

81. **Noor, Tayyaba; Lind, Anna Maria; Holmen, Anders; Chen, De.**
Synthesis and characterization of Ni Hydrotalcite Catalyst for Hydrogen Production from Steam Methane Reforming. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

82. **Olderøy, Magnus Østgård; Xie, Minli; Strand, Berit Løkensgard; Draget, Kurt Ingar; Andreassen, Jens-Petter; Sikorski, Pawel.**
Powerful Polymorph Selection in the Calcium Carbonate System by Well Defined Alginate Oligomers. Gordon Research Conference: Biomineralization; 2010-08-15 - 2010-08-20

83. **Olderøy, Magnus Østgård; Xie, Minli; Strand, Berit Løkensgard; Draget, Kurt Ingar; Sikorski, Pawel; Andreassen, Jens-Petter.**
Control of calcium carbonate polymorphism and morphology by high molecular weight alginate and well defined alginate oligomers. International Workshop on Industrial Crystallization (BIWIC); 2010-09-08 - 2010-09-10

84. **Olderøy, Magnus Østgård; Xie, Minli; Østnæs, Simen; Strand, Berit Løkensgard; Draget, Kurt Ingar; Andreassen, Jens-Petter; Sikorski, Pawel.**
Control of calcium carbonate crystal polymorphism and morphology by high molecular weight alginate and well defined alginate oligomers. Biophysics meeting, Kongsvold 2010; 2010-03-03 - 2010-03-05

85. **Opedal, Mihaela Tanase.**
Fra kostnad til fremtidig ressurs: Fjerning av ekstaktiver fra prosessvann. Fremtidens produkter og produksjonsprosesser for norsk treforedlingsindustri; 2010-08-31

86. **Opedal, Mihaela Tanase; Stenius, Per Johan; Gregersen, Øyvind Weiby; Johansson, Lars; Hill, Jan.**
Removal of extractives from TMP process water using dissolved air flotation. 7th International Seminar on Fundamental Mechanical Pulp Research (IFMPRS 2010); 2010-06-21 - 2010-06-23

87. **Panahi, Mehdi; Skogestad, Sigurd.**
Comparison of Decentralized Controller and MPC in Control Structure of a CO_2 Capturing Process. 16th Nordic Process Control Workshop; 2010-08-19 - 2010-08-21

88. **Panditha Vidana, Daham S G; Venvik, Hilde Johnsen.**
New approach to metal dusting corroston. inGAP seminar; 2010-06-15 - 2010-06-16

89. **Panditha Vidana, Daham S G; Walsmley, John; Venvik, Hilde Johnsen.**
Experimental study of Ni based alloys in high carburising environment. Norwegian Catalysis Symposium 2010 and Annual Meeting for the KOSKII program of the Norwegian Research Council; 2010-11-29 - 2010-11-30

90. **Phan, Xuyen Kim; Bakhtiary, Hamidreza Davijany; Myrstad, Rune; Venvik, Hilde Johnsen; Thormann, Janina; Pfeifer, Peter; Holmen, Anders.**
Preparation and performance of Cu-based monoliths for metanol synthesis. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

91. **Preisig, Heinz A.**
Modelling the internal resonance effect in counter-current processes. 2010 AIChE Annual Meeting; 2010-03-13 - 2010-03-17

92. **Preisig, Heinz A.**
Simultenuous state reconstruction and parameter identification using wavelets. 2010 AIChE Annual Meeting; 2010-03-13 - 2010-03-17

93. **Preisig, Heinz A.; Haug-Warberg, Tore.**
Four levels of modelling. 2010 AIChE Annual Meeting; 2010-03-13 - 2010-03-17

94. **Puschke, Jennifer; Preisig, Heinz A.**
Dynamic Characteristics of Counter-Current Flow Processes. NPCW 2010; 2010-11-01 - 2010-11-05

95. **Rane, Shreyas Pandurang; Borg, Øyvind; Rytter, Erling; Holmen, Anders.**
Effect of cobalt particle size on Fischer-Tropsch hydrocarbon selectivities for θ-alumina as support. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

96. **Reinoso, D. M.; Tonetto, Gabriela M.; Marchetti, Jorge Mario.**
A novel monolithic catalyst for the transesterification of vegetable oils to produce biodiesel. Renewable Energy Research Conference 2010; 2010-06-07 - 2010-06-08

97. **Rodionova, Galina.**
Surface modificatio of Microfibrillated Cellulose films by Gas-Phase Esterificaton: Improvement of Barrier Properties. International Conference on Nanotechnology for the Forest Products Industry (2010 TAPPI); 2010-09-27 - 2010-09-29

98. **Rusu, Marius; Gregersen, Øyvind Weiby; Yamakawa, Asuka.**
Relation between fibre flexibility and cross-sectional properties. 7th International Seminar on Fundamental Mechanical Pulp Research (IFMPRS 2010); 2010-06-21 - 2010-06-23

99. **Rønning, Magnus.**
Cobalt catalysts in Fischer-Tropsch synthesis. Metal Kokkola 2010; 2010-11-16 - 2010-11-17

100. **Rønning, Magnus.**
Studies of Fischer-Tropsch catalysts at real working conditions. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

101. **Rønning, Magnus; Tsakoumis, Nikolaos; Voronov, Alexey Sergeevich; Borg, Øyvind; Rytter, Erling; Holmen, Anders.**
Combined XRD and XANES studies of Co-Re/γ-Al_2O_3 catalyst at Fischer-Tropsch synthesis conditions. 239th American Chemical Society National Meeting & Exposition; 2010-03-21 - 2010-03-25

102. **Sad, Maria Eugenia; Iglesia, Enrique; Chen, De.**
Catalytic pathways for deoxygenation and carbon-carbon formation on supported metal clusters. 239th National Meeting of the American Chemical Society; 2010-03-21 - 2010-03-25

103. **Saiersten, Marion; Brendsdal, Egil; Deshmukh, Salim Abdul R K.; Dugstad, Arne; Endrestøl, Guttorm; Ek, Arild; Watterud, Geir; Andreassen, Jens-Petter.**
Development of a simulator for ethylene glycol loops based on solution thermodynamics and particle formation kinetics. NACE Corrosion 2010; 2010-03-14 - 2010-03-18

104. **Salmimies, Riina; Häkkinen, Antti; Kallas, Juha; Ekberg, Bjarne; Andreassen, Jens-Petter; Beck, Ralf.**
Characterization of filter media used in the dewatering of iron ore. 13th Nordic Filtration Symposium; 2010-06-10 - 2010-06-11

105. **Sandru, Marius; Helberg, Ragne M. L.; Hägg, May-Britt.**
Development of hollow fiber membranes. Statoil-Memfo seminar; 2010-10-19

106. **Sandru, Marius; Helberg, Ragne M. L.; Hägg, May-Britt.**
Polysulfone hollow fibers optimization as support for CO_2 capture composite membranes. EMS membrane summer school; 2010-06-14 - 2010-06-19

107. **Shamsuzzoha, Mohammad; Skogestad, Sigurd; Halvorsen, Ivar J.**
A simple approach for on-line PI controller tuning using closed-loop setpoint responses. 20th European Symposium on Computer Aided Process Engineering - ESCAPE 20; 2010-06-06 - 2010-06-09

108. **Silva, Eirik Falck da; Svendsen, Hallvard Fjøsne; Merz, Kennie.**
Theoretical study of the equilibrium constants for solvents for CO_2 capture. The Greenhouse Gas Control Technologies (GHGT) conference; 2010-09-20

109. **Skancke, Jørgen; Lale, Rahmi; Bar, Nadav.**
Free Energy Caculations Give Insight Into The Process of Promoter Escape. 11th International Conference on Systems Biology; 2010-10-11 - 2010-10-14

110. **Skogestad, Sigurd.**
A Systematic Approach to Plantwide Control. Symposium on Recent and Emerging Advances in Chemical Engineering (REACH); 2010-12-02 - 2010-12-04

111. **Svendsen, Hallvard Fjøsne.**
Carbon Capture by Absorption. 2nd French-Norwegian Workshop on CCS; 2010-12-13

112. **Svendsen, Hallvard Fjøsne.**
CO_2 capture by absorption; challenges and possibilities. Tsinghua University; 2010-06-02

113. **Svendsen, Hallvard Fjøsne.**
CO_2 capture by solvents; challenges and development in post combustion technologies. KAIST; 2010-09-09

