Global J. of Engng. Educ., Vol. 2, No.3
Printed in Australia
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Chemical Engineering Education in Indonesia*

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The chemical engineering curriculum in Indonesia is governed by the Ministry of Education and Culture regulation 0218/U/1995 (25 July 1995). The curriculum is based on engineering science principles and oriented towards practical engineering application. The national curriculum for chemical engineering education consists of three subject groups: general-basic subjects (10 credits), skill-basic subjects (44 credits) and major subjects (39 credits).

INTRODUCTION

Chemical engineering is the profession concerned with the creative application of the scientific principles underlying the transport of mass, energy and momentum and the physical and chemical change of matter. As a distinct discipline, chemical engineering developed during the twentieth century in answer to the needs of the chemical industry, which was no longer able to operate efficiently with manufacturing processes that in many cases were simply larger scale versions of laboratory equipment.

Chemical engineering education in Indonesia has changed significantly during the past decade. The curriculum is based on engineering science principles and oriented towards practical engineering application.

THE CHEMICAL ENGINEERING CURRICULUM IN INDONESIA

The classical role of the chemical engineer is to take the discoveries made by the chemist in the laboratory and develop them into money making, commercial-scale chemical processes. From this perspective, the aim of chemical engineering education in Indonesia is to prepare human resources capable of developing, designing and constructing a chemical plant.

There are three degree programmes offered in Indonesia, S-1 (Strata 1), S-2 and S-3; only S-1 will be considered here. The course is run using a credit system.

An academic year is divided into two semesters of 14-16 weeks each. In each semester, students attempt approximately 20 credits worth of subjects, with each subject weighted from one to three credits (a one credit course comprises lectures and tutorials of fifty minutes duration, structured assignments and weekly self-study of fifty minutes; a one credit laboratory comprises three hours practical work in the laboratory weekly). S-1 students have to complete 144-160 credits, depending on the university policy.

The chemical engineering programme includes courses in stoichiometry (using material and energy conservation ideas to analyse chemical process steps), unit operation (chemical processes), transport phenomena (heat, mass and momentum transfer), chemical engineering laboratories (in which equipment is operated and tested), chemistry, mathematics, environmental, thermodynamics, mechanics, and chemical plant design (in which cost factors are combined with technical elements to arrive at preliminary plant design).

These courses, determined by the Ministry of Education and Culture regulation 0218/U/1995 (25 July 1995), are the core of the chemical engineering curriculum in Indonesia, and consist of 93 credits divided into three subject groups: general-basic subjects (10 credits), skill-basic subjects (44 credits) and major subjects (39 credits). As well as the core curriculum, there are also local chemical engineering education curricula

* An expanded version of a paper presented at the *1st Asia-Pacific Forum on Engineering and Technology Education*

in Indonesia, with some universities including biotechnology courses, and others, equipment design courses, and so on; the local curriculum is worth 59-67 credits. Since it was recognised that social, political and human factors are vitally important in designing and operating a chemical process, the number of courses in the humanities and social sciences in local curriculum have actually increased, requiring some cuts in the local non-chemical engineering part of the curriculum. Peripheral engineering courses have been reduced, but the chemistry content of most curricula has remained strong.

The development of local curricula to anticipate the growth of Indonesian industry

The last two decades have seen the chemical industry in Indonesia grow very fast, with some exponents using new technology and high technology processes that have resulted in greater efficiency. But this situation has contributed to the difficulties facing chemical engineering education in Indonesia.

The first problem is that many students do not have a clear picture of what chemical engineering is about until they take a junior level *unit operation* course, and thus some find out too late that they really do not want to be chemical engineers. Some students are also poorly motivated during their sophomore year.

Ways have been found in the Department of Chemical Engineering, Widya Mandala Catholic University, to move some of the *unit operations* material down into the first sophomore chemical engineering course, with the objective that students will acquire a good understanding of what chemical engineering involves at an early stage. An added benefit is that students who like the material should be better motivated to put in the necessary time and effort to make it successfully through the tough chemical engineering curriculum.

The second problem is that graduates from some universities discover that what they have learned is very different from the reality in industry. The solution for some universities has been to develop a supplementary curriculum based on local industry and its needs.

THE CHEMICAL ENGINEERING CURRICULUM, WIDYA MANDALA CATHOLIC UNIVERSITY

The Department of Chemical Engineering, Engineering Faculty, Widya Mandala Catholic University, offers the S-1 degree programme, with a chemical engineering curriculum of eight semesters or four years duration. The first three semesters of the course establish a general foundation in engineering and science, with an emphasis on chemistry and mathematics. The main stream of the senior years is made up of specialised chemical engineering courses in the handling of process materials, design of reactors, transfer of mass, heat and energy, unit operations and separation processes, process control, plant design, and economics. A plant design project and a research project conclude the course.

