Available online at www.sciencedirect.com
SCIENCE DIRECT®

Journal of Loss Prevention in the Process Industries 18 (2005) 205–208

Journal of Loss Prevention in the process industries
www.elsevier.com/locate/jlp

The unfolding of Bhopal disaster

T.R. Chouhan*

Ex-MIC Plant Operator, Union Carbide Plant, Bhopal

Abstract

As an employee of Union Carbide India at the Bhopal plant, I know how the disaster happened. The merciless cost-cutting severely affecting materials of construction, maintenance, training, manpower and morale resulted in the disaster that was waiting to happen. Significant differences between the West Virginia, USA plant and the Bhopal, India plant show the callous disregard of the corporation for the people of the developing countries. The narrative below, if given a proper thought by the management and governments, should help in significantly reducing industrial accidents.

Keywords: Bhopal gas tragedy; Safety; Industrial accidents; Methyl isocyanate; MIC

1. The details

Since I was an employee of the Union Carbide India before and also when the tragic event took place on the night of December 2–3, 1984 in Bhopal, I am aware of the sequence of events that led to it. I am here today to share my experience with you.

To begin with, I would like to state that the disaster was not merely an accident! Extensive details are given in (Chouhan, 2004). The points that I would highlight subsequently will prove how such a big multi-national corporation (like Union Carbide) had little concern about the safety and well-being of people in a developing country like ours. Not just that, even the technology they used was unproven and faulty. For instance: emergency procedure for MIC storage tanks for Bhopal plant as per the MIC operating manual reads: 'If a leak develops in a tank that cannot be stopped or isolated, the material in the tank may be pumped to another tank… There will be exceptions to all these guidelines… We will learn more and more as we gain actual experience…' It implies that they did not know the process well enough to advise the emergency procedure in many situations.

The toxic gas that leaked into the Bhopal atmosphere that night was due to water (along with catalytic material: iron, rust, etc.) entering the storage tank 610 of the Union Carbide MIC plant. The phosgenes stripping still and the quench filters' safety valves downstream (four in numbers) were connected to the relief valve vent header (RVVH). These lines were badly choked with solid sodium salts deposition. The exercise of washing these filters started at 8:30 PM on 2nd December 1984. Because of the choking of these lines and malfunctioning of RVVH isolation valve, the water entered the RVVH main header (Fig. 1). This header was connected to the MIC storage area. The RVVH header of storage area was also connected to the process vent header (PVH) with a jumper line (Fig. 2 shows where the jumper line was connected. It was removed when the remainder MIC was utilized on December 16, 1984). The blow down valve of the MIC tank 610 was malfunctioning and was in an open position. (The tank had been unable to maintain pressure when pressurized using nitrogen a few days earlier.) The water along with the catalytic material entered the tank. Other MIC storage tanks, numbered 611 and 619, were holding pressure so that they were not contaminated.

As the 42 tons of MIC in tank 610 got contaminated with water and the catalytic material, the exothermic reactions began and within an hour, turned into violent runaway reactions resulting in high pressure and temperature in the tank. The reaction products and the unreacted MIC started coming out through PVH → Jumper line → RVVH → VGS and finally to the atmosphere through the atmospheric vent line and overflow vent line of scrubber, between approximately 12:15 and 2:30 AM.

* Corresponding author. Tel.: +91 755 2600732; fax: +91 9302370740.
E-mail address: trbhopal@rediffmail.com

0950-4230/$ - see front matter © 2005 Published by Elsevier Ltd.
doi:10.1016/j.jlp.2005.07.025

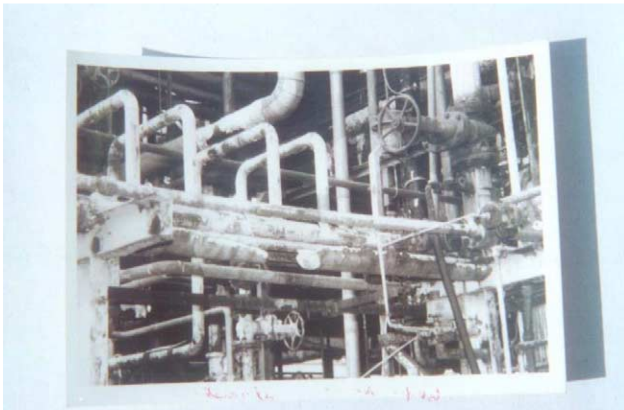

Fig. 1. Four quench filters and RVVH isolation valve (with wheel, top right).

The safety equipment provided for the Bhopal plant were as follows:

1. *Vent gas scrubber (VGS*, Fig. 3). It was designed to neutralize the toxic release material released from various equipment of MIC plant. However, it was not capable of controlling the runaway reaction. (Further, it was not operational that night).
2. *Flare tower* (Fig. 4). It was designed to burn out excess CO and MIC vapors at a controlled rate and was not capable of burning the huge amounts released that night. (Further, it was under maintenance that night).
3. *MIC storage 30 tons refrigeration system.* It was installed to keep the storage tank material below 5 °C. (However, the system had been shutdown in May 1984 to save power, approx. $ 20/day).
4. *Water spray.* This could be used to knock out the toxic chemical vapor by spraying large amount of water. But, while the toxic gases were released at 30-m (100 ft) above ground, the water spray could not reach that height and hence could not knock out any gas.

Fig. 2. Jumper line was connected to PVH line (left) and RVVH line (right, larger diameter).

5. *Danger alarm (siren).* Installed for warning the community people, was switched off after 5 min as per the revised company policy. Thereafter, only the muted siren for the plant personal was sounded. No plant person died due to the gas. If the loud alarm for the community had been sounded for long, many would have escaped before the gas overpowered them.
6. *Evacuation plan.* It was only made for the plant personal, not for the community.

The management had told the workers that the Bhopal plant was designed and built on the basis of 20 years' experience in making MIC in the West Virginia, USA plant.

Table 1
Comparative designs of Union Carbide MIC production plants in West Virginia, USA and Bhopal, India

West Virginia plant	Bhopal plant
All lines and instruments spread out over whole tank	On one single manhole
Computerized control	No computerized control
PVH and RVVH lines: 304 SS	C-Steel (although prohibited due to safety considerations)
Unit storage tank between MIC manufacture and large storage tank to check purity	No such tank
Four Vent Gas Scrubbers (VGS, inbuilt redundancy)	One vent gas scrubber (no redundancy)
VGS had no atmospheric vent	VGS released gases into air. *This caused the tragedy*
Two flare towers (FT, inbuilt redundancy)	One flare tower (no redundancy)
Designed for emergency MIC release	Designed for occasional releases only
VGS, FT operational around the clock due to redundancy	Not available when shutdown for repairs
Intermediate, non-interactive refrigerant	Direct brine as coolant: could react with MIC in case of leak
α-Naphthol added through pipe line	α-Naphthol added manually from jute sacks after opening MIC reactor manhole. Several other hazardous operations performed manually
Pressure, temperature, level instruments functioned well	Not trustworthy; temperature indicator worked only the first few months
PVH and RVVH lines from storage tank direct to VGS and flare tower	Lines from other equipment also joined these lines. Probability of contamination of MIC high
MIC storage temperature ≤ 5 °C	<5 °C when drums being filled to minimise vapor loss. Refrigeration shutdown since May 1984. Power saved ($\sim$ $ 20/day) > cost of MIC vapor loss
Operation and maintenance under trained, experienced staff, enough in number	Not so (training and number declined)
Complete evacuation plan for community in place	No evacuation plan for community
Hospital, train, road, river transport, police, civic administration informed in an emergency	No such arrangements existed