114. **Svendsen, Hallvard Fjøsne.**
CO_2 capture by solvents; challenges and Possibilities. Post-Combustion CO_2 Capture Workshop; 2010-07-11 - 2010-07-13

115. **Svendsen, Hallvard Fjøsne.**
Norwegian CO_2 Capture Research activities. Innovation Norway Seminar; 2010-09-10

116. **Svendsen, Hallvard Fjøsne.**
Nye effektive absorbenter for CO_2 fangst. CLIMIT seminar; 2010-10-12

117. **Svendsen, Hallvard Fjøsne; Kim, Taek Joong; Kim, Inna.**
Frief overview on CO_2 capture activity at & SINTEF. Petronas meeting; 2010-10-07

118. **Svenum, Ingeborg-Helene; Borck, Øyvind; Walle, Lars Erik; Schulte, Karina; Borg, Anne.**
Adsorption of CO on Ni_3A_l(111): A combined theoretical and experimental study. ECOSS 27; 2010-08-29 - 2010-09-03

119. **Tsakoumis, Nikolaos; Voronov, Alexey Sergeevich; Rønning, Magnus; Borg, Øyvind; Rytter, Erling; Holmen, Anders.**
Co-based Fischer-Tropsch Synthesis: an Operando study from catalyst activation to deactivation. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

120. **Uddin, Mohammad Washim; Kim, Taek Joong; Hesstvedt, Camilla; Hägg, May-Britt.**
Polymeric Blend Membrane in Natural Gas Sweetening - Durability Study. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

121. **Vanhaecke, Estelle Marie M.; Huang, Fan; Chen, De.**
Catalytic consequence of the interface between catalysts and foils in synthesis of aligned nanocarbons on foils. Carbocat IV; 2010-11-07 - 2010-11-10

122. **Vanhaecke, Estelle Marie M.; Huang, Fan; Chen, De; Rønning, Magnus.**
Development of nanostructured electrodes on foils. 1st International Conference on Materials for Energy; 2010-07-04 - 2010-07-08

123. **Venvik, Hilde Johnsen; Pfeifer, Peter; Myrstad, Rune; Aartun, Ingrid; Bakhtiary, Hamidreza Davijany; Hayer, Fatemeh; Phan, Xuyen Kim; Enger, Bjørn Christian; Lødeng, Rune; Görke, Oliver; Schubert, Klaus; Holmen, Anders.**
Microstructured reactors in compact conversion of natural gas and biomass to liquid fuels and hydrogen. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

124. **Vevelstad, Solrun Johanne; Eide-Haugmo, Ingvild; Silva, Eirik Falck da; Svendsen, Hallvard Fjøsne.**
Degradation of MEA; a theoretical study. GHGT-10 (10th International Conference on Greenhous Gas Control Technologies); 2010-09-19 - 2010-09-23

125. **Vevelstad, Solrun Johanne; Grimstvedt, Andreas; Lepaumier, Helene Marie; Zahlsen, Kolbjørn; Kjos, Marianne Stensvik; Knudsen, Jacob; Svendsen, Hallvard Fjøsne.**
Identification and quantification of amine degradation products by Ion chromatography. Pacifichem 2010; 2010-12-15 - 2010-12-20

126. **Volden, Sondre; Glomm, Wilhelm.**
Bionanotechnology research at the Ugelstad Laboratory. 1st NanoLab Seminar on Nanobiotechnology and Nanomedicine; 2010-02-19

127. **Voronov, Alexey Sergeevich; Tsakoumis, Nikolaos; Rønning, Magnus; Borg, Øyvind; Rytter, Erling; Holmen, Anders.**
In situ deactivation study of the rhenium behaviour in Co-Re Fischer-Tropsch catalyst. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

128. **Voss, Georg Johannes Bernhard; Rønning, Magnus.**
The State of Promotors in Fischer-Tropsch Catalysts. Norwegian Catalysis Symposium 2010; 2010-11-29 - 2010-11-30

129. **Walmsley, John C; Dehghan-Niri, Roya; Vullum, Per Erik; Holmestad, Randi; Rønning, Magnus; Holmen, Anders; Hauback, Bjørn.**
TEM analysis of catalyst and energy storage materials. International Symposium on Advanced Electron Microscopy for Catalysis and Energy Storage Materials; 2010-01-17 - 2010-01-20

130. **Wang, Hongmin; Dam, Anh Hoang; Blaylock, D. Wayne; Ogura, Teppei; Zhu, Yian; Holmen, Anders; Green, William H.; Chen, De.**
Kinetic study of methane steam reforming over core-shell structured bimetal Ni based catalyst. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

131. **Wang, Yuefa; Chao, Zhongxi; Jakobsen, Hugo Atle.**
Numerical simulation of solid flow patterns in the bubbling fluidized bed with a 3D two-fluid model. CHISA 2010 ECCE 7; 2010-08-28 - 2010-09-01

132. **Wangen, Espen Standal; Blekkan, Edd Anders.**
The Effect of Soot Deposition on Catalytic Activities in the Steam Reforming of a Simulated Producer Gas. Novel Gas Conversion symposium; 2010-05-30 - 2010-06-03

133. **Wangen, Espen Standal; Osatiashtiani, Amin; Blekkan, Edd Anders.**
Catalytic steam reforming for the production of biomass derived synthesis gas. Renewable Energy Research Conference; 2010-06-07 - 2010-06-08

134. **Wangen, Espen Standal; Osatiashtiani, Amin; Blekkan, Edd Anders.**
Production of biomass derived synthesis gas by catalytic steam eforming. Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

135. **Xie, Minli; Olderøy, Magnus Østgård; Strand, Berit Løkensgard; Andreassen, Jens-Petter; Sikorski, Pawel.**
Nanoscale control of mineral deposition within alginate gel networks. Biophysics meeting, Kongsvold 2010; 2010-03-03 - 2010-03-05

136. **Xie, Minli; Olderøy, Magnus Østgård; Strand, Berit Løkensgard; Standal, Therese; Zhang, Zhibing; Andreassen, Jens-Petter; Sikorski, Pawel.**
Bio-inspired mineralization of alginate hydrogels with hydroxyapatite for new composite materials in tissue engineering. Gordon Research Conference: Biomineralization; 2010-08-15 - 2010-08-20

137. **Yang, Jia; Borg, Øyvind; Chen, De; Holmen, Anders.**
Re Promotion Effect of Carbon Nanotube Supported Cobalt Catalyst for Fischer-Tropsch Synthesis Studied by SSITKA. CarboCat IV 4th International Symposium on Carbon for Catalysis; 2010-11-07 - 2010-11-10

138. **Yang, Jia; Lillebø, Andreas Helland; Chen, De; Holmen, Anders.**
Effect of ppm level alkali metal on $CoRe/Al_2O_3$ catalyst for the Fischer-Tropsch reaction studied by SSITKA. 9th Novel Gas Conversion Symposium; 2010-05-30 - 2010-06-03

139. **Yang, Jia; Lillebø, Andreas Helland; Chen, De; Holmen, Anders.**
Effect of ppm level sodium on $CoRe/Al_2O_3$ catalyst for the Fischer-Tropsch reaction studied with SSITKA. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

140. **Yang, Jia; Tveten, Erik Zakarias; Borg, Øyvind; Rytter, Erling; Holmen, Anders.**
Effect of support on the Intrinsic Activity and Selectivity for Co-based Fischer-Tropsch Catalyst. EuropaCat IX; 2010-08-30 - 2010-09-04

141. **Yang, Jia; Zhao, Tiejun; Tveten, Erik Zakarias; Chen, De; Holmen, Anders.**
Origin of in-situ reduction and oxidation of Co/Al_2O_3 in the Fischer-Tropsch Synthesis. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

142. **Yang, Jia; Zhao, Tiejun; Tveten, Erik Zakarias; Chen, De; Holmen, Anders.**
Types and reactivity of surface species on Co/Al_2O_3 catalyst for Fischer-Tropsch Synthesis. 14th Nordic Symposium; 2010-08-29 - 2010-08-31

143. **Yelchuru, Ramprasad; Skogestad, Sigurd.**
MIQP Formulation for Optimal Controlled Variable Selection in Self Optimizing Control. The 5th International Symposium on Design, Operation and Control of Chemical Processes; 2010-07-25 - 2010-07-28

