



Annual Report 2006

Department of Chemical Engineering

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Annual Review

'The education, research and innovation of the Department shall consolidate our position among the best chemical engineering departments in Europe'.

'It is our aim to be the preferred chemical engineering research partner of industries within energy, chemistry, biotechnology and pharmacy'.

Head of Department – Globalization
and Cooperation

Advisory Board

Highlights 2006

Head of Department – Globalization and Cooperation



Kim Dam-Johansen,
Professor, Head of
Department

It is with considerable pleasure and pride I present our annual report 2006. Thanks to the competence, commitment and motivation of our staff we have reached all goals for the year. And the perspectives for the future certainly look bright.

Our multicultural working environment, with coworkers from 29 nations around the world gives us the best possible background for meeting the rapidly growing challenges of globalization. As you will see from the report we receive students from many countries – just as we send Danish students to other countries and cultures to get international experience.

In this way a graduate of the Department, Klavs Flemming Jensen, went to the USA and took his PhD at University of Wisconsin. 34 years later, now as a celebrated professor at MIT, he returned to Denmark to receive an honorary doctorate at the 2006 annual celebration of the DTU. Recently he has taken up a new challenge as Head of the Chemical Engineering Department at MIT. I hope that the example of Klavs F. Jensen will inspire our current generation of students.

In 2006 we announced several new faculty positions that attracted a large number of very qualified applicants from all over the world. During the summer, two Professors in Bio-Chemical Engineering with special focus on Bio-catalysis were offered positions at the Department. On August 1st Professor Anne Meyer succeeded Professor John Villadsen in the Novo Nordisk Foundation Chair in Bio Process Technology, and at the same time Professor John Woodley (from University College, London) accepted a position, effective from April 1st, 2007. Professor John Villadsen is acknowledged for his outstanding contributions to the Department – and he will, indeed, continue to work here, hopefully for a good many years. And welcome Anne Meyer and John Woodley – with such high-profile professors the Department expects rapid development in the field of Bio-catalysis!

Also, in the conventional field of heterogeneous catalysis the Department expects to see a growing research presence. The Haldor Topsoe Chair in Chemical Engineering was announced in late 2006 – and again strong applicants have shown interest in the position. I look forward eagerly to introduce the successful applicant in next years report.

With respect to infrastructure, 2006 was a year of enormous progress, since we finished a comprehensive renovation of the buildings and laboratories, giving world class facilities in all areas. The conclusion of the successful project was celebrated on September 15, with many guests, students and employees.

In recent years we have worked on developing practical courses in Process Engineering and Unit Operations to students from other universities. Now we are ready, and in 2007 we are delighted to launch summer schools in chemical and biochemical process engineering held for students from the USA and Europe. We look forward to welcoming new university partners for the course in the years to come.

For many years the production of oil and gas – as well as clean and efficient production of electricity, heat and process energy - has been a stronghold of the Department. We have a considerable experimental infrastructure from small to very large scale, and we cover traditional production processes as well as new technologies for e.g. enhanced oil recovery, including CO₂ utilization, and new power producing processes (e.g. oxy fuel and gasification) with the potential of a significant reduction of CO₂ emissions. As Energy and Environment have acquired top priority on the international agenda we invite academic, industrial and governmental organizations to cooperate and utilize our long experience in this field.

The Leader Team.
(From the top, left to right):
Kim Dam-Johansen, Hans Livbjerg,
Ole Hassager, Rafiqul Gani,
May Brandt and Erling H. Stenby.

Finally, I wish to welcome our many new colleagues to the Technical University of Denmark. On January 1st 2007 DTU merged with the Risø National Laboratory, the Danish Institute for Fisheries Research, the Danish National Space Centre, the Danish Transport Research Institute and the National Food Institute, making the University even stronger. The Department of Chemical Engineering is looking forward to strong interactions in the future.

I wish you all inspiring and pleasant reading



Kim Dam-Johansen
Professor, Head of Department



Advisory Board



Executive Vice President
Per Falholt,
Novozymes A/S

In terms of industrial collaboration KT is at the front line and our co-operation is exemplary. To Novozymes it is very important that possible future technologies are developed and tested within a university framework where new valuable employees get their education and where real solutions to major challenges to society are found. KT fully answers these demands, benefiting both society and Novozymes.



Vice President
Knud Petersen,
DONG Energy

Over the last 20 years a strong platform for cooperation has been established between KT and the Danish energy sector, creating stability and competitiveness and allowing for fine-tuning of research in new areas benefiting both Dong Energy and KT. This collaboration ensures an ongoing dialogue between researchers and employees in the energy sector and has significantly optimized efficiency in the sector.



Vice President
Allan Skov,
Cheminova A/S

Excellence in education and research is a precondition for Danish industry to stay competitive in the harsh environment of international business today. KT's contributions in these fields are important for society in general and instrumental for the continuing development of Cheminova.



Executive Vice President
Lars Bang,
H. Lundbeck A/S

Scientific research at university level is a prerequisite for the development of Lundbeck's chemical activities in Denmark. We have had a beneficial cooperation with KT for several years, collaborating on PhD projects and recruiting several of its candidates. Furthermore, it has been a great advantage to be able to draw on the knowledge of KT's scientific staff as advisors/consultants.



Director of
Research & Development
Bjerne Clausen,
Haldor Topsøe A/S

Working closely with the best research groups within the fields of our core competences is of major importance to Haldor Topsøe A/S. Our cooperation with KT enables us to resolve research challenges beyond our competences and resources and is an important source of inspiration and knowledge for employees at Haldor Topsøe, benefiting their own and the company's development.



Vice President, Technical
Division and R&D
Kim Pandrup Christensen,
FLSmidth A/S

FLSmidth's close cooperation with KT ensures focused and long-term emphasis on development and innovation, both core elements in FLSmidth's strategy to keep a leading position in the market.



1. Klavs Flemming Jensen, Professor of Materials Science and Engineering and Lamont du Pont Professor of Massachusetts Institute of Technology (MIT), was conferred the honorary degree „doctor technices honoris causa” at DTU.

Highlights 2006

26-28 January

55 delegates mainly from the Nordic countries participated in The 13th Nordic Process Control Workshop (NPCW), organized by CAPEC at DTU. On this occasion Professor Manfred Morari (ETH-Zürich) received the prestigious Nordic Process Control Award for his many contributions in the area of Process Control. Professor Morari also gave an award lecture entitled "Beyond Process Control"

14 February

Mario R. Eden, graduate from the Department, now Assistant Professor at Auburn University, USA, was awarded the US National Science Foundation's CAREER Award. Our congratulations to Mario and Auburn University!

22. march 06

Associate Professor Søren Kiil received the annual Statoil-price, 100.000 DKK, for his research in develop-

ment of new efficient and environmentally friendly antifouling coatings. The core of Søren Kiil's research is developing mathematical models making it possible to achieve detailed knowledge about product behaviour. Søren Kiil's research partner is the company Hempel A/S, manufacturer of antifouling coatings

6 April

The Ministry of Science and Technology visited the pilot plant in building 228

27 April

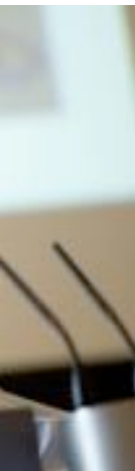
Departmental Seminar by Professor Klavs F. Jensen from Massachusetts Institute of Technology, Cambridge on the subject, "Reaction Engineering at the Interfaces to Chemistry, Materials, and Biology"

28 April

Professor Erling H. Stenby gave an invited speech at the DTU Annual Party "De sidste 77% – Danmarks olie" ("The last 77% – Denmark's oil")

28 April

Professor Klavs F. Jensen was conferred the degree "doctor technices honoris causa" at DTU



2-5. The second Danish conference for chemical engineers, dk₂, was hosted by the Department of Chemical Engineering, DTU from May 31-June 2, 2006. Altogether 250 people participated in the conference, of whom about 160 came from the Danish chemical, biotechnological, pharmaceutical and energy related industries. **3.** Group Chief Executive Anders Eldrup, DONG Energy A/S, was one of the speakers at the dk₂ conference. **4.** In his keynote speech at dk₂ Rector of DTU, Lars Pallesen, spoke about the challenges for Danish chemical engineers in a globalized world.

15 May-14 August

Regent's Professor Paul Marshall from University of North Texas, USA visited KT. The visit was funded by a grant from the Otto Mønsted's Fond

31 May-2 June

dk₂ Conference

The Danish Chemical Engineering Conference was held with great success for the second time from May 31 – June 2, 2006. Altogether 250 people participated in the conference, of which about 160 came from the Danish chemical, biotechnological, pharmaceutical and energy related industries. The conference featured 16 invited talks in six plenary sessions from industry and academic leaders. Globalisation was a central theme in the plenary sessions. Sixty talks, mostly submitted by industry, were given in four parallel sessions. A poster session with 50 posters was held in "Oticonsalen" showcasing mainly PhD research

4-6 June

The CAPEC Annual Meeting 2006 had 69 participants, of whom 30 were member company representatives, 8 were invited guests and the rest were CAPEC co-workers. The response from the questionnaire related

to the meeting has been summarized. We are happy to note that the general level of satisfaction on almost all issues was very high

12 June

Departmental Seminar by Professor John P. O'Connell from University of Virginia on the subject, "Process and properties modeling of thermo chemical production of hydrogen from water"

13 June

The CHEC research centre hosted its Annual Meeting at DTU together with more than 60 invited guests from partner companies and sponsors

14 June

Symposium for Professor John Villadsen, "A pioneer in chemical and biochemical engineering turns 70"

26-28 June

The IVC-SEP held its annual Discussion Meeting. The venue was LO-skolen in Elsinore. Like previous years a number of members of the IVC-SEP international Consortium participated together with collaborators from Danish and international companies



1. More than 300 employees, former employees, students, cooperating partners and family members celebrated our new laboratories during the 'Open House' day in september. **2.** Funny and educative experiments shown in the laboratories were a great hit for the kids at the 'Open House' event.

28 June-1 July

The "22nd European Symposium on Applied Thermodynamic" took place at LO-skolen. 120 participants from 22 countries, 5 of these from outside Europe. The conference included more than 40 oral presentations; 7 from different industrial participants. Two poster sessions were also part of the conference and for the first time in the history of ESAT, the ESAT award was given to the best poster presented by a PhD student. The award was sponsored by Mærsk Oil and Gas and was given to PhD student Eirini Karakatsani for her work within the SAFT model for complex mixtures

30 June

MSc student Søren Prip Beier was awarded DKK 2,500 for the best master project in 2005 awarded by the DTU Foundation of Technical Chemistry. Søren carried out an exam project under "Dynamic Membrane Filtration" with Prof. Gunnar Jonsson as his supervisor

1 August

Professor Anne S. Meyer took over the Novo Nordisk Foundation Chair as new Director of Center for Bioprocess Engineering. Anne S. Meyer's research focuses on the development of optimized food ingredients, prebiotics and design of new bio-processes

6 -11 August

Associate Professor Peter Glarborg gave an Invited Plenary Lecture at the 31st International Symposium on Combustion, Heidelberg : "Hidden Interactions: Trace Species Governing Combustion and Emissions"

3 September-

The program for continuous two-way faculty exchange between the Department of Chemical Engineering at DTU and University of Wisconsin, Madison was initiated in 2006 with the exchange of Associate Professor Manos Mavrikakis and Associate Professor Kaj Thomsen

13-15 September

Professor Rafiqul Gani gave a 3-days intensive course at the Lappeenranta University of Technology, Lappeenranta, Finland

15 September

The "Open House" arrangement was a great success. More than 300 people, i.e. employees, former employees, students, cooperating partners, and family members celebrated our new laboratories. Funny and educative experiments were shown in our laboratories, and a "jumping castle" was a great hit for the kids, as was the Mexican food for the grown-ups



3+4. The Departmental Annual Seminar and Christmas meeting held in KolleKolle in Værløse was a great success and gave inspiration to new strategic goals of the Department.

