PhD programme
Process, Energy and Automation Engineering

Annual Report 2014

Telemark University College,
Faculty of Technology
Process, Energy and Automation Engineering

Telemark University College (TUC) has approximately 7,000 students. Faculty of Technology, with approximately 700 students, is located at the campus in Porsgrunn.

The faculty has run a PhD programme in Process, Energy and Automation Engineering since 2009, and currently 32 PhD students are enrolled in the programme. In 2014, seven candidates were awarded the PhD degree after finishing their dissertation.

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The PhD committee at the faculty 2014:

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Prof. Britt Halvorsen
Prof. Svein Thore Hagen
Joachim Lundberg (PhD student)¹ / Thomas Øyvang (PhD student)²
Inger Kristiansen (secretary)
Assoc. Prof. Lars-André Tokheim (PhD programme coordinator)

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² November-December 2014
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Some of the PhD students, post docs, supervisors and engineers associated with the PhD programme at TUC, Faculty of Technology.
Personnel affiliated with the PhD programme

Academic staff

Rune Bakke (Professor)  Svein Linge (Professor)  Marius Lysaker (Assoc. Professor)  Morten C. Melaaen (Professor)  Saba Mylvaganam (Professor)  Carlos Pfeiffer (Assoc. Professor)  Chandana Ratnayake (Assoc. Professor)  Wilhelm G.J. Rondeel (Assoc. Professor)  Nils-Olav Skeie (Assoc. Professor)  Lars-André Tokheim (Assoc. Professor)  Knut Vågsæther (Assoc. Professor)  Magne Waskaas (Professor)  Lars Erik Øi (Assoc. Professor)

Dag Bjerkevetd (Professor)  Dag Eimer (Adj. Professor)  Kim Esbensen (Adj. Professor)  Bjørn Glemnestad (Adj. Professor)  Svein Thore Hagen (Professor)  Maths Halstensen (Assoc. Professor)  Brit Halvorsen (Professor)  Finn Aakre Haugen (Assoc. Professor)  Klaus-Joachim Jens (Professor)  Bernt Lie (Professor)

Carlos Dinamarca (Assoc. Professor)  Rune Bakke (Professor)  Dag Bjerkevetd (Professor)  David Di Ruscio (Assoc. Professor)  Carlos Dinamarca (Assoc. Professor)  Dag Eimer (Adj. Professor)  Kim Esbensen (Adj. Professor)  Bjørn Glemnestad (Adj. Professor)  Svein Thore Hagen (Professor)  Maths Halstensen (Assoc. Professor)  Brit Halvorsen (Professor)  Finn Aakre Haugen (Assoc. Professor)  Klaus-Joachim Jens (Professor)  Bernt Lie (Professor)

PhD students

Mirnes Alic  Anushka Perera  Wathsala Perera  Chaminda Pradeep  Kanchan Rai  Yan Ru  Gamunu Samarakoon  Vladyslav Shchuchenko  Ole Kristian Sommersel  Michal Sposób  Rajan Kumar Thapa  Sindre Tøsse  Juan Ignacio Videla  Zhou Wenjing  Zhimin Xi  Thomas Øyvarg  Haavard Aakre

Ronnie Anseth  Udara Arachchige  Christian Berg  Wenche Bergland  Khim Chantyal  André Gaathaug  Per Morten Hansen  Chameera Jayaratna  Wathsala Jinadasa  Jan Kudlicka  Bo Li  Lu Li  Helge Lorenzen  Joachim Lundberg  Anjana Malagalage

Post doc fellows

Hiromi Ariyaratne (PhD)  Christina Perianu (PhD)  Elin Fjeld (PhD)  Zulkifli Idris (PhD)
Technical and administrative staff (shared with other TUC units)

Eivind Fjelldalen (Head Engineer)
Hildegunn Hegna Haugen (Senior Engineer)
Randi T. Holta (Department Head Electrical Eng., Information Tech. and Cybernetics)
Klaus-Joachim Jens (Department Head Process, Energy and Environment)
Inger Kristiansen (Higher Executive Officer)
Jan Gunnar Lode (Head Engineer)
Morten C. Melaaen (Dean)
Morten Pedersen (Assistant Professor)

Doctoral dissertations 2014

2014-1: Jingyi Han: "Mass transfer characteristics of CO₂ absorption into liquid droplets" (main supervisor: Prof. Morten C. Melaaen)

2014-2: Sanoja Jayaratna: "Post Combustion CO₂ Capture: Modelling for Control, and Physical Property Analysis of Amines" (main supervisor: Prof. Morten C. Melaaen)

2014-3: Elin Fjeld: "Small-scale arc fault testing of medium voltage switchgear" (main supervisor: Prof. Svein Thore Hagen)

