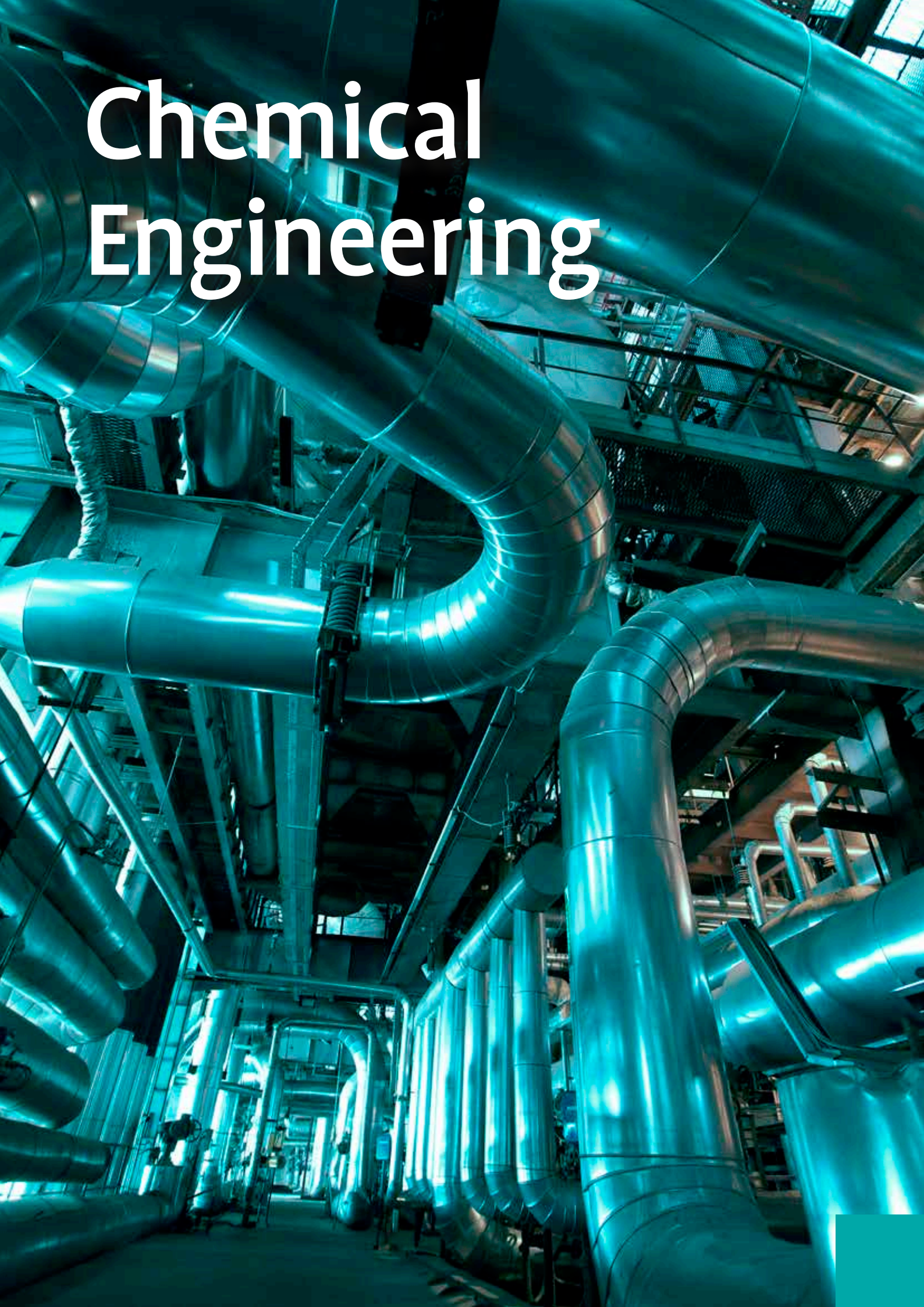
Chemical Engineering



The CHEMICAL ENGINEERING programme trains professionals involved in the production process in the process industry, with the emphasis on the chemical industry. Graduates concentrate their efforts on designing, developing, upgrading, implementing and evaluating integrated systems of plant and equipment, energy, materials, feedstocks and processes in the process industry.

The chemical engineer's objectives are to optimise reliability, ensure safety and meet product specifications while eliminating wastage of materials, energy, time and other resources. The chemical engineer knows about physical and chemical processes, product characteristics and process steps and is able to place all of this within the context of more abstract theoretical models.
Graduates are involved in or even primarily responsible for managing and controlling some or all of the production process. Working as part of a team, they develop or apply new processes or improve existing processes, products or materials. To this end, they consult both operators and senior management and external parties, take decisions on process changes or prepare for these decisions and report on the normal or abnormal progress of the process, changed process conditions and the result.

Because of the powerful focus on the process industry, graduates can also be deployed more widely throughout the process industry, including the food or paper industry, waste processing, in water supply companies and in the bio-process industry.

