The unfolding of Bhopal disaster

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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.

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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.
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 $58^\circ C$. (However, the system had been shutdown in May 1984 to save power, approx. $20/\text{day}$).

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.

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

<table>
<thead>
<tr>
<th>Comparative designs of Union Carbide MIC production plants in West Virginia, USA and Bhopal, India</th>
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<tbody>
<tr>
<td><strong>West Virginia plant</strong></td>
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<tr>
<td>All lines and instruments spread out over whole tank</td>
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<tr>
<td>Computerized control</td>
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<td>PVH and RVVH lines: 304 SS</td>
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<tr>
<td>Unit storage tank between MIC manufacture and large storage tank to check purity</td>
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<tr>
<td>Four Vent Gas Scrubbers (VGS, inbuilt redundancy)</td>
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<tr>
<td>VGS had no atmospheric vent</td>
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<tr>
<td>Two flare towers (FT, inbuilt redundancy)</td>
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<tr>
<td>Designed for emergency MIC release</td>
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<tr>
<td>VGS, FT operational around the clock due to redundancy</td>
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<tr>
<td>Intermediate, non-interactive refrigerant</td>
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<tr>
<td>$\alpha$-Naphthol added through pipe line</td>
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<tr>
<td>Pressure, temperature, level instruments functioned well</td>
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<tr>
<td>PVH and RVVH lines from storage tank direct to VGS and flare tower</td>
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<tr>
<td>MIC storage temperature $\leq 5^\circ C$</td>
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<tr>
<td>Refrigeration shutdown since May 1984. Power saved (~ $20/\text{day}$) &gt; cost of MIC vapor loss</td>
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<tr>
<td>Operation and maintenance under trained, experienced staff, enough in number</td>
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<tr>
<td>Complete evacuation plan for community in place</td>
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<tr>
<td>Hospital, train, road, river transport, police, civic administration informed in an emergency</td>
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</table>
We felt excited knowing that we were going to work in a modern, sophisticated and automatic chemical plant. After the disaster, I came to know of a lot of differences between the MIC plants in W. Virginia and Bhopal (Table 1). It is evident from Table 1 that the Bhopal plant was not designed to handle emergencies that the West Virginia plant could have.

2. Causes behind the Bhopal gas disaster

The order for water washing was given without

- Placing slip blinds
- Checking related lines
- Disconnecting various lines.
  - Sodium hydroxide (NaOH) solution, in the VGS unit and field storage tanks, was insufficient for neutralization of such a large amount of gas.
  - The pressure control valve for the MIC storage tank (610) had not been functioning for over a month. Water entered through this route.
  - The temperature sensor and alarm for the MIC storage tank had not been working for almost 4 years. Therefore, regular recording of temperature in the log sheets was not done. According to the officers this parameter was not important. However, it could have warned of the runaway reaction occurring much earlier.
  - The refrigeration unit (30 tons capacity) had been ‘down’ for over an year, and was totally shutdown in May 1984. As a result, the MIC tank was at ambient temperature while the MIC manual had strongly recommended keeping MIC below 5 °C.
  - The vent gas scrubber was not operating at the time of the accident.
  - The flare tower had been under maintenance since November 25, 1984 and maintenance was not completed until the accident. The job could have been completed within 8 h but for the shortage of staff.
  - Manpower was reduced in all categories (Fig. 5)
  - Fire and rescue squad (emergency squad) members were not qualified and trained to handle such an accident.
  - There was no maintenance supervisor for the night shift.
  - Nobody was aware of such types of runaway reactions in the storage tank and therefore proper emergency steps were not taken.
  - MIC plant operating personnel did not have the qualifications and training that were necessary. Training had been reduced over the years (Figs. 6 and 7).
The agreement between the union and the management was completed in 1983 by-passing the safety rules.

- Improper behavior of management with the operating personnel.
- Incorrect modifications of the relief valve vent header (RVVH) and process vent header (PVH) by providing interconnection with a jumper line in the MIC storage area (Fig. 2).
- The design and technology given by the Union Carbide Corporation was not safe and sufficient for preventing contamination and controlling runaway reaction.
- The loud siren did not start at the proper time and was shut down after 5 min since the siren policy had been modified.
- There was no evacuation plan for the neighboring area/community. Even after the accident the neighboring communities were not informed.
- The Plant superintendent did not inform outside agencies about the accident. Initially, he denied the accident, and then stated that MIC gas was like a tear gas and the effects would be temporary. No effective antidote was told.
- The civic authorities did not know the treatment since they had not been informed of the extremely hazardous nature of the material stored.
- Keeping all the above developments in mind, no one should be surprised that such a major accident took place. It was waiting to happen (Fig. 8).

My objective in this presentation is to see that such disasters are averted all over the world. I do hope that MNCs while investing in such projects in developing countries would be as concerned and careful of the safety and well-being of the recipient country people as they would be of their own.

References