2014-4 Finn Haugen: "Optimal Design, Operation and Control of an Anaerobic Digestion Reactor" (main supervisor: Prof. Bernt Lie)

2014-5 Wang Shuai: "Anaerobic digestion of industrial carbon capture reclaimer MEA waste" (main supervisor: Prof. Rune Bakke)

2014-6 Roshan Sharma: "Optimal operation of gas-lifted oil fields and ESP lifted oil fields: An approach based on modeling, simulation and control" (main supervisor: Adj. Prof. Bjørn Glemmestad)

2014-7 Hiromi Ariyaratne: "Utilization of waste-derived biofuels and partly CO₂-neutral fuels in cement kilns" (main supervisor: Assoc. Prof. Lars-André Tokheim)
Research areas
TUC is doing research within several different areas, listed alphabetically and described below.

Alternative Fuels
Alternative fuels can be utilized in the industry to reduce the consumption of fossil fuels. Net emissions of pollutants such as CO₂ and NOₓ may be reduced, and in many cases the replacement of coal or other fossil fuels is also economically sound for the industry. Moreover, since many alternative fuels are based on waste streams, increased use of such waste-based fuels contributes in solving a waste problem in the society.

CO₂ Capture
The overall goal of our work on CO₂ capture is to find innovative solutions to the climate challenge. This means finding new solutions as well as improving existing ones with regard to optimization of the CO₂ capture process and related environmental challenges. It furthermore comprises collection and transportation solutions for captured CO₂. The research is carried out in close cooperation with the Tel-Tek research institute.

Environmental biotechnology
The environmental biotechnology research focus is on resource recovery, organic waste and water treatment, combined with biofilm research. The work includes fundamental research as well as applied activities.

Gas explosions and Technical Safety
The focus is on experimental and numerical investigation of pre-mixed combustion, dispersion, ignition, explosions and shock waves in various types of processes, equipment and systems.

Industrial Applications of Electromagnetics
Research in this group is dedicated to modern industrial applications of electromagnetism. Basic approach is based on solving Maxwell’s equations for static, quasi-static, and dynamic phenomena. The different applications currently under study are induction heating, quasi-static analysis of sensors exploiting electromagnetic phenomena, estimating parameters of complex cable structures. Sub groups are doing research on electric drive modelling, energy loss reduction, gas insulated switchgears, induction heating and tomography.

Industrial Automation Applications
Industrial Automation Applications include the use of sensor technology, industrial IT, modelling and simulation, estimation and monitoring, and control and optimization. Different groups are doing research on applied chemometrics, hydropower control and process control.
Industrial Automation Methods

Industrial Automation Methods include studies in methods within the areas of sensor technology, industrial IT, modelling and simulation, estimation and monitoring, and control and optimization. There are groups doing research on model predictive control, sensor technology, state estimation and system identification.

Industrial Flow Processes

Different flow systems are studied using experimental measurement techniques and computational fluid dynamics (CFD). Most of the experimental studies are performed using laser-based techniques such as Laser Doppler Anemometry (LDA), Phase Doppler Anemometry (PDA) and Particle Image Velocimetry (PIV), and other measurement techniques are applied as well.

Powder Science and Technology

Our research and development work includes all aspects of handling, storage, processing, separation, and characterization of particulate materials. The research is carried out in cooperation with the Tel-Tek research institute.

Research groups

In 2014, the research at TUC was re-organized by establishing a number of research groups, described below.

Hydro Power, Transmission and Distribution (HPTD)

The group (headed by Prof. Svein Thore Hagen) is doing research on methods to produce more electrical power from the Norwegian hydro power system. This may be achieved by mathematical models or improved measuring techniques. It is also important to ensure reliable transmission and distribution of electrical power to all customers. Many components in the grid may be highly stressed, e.g. high temperatures.

Energy and CO₂ Capture (ECC)

ECC (headed by Prof. Rune Bakke) is doing research on solutions required for the society to switch from fossil fuel based energy dependence to a carbon neutral energy matrix. This transition requires parallel efforts on:

- Reduction in waste of energy by implementation of more efficient processes, buildings etc., applying analysis of energy systems and thermodynamics.
- Transition measures to reduce the environmental impacts of exploration and utilization of fossil resources and adapting such for growing renewable fractions.
- Carbon capture and sequestration (CCS) from point source emissions.
- Technology to support more use of carbon neutral renewable energy.
The overall goal of the ECC research group is to make significant contributions to innovative solutions to the climate challenge, developing concepts for robust energy matrices and reducing the environmental impact of energy technology.

**Process Safety, Combustion and Explosions (PSCE)**

The group (headed by Prof. Dag Bjerketvedt) is doing research on explosions and other rapid phenomena controlled by flow, heat transfer and chemical reactions. The aim is improved safety in the society. Research is done within three main areas; i) experimental investigations, ii) numerical computations (CFD) and iii) image processing.