144. **Zakeri, Ali; Einbu, Aslak; Wiig, Per Oscar; Øi, Lars Erik; Svendsen, Hallvard Fjøsne.**
Experimental Investigation of Pressure Drop, Liqid Hold-Up and Mass Transfer Parameters in a 0.5 m Diameter Absorber Column. GHGT-10 (10th International Conference on Greenhous Gas Control Technologies); 2010-09-19 - 2010-09-23

145. **Zhao, Tiejun; Eiras, Sara Boullosa; Yu, Yingda; Chen, De; Holmen, Anders; Rønning, Magnus.**
Pechini route in pore: Synthesis of supported catalysts by impregnation and calcination of room-temperature polymerizable metal-complexes. 14th Nordic Symposium on Catalysis; 2010-08-29 - 2010-08-31

146. **Zhao, Tiejun; Eiras, Sara Boullosa; Yu, Yingda; Chen, De; Holmen, Anders; Rønning, Magnus.**
Synthesis of supported catalysts by impegnation and cacination of roomtemperature. Norwegian Symposium on Catalysis; 2010-11-29 - 2010-11-30

147. **Zhao, Tiejun; Yu, Yingda; Chen, De; Rønning, Magnus.**
Preferential oxidaton of CO in H_2-rich feed over unsupported nanobomposite and structured carbon nanofiber cupported $Cu-CeO_2$ catalysts. ACS Spring conference; 2010-03-21 - 2010-03-25

148. **Zhao, Tiejun; Yu, Yingda; Chen, De; Rønning, Magnus.**
Structured carbon nanofiber supported $Cu-CeO_2$ catalyst: Catalytic behavior in the preferential oxidation of CO in H2-rich gases. 9th Novel Gas Conversion symposium; 2010-05-30 - 2010-06-0

149. **Zhu, Jun.**
Study on Active Sites on Pt Nanoparticles for Propane Dehydrogenation.. Norwegian Catalysis Symposium 2010 and Annual Meeting of the KOSK II program of the Norwegian Research Council; 2010-11-29 - 2010-11-30

150. **Zhu, Jun; Chen, De; Rønning, Magnus; Yu, Yingda; Holmen, Anders.**
The Nature of active sites in Pt anoparticles for propane dehydrogenation. 9th Novel Gas Conversion Symposium (NGCS 9); 2010-05-30 - 2010-06-03

151. **Øye, Gisle.**
Correlations between crude oil properties and produced water quality. Internatonal symposium of Advanced Energy Science 2010; 2010-11-18 - 2010-11-19

152. **Øye, Gisle; Aarhoug, Kristin; Flåten, Geir Rune; Dudasova, Dorota.**
Correlations between physiochemical properties of crude oils and o/w emulsion behaviour. 21st International Oil Field Chemistry Symposium; 2010-03-15 - 2010-03-17

CHAPTER 4: EDUCATION

Chemical Engineering

The specialization in Chemical Engineering starts in the third year with the basic technological courses in Separation Technology, Reaction Engineering, Thermodynamics and Process Design. In the fourth year the students elect further specializations for the remaining of the studies. The students choose between 5 specializations: Petrochemistry and Catalysis, Colloid and Polymer Chemistry, Environmental Engineering and Reactor Technology, Process Systems Engineering and Paper and Fibre Technology.

The goal of the education is a Master (MSc) at a high international level in Chemical Engineering.

Students with a bachelor degree in a relevant area from colleges can be admitted to the fourth year of the MSc-degree programme (2 year MSc programme). The degree provides the candidates qualifications for jobs in a wide range of industries, as well as the public sector and in research. It is also the basis for admission to the PhD-studies in Chemical Engineering.

Master courses given in 2010:

Course code	Course title	Credits	Year	Registered	Passed
TKP4100	Fluid Flow and Heat Transfer	7.5	2	95	82
TKP4105	Separation Technology	7.5	3	86	74
TKP4110	Chemical Reaction Engineering	7.5	3	104	96
TKP4115	Surface and Colloid Chemistry	7.5	3	75	67
TKP4120	Process Engineering	7.5	2	162	143
TKP4130	Polymer Chemistry	7.5	4	22	20
TKP4135	Chemical Process Dynamics and Optimization	7.5	4	7	5
TKP4140	Process Control	7.5	4	39	34
TKP4145	Reactor Technology	7.5	4	11	7
TKP4150	Petrochemistry and Oil Refining	7.5	4	42	24
TKP4155	Reaction Kinetics and Catalysis	7.5	4	60	48
TKP4160	Transport Phenomena	7.5	4	38	28
TKP4165	Process Design	7.5	4	26	24
TKP4170	Process Design, Project (autumn)	7.5	4	30	30
TKP4171	Process Design, Project (spring)	7.5	4	4	4
TKP4175	Thermodynamic Methods	7.5	3	36	23
TKP4180	Bioenergy and Fiber Technology	7.5	4	5	3
TKP4185	Nuclear Power, Introduction	7.5	4	17	15
TKP4190	Fabrikasjon og anvendelse av nanomaterialer	7.5	4	20	16
TKP4510	Catalysis and Petrochemistry, Specialization Project	15	5	10	10
TKP4511	Catalysis and Petrochemistry, Specialization Project	7.5	5	1	1
TKP4515	Catalysis and Petrochemistry, Specialization Course	7.5	5	11	11
TKP4520	Colloid and Polymer Chemistry, Specialization Project	15	5	1	1
TKP4521	Colloid and Polymer Chemistry, Specialization Project	7,5	5	-	-
TKP4515	Colloid and Polymer Chemistry, Specialization Course	7.5	5	2	2
TKP4530	Reactor Technology, Specialization Project	15	5	16	16
TKP4531	Reactor Technology, Specialization Project	7,5		-	-
TKP4535	Reactor Technology, Specialization Course	7,5	5	13	13
TKP4550	Process Systems Engineering, Specialization Project	15	5	8	8
TKP4551	Process Systems Engineering, Specialization Project	7.5	5	1	1
TKP4555	Process Systems Engineering, Specialization Course	7.5	5	13	11
TKP4560	Paper and Fibertechnology, Specialization Project	15	5	2	2
TKP4561	Paper and Fibertechnology, Specialization Project	7.5	5	-	-
TKP4565	Paper and Fibertechnology, Specialization Course	7.5	5	3	2
TKP4850	Experts in Team, Interdisciplinary Project	7.5	4	30	29
TKP4500	Final Year Design, for Spanish students	60	5	2	2
TKP4900	Chemical Process Technology, Master Thesis	30	5	31	31

Master theses 2010 total 29, 14 female and 15 male

Arthur, Theophilus
Control structure design for methanol process
Supervisor: Sigurd Skogestad

Asif, Naveed
Adsorption/Desorption studies related to Enhanced Oil Recovery by Low Salinity Water Flooding
Supervisor: Gisle Øye

Azpeleta, Cristina
Partial oxidation of methane by chemical looping
Supervisor: Anders Holmen

Badina, Aderonke
Characterization of products from the slurry hydrocracking of heavy oil using multivariate analysis of data from LC-MS, ^{1}H-NMR and FT-IR spectroscopy
Supervisor: Edd A. Blekkan

Besteiro Aparicio, Carlos
Direct synthesis of dimethyl ether (STD) from syngas on bifunctional catalyst
Supervisor: Hilde J. Venvik

Bouvier, Nicolas
Modelling and Optimization of a Gas-to-Liquid plant.
Supervisor: Magne Hillestad

Dreilllard, Matthieu
Energy conciderations around an amine CO_2 capture plant
Supervisor: Magne Hillestad

Eklund, Pål
Refining of high yield kraft pulps
Supervisor: Størker Moe

Freire López, Juan Bautista
Catalytic partial oxidation of methane at moderate temperatures
Supervisor: Anders Holmen

Gao, Bicheng
Characterisation and Rheological Properties of Model Gas hydrate particles
Supervisor: Gisle Øye

Gondal, Shahla
The VLE of CO_2-Water-MEA; Empirical Data and Refined e-NRTL Model Predictions
Supervisor: Hallvard Svendsen

Haider, Shamim
Optimization of Pretreatment Process for Hollow Fibres in the Production of Carbon membranes for Air Separation
Supervisor: May-Britt Hägg