22 September

Professor Erling H. Stenby was elected chairman of the Collaborative Project on Enhanced Oil Recovery under the International Energy Agency. 12 nations from around the world participate in this collaboration

25-29 September

Professor Rafiqul Gani gave a course on Process Simulation and Design to MSc-level students of the Petroleum and Petrochemical College, at Chulalongkorn University, Bangkok, Thailand

3-6 October

Professor Rafiqul Gani gave a plenary lecture on "Systematic Computer-Aided Technologies for use in Formulated Chemical Product Design" at the 4th World Congress on Emulsions in Lyon, France

26-27 October

Professor Erling H. Stenby gave a two day course on "Phase behavior of Petroleum Fluids" at the Center for Integrated Petroleum Research, University of Bergen, Norway

2 November

The Annual Day of the Graduate School of Polymer Science had 40 participants from Danish industry and

academia. 10 young scientists gave presentations on current research issues. The invited lecturer was F. C. MacKintosh of Vrije Universiteit, Amsterdam, The Netherlands, who talked on "Viscoelasticity of cytoskeletal biopolymer solutions and networks: polymer physics and the cell

2 November

The Danish Polymer Centre hosted the inaugural meeting of the Industrial Consortium of Polymer Research. Ten companies participated

27 November

Steen Christensen, PhD student from CAPEC, won "The Third Industrial Fluid Properties Simulation Challenge" in the category 'State Conditions Transferability'

29 November

Departmental Seminar by Associate Professor Manos Mavrikakis on the subject, "Theory and experiments for advancing transition metal catalysts design"

8 December

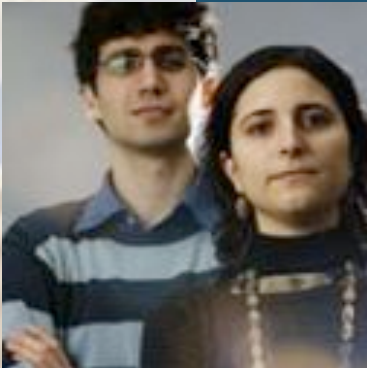
The Departmental Annual Christmas Seminar was held at KolleKolle in Værløse with success and gave inspiration to new strategic goals of the Department



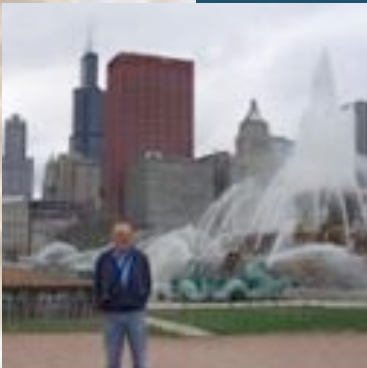
Education

Strategic goal:

'In close interaction with Danish and international industry the Department shall continue to ensure optimum career prospects for our graduates'.



They came, they learned and they got a job – in Denmark



Cross-atlantic insight and inspiration





Arnau Oliver González
and Mireia Fontarnau
Vilaro both came from
the Universitat Politècnica
de Catalunya (UPC) in
Barcelona to KT in 2004.
Both later found jobs in
Danish companies

They came, they learned and they got a job – in Denmark

Mireia and Arnau both studied earlier at the Universitat Politècnica de Catalunya (UPC) in Barcelona and shared a wish to do parts of their studies abroad. Both came to the Department of Chemical Engineering (KT), DTU in 2004:

"KT was one of the few departments where I could study in English," says Arnau who took his MSc here, "I checked the university, and everybody said that KT was a very interesting department."

"KT was recommended to me by a professor at my home University," says Mireia who also gives weight to the teaching in English at KT. She did her Master Thesis at KT and both she and Arnau got contracts with Danish companies even before they finished their studies in the summer of 2006. Arnau got a job at Haldor Topsoe and Mireia at FLSmidth.

Alfredo Zolin from Costa Rica met his later-to-be wife from the Faroe Islands in 1988 and after they settled in Denmark it seemed a natural step for him to continue his studies in Chemical Engineering at DTU. He finished his PhD in 2000 and after some years at Rockwool International A/S he today works for Haldor Topsoe A/S. To Alfredo the most valued quality in Danish company culture is the flat management structure:

"You feel that you can make a difference and the decision-taking process often seems very straight forward. The manager or supervisor seems almost as an extra colleague rather than a chief-in-command personality," says Alfredo.

"Danish companies are very internationally oriented," says Arnau, "they have to be because the Danish market is so small. This is why you find some very interesting Chemical Engineering companies in Denmark with important international projects."

Mireia emphasizes the resources of the Danish companies: "There are so many pilot plants and testing facilities – they have very good technology which they develop, use and improve themselves. The research and development departments in the companies are very important here. That makes Danish companies number one in inventing," she says.

When Alfredo came to Denmark in the early 90'ties there weren't many foreigners employed in Denmark. "You felt sometimes that you didn't fit in," he says, "but nowadays it is completely different. Companies appear to be proud of having many different nationalities represented."

Mireia and Arnau see the language barrier as the biggest obstacle when you start working as a foreigner in Denmark. But they both agree that their employers are very aware of this issue. Both are offered private lessons in Danish. "And everyone here speaks English of course," Arnau adds.

Asked about keywords for future progress of Danish companies in the field of chemical engineering both Alfredo, Arnau and Mireia mention creativity:

"In the future we will see a bigger focus in those areas where creativity is transformed into saleable intangible assets. Companies who know how to deal and protect such assets will have a competitive edge, and this yields great opportunities for companies in Denmark," says Alfredo.

"Danish and European companies will have to be one step ahead in making great inventions," says Arnau, "know-how and knowledge will continue to be the key values."

Exchange Program between KT and University of Wisconsin, Madison:

Cross-atlantic insight and inspiration

From August to December 2006 Associate Professor Kaj Thomsen, Department of Chemical Engineering, DTU (KT) was a visiting Professor at The Department of Chemical Engineering at the University of Wisconsin, Madison USA. Meanwhile, his colleague Manos Mavrikakis, Associate Professor at the University of Wisconsin, was a visiting Professor at KT. Thomsen and Mavrikakis were the first to endeavour in a new exchange program between the Chemical Engineering Departments of the two universities.

The exchange program was initiated from the management of the universities and the departments. The implementator of the exchange program is Professor Ole Hassager of KT who has maintained a close connection to the University of Wisconsin since he finished his PhD there in 1973. Later Hassager co-wrote the two volume book 'Dynamics of Polymeric Liquids' with his PhD supervisor at the University of Wisconsin Robert Byron Bird and his fellow student R. C. Armstrong.

Hassager was a guest professor at the University of Wisconsin in the 80'es and in 2005 he engineered the exchange program in which Thomsen and Mavrikakis were the first to be 'swapped over' across the atlantic. "Basically the program is an opportunity for teachers to find inspiration and gain insight into other educational methods," says Ole Hassager.

Kaj Thomsen agrees:

"The semester in Wisconsin gave me a new perspective and a chance to reflect," he says, "the areas we work with in KT and Wisconsin are different but complement each other, making the exchange program a source of great mutual benefit."

Meeting the elite

Unlike conditions at KT, Wisconsin students are presented with obligatory papers for homework. This is one of the features which caught Thomsens interest and now he is about to see it adopted by KT – a perfect example of how the exchange program can breed inspiration and exchange of methods.

"Another thing worth importing could be the weekly seminars held at the Department in Wisconsin – every Tuesday between 4 and 5 PM there would be a seminar at campus featuring highly esteemed researchers who were flown in from all over USA," says Thomsen.

The trip to Wisconsin gave Kaj Thomsen a chance to dine and discuss with one of the worlds leading capacities in his field when Edwin N. Lightfoot – co-author of the highly acclaimed educational textbook Transport Phenomena – invited him to his house north of Madison.



Kaj Thomsen in front of the University of Wisconsin, Madison



On the purest professional level the trip to Wisconsin was a welcome opportunity for Kaj Thomsen to collect notes and material within the field of his course: 'Introduction to the Thermodynamics of Aqueous Electrolytes'.

KT reaching out internationally

"I brought back a pile of notes and I plan to elaborate on this material and eventually publish a textbook since none exists so far in this field which becomes more and more important," says Kaj Thomsen who overall is extremely pleased with his guest visit abroad: "Teaching at a department which is ranging among the absolute top in the USA adds value to my CV and

made me realize KT's strength in education, in research and international cooperation. I would go again on a later stage in my career if I got the chance," he says.

This exchange program is not the only collaborative effort currently taking place between the two universities: In August 2006 the Professors Juan de Pablo and Michael D. Graham from the University of Wisconsin gave a PhD course in Molecular and Mesoscopic Simulation of Complex Fluids at KT – yet an example of the ways KT benefit from reaching out internationally and exchanging knowledge, people and resources with other of the world's leading Chemical Engineering Departments.

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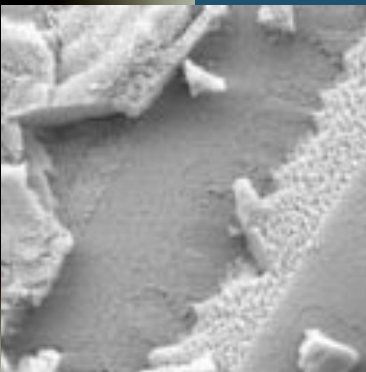
Research & Innovation

Strategic goal:

'The Department will ensure high quality of our research by stable funding, continuous development of research facilities, and by an extensive academic freedom with due respect for the overall department goals'.



Building a four-track highway for
Biotech Research



New research clarifies mechanisms of
SO₂ emission from cement production



The gloomy and the bright side
of aerosols



Professor Anne Strunge Meyer's research focuses on development of optimized food ingredients, pre-biotica and design of new bio-processes

Professor Anne S. Meyer, the Novo Nordisk Foundation Chair:

Building a four-track highway for Biotech Research

"I had a good start," Anne S. Meyer says with a smile. Indeed: Only a few months after she began tenure in the Novo Nordisk Foundations Chair in Bioprocess Engineering at the Department of Chemical Engineering, DTU (KT) in August 2006, Meyer received 20 million DKK in public funding for a prebiotics research center.

Not only will Anne Meyer as professor in the new Bioprocess Engineering Center at KT manage a research field which is brand new within the Department, she will also be in charge of a cross-disciplinary research program focusing on dietary fibres and new exciting processes for developing food ingredients which can strengthen our immune system and help prevent obesity.

The pioneering prebiotics research will be performed in the new DTU center called 'Biological Production of Prebiotics and Dietary Fibres' This research center is a collabo-

rative research effort between KT, BioCentrum-DTU, Herlev University Hospital and selected companies, and will be one of the three main research structures contained within KT's new Bioprocess Engineering Center. The other two are the Research Consortium 'Innovative Bioprocess Technology' and the Post-graduate School 'Novozymes Bioprocess Academy', respectively.

More importantly, the three units under the Bioprocess Engineering Center are intertwined in a matrix structure which engages companies operating in this field.

The overall goal of the BioProcess Engineering Center is to strengthen the synergy and cross-fertilization between the multi-disciplinary activities defining modern Bioprocess Engineering and notably to assist in carrying the research into practical use at mass production scale.

Bridging biotech research and mass production

The core of Anne Meyer's task is to carry both basic and more advanced research in biotechnology into practical use in the industry.

"In the past there was plenty of potential for biotech research to reach large scale production level within the industry. But experience has taught us that the lifting of the results to the level of actual mass production takes as much effort as does the provision of the fundamental research itself," Anne Meyer explains.

"Furthermore, the related companies have realized that there is a basic need for education in this field which DTU and in particular KT can fill."

"We need dialogue between research and industry. There are important criteria for cost and production efficiency which must be met in order for the research to succeed on a mass production scale."