The curriculum consists of three subject groups: general-basic subjects, skill-basic subjects and major subjects.

General-basic subjects (8 subjects, 16 credits)

This group of subjects comprises:

- Religion
- State philosophy (Pancasila)
- Civics (kewiraan)
- Indonesian language
- English language
- Technology concepts
- Logic
- Social ethics

Widya Mandala is a Catholic university, and has two streams of lectures in religion: one for Catholic students and one for non-Catholics. Social ethics and Logic are compulsory for all Catholic university students in Indonesia.

For English language, a certain standard of TOEFL will be required soon for graduation.

Skill-basic subjects (25 subjects, 54 credits)

This group of subjects comprises:

- Calculus I, Calculus II
- Physics I, Physics II, Physics Laboratory
- General Chemistry, General Chemistry Laboratory
- Organic Chemistry, Organic Chemistry Laboratory
- Analytical Chemistry I, Analytical Chemistry II, Analytical Chemistry Laboratory
- Physical Chemistry I, Physical Chemistry II, Physical Chemistry Laboratory I, Physical Chemical Laboratory II
- Chemical Engineering Principles I, Chemical Engineering Principles II
- Computer Programming
- Applied Mathematics for Chemical Engineering I,

Applied Mathematics for Chemical Engineering II, Applied Mathematics for Chemical Engineering III

- Chemical Engineering Thermodynamics I, Engineering Thermodynamics II
- Engineering Statistics and Research Methodology

Major subjects (33 subjects, 82 credits)

This group of subjects comprises:

- Material of Construction
- Introduction to Transport Phenomena
- Industrial Microbiology
- Chemical Engineering Kinetics
- Heat and Mass Transfer
- Unit Operation I
  - Chemical Industries Equipment
  - Industrial Microbiology Laboratory
  - Chemical Reactor
  - Process Control
- Unit Operation II
  - Unit Operation Laboratory I
  - Utility
  - Technical Drawing
  - Chemical Process Industries I
  - Equipment Design I
  - Chemical Process Calculation
- Unit Operation III
  - Unit Operation Laboratory II
  - Multi-component Separations
  - Chemical Process Industries II
  - Equipment Design II
- Engineering Economics
- Industrial Management
- Plant Design
- Process Synthesis
- Optional Subject I, Optional Subject II
- Laboratory Research
- Waste Management Technology
- Industrial Sociology
- Practical Work in Industry
- Plant Design Project

Courses included in Optional Subject I are:

- Energy Integration
- Mass Transfer with Chemical Reaction
- Unit Operation IV
- Process Optimisation and Advanced Catalytic Reaction Engineering

Course included in Optional Subject II are:

- Polymer Technology
- Petrochemical Technology
- Oil and Natural Gas Technology
- Food Technology
- Corrosion Technology

The course was designed with flexibility in mind, with a variety of elective or optional subjects in addition to the essential core subjects. The optional subjects contain courses that either provide advanced treatments of particular subjects or an introduction to specialised areas that may reflect the requirements of particular industries.

In the Plant Design Project, groups of two students design a complete chemical plant, including the design of equipment; estimating the cost of the plant and the profitability of the process; working out how to control, start up and shut down the plant; as well as the management aspect.

Nothing eases the transition from university to professional life better than industrial experience and training. Twice a year, third and fourth year students have the opportunity to visit industrial plants guided by lecturers. Because chemical engineering is concerned with large scale plants, it is important that chemical engineering candidates have an appreciation of the scale and complexity of modern plants before they graduate. This cannot be achieved easily within the confines of a university environment, but can be imparted through a training period in industry; thus in their last semester, students undertake practical work in industry for two months. In this period students have the opportunity to review and digest the academic content of their seven semesters, to apply this knowledge to real engineering situations and to obtain some understanding of how industry works. This maturing enables a student to obtain the maximum benefit from the final period of academic study. During the practical work period in industry, students produce a report on their training, supplemented by a separate score report from their employer. They must also give a presentation about their work and report.

The university's courses are constantly up-dated to meet both changes in technological, economic and environmental conditions, and in industry needs. Important feedback is provided by former students, now working in industry. Specialists from industry or large companies are also regularly invited as guest lectures, bringing with them much useful information regarding industry's needs.

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BIOGRAPHIES

Mudjijati is a Professor in the field of kinetics and catalytic reactions and physical chemistry. She received her PhD from De La Salle University, Philippines, in 1985. Professor Mudjijati has undertaken much research, and has been lecturing since 1965 in Widya Mandala Catholic University.

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