**Self-Monitoring, Analysis and Reporting Technologies (SMART)**

The main area for the SMART research group (headed by Assoc. Prof. Nils-Olav Skeie) is optimizing the energy consumption and usage of welfare technology in smart buildings.

The aim of the research group is to develop mathematical models for Self-Monitoring, Analysis and Reporting Technologies (SMART), to let models be able to learn from the monitoring and analysis part. These adaptive models can be based on both mechanistic models (“white” model) and empiric models (“black” model) as “grey” models. The models should adapt to the way the humans are living, the humans should not adapt to the functions of a smart building. Applications within the energy consumption area and welfare technology have a lot of common research challenges in order to have a smart building.

**Telemark Modeling and Control Center (TMCC)**

TMCC (headed by Prof. Bernt Lie) is doing research on generic methods within sensor technology, industrial IT, model development with main emphasis on dynamic models, and model based analysis and synthesis. Analysis and synthesis includes e.g. computational tools and simulation, optimization, design of control systems, monitoring and fault detection. A core idea for TMCC is the idea of the transfer of methods and tools between various application areas.
Journal papers, conference papers and books 2014


Adhikari, Amrit; Gaathaug, Andre Vagner; Bjerketvedt, Dag; Vågsæther, Knut. An experimental study of temperatures in cloud from release of flashing liquid CO2 in 3m long channel. The International Journal of Energy and Environment 2014; Volume 5 (5), pp. 567-574


Amaratunga, Polwattage Don; Perera, Kshantha; Mathiesen, Vidar; Halvorsen, Britt Margrethe. CFD simulation of a heavy oil resevoir with AICV completion. WIT transactions on ecology and the environment 2014; Volume 190


Ariyaratne, Hiromi Wijesinghe; Malagalage, Anjana Tharanga; Melaaen, Morten Christian; Tokheim, Lars Andre. CFD modeling of meat and bone meal combustion in a rotary cement kiln. International Journal of Modeling and Optimization 2014; Volume 4 (4)

Ariyaratne, Hiromi Wijesinghe; Manjula, Edirisinghe V. P.I.; Melaaen, Morten Christian; Tokheim, Lars Andre. Kiln process impact of alternative solid fuel combustion in the cement kiln main burner - Mathematical modelling and full-scale experiment. Advanced Materials Research 2014; Volume 875-877, pp. 1291-1299


Bergland, Wenche Hennie; Dinamarca, Carlos Antonio; Bakke, Rune. Efficient biogas production from the liquid fraction of dairy manure. The Renewable Energies and Power Quality Journal (RE&PQJ) 2014 (12)

Bergland, Wenche Hennie; Dinamarca, Carlos; Bakke, Rune. Effects of Psychrophilic Storage on Manures as Substrate for Anaerobic Digestion. BioMed Research International 2014

Chen, Zhiqiang; Guo, Zirui; Wen, Qinxue; Huang, Long; Bakke, Rune; Du, Maoan. A new method for polyhydroxyalkanoate (PHA) accumulating bacteria selection under physical selective pressure. International Journal of Biological Macromolecules 2014; Volume 72 (January), pp. 1329-1334

Chen, Zhiqiang; Wen, Qinxue; Guan, Huabin; Bakke, Rune; Ren, Nanqi. Anaerobic treatment of domestic sewage in modified septic tanks at low temperature. Environmental technology 2014; Volume 35 (17), pp. 2123-2131

Dayarathna, Sithara; Weerasooriya, Achini; Hussain, Shahid; Zarsav, Mojgan; Mathisen, Anette; Sørensen, Henriette; Melaaen, Morten Christian. Simulation of CO2 capture from an aluminium production plant. WIT Transactions on Ecology and The Environment 2014; Volume 181, pp. 729-740

Edvardsen, Håkon Molland; Winkler, Dietmar. Modelling the system dynamics of islanding asynchronous generators. Linköping Electronic Conference Proceedings 2014 (96), pp. 969-978


Ergon, Rolf. Comparison of simple projection methods (OPLS, PLSO, and TP) for separation of predicting and non-predicting information in PLSR and PCR, with focus on DA. Journal of Chemometrics 2014; Volume 28, pp. 805-813


Halstensen, Mathis; Amundsen, Lene; Arvoh, Benjamin Kaku. Three-way PLS regression and dual energy gamma densitometry for prediction of total volume fractions and enhanced flow regime identification in multiphase flow. Flow Measurement and Instrumentation 2014; Volume 40, pp. 133-141

Halstensen, Mathis; Ihunegbo, Felicia Nkem; Ratnayake, Chandana; Sveinsvold, Karl. Online acoustic chemometric monitoring of fish feed pellet velocity in a pneumatic conveying system. Powder Technology 2014; Volume 263, pp. 104-111

