Assessment report
Limited Framework Programme Assessment

Master Chemical Engineering

University of Groningen

Contents of the report

1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Master Chemical Engineering of the University of Groningen. The programme was assessed according to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, as published on 20 December 2016 (*Staatscourant* nr. 69458).

The mission of the programme is to train chemical engineers in the design of industrially relevant (formulated) chemical products in relation to their desired performance and integrate this knowledge in a process design at an advanced level. The programme aims to deliver graduates who are well prepared for jobs in the industry or academia. The panel considers the objectives of the programme to be very sound and relevant. The panel appreciates the unique profile of the programme, with its focus on product engineering, combining classical chemical engineering with advanced chemistry. The learning outcomes are coherently formulated around this profile. They are also up to date, fit within relevant international frameworks and meet the academic requirements for a master in the field of chemical engineering.

The programme consists of a compulsory core programme, an internship in a company, the Master's Research Project and a specialization: Polymeric products; Bio-based products; Industrial catalysts; Green Chemistry and Catalysis; or Advanced process technology. The curriculum complies with the intended learning outcomes. The programme is logically structured, with a clear focus on product technology, in line with the profile of the programme.

The content of the curriculum and course materials are up-to-standard or exceeding it, and fit in the profile of the programme. The educational methods are adequate. The programme is capitalizing on its small scale. Attention is paid to research skills, with special attention to the skills for integration of product and process technology.

The admission requirements and admission procedures of the programme are well elaborated and appropriate. The programme has set reasonable admission criteria.

The programme is doable; it is intensive but feasible. The dropout is comparable to other programmes. The system of tutoring and the individual study plan is beneficial to the feasibility of the programme. The panel appreciates the personal attention paid to the students' progress.

The lecturers are highly motivated and well appreciated by the students. Teachers are mainly drafted among researchers from the Engineering and Technology Institute Groningen. Nearly all lecturers have a PhD and are actively involved in research. Many of them have an industrial background. The research of the Institute has been evaluated as very good in the most recent research review. This academic track record clearly benefits the curriculum. Also, the didactical capabilities of the teachers are up-to-standard as demonstrated by the percentage of lecturers with a university teaching qualification. The size of the staff is small but adequate.

The examination and assessment policies are adequate. The Board of examiners is functioning corresponding to its formal tasks and takes its responsibility seriously. The Board has adequate procedures in place to ensure the validity and the reliability of assessments, exemplified by the course unit assessment overview and the peer review of assessments. The course unit assessment overviews and

assessment matrices of the current courses are well elaborated and satisfactory. The reviewed assignments and tests are up to standard and reflect the desired level.

The panel confirms that the learning outcomes are realized. The panel has reviewed fifteen final theses and concludes that they clearly demonstrate the intended level of the programme. The panel notes room for improvement in enhancing the consistency of the grading of the final thesis, as examiners can now give different weights to the items within a category on the assessment form. The panel also recommends having the first and second examiner of the thesis to make independent judgments.

The panel also considers the satisfaction among alumni and representatives of the professional field an indication that the programme meets the demands of the professional field and that students achieve the desired level. Graduates of the programme appear to be in high demand. A recent survey shows the majority of the graduates decide to pursue a professional career, 43% from them as process or product engineer. Also, a relatively large share of graduates pursues a PhD (17%). The members of the external Advisory Board, too, report to be satisfied with the level of the graduates.

The panel that conducted the assessment of the Master Chemical Engineering programme of the University of Groningen assesses this programme to meet the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, judging the programme to be good. Therefore, the panel recommends NVAO to accredit this programme.

Rotterdam, March 16th, 2019

Prof. dr. M.A. Cohen Stuart (panel chair)	T.T. Lamers MSc (panel secretary)

2. Assessment process

The evaluation agency Certiked VBI received the request by University of Groningen (UG) to support the limited framework programme assessment process for the Master Chemical Engineering of this university. The objective of the programme assessment process was to assess whether the programme would conform to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (*Staatscourant* nr. 69458).

Management of the programmes in the assessment cluster Chemistry and Chemical Engineering convened to discuss the composition of the assessment panel and to draft the list of candidates.

