Process & Energy

Realising significant scientific impact

TU Delft

Contents

Delft University of Technology

Overview

TU Delft, founded in 1842 by King William II, is the oldest and largest University of Technology in The Netherlands, offering 15 bachelor and 33 masters programmes to over 19,000 bachelor, master and PhD students, 16 per cent of whom are international students. The University comprises 3,380 academic staff of whom 437 are professors, and in 2014 it was ranked 42nd in the The World University rankings and was 95th in the 2013 QS World University rankings. TU Delft is a multifaceted institution offering education and carrying out research in technical sciences at an internationally recognised level. Education, research and design are strongly oriented towards applicability. TU Delft develops technologies for future generations, focusing on sustainability, safety and economic vitality. At TU Delft you will work in an environment where technical sciences and society converge. TU Delft comprises eight faculties within which there are exclusive laboratories, research institutes and departments. TU Delft cooperates with many other educational and research institutions, both in The Netherlands and abroad, enjoying numerous contacts with governments, trade associations, consultancies, industry and small and medium- sized companies. Notable partners include:

- 3TU Federation: combining the strength of the three technical universities in The Netherlands; TU Delft, University of Twente and TU Eindhoven;
- The IDEA League: partnering ETH Zurich, Aachen and Chalmers;
- The European Leuven Network: consisting of a limited number of prominent European technical universities who work together in permanent education and research partnerships.

For more information on University collaborations in Europe and the rest of the world please visit: www.tudelft.nl/en/current/collaboration-between-universities

Collaboration is an essential aspect of the University's approach and helps the faculties to build on the foundations of the University's strong identity and reputation. TU Delft aims to be a breeding ground for the cutting-edge technological scientific developments that will meet the great societal challenges of our age.

The University comprises eight faculties, namely:

- Aerospace Engineering;
- Applied Sciences;
- Architecture and the Built Environment;
- Civil Engineering and Geosciences;
- Electrical Engineering, Mathematics and Computer Science;
- Industrial Design Engineering;
- Mechanical, Maritime and Materials Engineering;
- Technology, Policy and Management.

The Department of Process & Energy sits within the Faculty of Mechanical, Maritime and Materials Engineering (3mE).

Faculty of Mechanical, Maritime and Materials Engineering (3mE)

