화학공학의 역사
(단위조작)

충남대학교 화공과
김 인호

목차

- 단위조작의 개념형성
- 단위조작의 구성(1923)
  - 유체이동
  - 열전달
  - 물질전달
  - 열역학공정
  - 기계적공정

단위조작의 개념형성

- 1880 Sir H. Hartley-화학공장의 경험에서 공학을 인식한 화학자나 화학을 좋아하는 공학자가 화학공학자 그룹을 형성
- 1886 E.K.Muspratt-화학과 공학의 지식을 겸비한 매니저를 구하기 힘들기에 그런 인재를 교육할 필요
- 1888 MIT-화학공학자 교육 시작
- 1904 G. Davis-화학공장의 설계와 건설에 필요한 기본 원리를 화학공학에서 교육해야함
- 1904 H. Schwartzer-미국화학회에서 미국화학공학회(AIChE)설립을 반대

George Davis (1850-1907). Founder of the profession

- 1908 C. McKenna-AIChE창립 총회에서 화학공학의 미래의 비전 표명
- 1910 F.W.Atkinson (Brooklyn Polytech Institute)-화학공학의 정의를 명확히 할 필요성 제기
- 1911 M.C.Whitaker(Columbia Univ)-기존 및 향후 건설될 화학산업의 조직화, 운전, 운영에 대한 교육을 위해 화학 물리 수학의 교육을 복합적으로 화학공학교육에서 수행
- 1911 O. Hougen(Univ of Minnesota)-1972년 회견에서 1911년 당시의 화학공학 교육과정이 1970년대와 다름을 지적. 단위조작, 열 및 물질 전달, 화공양론,열역학, 반응공학, 촉매공학 부재
- 1915 A.D.Little-Any chemical process may be resolved into a coordinatedseries of what may be termed “unit operations” as pulverizing, drying, roasting, crystallizing, filtering, evaporation so on.

Chemical Engineering

- Chemical engineering, as distinguished from the aggregate number of subjects comprised in courses of that name, is not a composite of chemistry and mechanical and civil engineering, but a science itself, the basis of which is those unit operations.

The Principles of Chemical Engineering

- Historically, the different chemical industries were regarded as different industrial processes and with different principles. In 1923 William H. Walker, Warren K. Lewis and William H. McAdams wrote the book *The Principles of Chemical Engineering* and explained the variety of chemical industries have processes which follow the same physical laws.
- They summed-up these similar processes into unit operations. Each unit operation follows the same physical laws and may be used in all chemical industries.
- Chemical engineering unit operations and chemical engineering unit processings form the main principles of all kinds of chemical industries and are the foundation of designs of chemical plants, factories, and equipment used.

PRINCIPLES OF CHEMICAL ENGINEERING

BY
WILLIAM K. WALKER
WARREN L. MCCABE
AND
WILLIAM H. MCADAMS

FIRST EDITION

McGRAW-HILL BOOK COMPANY, Inc.
NEW YORK AND LONDON
1923

Chemical engineering unit operations consist of five classes

- Fluid flow processes, including fluids transportation, filtration, solids fluidization etc.
- Heat transfer processes, including evaporation, condensation etc.
- Mass transfer processes, including gas absorption, distillation, extraction, adsorption, drying etc.
- Thermodynamic processes, including gas liquefaction, refrigeration etc.
- Mechanical processes, including solids transportation, crushing and pulverization, screening and sieving etc.

Other unit operations

- Chemical engineering unit operations also fall in the following categories:
- Combination (mixing)
- Separation (distillation)
- Reaction (chemical reaction)

Distillation (McCabe-Thiele method)

- The graphical approach presented by McCabe and Thiele in 1925, the **McCabe–Thiele method** is considered the simplest and perhaps most instructive method for analysis of binary distillation.
- This method uses the fact that the composition at each theoretical tray (or equilibrium stage) is completely determined by the mole fraction of one of the two components

Perry's Chemical Engineers' Handbook

- *Perry's Chemical Engineers' Handbook* was first published in 1934 and the seventh edition was published in 1997.
- It has been a classic source of chemical engineering knowledge found to be indispensable by chemical engineers, and a wide variety of other engineers and scientists, through six previous editions spanning more than seventy years.

Perry's Chemical Engineers' Handbook (Subjects covered)

- Physical properties of chemicals and other materials; mathematics; thermodynamics; heat transfer; mass transfer; fluid dynamics; chemical reactors and chemical reaction kinetics
- Transport and storage of fluid; heat transfer equipment
- Psychrometry and evaporative cooling; distillation; gas absorption; liquid–liquid extraction; adsorption and ion exchange; gas–solid, liquid–solid and solid–solid operations
- Biochemical engineering; waste management, materials of construction, process economics and cost estimation; process safety and many others.

UK's Chemical Engineering

- Whilst Chemical Engineering took off as a distinct profession in America, in the U.K. it is only since the second world war that the value of chemical engineers has become truly appreciated.
- This change has been driven to a large extent by the expansion of the oil industry; the first oil refinery in the U.K., and still the largest, was built by Esso at Fawley after the war.

UK's Chemical Engineering

- In Britain in the 1920s, the four courses in Chemical Engineering, including those at Imperial and University Colleges, London, produced fewer than 100 chemical engineers.
- Towards the end of the second world war the U.K. government identified a shortage and formed a committee, headed by Herbert Cremer.
- Cremer recommended establishing new, and expanding existing, courses. Cambridge hosted one of the first new departments, founded in 1945 and funded by Shell.

Institution of Chemical Engineers (IChemE)

- In the U.K., despite the Father of Chemical Engineering, George Davis highlighting the need for a professional body back in 1888, the Institution of Chemical Engineers (IChemE) was not formed until 1922.
- It existed as a corporate body under the Board of Trade, despite objections by the Institute of Chemistry and the Institution of Civil Engineers.
- The first president, Sir Arthur Duckham, stated at the first meeting that "*The aim of the Institution is to produce chemical engineers and hallmark such men so that they may be accepted as providing a valuable service to the process industries.*"

Transport phenomena(1950s)

- As the chemical engineering profession developed in the first half of the 20th century, the concept of "unit operations" arose as being needed in the education of undergraduate chemical engineers.
- The theories of mass, momentum and energy transfer were being taught at that time only to the extent necessary for a narrow range of applications.
- As chemical engineers began moving into a number of new areas, problem definitions and solutions required a deeper knowledge of the fundamentals of transport phenomena than those provided in the textbooks then available on unit operations