Helberg, Ragne Marie Lilleby
Optimization of PSf hollow fiber membranes and preparation of two types of PVAm/PSf membranes for CO_2 capture from flue gas
Supervisor: May-Britt Hägg

Helgestad, Dag-Erik
The Drilling Process: A Plantwide Control Approach
Supervisor: Sigurd Skogestad

Hesstvedt, Camilla
The effects of contamination in flue gas and natural gas streams on carbondioxide capture performance of FSC (Fixed-Site-Carrier) membranes
Supervisor: May-Britt Hägg

Hyllestad, Elisabeth L.
Stabilization of two-phase flow in risers from reservoirs (anti-slug control)
Supervisor: Sigurd Skogestad

Jacobsen, Julie Berild
Size enlargement of carbonate particles precipitated during gas production
Supervisor: Jens-Petter Andreassen

Jensen, Martin Buus
Dynamic model for nutrient absorption in fish
Supervisor: Nadav Skjøndal-Bar

Lillebø, Andreas Helland
Characterization and catalytic activity testing of cobalt/rehnium-gamma alumina Fischer-Tropsch catalyst. Effect of sodium, potassium, lithium and calcium promotron
Supervisor: Anders Holmen

Mba, Emmanuel
CO_2 solubility measured by the N2O analogy
Supervisor: Hallvard Svendsen

Munkejord, June
Comparison of solvents for postcombustion capture of carbon dioxide by chemical absorption potassium, lithium and calcium promotron
Supervisor: Jens-Petter Andreassen

Nergård, Liv-Turid
Sensitivity Studies of Liquefaction Processes Using Cubic Equations of State
Supervisor: Tore Haug-Warberg

Osatiashtiani, Amin
Catalytic conversion of producer gas
Supervisor: Edd A. Blekkan

Piella Bagaria, Jordi
Protein-nanoparticle constructs for intracellular delivery
Supervisor: Wilhelm Glomm

Ringstad, Renate Gjørva
Carbon dioxide capture from aluminium-production
Supervisor: Hallvard Svendsen

Roel, Carl Marius
Corrosive sulfur in transformer oils.
Supervisor: Wilhelm Glomm

Roset, Stine Thysnes
Removal of basic compounds from absorber exhaust in post CO_2 capture. Vapour-liquid equilibrium for ammonia in aqueous amine solutions
Supervisor: Hallvard Svendsen

Skjeldestad, Kjetil
Carbonization and characterzation of carbon hollow fiber membranes for air separation
Supervisor: May-Britt Hägg

Ton, Xuan-Anh
Synthesis and Characterization of Sol-Gel Derived Organic-Inorganic Hybrid Hydrogels for Potential Controlled Release
Supervisor: Wilhelm Glomm

Widarena, Trimaharika
Quantitative Efficiency Assessment of an Oil and Gas Processing Platform
Supervisor: Magne Hillestad

Østbye, Helene
Dynamic modelling of a post combustion CO_2 capture plant
Supervisor: Magne Hillestad

Some of the masterstudents

First row: Aderonke Badina, Elisabeth Hyllestad, Renate Ringstad, Stine Roset, Julie Berild Jacobsen, June Munkejord, Camilla Hestvedt
Second row: Emmanuel Mba, Anders Haukvik Røed, Carl Marius Roel, Kjetil Skjeldestad, Dag-Erik Helgestad, Andreas H. Lillebø, Martin Buus Jensen

5th year students 2010/2011
Total 34, 13 female and 21 male

Alam, Mahmud
Almeland, Silje Kreken
Bøhn, Kristian
Esmaelpour, Ayob
Evenrud, Vegar
Graff, Vidar
Greene, Jonathan Ashley
Grimholt, Chriss Tony Robert
Haglund, Ola Kjølberg
Hareide, Henning
Håseth, Jenny Kristin
Heggvoll, Børge
Helgesen, Anette Hoel
Idrees, Muhammad Usman
Jens, Christian Morten
Karlsen, Aina Elin
Karlsen, Stine
Kjos-Hanssen, Øyvind Jacob
Krossholm, Charlotte
Kvam, Torunn
Leithe, Anna Elise
Lien Bjørnstad, Ida
Meland, Knut Åge
Nazir, Ahsin
Nergaard, Margrethe
Osmani, Kimete
Plünnecke, Katrine S. Biesterfeld
Rahman, Mohammad Mashukur
Roll, Sebastian
Saeed, Muhammad
Saleem, Fahad
Viatkin, Dimitri
Williams, Rebecca Sian
Zaidy, Syed Amjad Hussain

4th year students 2010/2011
Total 31, 13 female and 18 male

Asphaug, Sindre
Barland, Astrid Odland
Berstad, Eivind
Bersås, Anita
Carlsen, Christina
Dolgov, Iakov
Glas, Sophie Anne Amelie
Gynnild, Nina Tung
Henriksen, Fridtjof Finsnes
Hildenes, Knut Arne Wuttudal
Holene, Axel Lødemel
Håseth, Jenny Kristin
Håvik, Sindre
Johannessen, Petra-Kristine
Johansen, Stine
Johansson, Emma Matilda
Kjos-Hanssen, Øyvind Jacob
Krossholm, Charlotte
Kvam, Torunn
Leer, Roald Bræck
Midttveit, Anette
Nerland, Carina Renée
Nesje, Ivar
Nogva, Stig-Erik
Nordvåg, Ole Kristian
Pylilo, Alexei
Shadman, Amir
Stavnes, Signe Marie Nielsen
Sørheim, Anders
Tangen, Stian
Aasgaard, Lasse Svenkerud

3rd year students 2010/2011
Total 45, 28 female and 17 male

Berstad, Sigrun Dyvik
Brodtkorb, Thea Wilhelmine
Correia, Joana Catarina
Djuve, Eirik
Duus, Ane Cecilie
Ekrheim, Hilde Bråtveit
Fiske, Thomas Haukli
Foss, Kristine Bentzen
Foss, Martin Skjærvø
Hjetland, Ola Sæterli
Hodneland, Solveig
Houge, Emilie Øritsland
Hove, Hanne Ekeberg
Hyllestad, Ketil
Håbrekke, Åshild
Haarsaker, Trine Vilde
Jenssen, Kaia Andersson
Jevne, Ivar Magnus
Johnsen, Birgit
Kjemperud, Jostein
Kløcker, Kaja Neeb
Knutsen, Kristine Tomte
Lefsaker, Martine
Liland, Ingvild Skeie
Lindersen, Peter Johan Bergh
Lindgren, Camilla
Marvik, Tor Anders
Mielnik, Monika Maria
Nilsen, Anne Sofie
Nordbø, Jørgen
Nythe, Odd Martin
Næss, Henriette Sæd
Olhaye, Mohammed Omar
Paulsen, Helene
Selvaag, Kristian
Snarvold, Kristin S.
Stewart, Nicola Josefine
Susort, Nils Arne
Tomasa, Tina
Trapnes, Siri Hofstad
Trondsen, Gaute Tolås
Øien, Marianne
Østbye Pedersen, Eirik
Aaltvedt, Stian
Aanonsen, Charlotte

International master students autumn 2010, total 9, 2 female and 7male

Name	Nationality
Ali, Hassan	Pakistan
Ahmad, Rafiq	Pakistan
Bandyopadhyay, Sulalit	India
Hussain, Saddam	Pakistan
Katto, Aristides	Tanzania
Leruth, Alexandre	Belgium
Lesaint, Caterina Rusu	Romania
Sheng, Juejing	China
Usman, Muhammad	Pakistan

Two year domestic master degree program autumn 2010, total 5, 2 female and 3 male

Gynild, Nina Tung
Henriksen, Fridtjof Finsnes
Håvik Sindre
Nerland, Carina Renée
Tangen, Stian

Student exchange 2010

31 exchange students visited our Department (10 females and 21 males)