"It's a balance," says Anne Meyer, "on the one hand it is vital that the research is geared towards being pre-competitive and of fundamental significance, on the other hand the research has to be relevant for industrial applications. Fortunately I have the notion that a very fine – and I believe unique – tradition has been established in this Department, where the companies not only engage but are also supportive and involved even when we do the most basic research."

KT supplies the technical skills

Anne Meyer sees KT as the ideal environment for strengthening the bridge between fundamental biotech research and production on a larger, industrial scale.

"KT has the required know-how when it comes to developing, building and implementing the specific technical

solutions," says Anne Meyer, "technical and biological research must go hand in hand if our goals are to be reached. And there are huge challenges lying ahead in smoothing the road from lab research to production."

Research Director and member of KT's advisory board Per Falholt, Novozymes, has publicly expressed very positive views about how the Novozymes Bioprocess Academy has heightened the focus on research aimed at transferring biotech results from lab scale to industrial scale within DTU. Novozymes funds 50% of the Academy, a fact which Meyer calls "a saline injection to the entire research area."

"With DTU highlighting this field we are going to attract more and more leading researchers from abroad," says Anne Meyer, "International cooperation is something we give the highest priority and on the same note we want to create solutions that are valid and usable way beyond the Danish borders. We are very ambitious about this."

"And we know for a fact that those who come here to be educated for an MSc or PhD degree – they get a job right away afterwards."

During 2002 negotiations between Per Falholt, R&D Director of Novozymes A/S and Professor Kim Dam-Johansen, Head of the Department of Chemical Engineering successfully resulted in the establishment of The Novozymes Bioprocess Academy. On this basis the Center for BioProcess Engineering was launched in February 2004 in close cooperation between KT and BioCentrum. The object was to provide a strong platform for Biotech-related research and education. Professor John Villadsen was the first to hold the Novo Nordisk Foundations Chair and when Anne S. Meyer took over in August 2006 she stated in her inauguration speech: "The vision is to make DTU an international leader in application of quantitative principles of Enzyme Technology, design of new enzyme based processes and production and formulation of enzymes."

New research clarifies mechanisms of SO₂ emission from cement production

SO₂ is formed and released into the atmosphere during cement production at places where the raw materials contain impurities of sulfur. With the huge number of cement plants in the world – there are about 300 in Europe alone – the pollution caused by the SO₂ released from cement production is substantial.

Though cement production in rotary kilns began in the early 19th century and plants are found today all over the world, very little has been known about the detailed mechanisms of SO_2 emission from the production process. Recent research done by PhD student Guilin Hu at the Department of Chemical Engineering (KT), DTU has to a high degree clarified the underlying chemical mechanisms that are responsible for the SO_2 emission, an important progress in the efforts to limit/eliminate SO_2 emissions from cement industry.



Guilin Hu's research showed that the sulfation of limestone involves oriented nucleation and growth of the solid product. The formed product grains are usually in nano size. The above SEM image demonstrates this phenomenon. The formation of these grains of the solid product has been shown to influence the sulfation kinetics significantly.

SO₂ emission from cement production is caused by oxidation of sulfur contained in the raw materials, mostly in the form of pyrite, as the raw materials are heated in the process. The SO₂ emission level, though being different from plant to plant because of variations in raw material qualities and process conditions, can often be as high as several thousand mg/Nm³.

Guilin Hu began his PhD project about SO_2 emission from cement production in 2004. In this project, through thorough literature studies and experimental work, he has clarified the general mechanisms of pyrite oxidation and limestone sulfation – the two major reactions that determine the SO_2 emission from a cement production process. He found for example that the sulfation of limestone involves oriented nucleation and growth of calcium sulfate crystals – the solid product.

Limestone sulfation has a relatively fast initial reaction rate, which however drops dramatically with increasing conversion. The fast drop in reaction rate is found to be caused by the significant influence of solid-state diffusion and the shielding of limestone surface by the product crystals,” explains Guilin Hu.

"The findings in this project explain a lot of phenomena related to pyrite oxidation and limestone sulfation which have not been particular well understood before. One of the important achievements in the project is the determination of the initial kinetics of limestone sulfation which is important for SO₂ absorption in a cement production process as the contact time between the SO₂ polluted gases and the calcium containing raw material particles is within only 10-20 seconds. It is the first time the initial sulfation kinetics has been experimentally measured. Compared to the extrapolated values from the data of long-duration sulfation



PhD student Guilin Hu working at the pilot reactor at KT

reported in the literature, the measured initial rates are actually up to about 100 times faster.”

The study of the initial kinetics of limestone sulfation was carried out in a pilot reactor built particularly for this purpose during Guilin Hu’s PhD study. The building of this advanced pilot reactor was done in close cooperation with FLSmidth A/S and with financial support from the company.

”In the beginning of 2006, after more than one year’s efforts with the help from technical staffs from both the CHEC research group and the workshop of the Department, the reactor was successfully installed and taken into use. This new reactor permits us to study limestone sulfation with a residence time shorter than 0.1 second. The study of initial kinetics in such a short reaction time is often impossible in a traditional reactors.”

”With this new pilot reactor – in addition to the study of limestone sulfation kinetics – we can also study

SO₂ emission with real raw materials under conditions very close to those in an industrial cyclone preheater,” explains Guilin Hu.

Today, SO₂ emissions from cement production are restricted more and more by legislations. In the EU, an emission level around 200-600 mg/Nm³ (at 10% O₂) is generally imposed for new plants. The abatement of SO₂ emission is thus a serious challenge to the cement industry in the near future. The findings obtained in Guilin Hu’s PhD study provide background knowledge for the development of effective and economically sound methods for limiting/eliminating SO₂ emission from cement production.

Guilin Hu’s work is part of the CHEC (Combustion and Harmful Emission Control) Research Center and is financially supported by DTU and FLSmidth A/S. PhD supervisors are Kim Dam-Johansen and Stig Wedel, KT, and Jens-Peter Hansen, FLSmidth.





Pinoneering Nano Space at KT:

The gloomy and the bright side of aerosols

Small means dangerous – as far as particles are concerned. Aerosols are particles in the size-range from 2.5 micrometer to a few nanometres. Our atmosphere is full of them and most derive from natural sources like volcanos, dust storms, forest fires and sea spray, but some 10% of aerosols have human origin and can be found e. g. in flue gases from power plants and combustion engines.

In the early nineties, American authorities warned about the potential health risks related to aerosols. To Hans Livbjerg, Associate Professor at the Department of Chemical Engineering, DTU (KT), these early warnings triggered a long journey into the nano-world.

”Danish companies got worried about potential aerosol hazards in the wake of the American alert and wanted us to examine the amount and role of aerosols in different processes in which they were engaged,” says Hans Livbjerg who has been heading the aerosol activities at KT since the early nineties.

”it turned out that no research at university level was carried out in this field in Denmark at the time so there was quite a lot of pioneer spirit behind the initial work. We started from scratch and soon realized that research in the field was done by huge research centres around the world and made contacts to researchers abroad, primarily from the USA and Finland,” says Livbjerg.



Associate Professor Hans Livbjerg,
Director of the Aerosol Laboratory

Bio mass – an aerosol culprit

1992-93 saw the launch of the first three PhD projects at KT related to aerosols. All three based on inquiries from Danish companies:

"The Danish companies with potential aerosol issues wanted to know specifically what types of aerosols they had in their processes or emitted to the atmosphere with the flue gases, and we started sampling in the field at a large scale to examine and measure the nano-particles," says Hans Livbjerg.

At that time the Danish power plants began firing with bio-mass which caused extensive aerosol emission. In cooperation with the Danish power companies, FLS Miljø A/S and Risø National Lab, Hans Livbjerg and colleagues from the CHEC Centre at KT engaged themselves in huge measuring campaigns. Today aerosols emitted from Danish power plants are no longer unknown sub-microscopic territory:

"Our contribution was to specify the amount of aerosol pollution by measuring the amount and size of emitted nano-particles. It was discovered that the conventional electro filters used in power plants are inadequate when it comes to removing aerosols."

"These filters may remove 99,9% of the total particle mass, but more than 20% of the very small particles pass right through. Almost all particles which pass the filters are of submicron size," says Hans Livbjerg, who believes that the only way ahead is to optimize the efficiency of the filters.

In 1995, the Aerosol Laboratory was founded and in 1997 the industry focus on aerosols sharpened when American authorities introduced a special regulation for aerosol particles less than 2.5 microns in size.

The American model establishes a time frame of 15 years for research and investigation into the regional distribution of the aerosol pollution before any regulations effectively become imbued on companies. The EU also has tighter regulations for aerosol gases in the molding. It all adds up to the fact that authorities will begin to clamp down on local sources of aerosol pollution within the next few years and the focus on

aerosol-issues will undoubtedly intensify over the coming 10-20 years.

The bright side of Aerosols

The tricky thing about aerosols is that they are not poisonous due to their material properties – these particles are dangerous simply because of their small size. No matter what substance the particle is made of, if it is small enough it can enter the bloodstream directly via the lungs. According to Hans Livbjerg the only way forward is to minimize the emission of man-made nano-particles to the atmosphere by improving the filtering methods and optimizing the chemical and combustion processes that generate the particles.

But aerosols are not just bad news. If produced and handled in the right way they can be extremely useful. Since 1999 The Aerosol Laboratory activities have embraced a different aspect of aerosols and has been researching and developing the so-called 'Constructive Aerosol Technologies'.

"We concluded that if undesired aerosols were a result of combustion, then combustion could be reversed to a source for useful nano-particles for use in the production of certain materials," explains Hans Livbjerg, "if you can produce particles around the size of 10 nanometers you'll get material with a very large surface which in turn can be used to create tiny membranes with very small pores. And these membranes can be used to filter nanosize particles."

The Aerosol laboratory is underway with a range of patents in this very promising field. Overall research

in the aerosol field has made immense progress since Hans Livbjerg and colleague Stig Wedel started out in 1992 – later joined by Tue Johannessen. The CHEC Centre, which has cooperated closely with the Aerosol Laboratory since the early days of aerosol research at KT, will take charge of the field when Hans Livbjerg retires in August of 2007.

"A process has been started and the focus on this area will definitely increase over the coming years, so it is important that the Department continues the research," says Hans Livbjerg.

How the mystery behind blue smoke was solved

When sulphur dioxide and ammonia are mixed in a flue gas small particles of ammonium sulphate can be formed. A huge power plant in Mannheim, Germany was shut down as a direct result of blue smoke. When this phenomenon was investigated in the lab some peculiar results came out: At certain times of the day the formation of sulphate would be substantial, at other times there was no formation. "We discovered that the sulphate production was immense when – and only when – there was sunlight," says Hans Livbjerg. "We attributed the effect to the presence of ultraviolet rays. This was confirmed through experiments."

By their unique discovery the Aerosol Laboratory researchers clarified the mechanisms behind the formation of aerosols present in smoke gas from power plants where SO_2 is washed away with ammonia: Ultraviolet light will oxidate SO_2 into sulphate thus creating a characteristic blue plume of smoke.



Organization

Strategic goal:

'The organization of the Department shall be continuously adjusted with the purpose of providing – at any time – modern and dynamic education and research, and with the purpose of running an attractive and efficient organization.'



CHEC | IVC-SEP



CAPEC | DPC.DTU



Aerosol | BioProcess Engineering



Administration & Technical Support



A vital part of our research is conducted in very close collaboration with industrial enterprises and international research organizations.

The industrial relations cover close joint projects with mutual exchange of staff and cooperation on experimental research ranging from microscale over pilot plants to full-scale industrial production plants. This approach ensures high relevance of our research and efficient exchange of technology and know-how.

Kim Dam-Johansen, Director of CHEC

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Director, Professor Kim Dam-Johansen | kdj@kt.dtu.dk | Phone: +45 4525 2845

Associate Professor Peter Glarborg | pgl@kt.dtu.dk | Phone: +45 4525 2840

CHEC

Combustion and Harmful Emission Control – the CHEC Research Centre

CHEC is an internationally recognized research centre mainly in the field of Chemical Reaction Engineering and Combustion, emphasizing on high-temperature processes, formation and control of harmful emissions and product design.