Having conferred with the management of the Master Chemical Engineering programme of the University of Groningen, Certiked invited candidate panel members to sit on the assessment panel. The panel members agreed to do so. The panel composition was as follows:

- Prof. dr. M.A. Cohen Stuart, professor emeritus, chair of Physical Chemistry & Colloid Chemistry, Wageningen University, professor emeritus of Physical Surface Chemistry, University of Twente, professor East China University of Science and Technology, Shanghai, China (panel chair);
- Prof. dr. A.H.T. Boyen, associate professor emeritus, Faculty of Sciences and Bio-engineering Sciences, Faculty of Medicine and Pharmacy, Vrije Universiteit Brussel (panel member);
- Prof. dr. R.M.J. Liskamp, professor, chair Chemical Biology and Medicinal Chemistry, School of Chemistry, University of Glasgow, United Kingdom, professor of Molecular Medicinal Chemistry, Utrecht University (panel member);
- Prof. dr. ir. G.B. Marin, professor of Chemical Reaction Engineering, head Laboratory for Chemical Technology, Ghent University (panel member);
- Prof. dr. Valter Castelvetro, Professor in Industrial and Macromolecular Chemistry, University of Pisa (panel member);
- Prof. dr. Leonard Prins, professor of Organic Chemistry, University of Padova (panel member);
- Dr. P. Berben, senior research manager BASF, member leadership team BASF De Meern (panel member);
- A.E.M. Melcherts BSc, student Master Chemical Sciences: Nanomaterials Science, Utrecht University (student member).

On behalf of Certiked, drs. W. Vercouteren served as the process coordinator and T.T. Lamers MSc (independent advisor) as secretary in the assessment process.

All panel members and the secretary confirmed in writing being impartial with regard to the programme to be assessed and observing the rules of confidentiality. Having obtained the authorisation by the University, Certiked requested the approval of NVAO of the proposed panel to conduct the assessment. NVAO have given their approval.

To prepare the assessment process, the process coordinator convened with management of the programme to discuss the outline of the self-assessment report, the subjects to be addressed in this report and the site visit schedule. In addition, the planning of the activities in preparation of the site visit were discussed. In the course of the process preparing for the site visit, programme management and the Certiked process coordinator regularly had contact to fine-tune the process. The activities prior to the site visit have been performed as planned. Programme management approved of the site visit schedule.

Well in advance of the site visit date, programme management sent the list of final theses of graduates of the programme of the last two complete years. Acting on behalf of the assessment panel, the process coordinator selected 15 final theses from this list. The grade distribution in the selection was ensured to conform to the grade distribution in the list, sent by the programme management.

The panel chair and the panel members were sent the self-assessment report of the programme, including appendices. In the self-assessment report, the student chapter was included. In addition, the expert panel members were forwarded a number of final theses of the programme graduates, these final theses being part of the selection made by the process coordinator.

A number of weeks before the site visit date, the assessment panel chair and the secretary discussed the self-assessment report provided by programme management, the procedures regarding the assessment process and the site visit schedule. The profile of panel chairs of NVAO was discussed as well. The panel chair was informed about the competencies, listed in the profile. Documents pertaining to a number of these competencies were presented to the panel chair. The discussion between the panel chair and the process coordinator served as the briefing for panel chairs, as meant in the NVAO profile of panel chairs. Prior to the date of the site visit, all panel members sent in their preliminary findings, based on the self-assessment report and the final projects studied, and a number of questions to be put to the programme representatives on the day of the site visit. The panel secretary summarised this information, compiling a list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

Shortly before the site visit date, the complete panel met to go over the preliminary findings concerning the quality of the programme. During this preliminary meeting, the preliminary findings of the panel members, including those about the final projects were discussed. The procedures to be adopted during the site visit, including the questions to be put to the programme representatives on the basis of the list compiled, were discussed as well.

On 10 and 11 January 2019, the panel conducted the site visit on the University of Groningen campus. The site visit schedule was in accordance with the schedule as planned. In separate sessions, the panel was given the opportunity to meet with Faculty Board representatives, programme management, Examination Board representatives, lecturers and students and alumni.

In a closed session at the end of the site visit, the panel considered every one of the findings, weighed the considerations and arrived at conclusions with regard to the quality of the programme. At the end of the site visit, the panel chair presented a broad outline of the considerations and conclusions to programme representatives.

Clearly separated from the process of the programme assessment, the assessment panel members and programme representatives met to conduct the development dialogue, with the objective to discuss future developments of the programme.

The assessment draft report was finalised by the secretary, having taken into account the findings and considerations of the panel. The draft report was sent to the panel members, who studied it and made a number of changes. Thereupon, the secretary edited the final report. This report was presented to programme management to be corrected for factual inaccuracies. Programme management were given two weeks to respond. After correcting these factual inaccuracies, the final report was established by the chair at March 16th, 2019. Subsequently, the Certiked bureau sent the report to the University Board to accompany their request for re-accreditation of this programme.

