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HISTORY OF CHEMICAL ENGINEERING—FLUID FLOW

1.1 INTRODUCTION

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 (see Chapter 27) were carried out 5000 years ago by the Egyptians. During this period, chemical engineering 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 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 supplies 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.

Fluid Flow for the Practicing Chemical Engineer. By J. Patrick Abulencia and Louis Theodore

1.2 FLUID FLOW

With respect to fluid flow, the history of pipes and fittings dates back to the Roman Empire. The ingenious "engineers" of that time came up with a solution for supplying the never-ending demand for fresh water to a city and then disposing of the wastewater produced by the Romans. Their system was based on pipes made out of wood and stone and the driving force of the water was gravity.[1] Over time, many improvements have been made to the piping system. These improvements have included the material choice, shape and size of the pipes; pipes are now made from different metals, plastic, and even glass, with different diameters and wall thicknesses. The next challenge was the connection of the pipes and that was accomplished with fittings. Changes in piping design ultimately resulted from the evolving industrial demands for specific requirements and the properties of fluids that needed to be transported.

The first pump can be traced back to 3000 B.C. in Mesopotamia. It was used to supply water to the crops in the Nile River valley.[2] The pump was a long lever with a weight on one side and a bucket on the other. The use of this first pump became popular in the Middle East and this technology was used for the next 2000 years. Sometimes, a series of pumps would be put in place to provide a constant flow of water to the crops far from the source. Another ancient pump was the bucket chain, a continuous loop of buckets that passed over a pulley-wheel; it is believed that this pump was used to irrigate the Hanging Gardens of Babylon around 600 B.C.[2] The most famous of these early pumps is the Archimedean screw. The pump was invented by the famous Greek mathematician and inventor Archimedes (287–212 B.C.). The pump was made of a metal pipe in which a helix-shaped screw was used to draw water upward as the screw turned. Modern force pumps were adapted from an ancient pump that featured a cylinder with a piston "at the top that create[d] a vacuum and [drew] water upward."[2] The first force pump was designed by Ctesibus of Alexandria, Egypt. Leonardo Da Vinci (1452–1519) was the first to come up with the idea of lifting water by means of centrifugal force; however, the operation of the centrifugal pump was first described scientifically by the French physicist Denis Papin (1647–1714) in 1687.[3] In 1754, Leonhard Euler further developed the principles on which centrifugal pumps operate and today the ideal pump performance term, "Euler head," is named after him.[4] In the United States, the first centrifugal pump to be manufactured was by the Massachusetts Pump Factory. James Stuart built the first multi-stage centrifugal pump in 1849.[3]

1.3 CHEMICAL ENGINEERING

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

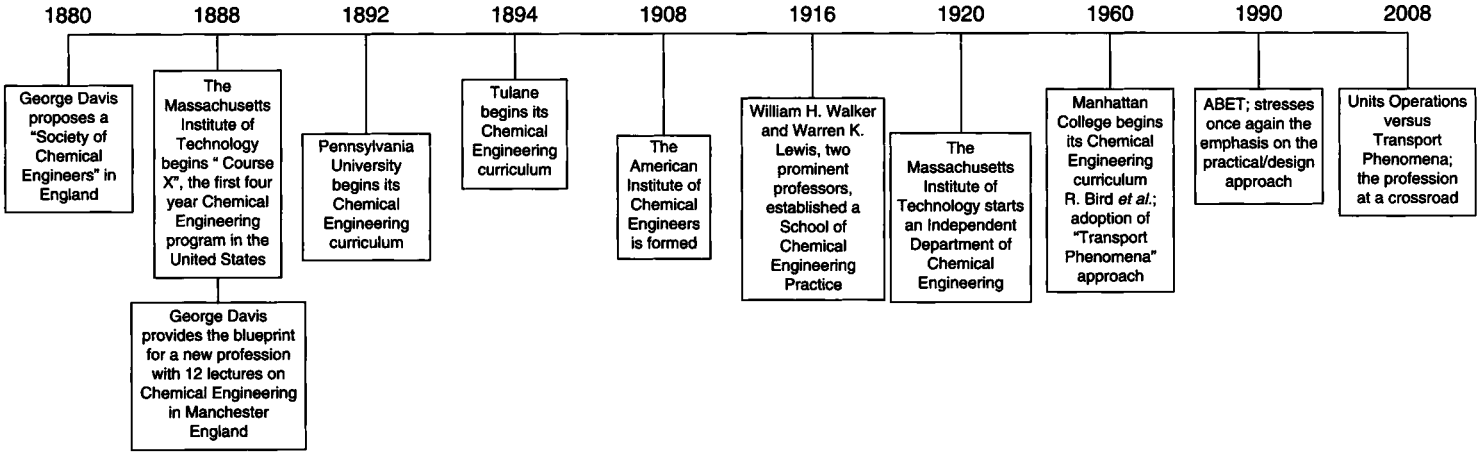

Figure 1.1 Chemical engineering time-line.

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.[5]

Chemical engineering began to gain professional acceptance in the early years of the twentieth century. The American Chemical Society was 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.[5]

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.[5] 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."

The key unit operations were ultimately reduced to three: Fluid Flow (the subject title of this text), Heat Transfer, and Mass Transfer. The Little report 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 Fig. 1.1.[5] 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 discussed in Chapter 4.

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