Name	University/Country	Group located
Azpeleta, Cristina	University of Valladolid, Spain	Catalysis Group
Barilleau, Claire	INPL, Nancy University, France	Catalysis Group
Besteiro Aparicio, Carlos	Universidad de Valladolid, Spain	Catalysis Group
Billot, Baptiste	Conseil Régional de Franche-Comté. France	Colloid- and Polymer Group
Blanco Mendizabal, Lara	University of the Basquie Country, Spain	Chemical Engineering
Boiron, Aurelia	Ecole Centrale de Lille, France	Process System Engineering Group
Bonilla Dominguez, Juan Alejandro	Universidad Politecnica de madrid, Spain	Environmental Egineering and Reactor Tehnology Group
Bouvier, Nicolas	Institut National Polytechnique de Lorraine, France	Environmental Egineering and Reactor Tehnology Group
Cattaneo, Simone	Politechnico Di Milano, Italy	Catalysis Group
Cicciotti, Matteo	Politechnico Di Milano, Italy	Process System Engineering Group
Chikhi, Benjamin	RWTH Aachen, Germany	Environmental Egineering and Reactor Tehnology Group
Chirnside, Morfula Pamela	RWTH Aachen, Germany	Chemical Engineering
Dreillard, Mattheu	Institut National Polytechnique de Lorraine, France	Environmental Egineering and Reactor Tehnology Group
Freire, Juan Bautista	Universidad de Valladolid, Spain	Catalysis Group
Gera, Vivek	Indian Institute of technology Kanpur, India	Chemical Engineering
Jiménez Ortega, Mario	University Rovira I Virgili, Spain	Catalysis Group
Kashyap, Vikas	Indian Institute of Technology Roorkee, Uttarakhand, India	Colloid- and Polymer Group
Kupka, Vojtech	Brno University of Technology, Czech Republic	Colloid- and Polymer Group
Lambrechts, Kalle	Kempen University College, Belgium	Colloid- and Polymer Group
Malizia, Mauro	University of Calabria, Italy	Environmental Egineering and Reactor Tehnology Group
Montazaud, Thomas	Ecole Centrale de Lille, France	Environmental Egineering and Reactor Tehnology Group
Muhamed, Rizqah	University of Cape Town, South Africa	Environmental Egineering and Reactor Tehnology Group
Pan, Xi	University of Technology Hamburg, Germany	Process System Engineering Group
Piella Bagaria, Jordi	Univeritat Politecnica de Catalunya, Spain	Colloid- and Polymer Group
Roudot, Solenne	Grenoble Institute of Technology, France	Pulp, Paper and Biorefinery
Taraba, Robert	Slovak University of Technology in Bratislava, Slovakia	Process System Engineering Group
Tavera Valero, Nuria	Universidat de Granada, Spain	Environmental Egineering and Reactor Tehnology Group
Tichelkamp, Thomas	Heinrich-Heine-University, Düsseldorf, Germany	Colloid- and Polymer Group
Troncoso, Urbano	University of Granada, Spain	Environmental Egineering and Reactor Tehnology Group
Ton, Xuan-Anh	ESPCI Paris Tech, France	Colloid- and Polymer Group
Vannier, Damien	INPL, Nancy University, France	Catalysis Group
Vos, Filip	Katholieke Hogeschol Kempen, Belgium	Process System Engineering Group

8 students from our Department (3 females and 5 male) on exchange

Name	To institution	Programme	Period
Bøhn, Kristian	Curtin University of Technology, Perth, Australia	Individ	01.01.10 – 31.06.10
Glas, Sophie Anne Amelie	Delft University, The Netherlands	Erasmus	01.09.10 – 30.06.11
Graff, Vidar	Curtin University of Technology, Perth, Australia	Individ	27.07.09 – 25.06.10
Grimholt, Chriss	University of California, Berkeley, USA	Bilateral	15.08.09 – 15.06.10
Haglund, Ola Kjølberg	Curtin University of Technology, Perth, Australia	Individ	27.07.09 – 26.06.10
Lethe, Anna Elise	Curtin University of Technology, Perth, Australia	Individ	01.01.10 - 31.06.10
Nergaard, Margrethe	University of California, Berkeley, USA	Bilateral	01.09.09 – 30.06.10
Sørheim, Anders	Technical University Berlin, Germany	Erasmus	01.09.10 – 30.06.11

PhD in Chemical Engineering

The Department of Chemical Enginerring offers a PhD-programme, which gives a higher education within the field of Chemical Engineering.
The PhD program in Chemical Engineering will provide training in how to generate and publish new knowledge in the field, as well as help strengthen the catidates acdemic horizont in Chemical Engineering.

The PhD proggram in Chemical Engineering are connected to the Departments research groups:

- Catalysis
- Colloid- and Polymerchemistry
- Process- Systems Engineering
- Environmental Engineering and Reactor Technology
- Biorafinery and Fibre Technology

PhD courses given at Department of Chemical Engineering:

Cours code	Course title	Credits	Registered	Passed	Semester
KP8100	Advanced Process Simulation	7.5	2	0	Fall 10
KP8102	Wood Chemistry in Pulping and Paper Making	7.5			Fall 11
KP8105	Methematical Modelling and Model Fitting	7.5			Fall 11
KP8106	Gas Cleaning with Chemical Solvents	9.0	6	6	Springl 11
KP8107	Advanced Course in Membrane Separation Process	9.0			Spring 11
KP8108	Advanced Thermodynamics: With applications to Phase and Reaction Equilibria	9.0	8	3	Spring 10
KP8110	Membrane Gas Purification	9.0	3	3	Spring 10
KP8115	Advanced Process Control	7.5	1	1	Fall 10
KP8117	Paper Physics and Paper Chemistry	9.0	3	2	Spring 10
KP8118	Advanced Reactor Modelling	12	2	2	Spring 10
KP8129	Colloid Chemistry for Process Industry	7.5			Spring 12
KP8130	Systembiology, Modelling and Analysis	7.5	2	2	Fall 10
KP8131	Crystallization and Particle Design	7.5			Fall 11
KP8132	Applied Heterogeneous Catalysis	7.5			Fall 11
KP8133	Characterization of Heterogeneous Catalysts	7.5	12	11	Fall 10
KP8134	Surfactants and Polymers in Aquous Soutions	7.5	3	2	Fall 10
KP8135	Surface, Colloid and Polymer Chemistry Special Topics	7.5	2	2	Fall 10
KP8136	Modelling of Catalytic Reactions	7.5			Spring 11
KP8137	Design and Preparation of Catalytic Materials	7.5			Spring 11
KP8901	Chemical Process System Engieering	7.5			Fall 11
KP8902	Reactor Technology	7.5	2	2	Spring 10
KP8903	Reaction Kinetics and Catalysis	7.5	8	5	Fall 10
KP8904	Transport Phenomena	7.5	3	1	Fall 10
		2	2	Fall 09	

PdD-Thesis 2010 total 16 – 6 female and 10 male

Amiri, Asal
Rheology of silica-based dispersions and Cross-sectional modeling of settling slurries
Supervisor: Johan Sjöblom

Bakhtiary, Hamidreza Davijany
Performance assessment of a packed bed microstructured reactor - heat exchanger for methanol synthesis from syngas.
Supervisor: Anders Holmen

Berglihn, Olaf Trygve
Dynamic simulation on a thermodynamic canonical basis
Supervisor: Tore Haug-Warberg

Borge, Tone
Development of hybride membrane materials (mixed matrix membranes)
Supervisor: May-Britt Hägg

Dones, Ivan
Studies on Process Modelling, Simulation, and Control with Applications to Distillation Columns
Supervisor: Heinz Preisig

Dupuy, Pablo Matías
Droplet Deposition in High-Pressure Natural-Gas Streams
Supervisor: Hallvard Svendsen

Boullosa Eiras, Sara
Comparative study of selected catalysts for methane partial oxidation
Supervisor: Anders Holmen

Farooq, Umer
Characterisation of Crude Oil-Water and Solid-Water Interfaces, and Adsorption/Desorption Properties of Crude Oil fractions. The effect of low salinity water and pH
Supervisor: Gisle Øye

Flaten, Ellen Marie
The effect of MEG (mono ethylene glycol) on the precipitation kinetics of calcium carbonate related to natural gas production from subsea wells
Supervisor: Jens-Petter Andreassen

He, Li
Sorption Enhanced Steam Reforming of Biomass-Derived Compounds: Process and Material
Supervisor: De Chen

Hessen, Erik Trøien
Thermodynamic models for CO_2 absorption
Supervisor: Hallvard Svendsen

Keleşoğlu,Serkan
Flow Behaviour of Water-in-North Sea Acidic Crude Emulsions and Preparation of Synthetic Reference Acidic Oils and Their Emulsions
Supervisor: Johan Sjöblom

Manum, Henrik
Simple implementation of optimal control for process systems
Supervisor: Sigurd Skogestad