Haugen, Finn; Bakke, Rune; Lie, Bernt. State estimation and model-based control of a pilot anaerobic digestion reactor. Journal of Control Science and Engineering 2014; Volume 2014

Haugen, Truls Erik; Elverhøy, Anita Bjerke; Mathiesen, Vidar; Halvorsen, Britt Margrethe. Increasing oil recovery by utilization of AlCV: a 3D multiphase simulation study of a heavy oil reservoir with an underlying water aquifer. WIT transactions on ecology and the environment 2014; Volume 190


Idris, Zulkifli; Peresunko, Nataliia Uriivna; Jens, Klaus-Joachim; Eimer, Dag Arne. Equilibrium solubility of carbon dioxide in aqueous solutions of 3-amino-1-propanol, 4-amino-1-butanol and 5-amino-1-pentanol at low partial pressures. Fluid Phase Equilibria 2014

Idris, Zulkifli; Jens, Klaus J.; Eimer, Dag A. Speciation of MEA-CO2 adducts at equilibrium using Raman spectroscopy. Energy Procedia 2014; Volume 63, pp. 1424-1431


Jilvero, Henrik; Jens, Klaus-Joachim; Normann, Fredrik; Andersson, Klas; Halstensen, Mathis; Eimer, Dag Arne; Johnsson, Filip. Equilibrium measurements of the NH3–CO2–H2O system – measurement and evaluation of vapor–liquid equilibrium data at low temperatures. Fluid Phase Equilibria 2014; Volume 385, pp. 237-247

Jilvero, Henrik; Mathisen, Anette; Eldrup, Nils Henrik; Normann, Fredrik; Johnsson, Filip; Müller, Gunn-Iren; Melaaen, Morten Christian. Techno-Economic Analysis of Carbon Capture at an Aluminum Production Plant – Comparison of Post-Combustion Capture Using MEA and Ammonia. Energy Procedia 2014; Volume 63, pp. 6590-6601

Kalinchyk, Iryna; Pfeiffer, Carlos; Inshekov, Evgenij. Retscreen modeling for combined energy systems fertilizers plant case. Linköping Electronic Conference Proceedings 2014 (108), pp. 7-16

Kardanpour, Zahra; Jacobsen, Ole Stig; Esbensen, Kim H. Soil heterogeneity characterization using PCA (Xvariogram) - Multivariate analysis of spatial signatures for optimal sampling purposes. Chemometrics and Intelligent Laboratory Systems 2014; Volume 136, pp. 24-35
Klausen, Andreas; Tørdal, Sondre; Sanden; Karimi, Hamid Reza; Robbersmyr, Kjell G; Jecmenica, Mladen; Melteig, Ole. Firefly optimization and mathematical modeling of a vehicle crash test based on single-mass. Journal of Applied Mathematics 2014; Volume 2014.


Linge, Svein; Mardal, Kent A.; Helgeland, Anders; Heiss, John D.; Haughton, Victor. Effect of craniovertebral decompression on CSF dynamics in Chiari malformation Type I studied with computational fluid dynamics. Journal of Eurosurger y: Spine 2014; Volume 21, pp. 559-564


Lysaker, Ola Marius; Nielsen, Bjørn Fredrik; Wall, Samuel T. Bidomain Simulations of Subendocardial Ischemia: The Forward and Inverse Problems. Computing in cardiology 2014; Volume 41, pp. 1149-1152

Mathisen, Anette; Ariyaratna, Sanoja D.; Eldrup, Nils Henrik; Müller, Gunn-Iren; Melaaen, Morten Christian. Integration of Post-combustion CO2 Capture with Aluminium Production. Energy Procedia 2014; Volume 63, pp. 6602-6610

Mathisen, Anette; Sørensen, Henriette; Eldrup, Nils Henrik; Skagestad, Ragnhild; Melaaen, Morten Christian; Müller, Gunn-Iren. Cost Optimised CO2 Capture from Aluminium Production. Energy Procedia 2014; Volume 51, pp. 184-190


Perera, Anushka; Pfeiffer, Carlos; Lie, Bernt; Hauge, Tor Anders. Making modelica models available for analysis in phyton control system library. Linköping Electronic Conference Proceedings 2014 (108), pp. 138-148


Perera, Kshanthi; Thapa, Rajan Kumar; Halvorsen, Britt Margrethe. Simulation and optimization of the steam gasification process using CPFD. WIT transactions on ecology and the environment 2014; Volume 190.
Perinu, Cristina; Arachchige, Gumunu L. Samarakoon; Arstad, Bjørnar; Jens, Klaus-Joachim. Application of 15N-NMR spectroscopy to analysis of amine based CO2 capture solvents. Energy Procedia 2014; Volume 63, pp. 1144-1150

