Chapter 1

History of Chemical Engineering and Mass Transfer Operations

A discussion on the field of chemical engineering is warranted before proceeding to some specific details regarding mass transfer operations (MTO) and the contents of this first chapter. A reasonable question to ask is: What is Chemical Engineering? An outdated, but once official definition provided by the American Institute of Chemical Engineers is:

> Chemical Engineering is that branch of engineering concerned with the development and application of manufacturing processes in which chemical or certain physical changes are involved. These processes may usually be resolved into a coordinated series of unit physical "operations" (hence part of the name of the chapter and book) and chemical processes. The work of the chemical engineer is concerned primarily with the design, construction, and operation of equipment and plants in which these unit operations and processes are applied. Chemistry, physics, and mathematics are the underlying sciences of chemical engineering, and economics is its guide in practice.

The above definition was appropriate up until a few decades ago when the profession branched out from the chemical industry. Today, that definition has changed. Although it is still based on chemical fundamentals and physical principles, these principles have been de-emphasized in order to allow for the expansion of the profession to other areas (biotechnology, semiconductors, fuel cells, environment, etc.). These areas include environmental management, health and safety, computer applications, and economics and finance. This has led to many new definitions of chemical engineering, several of which are either too specific or too vague. A definition proposed here is simply that "Chemical Engineers solve problems". Mass transfer is the one subject area that somewhat uniquely falls in the domain of the chemical engineer. It is often presented after fluid flow[(1)] and heat transfer,[(2)] since fluids are involved as well as heat transfer and heat effects can become important in any of the mass transfer unit operations.

Mass Transfer Operations for the Practicing Engineer. By Louis Theodore and Francesco Ricci

A classical approach to chemical engineering education, which is still used today, has been to develop problem solving skills through the study of several topics. One of the topics that has withstood the test of time is mass transfer operations; the area that this book is concerned with. In many mass transfer operations, one component of a fluid phase is transferred to another phase because the component is more soluble in the latter phase. The resulting distribution of components between phases depends upon the equilibrium of the system. Mass transfer operations may also be used to separate products (and reactants) and may be used to remove byproducts or impurities to obtain highly pure products. Finally, it can be used to purify raw materials.

Although the chemical engineering profession is usually thought to have originated shortly before 1900, many of the processes associated with this discipline were developed in antiquity. For example, filtration operations were carried out 5000 years ago by the Egyptians. MTOs such as crystallization, precipitation, and distillation soon followed. During this period, other MTOs evolved from a mixture of craft, mysticism, incorrect theories, and empirical guesses.

In a very real sense, the chemical industry dates back to prehistoric times when people first attempted to control and modify their environment. The chemical industry developed as did any other trade or craft. With little knowledge of chemical science and no means of chemical analysis, the earliest chemical "engineers" had to rely on previous art and superstition. As one would imagine, progress was slow. This changed with time. The chemical industry in the world today is a sprawling complex of raw-material sources, manufacturing plants, and distribution facilities which supply society with thousands of chemical products, most of which were unknown over a century ago. In the latter half of the nineteenth century, an increased demand arose for engineers trained in the fundamentals of chemical processes. This demand was ultimately met by chemical engineers.

The first attempt to organize the principles of chemical processing and to clarify the professional area of chemical engineering was made in England by George E. Davis. In 1880, he organized a Society of Chemical Engineers and gave a series of lectures in 1887 which were later expanded and published in 1901 as *A Handbook of Chemical Engineering*. In 1888, the first course in chemical engineering in the United States was organized at the Massachusetts Institute of Technology by Lewis M. Norton, a professor of industrial chemistry. The course applied aspects of chemistry and mechanical engineering to chemical processes.[3]

Chemical engineering began to gain professional acceptance in the early years of the twentieth century. The American Chemical Society had been founded in 1876 and, in 1908, it organized a Division of Industrial Chemists and Chemical Engineers while authorizing the publication of the *Journal of Industrial and Engineering Chemistry*. Also in 1908, a group of prominent chemical engineers met in Philadelphia and founded the American Institute of Chemical Engineers.[3]