3. Programme administrative information

Name programme in CROHO:	Chemical Engineering
Orientation, level programme:	Academic Master
Grade:	MSc
Number of credits:	120 EC
Specializations:	Polymer products, Bio-based products, Industrial catalysts, Advanced process technology, Catalysis and Green Chemistry
Location:	Groningen
Mode of study:	Full-time (language of instruction: English)
Registration in CROHO:	21PC-60437
Name of institution:	University of Groningen
Status of institution:	Government-funded University
Institution's quality assurance:	Approved

4. Findings, considerations and assessments per standard

4.1 Standard 1: Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings
The mission of the programme is to train chemical engineers in the design of industrially relevant (formulated) chemical products in relation to their desired performance and integrate this knowledge in a process design at an advanced level. This mission is well aligned with the general policy of the Natural Sciences faculty to strengthen its engineering activities. The programme aims to deliver graduates who are well prepared for jobs outside academia (industry, engineering companies, consultancies, research institutes) or for a continuation in academia – e.g. as a PhD or a PDEng (Professional Doctorate in Engineering) student. Therefore, the objective is that graduates possess knowledge on an advanced level on different product types and different production strategies. Moreover, they possess general (research and design related) academic skills and are able to reflect on their design, validate it, and define and execute research when needed for the design.

According to the management, the programme is unique due its focus on product engineering. The programme combines the attention on classical chemical engineering with advanced chemistry. This profile had been adopted in 2003 and has since been applauded by the professional field, who articulate a demand in trained chemical engineers with this profile.

The programme has defined its intended learning outcomes, which consist of general academic skills and specific programme-related knowledge and skills.

The programme shows how the learning outcomes relate to the internationally accepted descriptions for the Master's level, as demonstrated by the Dublin descriptors. Furthermore, the programme shows all learning goals are based on the Dutch qualification framework formulated by the 'VSNU Kamer Scheikunde' and meet the international requirements specified by the 'EFCE recommendations.' The programme also complies with the general Frame of Reference for Chemistry sciences, a document assembled by representatives of all Chemistry and Chemical Engineering programmes in the Netherlands.

Considerations
The panel considers the objectives of the programme to be very sound and relevant. The panel appreciates the positioning of the programme on the boundary of chemistry and chemical engineering with a deliberate focus on product engineering. Thus, the programme has a clear vision and a distinguishable profile. The panel has learnt this profile is supported by the external advisory board of the programme, and by the industry.

According to the panel, the learning outcomes are coherently formulated around the unique profile of the programme. The learning outcomes are also up to date and reflect current developments in the field of chemistry, also due to its profile making it in the forefront of innovations in the field of chemical engineering.

The intended learning outcomes fit within relevant international frameworks and meet the academic requirements for a master in the field of chemical engineering. This is exemplified by matching the Dublin descriptors for the Master programme, the EFCE recommendations and the Dutch national domain-specific framework.

Assessment of this standard
These considerations have led the assessment panel to assess standard 1, Intended learning outcomes, to be good.

4.2 Standard 2: Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings
The programme consists of a core programme (compulsory) with six course units, an internship in a company, the Master's Research Project and the specialization. The research project is usually carried out in a research group associated with the Engineering and Technology Institute Groningen (ENTEG) but may also be performed (partially) in an academic setting abroad. Students can choose between five specializations, of which three are product related (Polymeric products, Bio-based products and Industrial catalysts), one together with Chemistry (Green Chemistry and Catalysis) and one is in advanced process technology.

The programme has presented the mapping of the intended learning outcomes with the course unit, which demonstrates all learning outcomes are covered.

The programme mainly pays attention to research skills, which are integrated and not put in separate courses. Special attention is paid to the skills for integration of product and process technology.
The programme furthermore pays attention to employability, although the results of a recent questionnaire show this is not always visible to the student.

The didactic principles of the curriculum are: context-driven learning, activating teaching methods, increasing integration and intensification of content, teamwork in interdisciplinary and intercultural settings, interaction between research and education, clear embedding of academic skills and orientation on the labour market. Teachers informed the panel about practising new activating instruction styles to enhance class interaction. They also pay attention to group work. Lecturers note that while group composition is student-controlled, national and international students do not stick together anymore but mix well.

Both staff and students regard the programme as intensive but feasible. Students appreciate the approachability and open-door policy of teachers. Dropping out occurs only incidentally. However, the time it takes for students to obtain their degree is relatively long. The management has identified the internship and research project as main causes of delay and is attempting to avert any delaying elements and to improve careful planning by students.