The research approach involves a combination of modeling and experimental work. Experiments are conducted over scales ranging from small laboratory reactors to full-scale industrial units.

The models typically combine a generic description of the chemical reaction system with a process-specific flow description, and are used to analyze and extrapolate the experimental data, and to provide input for design and optimization.

The work is conducted in collaboration with enterprises and a range of national and international research organizations.

The new field of Product Design covers quantitative formulation engineering using traditional Chemical Engineering methods in the design of products, e.g. granular enzymatic products, and controlled release systems in different fields, a.o. paint technology and pharmaceuticals.

Waste fuel utilization, methods to reduce CO₂ emissions and production of liquid fuel from biomass have received gradually increasing attention in the CHEC Research Centre over the last years. The work is directed towards pyrolysis of biomass, oxyfuel combustion, gasification, methanol production and bioethanol production.

The CHEC Research Centre collaborates with the following industrial partners

Babcock & Wilcox Vølund ApS
B&W Energy A/S
Danish Gas Technology Center A/S
Dong Energy A/S
Energinet.dk
F.L. Smidth A/S
H. Lundbeck A/S
Haldor Topsøe A/S
Hempel A/S
MAN Diesel A/S
Morsø A/S
Novozymes A/S
Vattenfall A/S

The industrial support is supplemented with funding from these organizations

DTU
Nordic Energy Research
The Danish Council for Technology and Innovation
The Danish Research Training Council
The European Union
The Public Service Obligation Programme



For more than 25 years the IVC-SEP has been a leading research group in the area of applied thermodynamics. In close collaboration with industry, relevant authorities and research organizations, the research of IVC-SEP is implemented in industrial products and processes, and has generated a number of spin-off companies, patents and commercial software.

We believe in the power of knowledge transfer and we commit ourselves to generate research and education to the benefit of society. We strive to continue the proud traditions and excellent performance of the past.

Erling H. Stenby, Director of IVC-SEP

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Director, Professor Erling H. Stenby | ehs@kt.dtu.dk | Phone: +45 4525 2875

IVC-SEP

Centre for Phase Equilibria and Separation Processes (IVC-SEP)

The IVC-SEP is a dynamic research group with an excellent track record and international reputation in the areas of applied thermodynamics, transport processes, and mathematical modeling. With seven tenured faculty members the centre covers several topics and both experimental and theoretical research.

Currently, the main activities of the centre are in the areas of complex solutions (including polymers, electrolytes, peptides, and associating chemicals), non-equilibrium thermodynamics (diffusion and thermo diffusion), petroleum chemistry at the molecular level, and finally simulation of petroleum recovery processes (from the pore to reservoir scale). Furthermore the centre is active in several research projects of strategic importance such as CO₂ capture and sequestration and Enhanced Oil Recovery (EOR).

The Industrial Consortium of IVC-SEP has existed for 25 years and continues to be a valuable asset for the research and education at the Department. Many companies support research projects in addition to the membership. For instance the CHGP project (Chemicals in Gas Processing) which is largely sponsored by industry (Total, Statoil, BP, and Maersk Oil and Gas).

Furthermore, IVC-SEP participates in a new major effort on the use of CO₂ for EOR in the Danish North Sea. This is a collaboration with DONG Energy, supported by The Danish National Advanced Technology Foundation.

Many students get their first contact to the Danish or international industry through a project in IVC-SEP. In addition to research funding the Consortium members

provide experimental data, samples, and fruitful feedback to the centre.

One highlight from 2006 was that new funding enabled the center to initiate two PhD projects and employ one Post Doctoral fellow in the area of gas hydrates.

In 2006 the Consortium of IVC-SEP consisted of the following members

Akzo Nobel (S)
Baker Petrolite (USA)
BP (UK)
Chevron (USA)
DONG Energy A/S (DK)
Eni Agip (I)
Exxon Mobil (USA)
Gaz de France (F)
Haldor Topsøe (DK)
Institut Français du Pétrole (F)
Kommune Kemi (DK)
Linde (D)
Mærsk Olie og Gas A/S (DK)
Norsk Hydro (N)
OMV (AUT)
Petrobras (BRA)
Polimeri Europa (I)
RWE Dea (D)
Shell Global Solutions (NL)
SQM (Chile)
Statoil (N)
Total (F)
Vattenfall A/S (S)



Briefly, the research objectives of CAPEC are to develop computer-aided systems for process simulation, process/product synthesis, design, analysis and control/operation principally suitable for chemical, petrochemical/oil, pharmaceutical and biochemical industries.

Our computer-aided systems are developed on the basis of fundamental modeling studies that incorporate correlation and estimation of thermo-physical and phase equilibrium properties as well as modeling of the underlying phenomena/behavior of the processes and operations.

Rafiqul Gani, Director of CAPEC

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Director, Professor Rafiqul Gani | rag@kt.dtu.dk | Phone: +45 4525 2882

CAPEC

Computer Aided Process-Product Engineering Centre (CAPEC)

The CAPEC research centre applies a systems approach to develop comprehensive solutions to various industrial problems based on a thorough analysis of scientific issues and actual product/process requirements. The developed systematic methods are generic in character and therefore applicable to a wide range of problems in process and product engineering.

Additionally, the systems approach enables CAPEC to convert the developed methods into software tools for problem analysis and solution. Thus, the research at CAPEC has resulted in the development of a range of generic model-based techniques and their conversion into state of the art computer-aided tools for modeling, synthesis, design, operation, control and analysis – each method dedicated to systematic and efficient process/product engineering.

The research at CAPEC is organized into six research programs within a logical framework ranging from fundamental to applied research. Based on the fundamental modeling at the generic levels, computer-aided methods and tools are developed at the next (intermediate) levels for synthesis, design, analysis and control of process/product/operation. Again, these models, methods and tools are integrated in the final research levels, where end-user solutions are generated for the development of cleaner, safer and sustainable technologies.

Headed by Professor Rafiqul Gani, the CAPEC research centre constitutes a very distinct group of professors and associate professors, researchers, post-docs and PhD students that contribute to the joint activities of KT. Additionally, CAPEC usually hosts around 10 MSc and BSc students plus a varying number of visiting students and international visitors.

In 2006 CAPEC was supported by the following industrial consortium

Akzo-Nobel (NL)
Alfa Laval A/S (DK)
AstraZeneca (S)
Atomistix A/S (DK)
Avecia Pharmaceuticals (UK)
BASF (D)
Bayer AG (D)
ChemProcess Technologies (USA)
Danisco A/S (DK)
Data Physics Instruments GmbH (DE)
DSM (CH)
DuPont (USA)
Einar Willumsen A/S (DK)
Fantoft Process Tech. AS (N)
Firmenich (CH)
FLS-Automation A/S (DK)
FMC Corporation (USA)
GlaxoSmithKline (USA)
ICI Strategic Tech. Group (UK)
Instituto Mexicano del Petróleo (MX)
Invensys: SimSci-Esscor (USA)
Mitsubishi Chemical Corp. (JPN)
Neste Oil-Neste (SF)
Novozymes A/S (DK)
Optience (USA)
Petrobras (Brasil)
Processium (F)
ProSim SA (F)
Syngenta (UK)
Unilever (USA)



At the Danish Polymer Centre we are devoted to the application of molecular design, synthesis and processing of polymers to create materials and products with unlimited ranges of properties and applications.

We strive towards this goal in a balanced environment of education, research and industrial cooperation.

Ole Hassager, Director of DPC.DTU

www.kt.dtu.dk/dpc

Director, Professor Ole Hassager | oh@kt.dtu.dk | Phone: +45 4525 2973

DPC.DTU

The Danish Polymer Centre (DPC.DTU)

Organized within the Department of Chemical Engineering, the Department of Micro and Nanotechnology and the Department of Manufacturing Engineering and Management, the Danish Polymer Center (DPC.DTU) is an interdisciplinary center for polymer education, research and industrial cooperation. The main research areas are polymer chemistry, polymer physics, polymer technology and polymer fluid mechanics.

Equipped with state of the art instrumentation for polymer characterization, the laboratories at the DPC.DTU provide a common ground for polymer chemists, polymer physicists and chemical engineers. Current techniques include the synthesis with controlled molar mass, branching structure and functional groups, application of scattering methods for study of complex polymer systems, rheological characterization and the design of multi-phase systems.

MSc in Polymer Engineering

Students in the DTU masters program in Advanced and Applied Chemistry may specialize in Polymer Engineering. This will allow master students to be trained in our laboratories and engage in research at the DPC.DTU.

Research Consortium in Polymers at DTU

The basic purpose of this consortium which was established in 2006 is to ensure stability and continuity of contact and communication between the Polymer Centre at DTU and those parts of Danish industry, which commercially use polymers. The consortium will run a number of smaller research projects. The consortium will be a greenhouse for conceiving and innovating ideas and plans for future research and educational initiatives.

Graduate School of Polymer Science

Initiated in 2003, the Graduate School of Polymer

Science is a research education network between the Department of Chemical Engineering DTU, the Department of Chemistry at Aarhus University, Risø National Laboratory and associated industrial companies. Financial support to the DPC.DTU is provided by the Danish National Research Council, the European Union, the members of the Research Consortium in Polymers and the members of the Graduate School in Polymer Science.

Members of the Research Consortium in Polymers

Alfa Laval Nakskov A/S
Coloplast A/S
Dyrup A/S
Elektro-Isola A/S
Grundfos Management A/S
Hempel A/S
Nanon A/S
Novo Nordisk A/S
Radiometer Denmark A/S
Rockwool International A/S

Members of the Graduate School of Polymer Science

Aarhus University
Coloplast A/S
DTU
Elektro-Isola A/S
Grundfos A/S
NKT Research & Innovation A/S
Novo Nordisk A/S
Radiometer Denmark A/S
Teijin Twaron



Some research projects mainly involve students and faculty from the Chemical Engineering field but a majority of research projects benefit from cooperation between departments of DTU.

The basis for the majority of our material research is the continuous development/exploration of high-temperature processing of materials, but traditional areas like reaction engineering and models/-CFD-simulations are necessary fundamental tools for all projects.

Hans Livbjerg, Director of the Aerosol Laboratory

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Director, Associate Professor Hans Livbjerg | hl@kt.dtu.dk | Phone: +45 4525 2949

Aerosol

The Aerosol Laboratory

The Aerosol Laboratory was initiated in the 1990's due to an increased attention to undesired aerosol formation in industrial processes.

The centre applies aerosol dynamics in environmentally related projects, e.g. for investigation of formation and emission of sub-micron particles in coal-fired power plants. In addition, aerosol technology combined with fundamental knowledge in aerosol dynamics is used in high-temperature aerosol processes for the synthesis of nanoparticles, catalysts and composite metal oxides and for the preparation of ceramic membranes/-membrane reactors.

The Aerosol Group cooperate closely with other departments at DTU, especially Department of Chemistry and Department of Physics.

Research areas

- Flame-assisted aerosol routes for the manufacture of nanoparticles, nanostructured materials and ceramic membranes for catalytic applications
- Fuel cell technology and hydrogen storage
- Combustion aerosols: Theoretical and experimental
 - incl. field studies on full-scale power plants
 - analysis of processes for the formation of hazardous sub-micron particles
- Development and application of mathematical models for aerosol dynamics
- Analysis/design of reactors/processes by Computational Fluid Dynamics (CFD)

The Aerosol Laboratory cooperates with the following industrial partners

DONG Energy A/S

Energinet.dk

Haldor Topsøe A/S

IRD Fuel Cell A/S

Vattenfall A/S



The goal of the new Centre for BioProcess Engineering is to create a strong link between generic research and the industrial application of biotechnology.