The mold for what is now called chemical engineering was fashioned at the 1922 meeting of the American Institute of Chemical Engineers when A. D. Little's committee presented its report on chemical engineering education. The 1922 meeting marked the official endorsement of the unit operations concept and saw the approval of a "declaration of independence" for the profession.[3] A key component of this report included the following:

> Any chemical process, on whatever scale conducted, may be resolved into a coordinated series of what may be termed "unit operations," as pulverizing, mixing, heating, roasting, absorbing, precipitation, crystallizing, filtering, dissolving, and so on. The number of these basic unit operations is not very large and relatively few of them are involved in any particular process. . . An ability to cope broadly and adequately with the demands of this (the chemical engineer's) profession can be attained only through the analysis of processes into the unit actions as they are carried out on the commercial scale under the conditions imposed by practice.

It also went on to state that:

> 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 is itself a branch of engineering. . .

A time line diagram of the history of chemical engineering between the profession's founding to the present day is shown in Figure 1.1.[3] As can be seen from the time line, the profession has reached a crossroads regarding the future education/curriculum for chemical engineers. This is highlighted by the differences of Transport Phenomena and Unit Operations, a topic that is treated in the next chapter.

REFERENCES

1. P. Abulencia and L. Theodore, "*Fluid Flow for the Practicing Engineer*," John Wiley & Sons, Hoboken, NJ, 2009.
2. L. Theodore, "*Heat Transfer for the Practicing Engineer*," John Wiley & Sons, Hoboken, NJ, 2011 (in preparation).
3. N. Serino, "2005 Chemical Engineering 125th Year Anniversary Calendar," term project, submitted to L. Theodore, 2004.
4. R. Bird, W. Stewart, and E. Lightfoot, "*Transport Phenomena*," 2nd edition, John Wiley & Sons, Hoboken, NJ, 2002.

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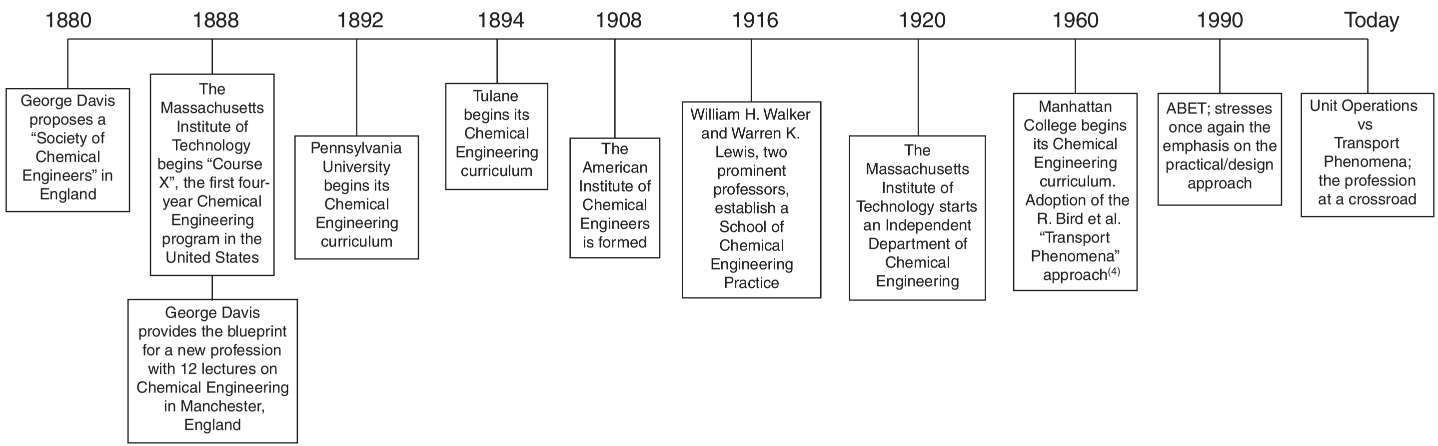

Figure 1.1 Chemical engineering time line.[3]