Patruno, Luciano Emanuel
Experimental and Numerical Investigations of Liquid Fragmentation and Droplet Generation for Gas Processing at High Pressures
Supervisor: Hugo A. Jakobsen

Paunonen, Sara Inkeri
Influence of moisture on the performance of polyethylene coated solid fiberboards and boxes
Supervisor: Øyvind W. Gregersen

Rusten, Hans Kristian
Simulation and modelling of hydrogen production by sorption enhanced steam methane reforming in fixed bed reactors
Supervisor: Hugo A. Jakobsen

11 PhD exchange students visited our Department in 2010 (3 female and 8 male)

Name	University/Country	Group located
Alcantara Cano, Francisco Salvador	Universitat Autónoma de Barcelona, Spain	Process Systems Engineering Group
Dadgar, Farbod	The Royal Institute of Technology (KTH), Sweden	Catalysis Group
Galloway, Patricia	University of Havana, Cuba	Environmental Engineering and Reactor Technology Group
González, Juan Maria	Consejo Superior de Investigaciones Cientificas (CSIC), Spain	Catalysis Group
Kubecek, Jakub	Czech Technical University, Prague, Czeck Republic	Process Systems Engineering Group
Luo, Jinzhao	Tsinghua University, Beijing, China	Environmental Engineering and Reactor Technology Group
Macron, Thomas	University of Montpellier, France	Environmental Engineering and Reactor Technology Group
Psaltis, Andreas	Patras University, Greece	Process Systems Engineering Group
Salmimies, Riina	Lappeenranta University of Technology, Finland	Environmental Engineering and Reactor Technology Group
Qiu, Weiwei	Petroleum University of China, Beijing, China	Process Systems Engineering Group
Vana, Zdenek	Czech Technical University, Prague, Czeck Republic	Process Systems Engineering Group

4 PhD students from our Department visited Universities abroad in 2010

Name	University/Country	Period
Rodionova, Galina	University of Tokyo, Japan	01.10.2010. –01.02.2011
Skancke, Jørgen	CRG – Centre de Regulació Genòmica, Barcelona, Spain	01.10.2010 – 01.08.2011
Vevelstad, Solrun J.	University of Austin, Texas, USA	05.06.2010 – 30.07.2010

Seminars, Conferences and meetings organized by the Department in 2010

KinCat seminars in Heterogeneous Catalysis:

Professor Sir John Meurig thomas, Cambridge University, UK
"Exploring the interface between heterogeneous and homogeneous catalysis", 20.05.2010

Dr. Louise Olsson, Competence Center for Catalysis, Chalmers University of Technology, Göteborg, Sweden
"Catalysis for cleaning emissions from vehicles", 26.10.2010

Dr. Claude Descorme, Institut de Recherches sur la Catalyse et l'environnement de Lyon, France
"Catalytic wastewater treatment: a focus on the catalytic wet air oxidation and the developmment of materials" 19.11.2010

Researchers Grand Prix:

PhD student Inger Lise Alsvik from our Department participated in "Forsker Grand Prix", November 2010, presenting her project: "Renewable Energy from Saline Power"

Guest lectures:

Harald Martens, UMB, Ås
"Modelometrics: multivariate soft meta-modeling of hard models" , 28.06.2010

Allahyar Montazeri, Fraunhofer Institute, Ilminau, Germany
"Active noise control", 22.09.2010

Krister Forsman, Perstorp, Sweden
"Plantwide control at Perstorp", 11.11.2010

Francisco Salvador "Salva" Alcantara Cano, **Universitat Autónoma de Barcelona, Spain**
IMC-like analytical H-infinity design with operating mode consideration: Utility in PID tuning guidance", 14.10.2010

Awards in 2010

NGSC9 award to professor Anders Holmen
The Award for Excellence in Natural Gas Conversion. Anders Holmen were recognized for his pioneering contributions to the science and practice of natural gas conversion and to the developåement and implementation of technologies needed to meet the chemical and fuel requirements of the world.
The award was received under the 9th NGSC symposium in Lyon, June 2010.

May-Britt Hägg received the "Nordens grønne belte, energipris 2010" inNovember 2010

CHAPTER 7: ORGANIZATION - ECONOMY

Organization (also see cover page)

The Department Board is the highest decision-making body. The Department Board shall make decisions regarding strategy and budget. The Board has 2-4 meetings each year.
It consists of two external members, a member from the scientific staff, administrative staff, PhD's and students. The board is elected for 4 years. The Head of Department is the chair of the board. The Head of Department is Professor Øyvind Gregersen, elected in 2009 for a four-year period (mid 2009 – mid 2013).

The scientific staff is divided in to five research groups. Each research group has a representative in the management team. The management team has also representatives from the PhD's, the students and technical staff. The management team meets every second week and discusses running matters, and gives advice to the Head of Department.

In addition to the scientific staff the department has 20 persons in a technical and administrative staff to support teaching and research of all the research groups.

Administrative responsibilities of faculty

Faculty Educational Committee (Department representatives)	Associate Professor Jens-Petter Andreassen deputy: Professor Edd Anders Blekkan
Faculty Research Committee (Department representatives)	Professor Sigurd Skogestad, deputy: Professor Hugo Atle Jakobsen
Study Program Chemical Engineering and Biotechnology (Industriell kjemi og bioteknologi) (Department representatives)	Associate Professor Jens-Petter Andreassen
Exchange of Norwegian students taking courses abroad (approval of course program), and approval of course program for visiting exchange students.	Associate Professor Jens-Petter Andreassen,
International Master program	Associate Professor Jens-Petter Andreassen and Senior Executive Officer Hege Johannessen

Department Economy

The department has three main sources of income:

- Regular funds from the University
- Strategic funding from the University
- External projects.

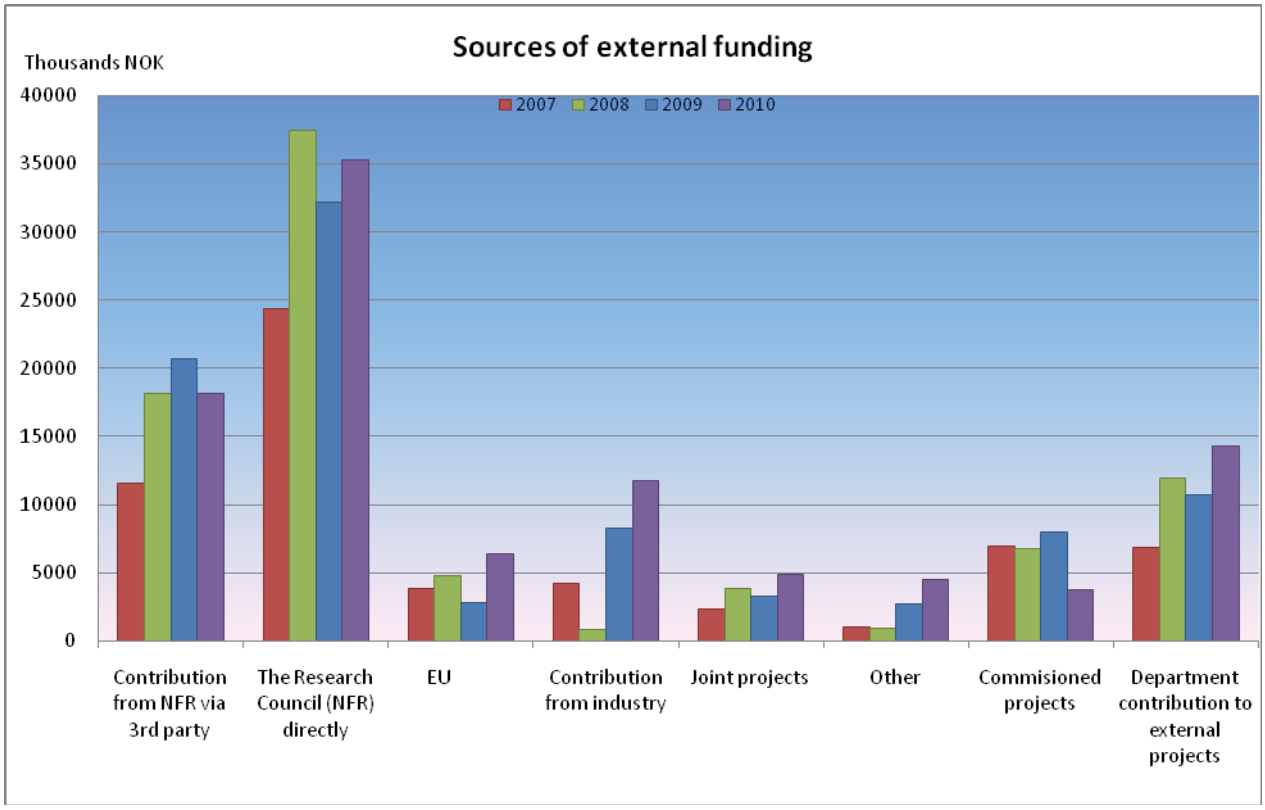
In terms of external funds, including contributions from the research Council and industry, the situation is very good. The gross regular funds from the University were about 45 million NOK in 2010. These funds are mainly used to pay salaries to the permanent staff, contribution to research projects and to investments. Furthermore has several strategic funds and internal projects been moved to the regular funds the last years so what appears as a substantial growth actually is just new ways of distributing the funds.
More details are shown in Table 1.

