Journal of Loss Prevention in the Process Industries 35 (2015) 59–64

Contents lists available at ScienceDirect

Journal of Loss Prevention in the Process Industries

journal homepage: www.elsevier.com/locate/jlp

Communicating costs and benefits of the chemical industry and chemical technology to society

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ARTICLE INFO

Article history:
Received 30 October 2013
Accepted 24 March 2015
Available online 25 March 2015

Keywords:
Process safety
Loss prevention
Risk analysis
Risk communication

ABSTRACT

Risk Communication is increasingly important to the chemical and manufacturing industries in the wake of a wave of major incidents in recent years. However, risk communication strategies as they are currently implemented tend to place the chemical industry on the defensive. Renewed attempts should be made to place the life-saving benefits of the chemical industry back in the public eye and counterbalance the popular political view that the chemical industry is often responsible for loss of life. In truth, while the chemical industry suffers on the job fatalities like many industries, the frequency is much less than many common industries and the chemical industry provides benefits to society that ultimately save far more lives.

1. Introduction

Risk Communication has been a subject of great importance in the last several decades as society has attempted to reconcile differences between the science-based conclusions of experts with the perceptions of the public (Covello and Sandman, 2013). Plough and Krimsky attribute the current state of risk communication in society as the result of a gradual process through which risk communication and risk management shifted from being a part of the "folk discourse" between average people, to being the responsibility of a relatively small group of government officials and experts (Plough and Krimsky, 1987). Throughout this decade long period experts have struggled to explain risk-based management decisions to the public. This leads to the formalization of risk communication as "any public or private communication that informs individuals about the existence, nature, form, severity, or acceptability of risks" which can be intentional or unintentional (Plough and Krimsky, 1987).

In its current form, Risk Communication tends to do one of two things: (1) Present and discuss the possible risks posed by a facility to the workers and the surrounding population followed by steps being taken to guard against those risks, i.e. explaining risk assessments. (2) Present and discuss the costs and potential risk reduction of specific proposed process modifications, i.e. explaining cost–benefit analysis. At this point it is already generally conceded that the chemical facility or industry in question is dangerous and risk communication is attempting to make the facility look less undesirable rather than trying to make it look like a net positive for the community and the country.

The benefits that the facility, the company and the industry as a whole bring to the community, the country, and the human race as a whole are seemingly rarely discussed. When these issues are considered, they are often presented with a heavy emphasis on economic benefits like new jobs for the community, lower gas prices, etc. This can lead the public to view the chemical industry as something that brings jobs and money at the risk of safety, health and environment. This perception supports the belief that the industry makes money at the costing of human life. This perception supports the beliefs that human life and health are being callously reduced to a cold numerical sum by rich men in a boardroom somewhere. This is made even worse whenever a company is ultimately forced to commit the "sin" of putting a monetary value on a human life in a risk or consequence analysis.

This perception is used against the chemical industry when accidents occur and the familiar refrain begins alleging that companies that are making massive profits are doing so by putting money ahead of safety and human lives. Because people are generally more concerned about their lives and the lives of their families than their jobs or the jobs of their neighbors this line of

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http://dx.doi.org/10.1016/j.jlp.2015.03.020
0950-4230/

discussion is doomed from the outset by casting the chemical industry in an unfavorable light. The current discourse favors the groups which perennially cry, “not in my back yard” (NIMBY) or “build absolutely nothing anywhere near anything” (BANANA). All of this in spite of the fact that the Chemical Industry is actually far safer by most metrics than many other industries and activities.

All of this discussion and rhetoric ultimately seems to miss the real benefits that industrial chemistry and chemical technology have brought to society, which can be measured not merely in terms of jobs and technological conveniences but in terms of human lives saved.

While cost–benefit analysis is a valuable tool, the discussion must be reframed from simply defending expansions or improvements in the industry to actively defending the industry as a whole and demonstrating that the industry and its products save more lives than are lost through periodic accidents and mishaps. This comparison may ultimately prove useful in moving the chemical industry from a seemingly constant defensive posture to being able to positively assert that the industry serves the greater interest of mankind.

This should be an “apples to apples” comparison in which lives lost are weighed against lives saved, not economic benefits or creature comforts. While a true estimate of the number of lives saved by industrial chemistry and the number of lives lost each year to accidents and mishaps would be difficult, the conclusion that industry is a net positive can be established qualitatively by citing some key applications of industrial chemistry to everyday life. This can be done, at least partially, by considering the use of industrial chemical products and processes to prevent the spread of infectious disease and to improve food production.