Perinu, Cristina; Arstad, Bjørnar; Bouzga, Aud Mjærum; Jens, Klaus-Joachim. 13C and 15N NMR characterization of amine reactivity and solvent effects in CO2 capture. Journal of Physical Chemistry B 2014; Volume 118 (34), pp. 10167-10174

Perinu, Cristina; Arstad, Bjørnar; Bouzga, Aud Mjærum; Svendsen, John Arild; Jens, Klaus-Joachim. NMR-based carbamate decomposition constants of linear primary alkanolamines for CO2 capture. Industrial & Engineering Chemistry Research 2014; Volume 53 (38), pp. 14571-14578

Pradeep, Chaminda; Ru, Yan; Vestøl, Sondre; Melaaen, Morten Christian; Mylvaganam, Saba. Electrical capacitance tomography (ECT) and gamma radiation meter for comparison with and validation and tuning of computational fluid dynamics (CFD) modeling of multiphase flow. Measurement science and technology 2014; Volume 25 (7)

Rabchuk, Kateryna Volodymyrivna; Lie, Bernt; Mjaavatten, Are; Siepmann, Volker. Stability map for ammonia synthesis reactors. Linköping Electronic Conference Proceedings 2014 (108), pp. 159-166

Rai, Kanchan; Bjerketvedt, Dag; Gaathaug, Andre Vagner. Gas explosion field test with release of hydrogen from a high pressure reservoir into a channel. International journal of hydrogen energy 2014; Volume 39 (8), pp. 3956-3962


Sharma, Roshan; Glemmestad, Bjørn. Mixed integer nonlinear optimization for ESP lifted oil field and improved operation through production valve choking. International Journal of Modeling and Optimization 2014; Volume 4 (6)


Sharma, Roshan; Glemmestad, Bjørn. Uncertainty and sensitivity analysis for a model of an electric submersible pump lifted oil field. International Journal of Modeling and Optimization 2014; Volume 4 (4)

Thapa, Rajan Kumar; Halvorsen, Britt Margrethe. Heat transfer optimization in a fluidized bed biomass gasification reactor. WIT Transactions on Engineering Series 2014; Volume 83

Thapa, Rajan Kumar; Halvorsen, Britt Margrethe. Stepwise analysis of reactions and reacting flow in dual fluidized bed gasification reactor. WIT Transactions on Engineering Series 2014; Volume 82


Tiller, Michael; Winkler, Dietmar. impact – A Modelica Package Manager. Linköping Electronic Conference Proceedings 2014 (96), pp. 543-548

Tøsse, Sindre; Vågsæther, Knut; Bjerketvedt, Dag. An experimental investigation of rapid boiling of CO2. Shock Waves 2014

Valciu, Serena C.; Dyrgåy, Are; Farnish, Richard J.; Agu, Cornelius Emeka; Lie, Bernt. Mechanical design principles and test results of a small scale airslide rig for alumina transport. Linköping Electronic Conference Proceedings 2014 (108), pp. 149-158

Viumdal, Håkon; Mylvaganam, Saba; Ruscio, David Luigi Di. System Identification of a Non-Uniformly Sampled Multi-Rate System in Aluminium Electrolysis Cells. Modeling, Identification and Control 2014; Volume 35 (2), pp. 127-146

Wang, Shuai; Hovland, Jon; Bakke, Rune. Modeling and simulation of lab-scale anaerobic co-digestion of MEA waste. Modeling, Identification and Control 2014; Volume 35 (1), pp. 31-41


Øi, Lars Erik; Bråthen, Terje; Berg, Christian; Brekne, Sven Kjetil; Flatin, Marius; Johnsen, Ronny; Moen, Iselin Grauer; Thomassen, Erik. Optimization of configurations for amine based CO2 absorption using Aspen HYSYS. Energy Procedia 2014; Volume 51, pp. 224-233


Øi, Lars Erik; Kvam, Stian Holst Pedersen. Comparison of energy consumption for different CO2 absorption configurations using different simulation tools. Energy Procedia 2014; Volume 63, pp. 1186-1195
Øi, Lars Erik; Lundberg, Joachim; Pedersen, Morten; Hansen, Per Morten; Melaaen, Morten Christian. Measurements of CO2 Absorption and Heat Consumption in Laboratory Rig. Energy Procedia 2014; Volume 63, pp. 1569-1577

Øyvang, Thomas; Winkler, Dietmar; Lie, Bernt; Hegglid, Gunne John. Power system stability study using modelica. Linköping Electronic Conference Proceedings 2014 (108), pp. 120-128

National scientific publication points gained at the Faculty of Technology since the startup of the PhD programme. PEM = Department of Process, Energy and Environmental Technology; EIK = Department of Electrical Engineering, Information Technology and Cybernetics.
Ongoing PhD projects