The vision of the Centre is to provide new knowledge led principles for designing new biobased production processes and products. At the same time the objective is to hatch top-qualified MSc and PhD candidates through research based teaching and supervision. We hope that this twofold strategy will contribute to fulfilling the potential of biotechnology to substantially impact industrial production and thereby contribute to development of new, ingenious, and sustainable processes and products.

Anne S. Meyer, Director of BioProcess Engineering

Director, Professor Anne S. Meyer | am@kt.dtu.dk | Phone: +45 4525 2909

BioProcess Engineering

Centre for BioProcess Engineering is a new multidisciplinary research centre established at Department of Chemical Engineering in 2006. The centre operates at the interface between biotechnology and chemical product and process engineering. Particular focus areas include biocatalysis and application of biochemical reaction engineering principles for analysing, modeling, developing, and controlling industrial, biobased processes. The Centre for BioProcess Engineering hosts three larger research structures:

The Novozymes BioProcess Academy was established in 2002 with substantial support from Novozymes A/S. The overall mission of the Academy is to strengthen the integration of chemical engineering, processing technology, and biotechnology. The particular objective is to ensure the education of candidates having a firm knowledge of product and process engineering acquired both in the laboratory and in the pilot plant scale to the booming Danish biotech industry. Currently, 8 full-time, post-graduate students studying for the qualification of PhD as well as 4 MSc students are enrolled with the academy.

The Research Consortium "Innovative BioProcess Technology" was established in 2005 as a major research collaboration between Centre for Biochemical Engineering – a cooperation between The Department of Chemical Engineering and BioCentrum, DTU – and the three major Danish biobased companies: Novozymes A/S, Danisco A/S, and Chr. Hansen A/S. In this Research Consortium generic research tools are being developed to address three main goals with respect to Bioprocess development: I. Procuring the scientific basis for the process, II. Choosing the right process scheme, and III. Quantifying the pace of the biocatalytic events. This research effort will run for at least 5 years and educate at least 5 PhD, 1 post doc, and 10 MSc candidates.

Centre for Biological Production of Dietary Fibres and Prebiotics was established at the end of 2006. The objective is to design high value carbohydrate products having potential health benefits.

The majority of the above listed activities rest on extensive cooperation between The Dept. of Chemical Engineering and BioCentrum, DTU. BioProcess Engineering encompasses design of biologically based processes with a current emphasis on industrial processes involving biocatalytic transformations. Biotech is a spearhead industry in Denmark and several Danish biotech based industries are world leaders in their respective fields. Thus, on a global scale, Danish processes and products contribute to improved value, health, welfare, cleaner and more environmentally friendly processes while at the same time generating new jobs. Via an academically driven research effort focusing on the generic problems of industrial production it is the mission of the Centre for BioProcess Engineering to positively enhance the transfer of new research from the laboratories to actual industrial implementation.

Centre for BioChemical Engineering cooperates with the following industrial partners

Chr. Hansen A/S

Danisco A/S

Foss Analytical A/S

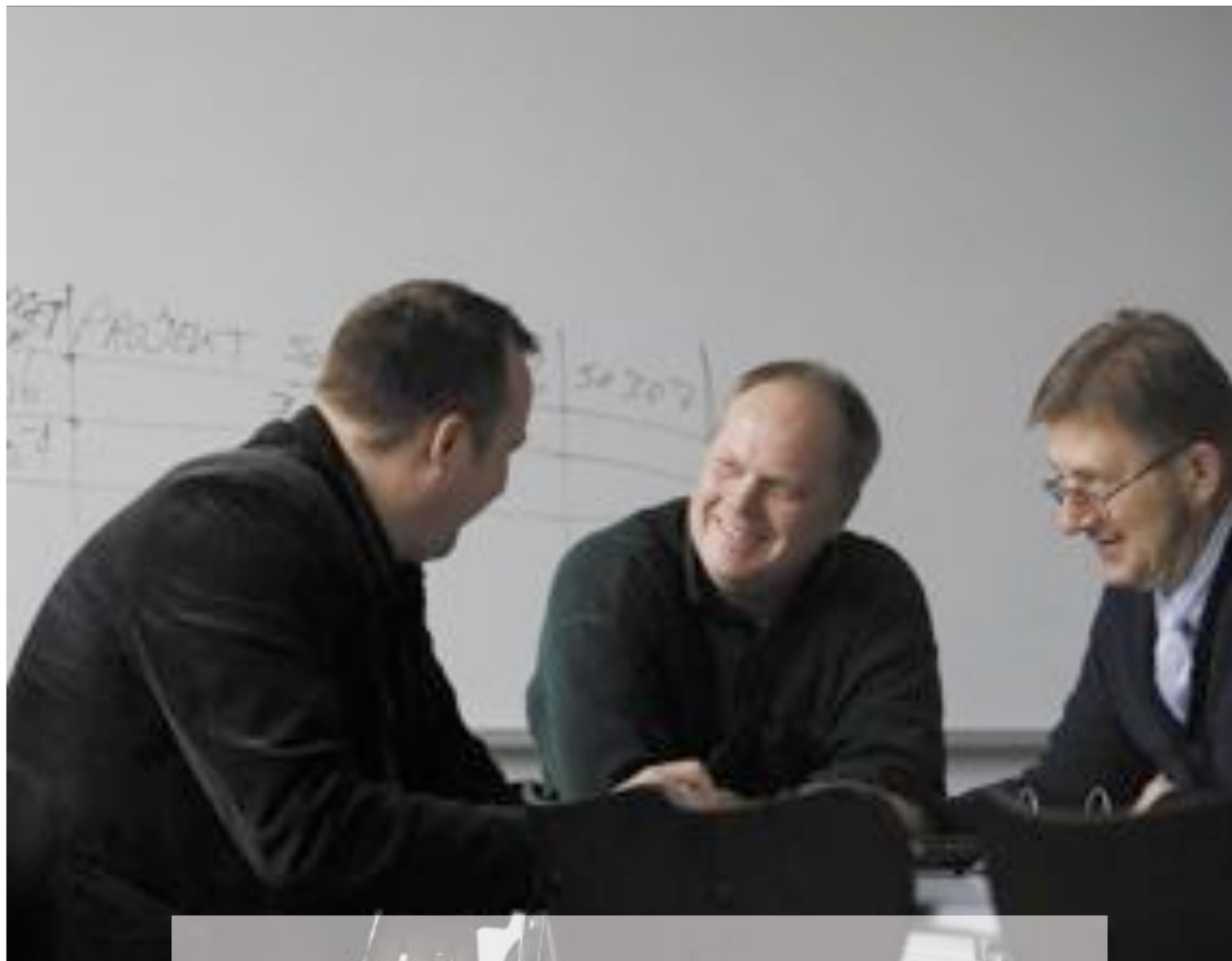
Iso Mix A/S

Lykkeby Stärkelsen Amba (Sverige)

Novo Nordisk A/S

Novozymes A/S

Vallø Saft A/S



Our support units provide important services for students, teachers and researchers and are responsible for the full array of technical and administrative functions at the Department.

You will find some remarkable people working as support staff at the Department of Chemical Engineering. Our team enjoys its work and benefits from relationships marked by trust and team spirit, both within our department and with our colleagues throughout the Technical University of Denmark.

May Brandt, MBA, Head of Administration

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Administration & Technical Support

Support Staff

Innovative teaching, research and consulting require the support of professional services. Our high-quality services enable us to deliver excellent education and project work.

Working in our support units means being a strong partner for our students, teachers and research teams, and accompanying them throughout all phases of their work.

Finances and Administration

Efficient support from our people in accounting, finances and the administrative functions plays an important role within our department. We provide services in many different areas, including financial accounting, project administration, budget consolidation, forecasts, controlling, contracts, travel expense accounting, facility management and general administration.

Corporate Communication

Our webeditor ensures that our website meet our high standards with respect to design and business communication, and writes up the latest company news in our corporate website and annual reports.

Service and Planning

The secretaries are the first point of contact for students, partners and colleagues alike. They handle a multitude of inquiries, information, and tasks, and even under pressure they never lose their diplomatic touch. They play a major role in ensuring that a wide range of internal processes run smoothly.

Information Technology Services

The focus of this unit is knowledge management (databases), IT consulting, IT solutions and support which include ordering, installing, and configuring hardware and software, as well as maintaining the IT back office.

Workshop

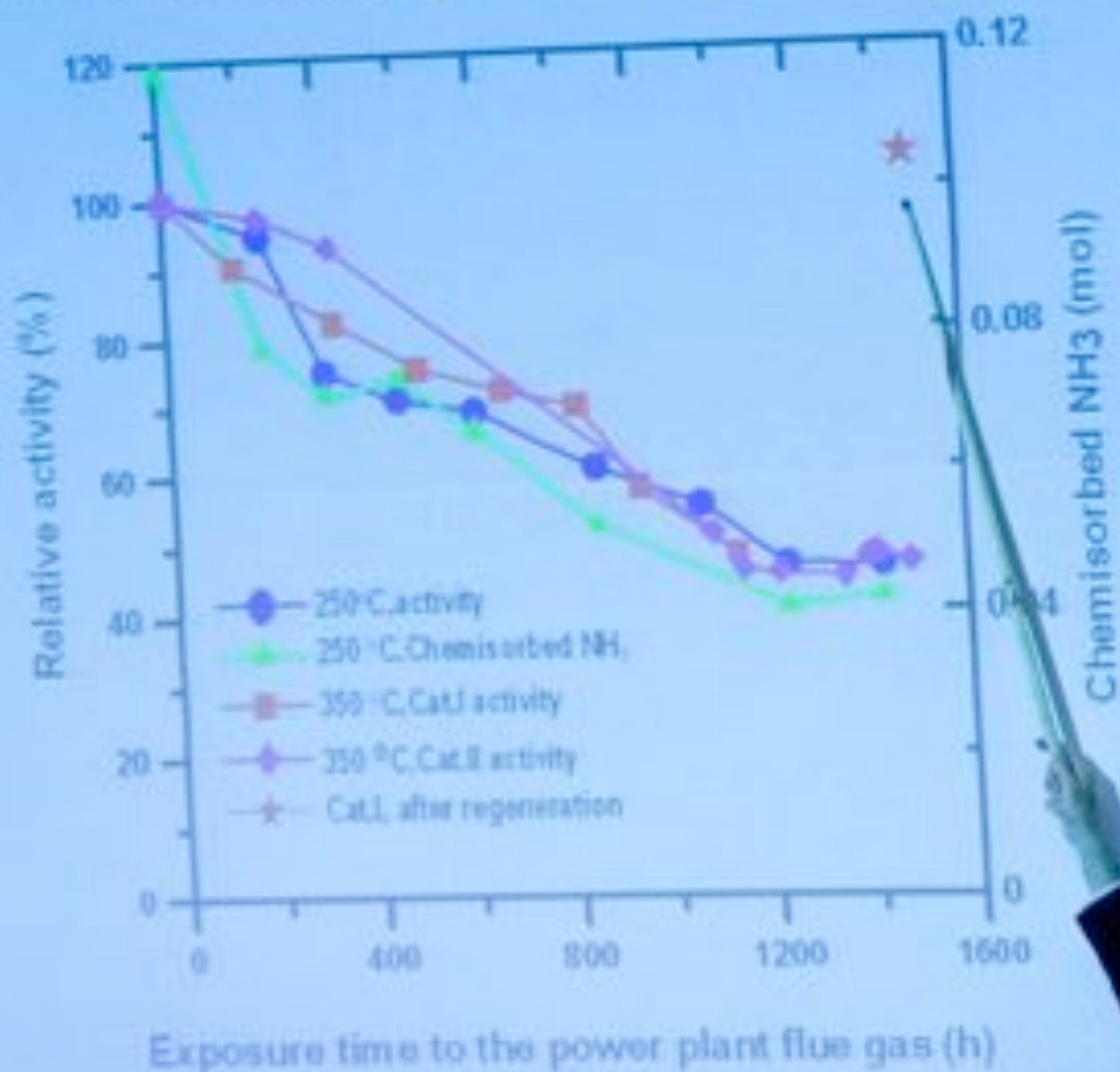
Craftsmanship and innovation go hand in hand when the workshop at the Department provides our small and large scale laboratories with custom made, high quality equipment.

