

16.1: Chemistry is Good...and Unavoidable

Many people are intimidated by the idea of chemistry and try to avoid it. But avoiding chemistry is impossible. That is because all matter — the air we must breathe, the water we must drink, and all living organisms — is made of chemicals. People who try to avoid everything that they regard as chemical may fail to realize that chemical processes are continuously being carried out in their own bodies. These are processes that far surpass in complexity and variety those that occur in chemical manufacturing operations. So, even those people who want to do so cannot avoid chemistry; they are, themselves, complex chemical factories. The best course of action with anything that cannot be avoided and that might have an important influence on our lives is to try to understand it. Hopefully that has happened as you have used this book.

During the approximately two centuries that chemical science has been practiced on an ever-increasing scale, it has enabled the production of a wide variety of goods that are valued by humans. These include such things as pharmaceuticals that have improved health and extended life, fertilizers that have greatly increased food productivity and prevented widespread starvation, and semiconductors that have made possible computers and other electronic devices. Without the persistent efforts of chemists and the enormous productivity of the chemical industry, nothing approaching the high standard of living enjoyed in modern industrialized societies would be possible.

But there can be no denying that in years past, and even at present, chemistry has been misused in many respects, such as the release of pollutants and toxic substances and the production of non-biodegradable materials, which has resulted in harm to the environment and living things, including humans. As the chemical industry developed and grew during the early and mid-1900s, most practitioners of chemistry remained unconcerned with and largely ignorant of the potential for harm of their products and processes. Environmental chemistry was essentially unknown and certainly not practiced by most chemists. Incidents of pollution and environmental damage, which were many and severe, were commonly accepted as a cost of doing business or blamed upon the industrial or commercial sectors. The unfortunate attitude that prevailed is summarized in a quote from a standard book on industrial chemistry from 1954 (*American Chemical Industry—A History*, W. Haynes, Van Nostrand Publishers, 1954): “By sensible definition any by-product of a chemical operation for which there is no profitable use is a waste. The most convenient, least expensive way of disposing of said waste — up the chimney or down the river — is best.”



Figure 16.1.1: A 2015 view of the Yellow River as it passes between Wubu and Jundu, China. The impact of chemical waste can be seen in the river itself and in the atmosphere above the cities. (N509FZ, CC BY-SA 4.0, via Wikimedia Commons)

It is now obvious that chemical science must be turned away from emphasis upon the exploitation of limited resources and the production of increasing amounts of products that ultimately end up as waste and toward the application of chemical science in ways that provide for human needs without damaging the Earth's support system and depleting its natural capital upon which all living things depend. Fortunately, the practice of chemical science and industry is moving steadily in the direction of environmental

friendliness and resource sustainability. The practice of chemistry in a manner that maximizes its benefits while eliminating, or at least greatly reducing, its adverse impacts has come to be known as **green chemistry**.

Despite their potential to cause harm, nobody is more qualified to accept responsibility for environmental damage from chemical products or processes than are chemists who have the knowledge to understand how such harmful effects came about. As the detrimental effects of chemical manufacture and use became more obvious and severe, chemists were forced, often reluctantly, to deal with them. At present, enlightened chemists and chemical engineers do not view the practice of environmentally beneficial chemistry and manufacturing as a burden, but rather as an opportunity that challenges human imagination and ingenuity.

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