Modelling of increased oil production with AICD (PhD student: Haavard Aakre; main supervisor: Britt Halvorsen)

Modeling, simulation and control of a metallurgical plant (PhD student: Mirnes Alic; main supervisor: Bernt Lie)

Sensor network for online monitoring and control of energy loss in pipeworks (PhD student: Ronnie Anseth; main supervisor: Magne Waskaas)

CO2 capture post combustion, experimental and simulation studies (PhD student: Udara Arachchige; main supervisor: Morten Chr. Melaaen)

Modeling for automatic control and estimation of influx and loss during drilling operations (PhD student: Christian Berg; main supervisor: Bernt Lie)

Two-stage, high rate biogas process analysis (PhD student: Wenche Bergland; main supervisor: Rune Bakke)

Data fusion based modeling and rheological parameter estimation when using additives in drilling fluids (PhD student: Khim Chantyal; main supervisor: Saba Mylvaganam)

Hydrogen gas explosions - experimental investigations of deflagrations and detonations (PhD student: André Gaathaug; main supervisor: Dag Bjerketvedt)

Fully integrated regenerative calcium cycling (PhD student: Chameera Jayarathna; main supervisor: Lars-André Tokheim)

Process Analytical Technology applied to CO2 solvents (PhD student: Wathsala Jinadasa; main supervisor: Maths Halstensen)

Energy efficiency in buildings (PhD student: Jan Kudlicka; main supervisor: Nils-Olav Skeie)

Model studies of natural gas conversion catalysts (PhD student: Bo Li; main supervisor: Klaus-Joachim Jens)

Olefin transformation catalysts (PhD student: Lu Li; main supervisor: Klaus-Joachim Jens)

Real time observation and analysis of GRID signals for optimal control of GRID performance (PhD student: Helge Lorenzen; main supervisor: Saba Mylvaganam)

Image-based sizing techniques for fire water droplets (PhD student: Joachim Lundberg; main supervisor: Dag Bjerketvedt)

Improving Efficiency of Offshore Drill-cuttings Handling Process (PhD student: Anjana Tharanga Malagalage; main supervisor: Chandana Ratnayake)

Experimental and theoretical studies of rapid phase transition to determine phase transition rates in a BLEVE (PhD student: Hansen Per Morten; main supervisor: Knut Vågsæther)
Model based control in the metallurgical industry (PhD student: Anushka Perera; main supervisor: Carlos Pfeiffer)

Optimization of energy consumption in buildings based on information from sensor networks (PhD student: Wathsala Perera; main supervisor: Nils-Olav Skeie)

Tomographic approach to automatic and non-intrusive flow regime identification (PhD student: Chaminda Pradeep; main supervisor: Saba Mylvaganam)

Hydrogen safety (PhD student: Kanchan Rai; main supervisor: Dag Bjerketvedt)

Usage of process tomographic techniques in the study of flow dynamics in fluid and particulate flow (PhD student: Yan Ru; main supervisor: Saba Mylvaganam)

Better and more intelligently formulated CO2 absorbents (PhD student: Gamunu Samarakoon; main supervisor: Klaus-Joachim Jens)

Energy modelling and simulation for optimal energy design of hospitals (PhD student: Vladyslav Shchuchenko; main supervisor: Bernt Lie)

Dispersion and ignition of hydrogen leaks (PhD student: Ole Kristian Sommersel; main supervisor: Dag Bjerketvedt)

Biological Removal of Sulphide in EGSB Reactor (PhD student: Michał Sposób; main supervisor: Rune Bakke)

Optimization of flow behaviour in gasification reactors (PhD student: Rajan Kumar Thapa; main supervisor: Britt Halvorsen)

Rapid boiling of carbon dioxide (PhD student: Sindre Tøsse; main supervisor: Knut Vågsæther)

Modeling, estimation and control of cogeneration-HVAC-building systems (PhD student: Juan Ignacio Videla; main supervisor: Bernt Lie)

Control and optimization of hydropower plant (PhD student: Zhou Wenjing; main supervisor: Bjørn Glemmestad)

Engineering Particulate Solids by Comminution to Manufacture Powders with Desired Flow Properties by Controlling Particle Size and Shape (PhD student: Zhimin Xi; main supervisor: Chandana Ratnayake)

Improved Hydro power control with Model Predictive Control (PhD student: Thomas Øyvang; main supervisor: Bernt Lie)
Ongoing research projects

The Chiari Malformation project (2009-2016)

The Chiari Malformation project is a collaboration between Simula Research Laboratory, the University of Wisconsin (USA), Telemark University College (through Prof. Svein Linge) and others. In brief, the aim is to better understand Chiari malformation via computer simulation models. Better understanding allows better treatment. In simple words, Chiari malformation is a medical condition where the brain partly prevents cerebrospinal fluid from pulsating freely in and out of the skull with every heartbeat. This causes severe pressure deviations in the skull and related complications.