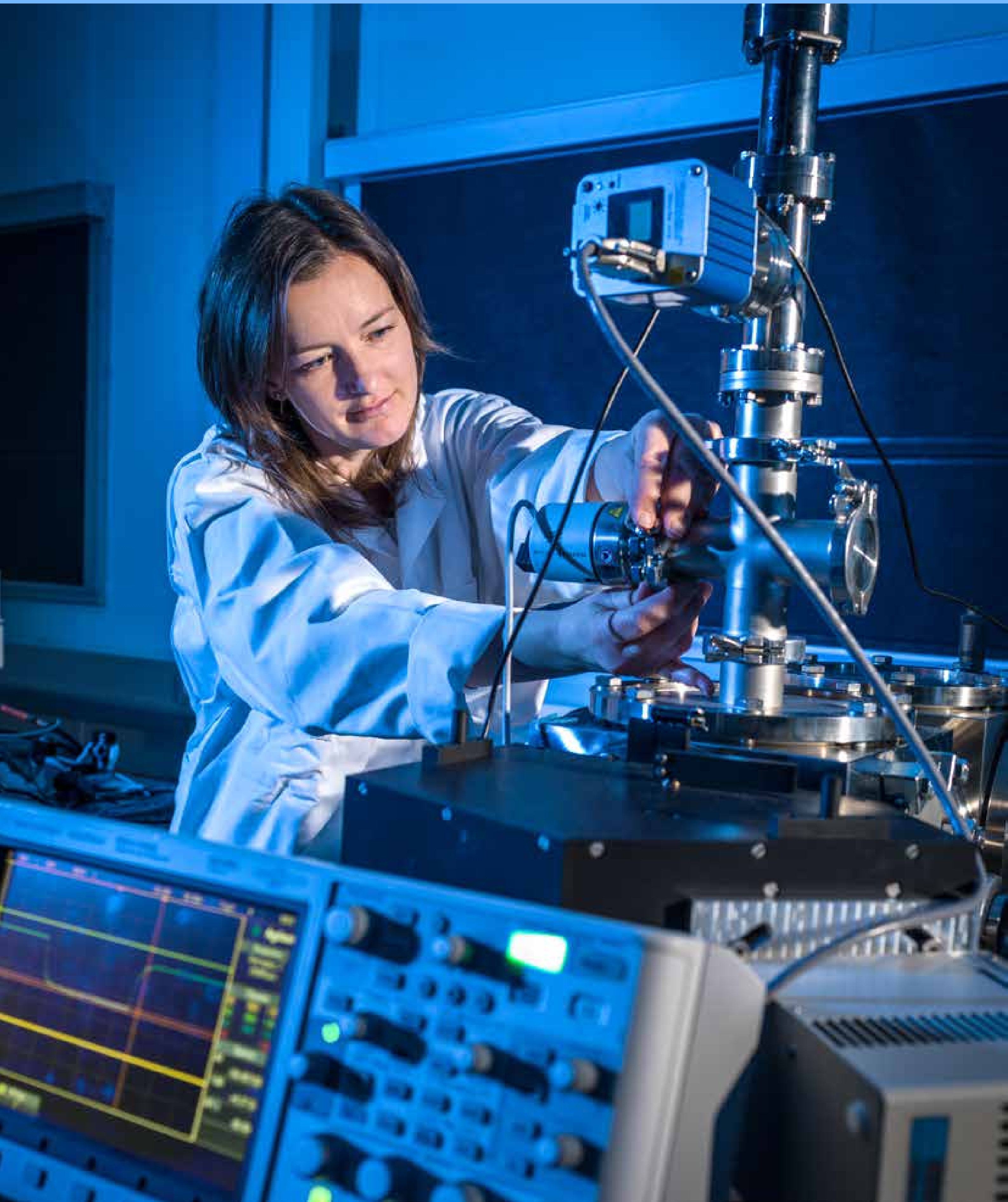
Overview

The Faculty of Mechanical, Maritime and Materials Engineering (3mE) currently comprises six departments, four of which (Precision and Microsystems Engineering, Process and Energy, BioMechanical Engineering and Maritime and Transport Technology) are directly linked to practice and to the strengths of the industrial economy, both today and in the future. The two remaining departments (Delft Centre for Systems & Control, and Materials Science and Engineering) are primarily concerned with fundamental research and the development of their respective disciplines. The faculty's educational activities revolve around three BSc programmes, each of which offers a choice of minor subjects geared towards three distinct types of engineer: specialist/researcher; designer and technical manager or entrepreneur.

The BSc programmes can be followed by any one of six highly challenging MSc programmes based on established fields of research. The TU Delft PhD programme provides a coherent and integrated curriculum of scholarly and doctoral education for excellent students. The 3mE Graduate School programme aims to support the development of scholarly knowledge, personal generic competencies and prospective professional development for future academic and non-academic career paths.

The faculty aims to educate dedicated engineers and PhD graduates and conducts breakthrough scientific research in the fields of mechanical engineering, maritime engineering and materials science. The faculty aspires to being an excellent example of a dynamic and innovative faculty that pursues a leading position in Europe and makes a direct contribution to the economy and society.
For more information on 3mE please visit:
www.3me.tudelft.nl/en

Intensified Reaction and Separation Systems (IRS)



Overview

The IRS Group is internationally recognized as the world leader in the field of Process Intensification, due both to its research activities and its trend-setting publications, including the world's first book in the field that was recently translated into Chinese. The IRS Chair is the founder of the European Process Intensification Centre (EUROPIC, www.europic- centre.eu), currently comprising twenty leading chemical companies from Europe, USA and China.

The main objective of our research is the development of fundamentally new concepts of "perfect" chemical reactors and separation systems. We develop new methods and related equipment to influence and control molecular interactions (orientation, forces and energies) in systems in which such interaction plays an important role, such as reactions, distillation or crystallization. The research involves a combination of experimental and modelling work and spans all relevant length scales, from molecule to process plant.