Laboratories

Our laboratory technicians ensure high safety standards and efficient caretaking of our laboratories, education and research facilities.



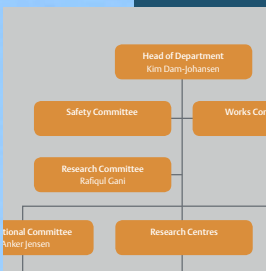
Pilotforsøg på Masnedø CHP



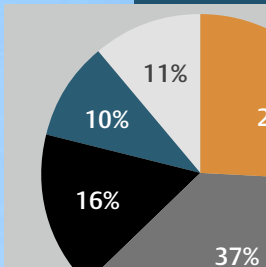
Productivity & Staff

Strategic goal:

'The Department aims to attract an increasing number of students, scientists and external partners by the continued development of a dynamic and innovative environment for research and education.'



Organization



Key figures



Publications – Education



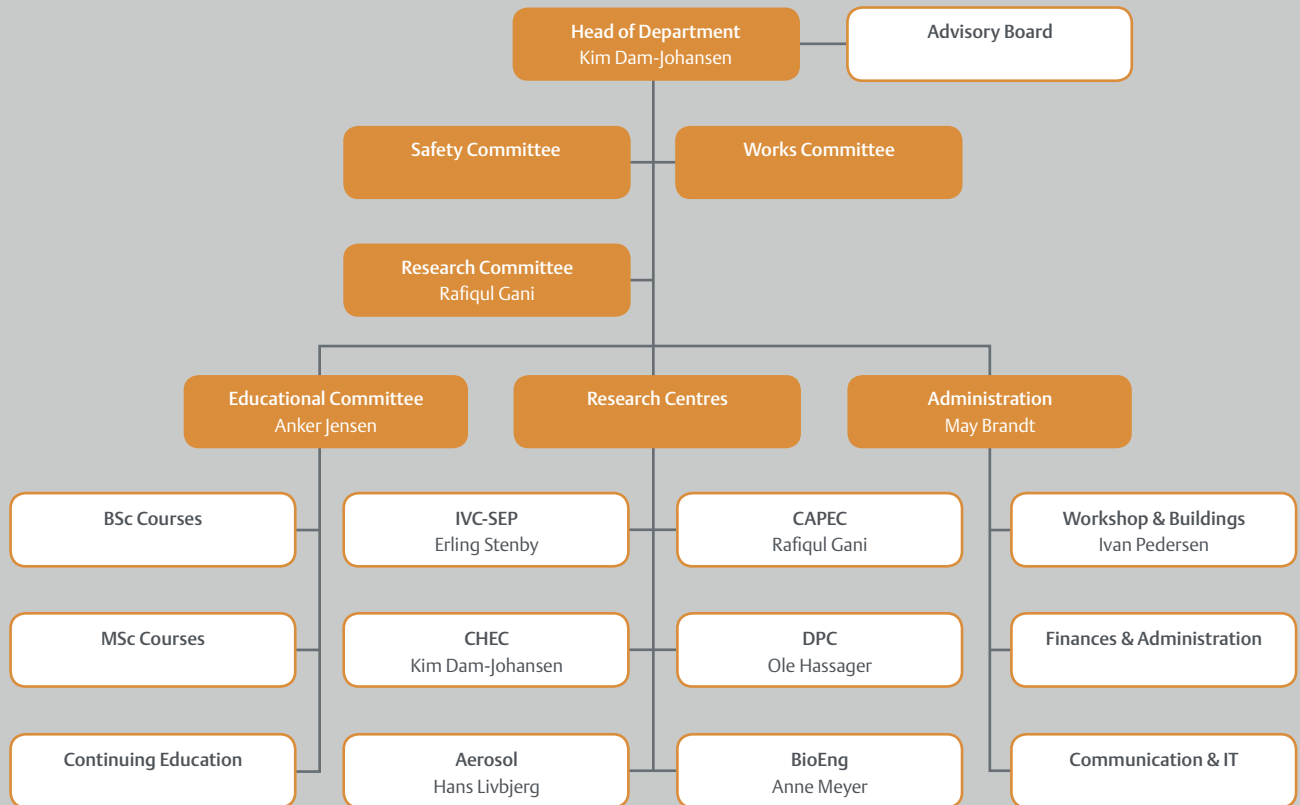
Staff

Student Committee



Student Committee (from left to right):
Yassir Ghiyodi Ibn Ziyad, Ryan Bradley,
Jacob Brix, Martin Ellegaard Christensen,
Peter Chr. K. Tybjerg, Stine Hansen og
Birgitte Zevner.

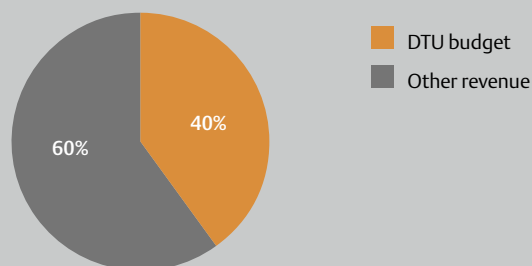
Organization



Key figures: Finances and staff 2006

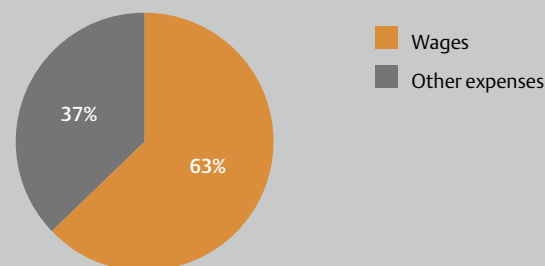
Revenue 2006

(Total 99,597 mill. DKK *)



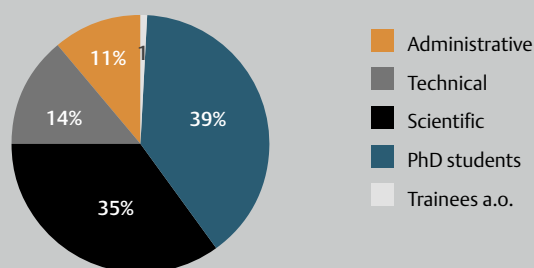
Expenditures 2006

(Total 91,464 mill DKK *)



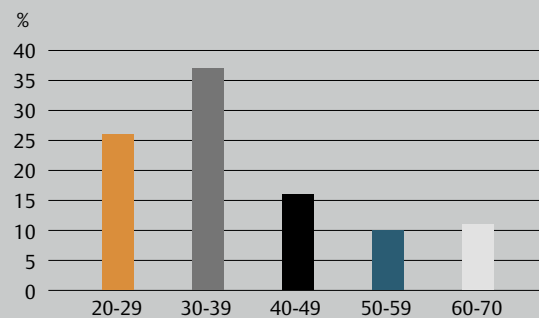
Type of staff

(Total 183 persons)



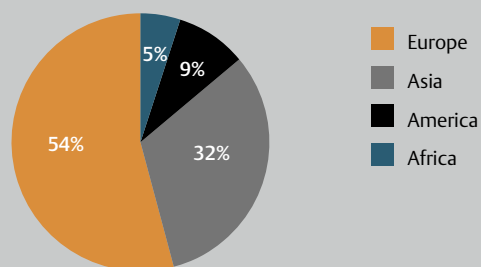
Staff distributed by age

(Total 183 persons)



Foreign scientific staff

(Total 57 persons)



Productivity

Teaching & Education 2006

Students, educational resources and -impact

Students in total (STÅ*)	173
Students per faculty man-year (STÅ*)	6.4
Students per mill DKK (STÅ*)**	5.8
Courses in 5-point units	74
Participants in special courses	59
Completed BSc projects	13
Completed MSc projects	45
Total Course units	91.6

*One STÅ is the equivalent of one student studying full time in a year

** Relative to the DTU-budget

Research & Innovation 2006

Publications, patents and commercialized research

Scientific publications with referee	100
Contributions to refereed conference proceedings (not indexed in ISI)	47
Contribution to books	8
Citations 2002-2006	1,100
PhD theses	10
Other publications, departmental reports	55

Publications

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Lin, Bao; Recke, Bodil; Schmidt, Torben Mønsted; Knudsen, Jørgen; Jørgensen, Sten Bay: **Modeling for control of cement kiln processes.** 13th Nordic Process Control Workshop. DTU, Lyngby, 26-28 January, 2006

Lin, Bao; Recke, Bodil; Jensen, Torsten Vagn; Knudsen, Jørgen; Jørgensen, Sten Bay: **Product quality estimation using multi-rate sampled data.** ESCAPE 16/PSE 9. Garmisch-Partenkirchen, Germany, 9-13 July, 2006

Lin, Bao; Recke, Bodil; Schmidt, Torben M.; Knudsen, Jørgen K.H.; Jørgensen, Sten Bay: **Data-driven soft sensor design with multiple-rate sampled data: a comparative study.** AIChE Annual Meeting 2006. San Francisco, USA, 12-17 November, 2006

Lopez-Arenas, Maria Teresa; Pérez-Cisneros, Eduardo S.; Gani, Rafiqul: **Static/dynamic analysis and controllability issues in reactive distillation columns.** ESCAPE 16/PSE 9. Garmisch-Partenkirchen, Germany, 9-13 July, 2006

Mitkowsky, Piotr Tomasz; Jonsson, Gunnar Eigil; Gani, Rafiqul: **Computer aided design of hybrid processes consisting of reactor and membrane-based separation unit.** CAPE Forum in Gliwice. CAPE Forum 2006, Gliwice, Poland, 11-12 February, 2006

Mitkowsky, Piotr Tomasz; Jonsson, Gunnar Eigil; Gani, Rafiqul: **Generic hybrid models of solvent-based reactive systems combined with membrane separation system.** ESCAPE 16/PSE 9. Garmisch-Partenkirchen, Germany, 9-13 July, 2006

Mitkowsky, Piotr Tomasz; Jonsson, Gunnar Eigil; Gani, Rafiqul: **Generic hybrid models of solvent-based reactive systems combined with membrane separation.** CHISA 2006. Prague, Czech Republic, 27-31 August, 2006

Møllerup, Jørgen: **Ligand Binding I: Ion-Exchange Chromatography.** ESAT 2006 22nd European Symposium on Applied Thermodynamics. Lo-skolen, Elsinore, Denmark, 28 June-1 July, 2006

Møllerup, Jørgen: **Ligand Binding II: Hydrophobic Interaction – Chromatography and Solubility.** ESAT 2006 22nd European Symposium on Applied Thermodynamics. Lo-skolen, Elsinore, Denmark 28 June-1 July, 2006

Møllerup, Jørgen: **Ligand Binding III: Binding of Oxygen to Hemoglobin.** ESAT 2006 22nd European Symposium on Applied Thermodynamics. Lo-skolen, Elsinore, Denmark, 28 June-1 July, 2006

Monsalvo, Matias Alfonso; Shapiro, Alexander: **Adsorption of Multicomponent Mixtures on Heterogeneous Microporous Solids.** ESAT 2006 22nd European Symposium on Applied Thermodynamics. Lo-skolen, Elsinore, Denmark, 28 June-1 July, 2006

Monsalvo, Matias Alfonso; Shapiro, Alexander; Thomsen, Kaj: **Modeling Phase Equilibria and Volumetric Behavior of Refrigerant + Lubricant Mixtures.** dk₂ Dansk Kemiingeniørkonference 2006. Technical University of Denmark, 2006

Morales Rodriguez, Ricardo; Sales-Cruz, Alfonso Mauricio; Gani, Rafiqul; Déchelotte, Stéphane; Vacher, Alain; Baudouin, Olivier. **Interoperability between Modeling Tools (Mot) and Process Simulators (Prosim) through Cape-Open Standards.** AIChE Annual Meeting 2006. San Francisco, USA, 12-17 November, 2006