CO$_2$ capture from industrial point sources and further development of amine reclaimer waste handling by incineration and biological treatment (2010-2014)

This research project (type KMB) is supported by the Norwegian Research Council and Gassnova through the CLIMIT research programme, and by industrial and academic partners. The project is run by Tel-Tek, but TUC personnel are managing the four work packages of the project: I) CO$_2$ capture and energy integration (Professor Morten C. Melaaen), II) Chemical characterisation of amines and degradation products (Professor Klaus-Joachim Jens), III) Bio-degradation of amine waste (Professor Rune Bakke), IV) Amine waste as a NOx reduction agent in incineration (Associate Professor Lars-André Tokheim). Two PhD students are educated and 1 post doc position is part of the project, which involves international cooperation with international universities (Chalmers University of Technology and Denmark Technical University) and industrial companies.

Characterizing Fire Water Droplet Spray (2010-2014)

Statoil has been funding a four-year PhD project at TUC and Tel-Tek. In this project, an image-based method for characterizing the flow properties of the spray from a medium velocity deluge nozzle has successfully been developed. This nozzle is used for fire protection in off-shore installations. A Cula laser and a high-speed camera (12 000 frames/s) are used to capture images of the droplets in the spray. An image processing code finds the spray droplet size distribution and the velocity. The results will be used as input to computational fluid dynamics (CFD) fire and explosion codes. Professor Dag Bjerketvedt, Associate Professor Marius Lysaker and Associate Professor Knut Vågsæter have worked on this project as supervisors of PhD student Joachim Lundberg.


This research project (type KMB) is supported by the Norwegian Research Council, The Norwegian Farmers Association (Norsk Bondelag) and Bioplan AS, and involves 8 academic partners in Norway, Sweden and Denmark. The total budget is MNOK 16. This research is coordinated by Bioforsk (Bioforsk Jord og miljø). One PhD student employed at NTNU is supervised by TUC professor Rune Bakke.
**Sulphide removal from wastewater streams (2013-2016)**

The project is conducted by TUC with the support of YARA AS. TUC is working on the design and optimization of a fluidized bed reactor for biological sulphide removal. A PhD student was engaged in the project in 2014. The project leader is associate professor Carlos Dinamarca, while Professor Rune Bakke is the main advisor of the PhD student.

**Fully Integrated Regenerative Calcium Cycling (2013-2016)**

Alstom Norway has been granted funding from Gassnova via the Climit programme for a three-year project investigating the potential of CO₂ capture by calcium cycling applying indirect heat transfer in the calciner. The project is a cooperation between Alstom Norway, Alstom Power (Germany), Telemark University College, Tel-Tek, IFE and ETH (Switzerland). The project has four different work packages, and TUC/Tel-Tek is strongly involved in one of these. One PhD candidate will be educated at TUC as part of the project. Associate Professor Lars-André Tokheim is the sub-project manager, and he is also the main supervisor of the PhD student.

**Venturi channel test rig (2014-2015)**

The project is supported by Statoil ASA. The purpose is to find alternative, less expensive methods to measure mud flow during drilling operations. A test rig has been constructed as part of a student project (spring 2014), and a new student group is working on the rig to get more experimental data. Professor Saba Mylvaganam, Professor Bernt Lie, Adjunct Associate Professor Geir Elseth and Assistant Professor Morten Pedersen are involved in the project.

**Towards a safer home living – Behavior classification as a method to detect unusual behavior for people living alone (2014-2015)**

This one-year research project is supported by "OsloFjordFondet". The project is a co-operation between the Skien municipality and the TUC faculties "Technology" and "Nursing and social work". The main goal of this preliminary research is to identify the requirements from the users, careholders and the designer perspectives for next generation of an automatic warning aid system. Important social and ethical factors should also be taken into consideration. Professor Carlos Pfeiffer is heading the project.


This project is supported by "OsloFjordFondet" and is carried out in cooperation with Biowater Technology AS (technology owner; project leader is Dr. Gang Xin) and Norsk spesialolje AS. The total budget is MNOK 7, and TUC takes part in the project (Professor Rune Bakke, Associate Professor Carlos Dinamarca, Dr. Wang Shuai and co-workers).

**Current interruption in air-filled medium voltage load break switches (2014-2017)**

The main objective of this project is to improve the thermal performance of medium voltage distribution switchgears. Computer modeling and optimized design of critical components are
applied in order to reduce heat dissipation in contacts and conductors and to improve the heat transport to surroundings. Professor Svein Thore Hagen is the TUC project leader, and Professor Dag Bjerketvedt, Adjunct Professor Wilhelm Rondeel, Associate Professor Knut Vågsæther and Post doc Elin Fjeld participate in the project, which is funded by NFR and ABB. 1 post doc works on the project.