ILLUSTRATION OF PROFESSIONAL FIELD

Occupations, jobs and roles for graduates are mostly to be found in the following professional domains (for a full description of the professional domains, see Section 2). A few examples are given for each domain.

Engineering and manufacturing
- Process engineer
- Project manager for upscaling
- Production process designer
- Production quality manager
- Production safety officer
- Process engineer and troubleshooter
- Production manager and plant manager
- Pilot plant manager
- Manager of a production line

Research and development
- Product developer for chemical products
- Product developer for production facilities such as reactors and separation technology

Commerce and customer service
- Safety and environmental consultant
- Fire officer

National programme profile

	Competence							
	Research	Experimentation	Development	Management	Advice	Instruction	Leadership	Self-management
Minimum national attainment target adopted for the programme	**II***	**II**	**II***	**I**	**I**	**_****	**I**	**II**

* At least one of these competences must be raised by one level.
** Students can choose to raise the level of these competences by making certain choices in their range of subjects, internship and graduation project during the last two years of their course.

Institutions that offer the programme

- Avans University of Applied Sciences, Breda
- The Hague University of Applied Sciences, The Hague
- Hanze University of Applied Sciences, Groningen
- HU University of Applied Sciences, Utrecht
- NHL Stenden University of Applied Sciences | VHL University of Applied Sciences, Leeuwarden
- Rotterdam University of Applied Sciences
- Saxion University of Applied Sciences, Enschede

Chemical Engineering

KNOWLEDGE

- **Safety*:** personal safety, process safety (e.g. HAZOP) and environmental aspects
- **Unit operations:** heat exchangers, separation techniques (e.g. distillation and membrane technology)
- **Thermodynamics**: 1st and 2nd main law, phasing, chemical thermodynamics
- **Statistics and mathematics:** chemical calculations, differentiation, integration, differential equations, reliability of measurements, data processing and data analysis (e.g. statistical tests, statistical software)
- **Chemical reaction engineering:** model reactors (batch, CSTR, PFR), kinetics (e.g. reaction mechanisms, catalysis, enzyme kinetics)
- **Process engineering:** process design (e.g. BFD, PFD, P&ID), measurement and control technology, process control
- **Process modelling:** simulation, modelling (e.g. stationary, non-stationary), experimental design, optimisation
- **Materials science:** material properties (e.g. metals, plastics) and applications for materials (e.g. processing techniques)
- **Physical transport phenomena:** fluid dynamics, mass and energy balances, stationary and non-stationary models
- **Chemistry:** *basic* (atomic and molecular construction, reactions in water, chemical equilibrium), *analytical* (such as spectroscopy, chromatography), *organic and polymer chemistry* (such as synthesis, functional groups, reaction mechanisms)
- **Economic aspects:** e.g. cost price calculations, operational and investment costs, feasibility studies

SKILLS

- **Research skills and systematic approach to problems:** problem analysis, preparing research questions, desk research, research planning and implementation
- **Design skills/upscaling:** translating lab-scale/pilot-scale experiments to production scale, setting up process models
- **ICT skills:** use and deployment of state-of-the-art digital tools/software (e.g. simulation, design, reporting and presentation software, data analysis and processing software)
- **Experimenting with pilot set-ups:** separation equipment (e.g. distillation, extraction, membranes), flow equipment (e.g. heat exchanger, pump) or reactors
- **Morally responsible actions:** making responsible choices based on safety, sustainability, technological and economic criteria
- **Safety at work in laboratory and industrial environment**
- **Social and communicative skills:** collaborating, issuing reports and giving presentations (internationally, at all events in English and locally e.g. in Dutch), project-based work
- **General laboratory skills and chemical analysis methods:** conducting experiments at laboratory scale, performing chemical analyses (e.g. titration, spectrometry, chromatography)

The Body of Knowledge and Skills is a summary of graduates' basic knowledge and basic skills which has been prepared by the HBO-programmes in consultation with the professional field. These are obtained during the first two years of education.

*The Chemical Engineering Safety Curriculum has been developed especially for the Chemical Engineering courses, in collaboration with the professional field. This is a comprehensive educational programme that is in line with the BoKS and that has been included in the curriculum by a number of programmes.

TYPICAL TEXTBOOKS

- *Chemistry*, J.E. McMurry. R.C. Fay e.a.
- *Shreve's Chemical Process Industries*, G.T. Austin
- *Elements of Physical Chemistry*, P. Atkins, J. de Paula
- *From Polymers to Plastics*, A.K. van der Vegt
- *Exact communiceren*, R. van der Laan
- *Wiskunde voor hoger onderwijs*, S. Kemme e.a.
- *Procestechnologie*, VAPRO
- *Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer*, J.R. Backhurst, J.H. Harker e.a.
- *Elements of reaction engineering*, H.S. Fogler
- *Statistiek om mee te werken*, A. Buijs
- *Chemical Engineering Safety Curriculum*, see https://appliedscience.nl/ veiligheidsonderwijs

The list of typical textbooks serves as an illustration to give an impression of the level at which the subject is taught in the study programme.