Students with a Bachelor's degree in Chemical Engineering from a university in the Netherlands are routinely accepted. The admission of students from other Dutch degree programmes as well as international students is by decision of the Admissions Board and is based on the goals and relevance of the curriculum of the completed Bachelor's degree programme, the applicant's academic record, research experience and proficiency in English. There is a special programme of 30 ECTS for students who come directly from a University of Applied Science (HBO) to remedy any deficiencies before entering the programme.

Students get guidance by the academic advisor in planning of the master programme. Furthermore, several meetings are organized to help students making informed choices regarding their track choice and future career.

Teachers are mainly drafted among researchers from the Engineering and Technology Institute Groningen. Nearly all lecturers have a PhD and are actively involved in research. According to information of the management, 46% of staff members have an industrial background or have a major affiliation at a company or research institute. Also professionals from the industry are involved as (guest) lecturers. They are especially teaching on generic knowledge of industrial processes. The research of the Institute has been evaluated as very good in the most recent research review.

Most of the staff members (64%) have a university teaching qualification. Staff members who were appointed recently are still enrolled in the course to obtain this qualification.

The core faculty of the programme consists of seven members. According to the management, the student-staff ratio has to be lowered. Measures have been taken to ease the work-load and new staff is currently being recruited. This will result in a student to staff ratio of 25:1 for the academic year 2018-2019.

According to the management and teachers, the workload of individual teachers has increased substantially due to the recent rise in bachelor and master student numbers in both the Chemistry and Chemical Engineering programmes. The number of first-years students in this master programme has doubled from approximately 15 in 2011 to 30 in 2017. The panel learnt from the discussions that the workload is currently manageable and does not compromise the quality of the programme. Management is aware of the teacher's workload.

During research projects students are provided with a fully equipped work space in the lab and have access to state-of-the-art research equipment. Lecturers have expressed their wish for more advanced facilities, especially a continuous reactor. The programme management is considering several scenarios about the development of the student population size, to be able to continue the provision of sufficient facilities (lab infrastructure, etc.).

Considerations
The panel has established that the curriculum of the programme complies with the intended learning outcomes. The programme is logically structured, with a clear focus on product technology, in line with the profile of the programme. The panel has reviewed the curriculum and course materials and concludes that they are up-to, or exceeding standards, and also fit in the profile. The courses are solid, well balanced and provide in-depth knowledge and skills in the field of Chemical Engineering. The panel regards the specializations as fitting in the structure of the curriculum and in line with the vision.

The panel finds the educational methods of the programme adequate, promoting student-activating learning, and aligned with the demands of the student population. The programme is furthermore capitalizing on its small scale. The accommodation is sufficient to provide the curriculum on this educational basis.

The admission requirements and admission procedures of the programme are well elaborated and appropriate. The programme has set reasonable admission criteria. Based on interviews with students, the panel has established that their ambition fits with the programme and the information provided by the study programme ensures the right expectations by students.

The panel considers the programme doable; the dropout is comparable to other programmes. The system of tutoring is beneficial to the feasibility of the programme. The panel appreciates the personal attention paid to the students' progress.

The panel regards the lecturers of the programme as highly motivated. Also, students are very positive about their teachers. The teaching staff has a very good academic track record and professional experience, which clearly benefits the curriculum. Also, their didactical capabilities are up-to-standard as demonstrated by the percentage of lecturers with a UTQ. The size of the staff is small but adequate.

Overall, the panel regards the teaching and learning environment as surpassing common levels, in particular due to its small scale structure and content of the courses, thereby forming a unique profile of the programme around product technology,.

Assessment of this standard
These considerations have led the assessment panel to assess standard 2, Teaching-learning environment, to be good.

4.3 Standard 3: Student assessment

The programme has an adequate system of student assessment in place.

Findings
The programme has formulated its principles with regard to assessment: different forms of assessment are used, the mode(s) of assessment match the nature of the course unit, the academic skills are all assessed, and the assessment provides feedback to the teachers.

The programme has an assessment plan, which comprises the learning outcomes of the programme, the examiners and modes of assessment of all course units, a list of individual research project supervisors, and a matrix clarifying the relationship between the learning outcomes and the course units of the curriculum.

For each course, a course unit assessment overview is available, which comprises a systematic description of the links between learning outcomes, modes of instruction and modes of assessment and marking, as well as the students' backgrounds and the position of the course unit within the curriculum.

The programme aims to ensure the quality of each test by means of a test matrix and peer review. And as a rule, exams and assignments are always drafted or checked by two lecturers (peer review) to ensure that the exam questions are clear, unambiguous and sufficiently assess whether the various learning outcomes of the course unit have been attained.