Intensification of and improved molecular control of chemical reactions and separations by means of alternative energy forms (such as microwaves, electric fields, plasma, light or acoustic fields) account for a significant part of our research. "Perfect chemical reactors" are studied under the ERC Advanced Investigator Grant of Prof. Stankiewicz, whereby molecular orientation and activation are locally controlled by means of electric or electromagnetic (laser, microwave, light) fields. In another project granted by the Bill and Melinda Gates Foundation, waste biomass is converted tar-free to pure synthesis gas in an innovative microwave plasma reactor. An important element of the IRS Group's activities is the application of fundamental concepts of process intensification for improved control of the crystallization processes. Fundamental control of crystal nucleation through molecular association processes, templates and alternative energies are investigated. Controlled crystallization under the influence of external fields such as plasma, electric fields, laser light and ultrasound is also studied.

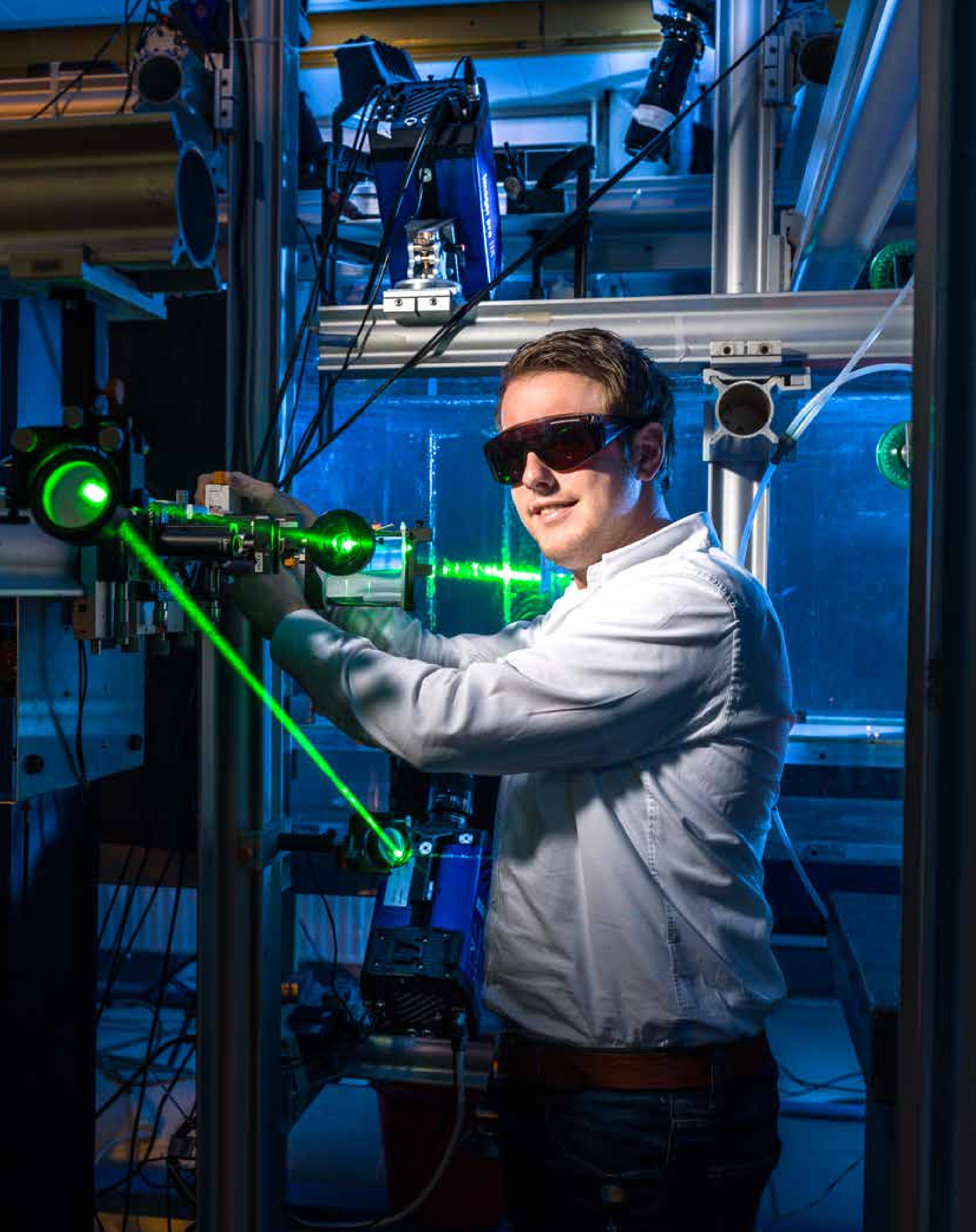
The research profile of the IRS Group, which focuses on intensified equipment with molecular-level control using alternative forms of energy, is unique on the international scale. The expertise in the field of applied crystallization is also unique within the Netherlands.