Muro Sunè, Nuria; von Solms, Nicolas; Michelsen, Michael Locht; Kontogeorgis, Georgios: **Further development of the CPA EoS for mixtures with organic acids.** ESAT 2006 22nd European Symposium on Applied Thermodynamics. Lo-skolen, Elsinore, Denmark, 28 June-1 July, 2006

Odgaard, Peter Fogh; Lin, Bao; Jørgensen, Sten Bay: **Observer-Based and Regression Model-Based Detection of Emerging Faults in Coal Mills.** 6th IFAC Symposium on Fault Detection, Supervision and Safety of Technical Processes. Beijing, China, 30 August – 1 September, 2006

Olsen, S., Kiil, S., Thorslund, Laursen, M., Dam-Johansen, K.: **Anti-fouling Paint Containing Enzymes as Active Antifoulant.** Dansk Kemiingeniørkonference (dk₂), 31. maj til 2. juni 2006, Danmarks Tekniske Universitet, DK-2800 Kgs. Lyngby

Olsen, S., Kiil, S., Thorslund, Laursen, M., Dam-Johansen, K.: **ENZYMES IN ANTIFOULING COATINGS, A REVIEW.** 13th International Conference on Marine Corrosion and Fouling, July 23rd-28th 2006, Rio de Janeiro, Brazil

Publications (continued)

Petersen, Nanna; Bonné, Dennis; Jørgensen, Sten Bay: **Modeling for reproducible/Optimizing Operation of Fed-Batch Processes**. AIChE Annual Meeting 2006. San Francisco, USA, 12-17 November, 2006

Rosgaard, L.; Andric, P.; Dam-Johansen, K.; Pedersen, S.; Meyer, A.S.: **Effect of Fed-Batch Loading of Substrate on Enzymatic Hydrolysis & Viscosity of Pretreated Barley Straw**, Conference proceedings (CD) and oral presentation (given by L. Rosgaard), Session: Biological Conversions and Processes for Renewable Feedstocks I, Topical: Sustainable Bio-refineries, AIChE Annual Meeting 2006, San Francisco

Rossing, Netta Liin; Lind, Morten; Petersen, Johannes; Jørgensen, Sten Bay; Jensen, Niels: **A Functional approach to HAZOP studies**. CISAP-2. Naples, Italy, 21-24 May, 2006

Rossing, Netta Liin; Lind, Morten; Petersen, Johannes; Jørgensen, Sten Bay; Jensen, Niels: **A systematic approach to HAZOP studies based on functional models**. AIChE Annual Meeting 2006. San Francisco, USA, 12-17 November, 2006

Sloth, Jakob; Kiil, Søren; Jensen, Anker; Bach, Poul: **Formation of Enzyme Containing Granules by Spray Drying**. Dansk Kemiingeniør Konference (dk₂), 31. maj til 2. juni 2006, Danmarks Tekniske Universitet, DK-2800 Kgs. Lyngby

Sales Cruz, Alfonso Mauricio; Gani, Rafiqul: **Model discrimination and parameter estimation through sensitivity analysis**. ESCAPE 16/PSE 9. Garmisch-Partenkirchen, Germany, 9-13 July, 2006

Soni, Vipasha; Abildskov, Jens; Jonsson, Gunnar Eigil; Gani, Rafiqul; Karayiannis, N.; Mavrantzas, V.: **Structural design of polymers for membrane based separation processes using reverse simulation approach**. ESCAPE 16/PSE 9. Garmisch-Partenkirchen, Germany, 9-13 July, 2006

Soni, Vipasha; Abildskov, Jens; Jonsson, Gunnar Eigil; Gani, Rafiqul; Karayiannis, Nikos; Mavrantzas, V.: **Model-based reverse design of structured polymers**. FOMMS 2006. Semiahmoo Resort, Washington, USA, July 9-14, 2006

Soni, Vipasha; Abildskov, Jens; Jonsson, Gunnar Eigil; Gani, Rafiqul: **Model and Analysis of Vacuum Membrane Distillation for the Recovery of Volatile Aroma Compounds from Black Currant Juice**. 16th Symposium on Thermophysical Properties. Boulder, Colorado, USA, July 30 – August 4, 2006

Soni, Vipasha; Abildskov, Jens; Jonsson, Gunnar Eigil; Gani, Rafiqul; Karayiannis, N.; Mavrantzas, V.: **Structural design of polymers for membrane based separation processes using reverse simulation approach**. 16th Symposium on Thermophysical Properties. Boulder, Colorado, USA, July 30 – August 4, 2006

Soni, Vipasha; Mitkowski, Piotr Tomasz; Abildskov, Jens; Jonsson, Gunnar Eigil; Gani, Rafiqul: **Systematic model-based synthesis design and analysis of hybrid processes**. CHISA 2006. Prague, Czech Republic, 27-31 August, 2006

Soni, Vipasha; Abildskov, Jens; Jonsson, Gunnar Eigil; Gani, Rafiqul; Karayiannis, Nikos Ch.; Mavrantzas, V.: **Multiscale property modeling for design of polymer based products**. AIChE Annual Meeting 2006. San Francisco, USA, 12-17 November, 2006

Soni, Vipasha; Mitkowski, Piotr Tomasz; Abildskov, Jens; Jonsson, Gunnar Eigil; Gani, Rafiqul: **Simultaneous Model-based Process and Product Design Using Reverse Design Approach**. AIChE Annual Meeting 2006. San Francisco, USA, 12-17 November, 2006

Tihic, Amra; Kontogeorgis, Georgios; von Solms, Nicolas; Michelsen, Michael Loch: **Recent applications with the simplified PC-SAFT equation of state**. ESAT 2006 22nd European Symposium on Applied Thermodynamics. Lo-skolen, Elsinore, Denmark, 28 June-1 July, 2006

Tihic, Amra; Kontogeorgis, Georgios; von Solms, Nicolas; Michelsen, Michael Loch: **Recent application with the simplified PC-SAFT equation of state**. dk₂ Dansk Kemiingeniørkonference 2006. Technical university of Denmark, 2006

Verdier, Sylvain Charles Roland; Plantier, F.; Bessièrès, D.; Andersen, S.I.; Stenby, Erling Halfdan: **Asphaltene Precipitation and Calorimetry**. ESAT 2006 22nd European Symposium on Applied Thermodynamics. Lo-skolen, Elsinore, Denmark, 28 June-1 July, 2006

Wang, Y.; Hansen, Flemming Yssing; Peters, Günther H.j.; Hassager, Ole: **Molecular dynamics simulation of polymer melts: potential model, chain architecture and**. The Society of Rheology 78th Annual Meeting. Portland, Maine, USA, 2006

Wang, Y.; Hassager, Ole; Hansen, Flemming Yssing; Peters, Günther H.j.: **DPD and its application in studying polymer science**. Nordic Polymer Days 2006. Copenhagen, Denmark, 2006

Yan, Wei; Kontogeorgis, Georgios; Stenby, Erling Halfdan: **Application of CPA to Reservoir Fluids in Presence of Water and Other Association Compounds**. ESAT 2006 22nd European Symposium on Applied Thermodynamic, 2006

Yebra, D M; Tanabe, T; Sánchez, A; Iwase, Y; Porsbjerg, M; Sasaki, H; Arias, S; Tanabe, H; Kiil, S.: **NOVEL NON-AQUEOUS ACRYLIC NANODISPERSIONS IN CONTROLLED-RELEASE SELF-POLISHING ANTIFOULING PAINTS**. 13th International Conference on Marine Corrosion and Fouling, July 23rd-28th 2006, Rio de Janeiro, Brazil

Yebra, D M; Tanabe, T; Sánchez, A; Iwase, Y; Porsbjerg, M; Sasaki, H; Arias, S; Tanabe, H; Kiil, S: **NOVEL NON-AQUEOUS ACRYLIC NANODISPERSIONS IN CONTROLLED-RELEASE SELF-POLISHING ANTIFOULING PAINTS**. Double Liaison no 553, Nov. 2006, 46-50

Yebra, D M; Kiil, S; Weinell, C E; Dam-Johansen, K: **ACCELERATED OPTIMISATION OF CHEMICALLY-ACTIVE AF PAINT PRODUCTS**. 13th International Conference on Marine Corrosion and Fouling, July 23rd-28th 2006, Rio de Janeiro, Brazil

Ödman, Peter; Eliasson Lantz, Anna; Gernaey, Krist; Olsson, Lisbeth: **Online monitoring and modeling of Streptomyces coelicolor cultivations**. 2nd Danish Chemical Engineering Conference (dk₂-2006), 2006

Ödman, Peter; Eliasson Lantz, Anna; Gernaey, Krist; Olsson, Lisbeth: **Online monitoring and modeling of Streptomyces coelicolor cultivations**. 1st Meeting on Process Analytical Technologies for graduate students and young researchers, 2006

Ödman, Peter; Eliasson Lantz, Anna; Gernaey, Krist; Olsson, Lisbeth: **On-line monitoring and modeling of Streptomyces coelicolor cultivations**. 6th European Symposium on Biochemical Engineering Science (ESBES 4), 2006

Åkesson, Bernt Magnus; Jørgensen, John Bagterp; Poulsen, Niels Kjølstad; Jørgensen, Sten Bay: **A Generalized Autocovariance Least-Squares Method for Kalman Filter Tuning**. 6th CMBC Workshop. Nordborg, DK, 23-24 November, 2006

Åkesson, Bernt Magnus; Jørgensen, John Bagterp; Jørgensen, Sten Bay: **Development of Systematic Tuning Procedures for Extended Kalman Filtering**. AIChE Annual Meeting 2006. San Francisco, USA, 12-17 November, 2006

Åkesson, Bernt Magnus; Jørgensen, John Bagterp; Poulsen, Niels Kjølstad; Jørgensen, Sten Bay: **A Tool for Kalman Filter Tuning**. ES-CAPE 16/PSE 9. Garmisch-Partenkirchen, Germany, 9-13 July, 2006

Chapters in Books

Rafiqul Gani: **Integrated Chemical Product-Process Design: CAPE Perspectives**. Computer Aided Process-Product Engineering – CAPE, L. Puigjaner, G. Heyen (Editors), Section 4, pp. 647-666, Wiley Interscience, Germany, 2006

Rafiqul Gani and Jens Abildskov: **Integrated Computer-Aided Methods and Tools as Educational Modules**. Computer Aided Process-Product Engineering – CAPE, L. Puigjaner, G. Heyen (Editors), Section 4, pp. 773-798, Wiley Interscience, Germany, 2006

Gani, Rafiqul; Papaiconomou, Eirini: **Conceptual Design and Synthesis of Batch Processes**. In: Batch Processes, pp. 43-82 ; Korovessi, E.-Buca Raton, USA : CRC Publications

Gernaey K.V., Lind M. and Jørgensen S.B.: **Towards understanding the role and function of regulatory networks in microorganisms**. in, Puigjaner L. and Heyen G. (Eds.) Computer Aided Process & Product Engineering, Wiley-VCH, Weinheim (Germany), vol. 1, Chapter 7, pp. 223-264

Hostrup, Martin; Harper, Peter M.; Moen, Øivind; Suñé, Núria Muro; Soni, Vipasha; Abildskov, Jens; Gani, Rafiqul: **Computer Aided Polymer Design Using Group Contribution Techniques**. In: Integrated Multiscale Modeling for Polymer Properties Design; ch. 5; Laso, M. Elsevier B.V./Ltd.