The Board of Examiners deals with all four programmes in the field of Chemistry and Chemical Engineering. The Board has intensified its proceedings since the previous audit. Three years ago, also an external member with educational expertise was added to the Board. The Board has taken measures to ensure the quality of the assessment. For example, the Board has set guidelines regarding oral assessment, stipulating that a transcript must be made. The Board annually checks the assessments of a number of course units; each course is checked once in three years. Furthermore, the Board is yearly reviewing a sample of theses. In its latest review, the Board has found that supervisors of theses could elaborate more on the justification of marks on the assessment form; it has asked for attention to this.

Besides, the Board of Examiners has to give its approval to any individual deviation from the structure of the programme and ensures all learning objectives have been met. This especially concerns students who go studying abroad; approval needs to be requested (and granted) beforehand. In addition, the committee conducts an individual check six months before graduation to determine whether all qualifications will be met, so as to avoid any surprises. In case of any deficiencies, this gives the student sufficient time for remedies.

Considerations
The panel considers the examination and assessment policies for the programme as adequate. The Board of examiners is functioning corresponding to its formal tasks and takes its responsibility seriously.

According to the panel, the Board of Examiners has procedures in place to ensure that the validity and reliability of assessments are adequate. This is exemplified by the course unit assessment overview and the peer review of assessments. The panel has reviewed the course unit assessment overviews and assessment matrices of the current courses and finds them well elaborated and satisfactory.

The panel has also reviewed assignments and considers them to be up to standard. The tests clearly reflect the desired level.

The panel concludes that the assessments are valid, reliable and sufficiently independent. The quality of interim and final examinations is sufficiently safeguarded. The system of assessment properly determines whether students have attained the intended learning outcomes.

Assessment of this standard
The considerations have led the assessment panel to assess standard 3, Student assessment, to be satisfactory.

4.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings
The programme demonstrates the achievement of the learning outcomes by the final theses and the success of graduates in their following study or career.

The final thesis is based on an individual research project. In the thesis students show the ability to integrate and apply knowledge in the field of Chemical Engineering. As the programme is on the boundary of Chemistry and Chemical Engineering, the programme regards it as natural that the thesis may also reflect in-depth knowledge of Chemistry. According to the programme management, most of the research projects have led to publication in a peer-reviewed scientific journal or in refereed conference proceedings with the student as one of the co-authors.

The programme uses a form for assessment of the thesis. The form comprises a grading scheme. Two assessors make the evaluation and fill in the form after debating the examination. If any external supervisor is involved, he or she has only an advisory role and can give written comments, while the final decision and the grading is done by the examiner of the programme.

Based on a recent survey, it appears that the majority of the graduates decide to pursue a professional career, 43% from them as process or product engineer. Also, a relatively large share of graduates pursues a PhD (17%). It furthermore appears that graduates find a job very fast.

The members of the external Advisory Board appear to be satisfied with the level of the graduates. Graduates of the programme are well appreciated by the professional field.

Considerations
The panel has reviewed fifteen recent final projects and determines that they all clearly demonstrate the intended level of the programme. The panel considers these theses as very solid, they show both good theoretical reasoning and experimental work. Some of the theses appear to have an emphasis on Chemistry rather than on Chemical Engineering, but this is in line with the profile of the programme.

The panel has concluded that the assessment forms are completed. Assessors use the same form, with a fixed weight for the different categories of assessment. The panel has noticed room for improvement in the accumulation of the different items within the categories. Apparently, different examiners can give different weights to the items within a category on the assessment form. The panel recommends improving the consistency of this.

In addition, the panel recommends that the first and second examiners make independent judgments, by each filling in an assessment form before debating the final grading. This increases the effect of the four eyes principle.

Furthermore, the panel considers the achievement of the intended learning outcomes as demonstrated by their positions in the industry or as PhD student, which shows that graduates have the right skills. Graduates of this programme appear to be in high demand.

The panel recommends the programme management to get more data on the career paths of alumni, in order to allow a better judgement of achieved learning outcomes.

Assessment of this standard
The considerations have led the assessment panel to assess standard 4, Achieved learning outcomes, to be good.

5. Overview of assessments

Standard	Assessment
Standard 1. Intended learning outcomes	good
Standard 2: Teaching-learning environment	good
Standard 3: Student assessment	satisfactory
Standard 4: Achieved learning outcomes	good
Programme	good

6. Recommendations

In this report, a number of recommendations by the panel have been listed. For the sake of clarity, these have been brought together below.

- To improve the consistency of the grading of the final thesis, as examiners can now give different weights to the items within a category on the assessment form.
- To have the first and second examiner of the final thesis make independent judgments, by first each filling in an assessment form prior to debating the final grading.
- To gather more data on the career paths of alumni.