**Guest lectures, seminars and workshops 2014**

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<th>Date</th>
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<td>19 February</td>
<td>Life-cycle analysis and life-cycle costs</td>
<td>Holger König, Ascona Gesellschaft für ökologische Projekte</td>
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<td>14 May</td>
<td>Multiphase flow measurements using tomography techniques</td>
<td>Assistant professor Jacek Nowakowski and PhD student Damian Pakulski, Institute of Applied</td>
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<tr>
<td>(Guest lecture)</td>
<td>Design Thinking in Engineering - reflections from Stanford University</td>
<td>Computer Science, Lodz University of Technology (Poland)</td>
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<td>21 August</td>
<td>RETScreen: Evaluating the feasibility of Clean Energy Projects</td>
<td>PhD student Iryna Kalinchyk, National Technical University of Ukraine</td>
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<td>10 September</td>
<td>Project and Problem based Sensor Data Fusion for Fruit Sorting Robotic System</td>
<td>PhD student Damian Pakulski, Lodz University of Technology (Poland)</td>
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<td>17 October</td>
<td>Ecology and economy – Sustainable development</td>
<td>Jacob Bomann-Larsen, MBA, writer and co-founder of “Framtiden i våre hender”</td>
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**PhD courses**

An overview of PhD courses (including individual curricula) given at TUC in 2014 is presented below.

*D0611 Theory of Science and Ethics (5 ECTS credits)*

Course content:  

a) Science in history: General outline of the historical development of science; the impact of science and technology on culture in the past and present; cases from the history of science.  
b) Theories, methods and problems of empirical science Induction, hypothetico-deductive method; philosophies of science: logical positivism, critical rationalism (Popper), theory of scientific revolutions (Kuhn), contemporary critiques; observation and theory: the problem of theory-dependence; different types of science/disciplines and their relationships: natural sciences, social sciences
and the humanities – explanation and understanding; methodological approaches in the social sciences: collectivism and individualism, hermeneutics, phenomenology, constructivism and positivism. c) Ethics and issues of value in science and research The role of value and interest in science and research: pure and applied science and research, commissioned research; the justification of science: Aristotle vs. Bacon; ethical responsibility in science and research: professional responsibility, social and environmental responsibility, responsibility to individuals; codes of ethics: their role and justification; uncertainty and managing risk in the acceptance of scientific theory and uses of technology. d) Science, Technology and Society The impact of technology on individuals and contemporary society.

Responsible: Professor Sven Arntzen

No of students 2014: 15

D0308 Matrix Methods (5 ECTS credits)


Responsible: Professor Bernt Lie / Associate Professor David Di Ruscio

No of students 2014: 3

D0214 Olefin conversion catalysis (10 ECTS credits)

Course description: The course reviews the basic principles of olefin conversion catalysis and the related basics of thermodynamics, kinetics, reaction engineering and gas conversion chemistry. Today’s conversion technology will be examined and current research frontiers will be reviewed and analysed.

Responsible: Professor Klaus-Joachim Jens

No of students 2014: 2

3 Participants from several universities and university colleges; three from TUC Faculty of Technology
**D0908 Natural Gas Conversion (10 ECTS credits)**

**Course content:** The course reviews the basic principles of catalysis and the related basics of thermodynamics, kinetics, reaction engineering and gas conversion chemistry. Today’s gas conversion technology will be examined and current research frontiers will be reviewed and analysed.

**Responsible:** Professor Klaus-Joachim Jens

**No of students 2014:** 1

**D0414 Object-oriented modeling with Modelica for control and optimization (10 ECTS credits)**

**Course content:** i) Basics of numerical solutions to Differential Algebraic Equations; solvability, index, index reduction – matching, BLT sorting, Pantelides algorithm, and dummy derivatives; various numerical methods for initial-value DAEs; available solvers – e.g. DASSL; ii) Programming in Modelica using Dymola; iii) Modelica; iv) CasADi

**Responsible:** Professor Bernt Lie

**No of students 2014:** 1

**D0511 Modelling, simulation and automation of buildings (10 ECTS credits)**

**Responsible:** Professor Bernt Lie

**No of students 2014:** 1
Mandatory and elective PhD courses offered at Telemark University College, Faculty of Technology.

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<td>D0611</td>
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<td>Essay</td>
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<td>D1208</td>
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<td>D1708</td>
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<td>D0408</td>
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Visit the research section in the TUC web site, www.hit.no, as well as our dedicated CO₂ research website, www.co2-lab.com, to learn more about us.