Jørgensen, John Bagterp; Kristensen, Morten Rode; Thomsen, Per Grove; Madsen, Henrik: **New Extended Kalman Filter Algorithms for Stochastic Differential Algebraic Equations**. In: International Workshop on Assessment and Future Directions of Nonlinear Model Predictive Control (2006)

Sten Bay Jørgensen, Dennis Bonné & Lars Gregersen: **Monitoring and Control of Batch Processes**. Chapter in Batch Processes. Ed. K. Korovessi & A. Linniger. Marcel Dekker, pp. 419-462

Shapiro, Alexander; Stenby, Erling Halfdan: **Multicomponent Adsorption Approaches to Modeling Adsorption Equilibria**. In: Encyclopedia of Surface and Colloid Science, pp. 4180-4189 – Seconded – New York: Taylor & Francis, 2006

Young-il Lim and Sten Bay Jørgensen: **Partial Differential Equations (PDE) and Computational Fluid Dynamics (CFD)**. Computer Aided Process-Product Engineering – CAPE, L. Puigjaner, G. Heyen (Editors), Wiley Interscience, Germany, Chapter 1.2, pp. 35-106

Publications (continued)

PhD Dissertations

Andreasen Anders:

Hydrogen Storage Materials with Focus on Main Group I-II Elements

Boisen Astrid:

Study of Transition Metal Catalysts for use in Production of Hydrogen

Chakraborty Debashish:

Pt-Ru Anode for Direct Methanol Fuel Cells: One Step Synthesis and Methanol Electrooxidation Kinetics

Folas Georgios:

Modelling of Complex Mixtures Containing Hydrogen Bonding Molecules

Johansen Johnny:

Synthesis of Ceramic Membranes by Deposition of Aerosol Particles

Li, Hong Wen:

Model Analysis for Optimal Operation – A Heat Integrated Distillation Case Study

Liège, Xavier C.:

Dissolution of Light Hydrocarbons in Drilling Muds, Prediction of the Nature of a Reservoir Fluid Based on Gas Shows.

Monsalvo, Matias Alfonso:

Phase Behavior and Viscosity Modeling of Refrigerant-Lubricant Mixtures

Sales-Cruz, Alfonso Mauricio:

Development of a Computer Aided Modelling System for Bio and Chemical Process and Product Design

Verdier, Sylvain Charles Roland:

Experimental Study and Modelling of Asphaltene Precipitation Caused by Gas Injection

Reports

Castellino, Francesco; Jensen, Anker; Johnsson, Jan Erik: **Selective Catalytic Reduction of Nitric Oxide by Ammonia over Vanadia-based Catalysts.**

Gani, Rafiqul; Abildskov, Jens: **CAPEC Research Report 2006**

Hede, Peter Dybdahl: **Towards Mathesis Universalis: Modern aspects of modeling batch fluid bed agglomerating and coating systems – a review.** Novozymes A/S, CHEC Research Centre, Department of Chemical Engineering, DTU, 2006 (pp. 1-101)

Jensen, Peter Arendt; Zhou, Haosheng; Zbogar, A.; Hansen, Jørn; Frandsen, Flemming; Glarborg, Peter; Madsen, B.; Stang, H.: **Final report – Ash deposit formation and removal in biomass fired boilers. Fundamental data provided with deposit probes – CHEC Research Centre, 2006**

Rasmussen, Christian Lund; Rasmussen, Anja Egede; Hansen, Jørn; Glarborg, Peter: **045-12 High Pressure Flow Reactor – Operations Manual**

Thomsen, Kaj; Jensen, Jørgen Peter; Simonsen, Peter; Sander, Bo: **Alkaligenanvendelse fra bioflyveaske**

Åkesson, Bernt Magnus; Jørgensen, John Bagterp; Jørgensen, Sten Bay: **Planned Work in CMBC on Extended Kalman Filtering.** Proceedings: CMBC Workshop (2006)

Education

Master and Bachelor Courses

The Department participates in a 3½ year education for the Bachelor of Engineering Degree, a 3 year education for Bachelor of Science and a 2 year education for the Master's Degree. Below, course numbers and names are shown. For 2006 the number of students attending shown in brackets.

Spring-semester

28012	Chemical and Biochemical Process Engineering (23) (B)
28015	Mathematical models for chemical and biochemical systems (39) (B)
28021	Unit Operations of Chemical Engineering (38) (B)
28110	Chemical and biochemical product analysis (10)
28120	Introduction to Chemical and Biochemical Engineering (58)
28121	Chemical Unit Operations Laboratory (10)
28153	Process Design (10) (B)
28160	Mathematical models for chemical systems (24)
28212	Polymer Chemistry (26)
28221	Chemical Engineering Thermodynamics (12)
28231	Laboratory in Chemical and Biochemical Engineering (26)
28312	Computer-Aided Product Design (14)
28321	Chemical Engineering Thermodynamics (18) (B)
28341	Chemical Reaction Engineering (29) (B)
28350	Process Design: Principles and Methods (43)
28351	Process Control (23) (B)
28375	Air Pollution Control (22) (B)
28415	Oil and Gas Production (27)
28423	Phase Equilibria for Separation Processes (39)
28434	Membrane Technology (36)
28443	Industrial Reaction Engineering (26)
28451	Optimising Plantwide Control (12)
28852	Risk Assessment in Chemical Industry (30)
28861	Mathematical Modeling for Chemical Engineers (13)
28863	Introduction to Fortran Programming (3)
28885	Technology and Economy of Oil and Gas Production (32) (B)

Course given in co-operation with other departments

1241	Petroleum Engineering (5)
41015	Mechanics and Materials (6)
42110	Materials Science (131)
42981	Materials Science (32) (B)
42983	Corrosion and Materials Selection (24)

Fall-semester

28001	Introduction to chemistry and chemical engineering (45)
28012	Chemical and Biochemical Process Engineering (50) (B)
28021	Unit Operations of Chemical Engineering (30) (B)
28120	Introduction to Chemical and Biochemical Engineering (4)
28140	Introduction to Chemical Reaction Engineering (36)
28150	Introduction to Process Control (22)
28153	Process Design (4) (B)
28213	Polymer Technology (24)
28241	Chemical Kinetics and Catalysis (22)
28244	Combustion and High Temperature Process (37)
28310	Chemical and Biochemical Product Design (28)
28315	Colloid and Surface Chemistry (54) (B)
28316	Colloid and Surface Chemistry, Laboratory Course(9)
28321	Chemical Engineering Thermodynamics (27) (B)
28341	Chemical Reaction Engineering (25) (B)
28351	Process Control (30) (B)
28420	Separation Processes (36)
28515	Enhanced Oil Recovery (10)
28530	Transport Processes (49)
28811	Polymers in Processes and Products (22)
28845	Chemical Reaction Engineering Laboratory (21)
28851	Chemical Plant Operation (14)
28861	Mathematical Modeling for Chemical Engineers(40)
28863	Introduction to Fortran Programming (4)

Courses given in co-operation with other departments

01913	Mathematical models for chemical and biochemical systems (24) (B)
12002	Design of biotechnological and environmental processes (72)
12411	Introduction to Petroleum Technology (47)
27004	Health, Diseases and Technology (27)
27406	Biotechnology Purification Methods (43)
41015	Mechanics and Materials (62)
42981	Materials Science (17) (B)
42983	Corrosion and Materials Selection (24) (B)

Education (continued)

Master of Science Degrees

45 students finished their research projects for the MSc Degree. The project titles and names of the students are listed below

Jimmy Andersen:

Effect of sulphur additives on combustion on natural gas

Sidsel Marie Andersen and Karin Madsen:

Population balance modelling of batch fluid bed granulation processes

Paola Arenas:

Solvents for Organic Synthesis

Maria Cinta Bardi and Josep Maria Vilaró Fabregat:

Small Sacle Wood Stove Combustion

Peik Malmo Bjarnason:

Ammonie Storage as Hydrogen source for Energy Production

Cristina Cobas Paz and Eva Valasco Quintanilla:

Process Development – Cost Estimation and Optimization of Process Economy

Helge Danneskiold-Samsøe:

Practical crystallization of potassium salts leached from biomass fly ash

Mireia Fontarnau Vilaró:

Kinetic and Mechanical Study of Simplified Epoxy Paint Systems

Patricia de la Higuera Garcia:

Production of lactobionic acid by the enzymatic oxidation of lactose

Arnau Oliver Gonzalez:

PAT for Drug Design

Morten Linde Hansen:

Combustion kinetics of waste fuels for cement production

Jon Geest Jakobsen:

Direct conversion of natural gas to liquid fuels

Jesper Jensen:

Drying of enzyme containing droplets

Andreas Bruun Jørgensen:

CFD Modeling of NO_x Formation from Cement Klins

Rasmus Momme Kock and Thomas Fiehn:

Conversion of alternative fuels

Kasper Emil Larsen:

Optimization of Fischer-Tropsch Catalyst

Ferran Roca Leon:

Thermodynamics in the polyolefin industry with advanced models based on statistical mechanics

Andre Lorentz-Petersen:

Analysis of a catalyst manufacturing process

Ana Isabel Martinho:

Modelling of Vegetable Oil Extraction Process

Abdul Rashid Abdul Nabi Memon:

Simulation of CO₂ Injection in Weyburn for EOR and Sequestration

Usama Mohamed Attia Mohamed:

Design of Polymer Networks

Martin Møllerhøj:

Modeling of the REED process

Mohamed Nasser:

Improving the stability of a silyl acrylate based coating – avoiding catastrophic incan failure

Hanne Hostrup Nielsen:

Aerosol formation in Biomass Combustion

Ben Niu:

Modeling of steam injection in petroleum reservoirs

Jesper Nielsen:

Integrated Bioreactor and Separation Process Design and Operation

Mathilde Outin:

Thermodynamic and kinetic modelling of the hydrodearomatization of aromatic compounds in a diesel hydrotrater

Nanna Petersen:

Multivariable Modelling and Control of Industrial Fed-Batch Cultivation

Christoffer Plamboeck:

Protein Chromatography

Julie Øblom Poulsen:
Optimization of skin adhesive

Søren Honore Rasmussen:
Tailoring particle mixtures for fluidized bed reactors using
high-throughput experimentation

Jose Manuel Roman Marin:
Development of pressure sensitive valves for microfluidics

Netta Liin Rossing:
Method Development for Systematic Quantitative Risk
Assessment

Asiha Parvez Sattar:
Enzymatic deacetylation and chemical branching of hyaluronic
acid

Lei Shang:
Intrinsic kinetics of the direct sulfation reaction of limestone

Per Aggerholm Sørensen:
Mechanisms for coating breakdown of epoxy resins on steel
substrates

Mohammad Tabatabaieyazdi:
PC-SAFT for complex polymer mixtures

Anders Daugaard Thomsen:
Functional Polymers and Block Copolymers

Maja Bøg Toftegaard:
CFD Modeling of the Haldor Topsøe Pilot Plant Autothermal
Reformer

Woril Dudley Turner:
Design & Modelling of Batch Distillation

Shijie Wang:
Continuous droplet polymerization

Bachelor of Engineering Degrees

13 students finished their research program for the BSc Degree. The project titles and names of the students are listed below

Establishment of a process window for polyethers based on
thermal and rheological characterisation (Kenneth Andersen and
Anne Louise Berg Madsen)

Determination of CO₂ solubility in flycol/water mixtures (Lise
Jensen)

Physio-chemical and rheological properties of the Sodium or
Calcium salt of hyaluron acid (Sara Sparre Kofoed and Sarah Dahl)

Design of a hydro cyclone for the dewatering of gypsum (Jonas
Kok)

Inhibitor loss during pipeline transport of oil and gas (Anders
Lyhne)

Phase Equilibria for mixtures containing gases, water and alcohols
(Martin Ingemann Olsen)

Gypsum from wet flue gas desulphurisation (Wet FGD) (Maria
Herleen Pedersen)

Synthesis of PEG derivatives and reaction in a PUF binder and
characterisation (Thomas Rove)

Soot Formation in ATR (Louise Wissing)

SCR-deNOx og NH₃-oxydation (Fatima Øzer and Anissa Achir)

Staff

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Christensen Lone	Secretary	
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