Energy Technology (ET)

Overview

One of the big problems that society will face in the coming decades is the provision of a clean, sustainable and reliable energy supply for the ever-growing world population. Future energy supply will probably be based on a mix of several energy sources, such as solar, wind, biomass, fossil and nuclear power. Due to the inherent intermittency of clean power generating technologies such as solar and wind, there will be a growing need for large-scale energy storage technologies. The only realistic option for large-scale energy storage will be in the form of chemicals (synthetic fuels).

The energy technology group, consisting of five permanent staff members and approximately 20 PhD and postdocs, develops new technologies for power generation based on renewable energy sources such as biomass and synthetic fuels. Examples are highly efficient supercritical power cycles with CO_2 as working fluid, biomass gasification, and high temperature fuel cells, which can be used to generate power from fuel and fuel from power (reversible fuel cells). A large part of the research is performed with the help of state-of-the-art large-scale experimental facilities, such as a 100 kW gasifier and a fuel cell laboratory. In addition to the experimental work, a substantial amount of computational work is performed by the group on flow, turbulence and turbulent heat transfer.



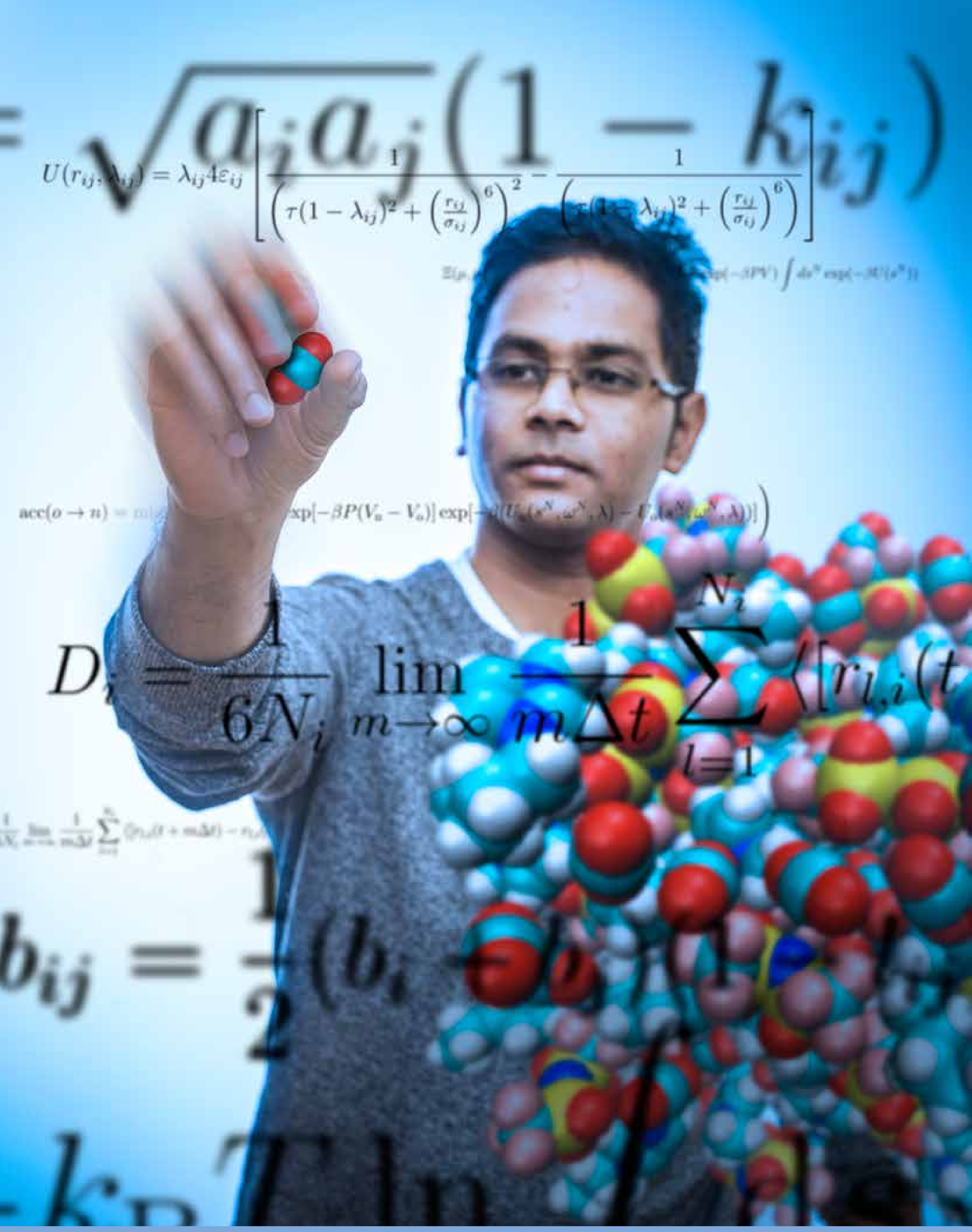
Fluid Mechanics (FM)