2. The role of chemical technology in disease prevention and sanitation

Disease prevention has advanced considerably in the last century and this has been aided considerably by the use of industrial chemical technology. Attempts to apply chemistry to solve medical problems have been linked to the beginnings of certain modern chemically-driven industries, a prime example of which being the work of William Henry Perkin. In 1856 he attempted to synthesize quinine, a malaria treatment, and produced a dye known as aniline purple from coal tar derivatives. He industrialized and commercialized the synthesis process and is cited as having created the modern synthetic dyestuffs industry (Perkin, 2013).

Before 1900 the city of Chicago had a primitive sewage, water treatment and sanitation system that involved gutters serving as street drains with underground pipes that dumped directly into Lake Michigan or nearby rivers. There were no water treatment facilities in the city until after 1930. Intake points for the city's water supply were moved to avoid contamination by human wastes being dumped into the lake, but this strategy failed to stop the spread of water-borne diseases including typhoid fever, cholera and dysentery. From 1860 to 1900, a 40 year period, the city averaged 65 deaths per 100,000 population per year from typhoid fever alone (Chicago Public Library, 1997). Inactivated whole-cell typhoid vaccine was not introduced until 1896 (Fraser et al., 2009). Therefore this data can be reasonably taken as representative of what an urban population would experience without modern sanitation, water treatment and vaccination practices.

The US population was 78% urban in 1990 and 79% urban in 2000 according to the US Census Bureau's 2000 Census of Population and Housing Unit Counts. The US Population is therefore largely urban and has been for some time (2000 Census, 2013). The urban mortality statistics would therefore seem reasonably applicable to the current US population as a whole, which stood at nearly 309 million as of the 2010 census (US Department of Commerce, 2013). With an average mortality rate of 65 per 100,000 population per year, the United States would currently expect approximately 200,000 deaths per year from typhoid fever alone. However, today the United States experiences only about 350–600 cases of typhoid fever a year, most of which are acquired during overseas travel, and many of which are non-fatal (US Centers for Disease Control and Prevention, 2013). This gives the United States a mortality rate of effectively zero for typhoid fever. The number of annual cases of typhoid fever has held reasonably steady at roughly 300–700 cases per year in the United States since the 1970s (US Centers for Disease Control and Prevention, 1998). The number of cases reported annually in the United States since 1980 is shown in Fig. 1 (US Centers for Disease Control and Prevention, 2013). This suggests that water treatment and sanitation practices save roughly 100,000–200,000 people per year, to say nothing of the health benefits to the number of people who would otherwise be sickened but survive.

To cite another example of a waterborne disease nearly wiped out by modern sanitation and waste water treatment, in 1854 a Cholera epidemic killed 5.5% of the population of Chicago. In 2010 the United States only had 13 cases of Cholera in the entire country for the entire year and all of those infections were acquired by travelers while abroad. The vast majority of the United States was completely free of cholera infections in 2010 as shown in Fig. 2 (US Centers for Disease Control and Prevention, 2013).

All of this says nothing about the effects of *Escherichia coli*, dysentery, salmonellosis and vibrio illness, all of which are waterborne diseases that have largely been eliminated from waterborne, as opposed to foodborne, transmission within the United States. Outside of the United States and other developed countries these diseases remain a serious threat largely because of contaminated water sources. It was estimated in 2009 that typhoid fever still causes 22 million cases and 200,000 deaths per year globally (Fraser et al., 2009).

The decline in morbidity from waterborne diseases in the United States coincides with the development of a workable vaccine at the end of the 19th century and implementation of water treatment and chlorination in the first half of the 20th century (Fraser et al., 2009). It is improved public sanitation that has nearly completely eliminated waterborne disease in the United States. However, while these advances are frequently attributed to advances in medical technology, their implementation relies heavily on the use of industrial chemistry.

Modern sanitation practices are completely dependent on industrial chemistry. Chlorine and hypochlorite are used by most water treatment facilities and pools in the United States to sanitize water, preventing the spread of infectious disease. Chlorine and hypochlorite are both industrially produced chemicals. Soaps used to clean hands, bodies, and clothes are produced in a complex process that involves chemical reactions between fats, alkali materials, glycerin and caustic solutions. The process also requires separation and purification steps that are accomplished through distillation and phase separation techniques (Human Touch of Chemistry, 2013). Hand sanitizers that are now commonly used extensively as disinfectants to prevent the spread of disease in lieu of soap are essentially concentrated alcohol solutions. These alcohols are produced industrially, typically through reaction and purification through distillation.

The vaccines and medications that are used to prevent illness and cure it when infection occurs are similarly the result of the use of industrial chemical technology. Many vaccines are derived from chemicals produced by bacteria in response to a pathogen or from the pathogenic organism itself. However, taking these naturally occurring compounds and producing the vaccine requires