Accounts	2007	2008	2009	2010
Income:				
University funding	26 554 529	33 064 000	39 151 000	44 775 000
Overhead external projects	2 846 260			
Sum income	29 402 796	33 064 000	39 151 000	44 775 000
Expenses:				
Wages	21 260 668	21 525 000	24 726 000	27 543 000
Investment	2 546 924	147 000	250 000	6 913 000
Operating expenses	3 472 929	2 778 000	2 684 000	1 648 000
NTNU contribution to ext. projects		9 053 000	9 810 000	7 720 000
Sum expenses	27 280 521	33 504 000	37 470 000	
Result	2 120 268	-439 000	1 681 000	951 000

Table 1. Department's income from University and spending.

External funding

In addition to the funding shown in Table 1, the Department has a yearly income from external contributors of approx. 85 million NOK. Details are shown in Tables 2 and 3. We have managed to continue to get financing of our projects and still have several big projects that raise the income. Most of the project costs are related to salary for PhD candidates. The main contributor to the external research activity is The Norwegian Research Council (NFR). Most of these projects are at the Department, but the second largest external source is NFR projects where we contribute as a third party. The level of funding from industrial contributions and commissioned research are slightly growing. The growth in EU-funding is pleasant, and is important because of The University focus on EU-funding that gives extra credit from the Ministry, and we keep on with the focus EU as a growth area for our research activities. A problem has been that such projects have been underfinanced, but new support routines from The University will help to balance the projects. We have many joint industrial programmes with industry partners from countries in Europe, North-America, South America and Asia. External funding from commissioned research was approx. 5% in 2010, and the customers come from the mentioned areas and Africa.



Strategic funds from University

The third source of income is strategic funding from the University to support teaching, research and academic profile. These funds are used for investments in research equipment or Ph.D. or Post doc. positions.

The Department did not get any new projects in 2010, but focused on fulfilling existing projects - like development of the research areas of SFF-finalists, and renewal of our big student laboratory.

CHAPTER 8: HEALTH, ENVIRONMENT AND SAFETY (HES)

Health, environment and safety at Chemical Engineering

The departments focus on HES and working environment
During 2010 we have made several changes to improve our standard in HES.

- For all Master thesis and student projects, a risk assessment is done by the students and professors before start up. The main purpose is to train the student in doing risk assessments.
- During the spring semester staff engineers have been thought how to use Eco Online for marking and to perform a risk assessment of chemicals in each laboratory.
- We are working on new working procedures, risk assessments and procedures for documentation of all technical material that may cause a risk when used.
- To improve both physical and psychosocial working conditions, needs of each co-worker are mapped during the annual performance review and followed up by relevant actions:
  - New employees get a contact person (buddy) upon arrival, helping them with all practical matters, and introduce them to social arenas at the department.
  - This year the performance reviews were followed up by a seminar and workshop in the laboratories for planning of work procedures and awareness of impact on personal health.
  - We have also arranged a one day seminar for everyone who build/construct research equipment and work with pipes. The course was attended by 30 persons showing the need for such a course (see picture below).

In addition annual HES activities are running.

HES Courses: 160 persons have fulfilled our HES course during 2010. The course is compulsory for all new employees, master students, exchange students, 3rd year students doing our laboratory course "Felleslab", and summer students.

Reported incidents during 2010:
High CO level due to a construction work motor running indoors, ceiling vented hood fell down, a lamp in a student office fell down almost hitting a student, welding close to flammable material, dust and smell problems, cut in fingers (no sick leave) and one incident of valuable metals disappearing.

Annual HES-audit 2010. The general HES state is mapped in the annual HES audit. The main focus areas in 2010 were safety data sheets for all chemicals in both Norwegian and English in all labs, storage and marking of chemicals. A few incidents of missing safety data sheets, wrong storage and marking were found. The person responsible for the lab was instructed to do the appropriate changes.

SWAGELOCK SAFETY INSTALLATION SEMINAR
Workshop/Practical part

Compulsory course for everyone who is building/constructing apparatus/equipment, working with pipes or tubes, fittings

Some pictures of different activities at the Department

Our buildings, from right: K4, K5, Experimental halls, and the PFI-building (blue)

Some professors (Hallvard, Magne, Sigurd, Hugo, Jens-Petter and Øyvind), participated in the NTNUs Flashmob video

Liyuan Deng, Tom-Gøran Skog and Karen N. Seglem demonstrating membrane modules

IKPs squashmachine is popular at "Forskningsdagene". All the kids wants tomake their own squash

Professor May-Britt Hägg is demonstrating CO_2-capture with membrane technology for the Minister of Research Tora Aasland.
Foto: Sølvi W. Normannsen

Nils, Anna Elise and Astrid are promoting our Department at KREATOR

LIST OF TELEPHONE NUMBERS (20.05.2011)