Overview

The Fluid Mechanics section at Delft University of Technology was founded by professor J.M. Burgers in 1918, as one of the first chairs in the World to be dedicated to this field. For almost a century, the laboratory has pioneered applied and fundamental fluid mechanics and has gained international recognition in the fields of turbulence and experimental fluid mechanics. At present, the staff of the section consists of two full-time professors, Prof. Jerry Westerweel and Prof. Dirk Roekaerts; a part-time professor, Ruud Henkes, two associate professors and five assistant professors. Their research and teaching covers a wide range of areas in fluid mechanics: e.g. microfluidics, multiphase flows, heat transfer, turbulence, cardiovascular flow, combustion, measurement and simulation techniques. This work is performed together with about 20 PhD candidates.

The research is aimed at fundamental aspects of flows, but always with a clear connection to a practical application or process in industry.

Experimental and computational studies are made of systems at different scales, from lab scale to industrial scale. Detailed investigations are made using laser diagnostic techniques (such as particle image velocimetry, laser-induced fluorescence, and spectroscopic methods) and using advanced computational models, such as large-eddy simulation and direct numerical simulation. The programme responds to a substantial movement within society and industry, towards, for example, more environmentally friendly combustion processes avoiding the formation of NOx and particulates (soot) in industrial combustion systems (furnaces, gas turbines and engines), and for the development of energy efficient processes (e.g., through drag reduction). The activities in microfluidic flows concentrate on the investigation of small-scale cardiovascular flows, flow geometries with complex boundary conditions (such as micro flagella), and micro-scale multiphase flows.



Engineering Thermodynamics (ETH)

Overview

It is a major challenge for engineers to provide the world with an increasing standard of living while significantly reducing the resulting ecological footprint. Engineering thermodynamics is a crucial tool for meeting this challenge, as it is indispensable to the development of energy-efficient processes (e.g. energy conversion processes and separation processes). Our mission is to apply and develop methods, tools and processes that will lead to more energy efficient processes in industry. This requires a detailed understanding of the thermodynamic and transport properties of (complex) fluids, which are governed by interactions on the microscopic and mesoscopic scale. Molecular thermodynamics, molecular simulation and mesoscopic modeling are important research areas in our group as it is often very difficult to access the required small length scales experimentally. This molecular viewpoint is often applied in the context of a distinct research goal or a process that takes place inside a machine or device, e.g. optimising the structure of a solvent, nanoporous hosts, or liquid crystal for carbon dioxide removal from gaseous streams.

The theory of non-equilibrium thermodynamics is used to find the state of minimal entropy production of given processes, i.e. this is the state in which fewer resources are wasted. Finding this state of minimal entropy production requires parameters that can be obtained from simulations and theory that is applied at the molecular level. Another important research area is the flow of complex fluids such as emulsions, suspensions, and slurries, as they are ubiquitous in industrial processes. There is high industrial demand for accurate constitutive relations to describe their deformation and flow. When fundamental understanding is lacking (which is often the case) industrial practitioners fall back on ad hoc fitting functions, which have a limited range of applicability and no predictive power.

