CHAPTER 1

Introduction

The chemical industry is one of America's largest; a $750 billion dollar enterprise, it represents more than 13% of U.S. manufacturing exports, and directly employs more than 780,000 [1]. About 54% of all chemists work in manufacturing, 37% in academia, and the remainder are self-employed or in the government. Bachelor's degree chemists represent the group most employed in industry at 83% [2]. If you are a chemist, there is a likelihood that you work in industry (either in manufacturing, analytical services, or research services). If you don't work in industry, knowledge of industrial chemistry is still important. If you are in academics, you might be collaborating with industrial colleagues or preparing students for industrial careers. Many government chemists have jobs associated with the chemical industry and work closely with industrial colleagues. Even if you are not a chemist, you are surrounded by chemicals and chemical products and knowledge of the chemical industry is useful.

There is a misconception among some that research occurs in academia and little goes on in industry. This is not true at all. Chemical companies expend major time and money on research and employ many chemists in that endeavor. For example, BASF ($2.0B), Bayer ($1.3B), Dow ($1.7B), and Dupont ($1.7B) each year spend much more than $1 billion on research [3].

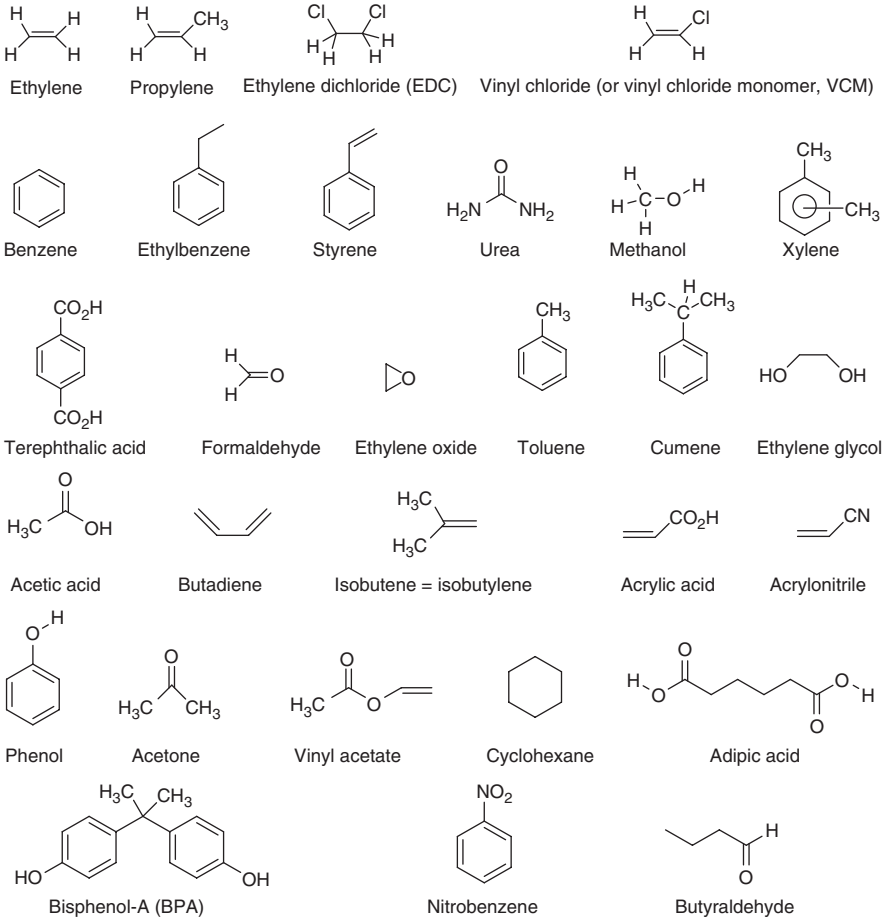
This text discusses how and why major chemicals are manufactured. Intertwined in these discussions are concepts such as separation techniques, cost, conversion, transport, byproduct formation, and other items critical to industrial chemistry. Many of the major chemicals are discussed. Also discussed are several different industries. Most of the largest volume organic chemicals that are produced are made as feedstocks for polymers. For this reason, polymer chemistry is given special attention. The text discusses many of the major industrial polymers including their synthesis and properties. A background in polymer science is also presented so that the reader becomes familiar with some important concepts such as glass transition,

Fundamentals of Industrial Chemistry: Pharmaceuticals, Polymers, and Business, First Edition. John A. Tyrell.

molecular weight, and additives. Many chemists work in the pharmaceutical industry and there is a discussion on this industry including some of the requirements such as GMP. Patent protection is critical for many industries. The importance of patents and patentability requirements are explained.

Some important inorganic chemicals, in approximate order of quantity produced, are: sulfuric acid (H_2SO_4), lime which is also known as calcium oxide (CaO), phosphoric acid (H_3PO_4), sodium hydroxide which is also known as caustic or caustic soda (NaOH), sodium chloride or salt (NaCl), sodium carbonate (Na_2CO_3), nitric acid (HNO_3), ammonium nitrate (NH_4NO_3) and titanium dioxide (TiO_2). Some important gases include nitrogen (N_2), oxygen (O_2), ammonia (NH_3), hydrogen (H_2), chlorine (Cl_2), and hydrochloric acid (HCl).

Some major organic compounds are:



Many of these chemicals are intertwined with each other. For example, chlorine is coproduced with sodium hydroxide and is reacted with ethylene to make ethylene dichloride, which in turn is used to make vinyl chloride. Many of the organic chemicals are produced to make polymers. For example, vinyl chloride is used to make polyvinyl chloride. The upcoming chapters will discuss these relationships and also the larger volume polymers.

The text is written for the student that would like to give their chemistry classes some perspective and perhaps learn something about chemical applications. The typical student will be a chemistry or chemical engineering student with at least a couple of years of classes. It is written for the upper-level undergraduate student or the first year graduate student. First or second year employees in the chemical industry will also benefit from the text.

The text assumes the reader has taken general and organic chemistry. Complete retention of everything from those courses is not assumed and when a concept is introduced, the background is given. The purpose of the text is to give the reader a general knowledge of several different aspects of industrial chemistry. It is not intended to make the reader an instant expert in a specific area. For example, reading the chapter on patents will give an appreciation of the major requirements for patentability, some key concepts and the importance of patents. It will also explain how to search patents and what can be learned from the patent literature. It will not make the reader ready to practice patent law nor be able to head the legal department. However, the reader will be better able to interact with patent attorneys and patent agents. Having a broad knowledge of several areas is also useful because over a career, the reader's work is likely to evolve and include increasing and broadened responsibilities.

REFERENCES

1. Melody Bomgardner, et al. Chemical and Engineering News 2013; 91(26):25–48.
2. Sophie Rovner. Chemical and Engineering News 2013; 91(38):10.
3. Alexander Tullo. Chemical and Engineering News 2011; 89(30):14.