The Bhopal Incident: Implications for Developing Countries

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SUMMARY

The author summarizes the events of the Bhopal disaster as they are currently known, and draws a number of very important conclusions regarding safety procedures. These have implications for all developing countries.

INTRODUCTION

The accidental release of Methylisocyanate (MIC) from a pesticide manufacturing factory on the night of 2nd/3rd December 1984 caused the death of about 2500 persons and affected about 100000 people (20% of the total population) at Bhopal, India. Some newspapers reported that 5000 to 8000 people died as a consequence of this accident. A number of implications for decision makers from developing countries arise from the accident, since it is an example of how a large number of socio-economic issues interacted with factory management systems and caused death and agony to a large number of people. This paper is an attempt to analyze the implications of the Bhopal accident. Developed countries, in attempting to transfer technology to less industrial countries, should both implement and enforce safety regulations and realize the importance of additional safety parameters to take into account the socio-technical environments of the developing countries.

NORMAL ACCIDENTS

Normal accidents can be characterized using two parameters, namely, interactiveness (complexity of the systems, which makes it difficult for the operators to make correct decisions at the time of emergency) and coupling (linkage between the subsystems, which makes it difficult to separate subunits during times of accidents). Figure 1 gives a classification of normal accidents based on these two criteria. As can be seen from the figure chemical plants have a high degree of interactiveness (Perrow, 1984), which baffles operators during exigencies; and strong coupling, which makes it difficult to separate the subunits when hazards occur. The Bhopal incident is an accident causing a major catastrophe because of the high toxicity of methylisocyanate and the failure of the safety systems which were incorporated in the plant for preventing the release of MIC. Given this background the Bhopal incident can be analyzed. Before analyzing the issues, a brief description of MIC and its toxicity is relevant.

METHYLISOCYANATE

Methylisocyanate has a formula CH_3–N=C=O, it is a colourless liquid with a powerful odour and is a methyl ester of isocyanic acid (H–N=C=O). The boiling point is 39°C at normal atmospheric pressure and it has a flash point of 7°C below zero. MIC is highly volatile, but stable under dry conditions. The vapour is 2.2 times denser than air. It is highly reactive and gives rise to a number of products ranging from simple carbamates to polyurethane formulations such as foams, adhesives and plastics. The chemistry of MIC is briefly given as an Appendix.

Methylisocyanate is biologically very active. Even in very small amounts it causes irritation of the eyes. When inhaled it reacts vigorously with fluids in the lungs. Since the gases produced are heavy, oxygen is expelled from lungs causing choking and death. Injury to humans from MIC occurs through two routes namely; i) the accidental absorption in massive doses, resulting in acute toxicity, or ii) through prolonged exposure to low concentrations of the vapour in air, leading to chronic toxicity or sensitization of the subjects (Kumar and Mukherjee, 1985).

Data on acute toxicity of MIC in terms of lethal dose (LD_{50}) (i.e. dosage required to kill 50 percent of the population under trials) for isocyanates and related compounds are given in Table 1. The threshold limit value (TLV) in air for MIC is 0.02 ppm as per the manual (Ramasehan, 1984) given by Union Carbide India at Bhopal (Table 2). A comparison of toxicity data with other materials shows (Table 2) the extreme toxicity of MIC. This is mainly due to its high volatility, high reactivity, low solubility and high penetration. Other TLV tables available also report (Sax, 1984) that the maximum allowable concentration of MIC in air is 0.02 ppm or 0.05 mg/m^3. MIC reacts with almost all vital bio-substances in the body such as

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