Chemical engineer Hanneke Bukkems:

‘Social skills are very important’

Name: Hanneke Bukkems
Age: 28
Course of study: Chemical Engineering
Place of employment: Nyrstar Budel
Job: Chemical engineer

‘In the first year of my studies, I opted for chemistry and subsequently, more specifically, for chemical engineering. That seemed to suit me best – abstract, a lot of working with figures, a man’s world, good prospects. I discovered during my graduate internship that I had definitely made the right choice. I really wanted to do my graduate internship abroad and ended up at Nyrstar Hobart in Australia, where I was allowed to work on all kinds of assignments of my own. I got the ideas for them by talking to operators, heads of department, technicians, laboratory staff, etc. I also took a good look around me, for example at possible ways of improving the process and the business (can operations be simplified? Can test results be improved by using different analysis methods, etc?).

As a chemical engineer, I am responsible for one of Nyrstar Budel’s four production departments. I look at ways of improving the current process, cutting costs, facilitating increased production, making the process more stable or, for example, extending the service life of materials. I also monitor the statutory environmental standards for emissions, waste, etc. and make adjustments where necessary. In addition, I am involved in maintenance when, for example, the catalyst in a reactor has to be inspected, replaced, etc. I then delve into the relevant history, contact contractors/experts, consider the pros and cons of the different suppliers, etc. And I have all kinds of routine duties. For example, I check a number of standard graphs (flows, pressures, temperatures, etc.) and test results every day, discuss them and, if necessary, adjust them. To do this, I work with a lot of people, including laboratory staff, mechanical engineers, technicians and operators.

Clear advice

The competences of **research**, **experimentation** and **development** are very relevant to my job; supervision, coaching, instruction and leadership | managing people less so. I have a very independent job that requires you to give properly substantiated, clear advice so that even a manager who is not familiar with the problem can understand you and take a well-considered decision. You also have to give instructions to or obtain information from operators, laboratory staff and external experts on a regular basis. Communication and social skills are therefore very important.

The theory you learn during the programme is very useful as a foundation and the practice gives you an idea of what the equipment does. The thing that was missing from the programme for me was: what happens if a graph does not follow the standard course or the analysis results are not within the specifications? What can be wrong and how can I solve the problem?

In future, I would like to work internationally, e.g. as an expert in shutdowns (overhauling production plants). Fortunately, I can continue to grow in my job with my current employer.’ ■

R&D engineer Erik Heijkamp:

‘There are always processes that can be optimised’

‘I was looking for a course that featured physics and chemistry and offered good prospects of future employment. Working in projects with different companies really appealed to me and I thought it was an advantage that my programme was provided entirely in English as that is almost indispensable in this professional field. So I opted for chemical engineering. It turned out better than expected: I had fellow students from all over the world and got to know many different cultures. I did my graduation project at DSM Special Products, where I made a basic engineering design for an extraction/pertraction system. I ended up at DSM through a friend, eventually arriving here at Unilever via Dosign Engineering.

I specialise in testing detergents for the European market: setting up and running my own tests, performing analyses and reporting the results and possibly obtaining claim support from them. I also make sure that the equipment keeps working and is in good condition, and I am on the lookout for possibilities of optimising the work.
In addition, I am responsible for maintaining the water plant – a plant in which all types of water (every country in the world has a different type of water) at different levels of hardness are produced. This system consists of all kinds of pumps, tanks and chemicals and is used by different departments at Unilever. Added to this is troubleshooting: you’re expected to put down your work immediately when problems arise. Of course, prevention is better than cure but everything wears out eventually.

I feel that the programme and my job fitted seamlessly together. You do gain an insight into how certain processes work, which allows you to detect problems more quickly. You can also do calculations more quickly and predict reactions of certain liquids. The only thing is that I am doing less engineering now, which I do sometimes miss.

Own initiative
There are always processes or operations that can be optimised. This is done on the basis of **research** and **experimentation**. These two steps must be completed properly so that you can convince your boss of all the advantages and disadvantages. It is always appreciated when you develop certain ideas on your own initiative, **manage** them and make plans which will improve things in future. I sometimes work on projects with a number of people and sometimes alone. It is important that you should be able to **manage** your work effectively and also give responsibility to other people. This will often require some coaching, but if you do it properly you will benefit from it more later and be able to achieve more.

I am very happy with my current job, where I still have many new things to learn and organise. Eventually, I would like to progress within Unilever. I would like to **train** and **advise** more people in my professional field, which I’m doing too little of at the moment.’ ■

Name: Erik Heijkamp
Age: 24
Course of study: Chemical Engineering
Place of employment: Unilever R&D
Job: R&D engineer laundry