50346	Agnihotri, Swarnima, Post doctor	PFI-3209
50536	Alexandrescu, Laura, Post doctor	PFI-3206
94055	Ahmad, Jamil, Ph.D. candidate	K4-213
91807	Alsvik, Inger Lise, Ph.D. candidate	K4-215
94209	Andreassen Jens-Petter, Associate Professor	K4-302
	Aronu, Ugochukwu Edwin, Ph.D. candidate	K4-309
50318	Barø Tove, Executive Officer	K5-101
94025	Beck Ralf, Post doctor	K4-305
50924	Benmekhbi, Mehdi, Ph.D.candidate	PFI-3408
94138	Berge, Arvid, Professor Emeritus	K5-M11
94157	Blekkan Edd Anders, Professor	K5-429
	Borka, Zsolt, Ph.D.candidate	K5-204
91664	Borthen Berit, Chief Engineer	K4167
94141	Boullosa Eiras Sara, Post doctor	K5-411
50326	Bruder, Peter, Ph.D. candidate	K4-308
94144	Brun Harry, Engineer	K5-341
94146	Chao, Zhongxi, Ph.D. candidate	K5-213
93149	Chen De, Professor	K5-407
	Ciftja, Arlinda, Ph.D. candidate	K4-432
94159	Dagsgård, Camilla, Principal Engineer	PFI-3407
95879	Dam, Anh Hoang, Ph.D. candidate	K5-245
94125	Dar, Hassan Jamil, Ph.D. candidate	K5-145
94126	Delic, Asmira, Ph.D. candidate	K5-249
	Deng Liyuan, Post doctor	K4-224
	Di Domenico Pinto, Diego, Ph.D.candidate	K4-408
50327	Doni Jayavelu, Naresh, Ph.D. candidate	K4-232
94156	Dragsten, Karin W., Principal Engineer	K5-432
50372	Dwivedi, Deeptanshu, Ph.D. candidate	K4-239
50924	Eftekhardadkahah, Mona, Ph.D. candidate	PFI-3408
	Eide-Haugmo, Ingvild, Ph.D. candidate	K4-430
97018	Enger, Bjørn Christian, Post doctor	K5-M12
	Enaasen, Nina, Ph.D. candidate	K4-411
94120	Erga Olav, Professor Emeritus	K5-237
94114	Fermoso Dominguez, Javier, Guest	K5-247
94161	Finnøy, Geir, Chief Engineer	K4-421
	Flid, Yulia, Laboratory Assistant	K4-307
94143	Fossum Arne, Engineer	K5-019
94017	Gawel, Bartlomiej, Researcher	K5-336
50372	Ghadrdan, Maryam, Ph.D. candidate	K4-239
94158	Glomm Wilhelm R. Associate Professor	K5-336
	Gondal, Shahla, Ph.D. candidate	K4-309
98354	Gorelkin, Ilya, Ph.D. candidate	K5-M4
94029	Gregersen Øyvind, Professor	PFI-2109
90338	Grimes Brian, Post doctor	K5-339
94126	Gunawardana, Daham Sanjaya	K5-158
	Gupta, Mayuri, Ph.D. candidate	K4-430
94039	Hammer, Nina, Post doctor	K5-251
50338	Hartono, Ardi, Researcher	K4-407
94108	Haug-Warberg Tore, Associate Professor	K4-228
94073	Hayer Fatemeh, Ph.D. candidate	K5-M6
94055	He, Xuezhong, Ph.D. candidate	K4-213
94031	Helle Torbjørn, Professor emeritus	PFI-2109
50304	Helmersen Tom, Office Manager	K5-101
94113	Hertzberg Terje, Professor Emeritus	K4-333
94122	Hillestad Magne, Professor	K4-437
94151	Holmen Anders, Professor	K5-401
94026	Hovin Odd Ivar, Engineer	Kh-155
50540	Håkonsen Signe, Senior Engineer	PFI3404
51128	Huang, Fan, Ph.D. candidate	K5-443
94033	Hägg May-Britt, Professor	K4-339
50372	Jahanshahi, Esmaeil, Ph.D. candidate	K4-239
50537	Janga, Kando Kalifa, Ph.D. candidate	PFI-3207
50327	Jacobsen, Magnus Glosli, Ph.D. candidate	K4-232
94132	Jakobsen Hugo Atle, Professor	K5-209
	Jonasse, Øystein, Ph.D. candidate	K4-307
93691	Jäschke, Johannes, Ph.D. candidate	K4-207
50342	Kaombe, Divina, Ph.D. candidate	PFI-3209
	Karimi, Mehdi, Ph.D. candidate	K4-411
94145	Kazi, Saima Sultana, Ph.D. candidate	K5-443
94149	Keleşoğlu, Serkan, Post doctor	K5-308
95867	Kim Taek-Joong, Researcher	K4-226
50346	Klimantos, Paris, Ph.D. candidate	K4-406
50325	Kovalchuk, Karina, Ph.D. candidate	K5-333
91605	Králová, Iva, Chief Engineer	PFI-3403
50540	Lesaint Caterina, Senior Engineer	PFI-3404
94105	Lesaint Cédric, Post doctor	K5-324
94118	Lillebø, Andreas H., Ph.D. candidate	K5-149
98379	Lou, Fengliu, Ph.D. candidate	K5-225
	Luo, Xiao, Ph.D. candidate	K4-411
50325	Lystvet, Sina Maria, Ph.D. candidate	K5-333
	Ma, Xiaoguang, Ph.D. candidate	K4-209
94153	Mathisen Torgrim, Higher Executive Officer	K4-166
	Mehdizadeh, Hamid, Ph.D. candidate	K4-411
94073	Mihai, Oana, Ph.D. candidate	K5-M6
94032	Moe Størker, Associate Professor	PFI-2108
	Monteiro, Juliana, Ph.D. candidate	K4-430
94156	Moljord, Kjell, Adjunct Professor	K5-146
94125	Muthuswamy, Navaneethan, Ph.D. candidate	K5-145
94148	Mørk Preben C., Professor	K5-M11
91807	Nafisi, Vajiheh, Ph.D. candidate	K4-215
50536	Narvestad, Hanne, Ph.D. candidate	PFI-3206
94137	Nenningsland, Andreas L., Ph.D. candidate	PFI-3401
98379	Noor, Tayyaba, Ph.D. candidate	K5-225
50924	Opedal, Nils van der Tuuk, Ph.D. candidate	PFI-3408
50338	Owrang, Farshid, Researcher	K4-407
91559	Panahi, Mehdi, Ph.D. candidate	K4-212
94111	Patanou, Eleni, Ph.D. candidate	K5-250
93147	Paso Kristofer, Post doctor	K5-304
50397	Paunonen, Sara, Post doctor	PFI-3103
94208	Phan, Xuyen Kim, Ph.D. candidate	K5-M12
92807	Preisig Heinz A, Professor	K4-233
98354	Radstake, Paul, Ph.D. candidate	K5-M4
50346	Rafiee, Ahmad, Ph.D. candidate	K4-406
95879	Rane, Shreyas P., Ph.D. candidate	K5-245
93691	Regalado Méndez, Alejandro, PhD.canditate	K4-207
50540	Reisen, Christian, Laboratory Assistant	PFI-3404
91686	Rodionova, Galina, Ph.D. candidate	PFI-3209
94139	Roel Jan Morten, Principal Engineer	Kh-155
94150	Roel Lisbeth B, Higher Executive Officer	K5-101
94146	Rout, Kumar Ranjan, Ph.D. candidate	K5-213
50536	Rusu, Marius, Ph.D. candidate	PFI-3206
94147	Rytter Erling, Adjunct Professor	K5-M11
94121	Rønning Magnus, Associate Professor	K5-408
	Samseth, Jon, Adjunct Professor	
	Sánchez, Rafael, Ph.D. candidate	K5-204
93942	Sandru Marius, Post doctor	K4-224
94073	Setekleiv Eddie, Ph.D. candidate	K5-M6
91657	Simon, Sebastien, Post doctor	PFI-3406
95505	Sjöblom Johan, Professor	K5-301
93942	Skancke, Jørgen, Ph.D. candidate	K4-212
91807	Skog, Tom-Gøran, Ph.D. candidate	K4-215
94124	Skjøndal-Bar, Nadav, Associate Professor	K4-227
94154	Skogestad Sigurd, Professor	K4-211
94312	Solsvik, Jannike, Ph.D. candidate	K5-206
94312	Sporleder, Federico, Ph.D. candidate	K5-206
94106	Sundseth Frode, Engineer	K5-033
94187	Surma, Miroslav, Ph.D. candidate	K5-M9
94100	Svendsen Hallvard, Professor	K4-402
94039	Svenum, Ingeborg-Helene Post doctor	K5-251
	Tavera Valero, Nuria, Ph.D. candidate	K4-307
	Trollebø, Anastasia, Ph.D. candidate	K4-308
	Tronstad, Ingvild, Ph.D. candidate	K5-
98379	Tsakoumis, Nikolaos, Ph.D. candidate	K5-225
94126	Udani, Charitha, Ph.D. candidate	K5-249
94055	Uddin, Mohammad, Ph.D. candidate	K4-213
94182	Vanhaecke, Estelle, Post doctor	K5-430

92831	Venvik Hilde, Professor	K5-406
50346	Vevelstad, Solrun, Ph.D. candidate	K4-430
94111	Vicinanza, Nicla, Ph.D. candidate	K4-250
94149	Volden Sondre, Post doctor	K5-308
94193	Volynkin, Andrey, Ph.D. candidate	K5-147
94187	Voronov, Alexey, Ph.D. candidate	K5-M4
94118	Voß, Georg, Ph.D. candidate	K5-149
94025	Wang, Lijuan, Ph.D. candidate	K4-305
94078	Wangen, Espen, Post doctor	K5-432
50537	Yamakawa, Asuka, Researcher	PFI-3207
93146	Yang, Jia, Ph.D. candidate	K5-411
91559	Yelchuru, Ramprasad, Ph.D. candidate	K4-212
94136	Yu, Qiang, Post doctor	K4-213
50326	Zakeri, Ali, Ph.D. candidate	K4-308
94114	Zhu, Jun, Post doctor	K5-247
94018	Øye Asbjørn, Chief Engineer	K5-144
94135	Øye Gisle, Professor	K5-307

Annual Report for Department of Chemical Engineering 2010

NTNU – Trondheim
Norwegian University of
Science and Technology

This is NTNU
The Norwegian University of Science and Technology (NTNU) is Norway's primary institution for educating the nation's future engineers and scientists. The university also has strong programmes in the social sciences, teacher education, the arts and humanities, medicine, architecture and fine art.

NTNU's cross-disciplinary research delivers creative innovations that have far-reaching social and economic impact.

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