Our goal is to provide novel, predictive constitutive relationships based on a fundamental understanding of the relationship between microscopic structure and macroscopic response. This is a challenging task, because complex fluid rheology depends sensitively on both material constitution and deformation mode. More applied research in our group is carried out in the field of refrigeration and heat pumps. We aim to deliver a contribution to more sustainable solutions for heating and cooling processes both in industry and in the building sector, and to develop solar energy supported thermodynamic systems that use natural operating fluids and low temperature heat wherever possible. Knowledge of the molecular and thermodynamic properties of the fluids involved is essential for this task: non-equilibrium thermodynamics plays a crucial part in finding the state with minimal entropy production and thus optimal energy efficiency.

As it is often difficult to access the molecular scale experimentally, molecular simulations and molecular thermodynamics are very important tools to obtain this fundamental understanding. A key objective of this research is to develop and apply these approaches in such a way that they lead to accurate predictions for macroscopic systems. Molecular simulations and theory are used to investigate the properties of systems of industrial interest (e.g. chemical and process industry), in close collaboration with experimentalists (both in and outside Delft), theoreticians (both in and outside Delft), and industry. Examples of these are:

1. transport and adsorption of guest molecules (e.g. hydrocarbons, CO_2, N_2, water, alcohols) in nanoporous nanomaterials (e.g. zeolites, metal-organic frameworks, carbon nanotubes);
2. self-assembly of nanocrystals (metal or semiconductor, in solution or in vacuum, capped or uncapped);
3. mechanical properties of gas hydrates;
4. developing predictive models for multicomponent transport coefficients in fluids;
5. the development of accurate descriptions of (coupled) transport of heat and mass in zeolite membranes and other systems.

Living and working in Delft

The Kingdom of The Netherlands consists of twelve provinces in the Northwest of Europe (commonly known as The Netherlands) as well as three islands in the Caribbean. The Netherlands, with a population of over 16 million, is a constitutional monarchy with a parliamentary system. Geographically, it is a low-lying country, with about 20 per cent of its area and 21 per cent of its population located below sea level, and 50 per cent of its land lying less than one meter above sea level. This small nation boasts a wealth of cultural heritage and is famous for its painters, windmills, tulips, clogs and notoriously flat lands. Today, international trade is still the main motor of economic growth. The Netherlands is the sixteenth largest economy in the world and one of the ten leading exporting nations. As a modern European country, it preserves its highly international character and is known for its liberal mentality. As a founding member of EU and NATO, and as the host to the International Court of Justice in The Hague, The Netherlands is at the heart of international cooperation. Its small size, its welcoming attitude to travellers and its many sights make it a unique and easily discoverable destination.

Dutch society

Dutch society is multicultural and focused on international relations, thanks to the merchant and exploring spirit of the Dutch as well as to the influx of immigrants. The country is the birthplace of Nobel Prize winners and controversial philosophers as well as ground-breaking artists and scientists. The United Nations has ranked The Netherlands as the fourth happiest nation on earth, with the happiest children (as ranked by UNICEF). The benefits of living and working in The Netherlands include a satisfying balance between life and work, a high standard of living, an excellent education and health system, and a strong sense of community.

About Delft

Delft is a compact, historic town between Rotterdam and The Hague in the province of South-Holland. It forms part of the 'Randstad', the urban agglomeration in the western part of The Netherlands and is the nation's main educational and research centre. Today, it revels in the 'High-tech' tag due to the abundance of technology-based institutions and organisations close to and often involved with the University. Built on reclaimed marshland, a 'polder' area, Delft borders on the agricultural centre of the Randstad. The city of Delft enjoys a worldwide reputation thanks to its connection with Johannes Vermeer, the master of light and the creator of 'The Girl with the Pearl Earring', while the world famous Delft Blue earthenware and the Royal House relive its glorious past as you wander along canals and past churches, mansions and courtyards. This university town also offers canal tours, museums, markets and many pubs and restaurants. The Old and New Church and the 'Prinsenhof' are a testament to the strong connection between Delft and the Dutch Royal Family.

Taxation

Certain categories of international staff can receive tax exemption on approximately 30 per cent of their gross salary. This is to compensate for the extra costs they incur in living abroad, such as having to rent temporary accommodation, etc. In principle, the 30 per cent rule applies to foreign staff who have been specifically recruited and who have a formal contract of employment in The Netherlands.

More information

For more information on moving to Delft, including housing, healthcare, schools, transport, banking and leisure please see: www.tudelft.nl/en/about-tu-delft/working-at-tu-delft/tu-delft-as-employer/international-candidates/

Colophon

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