Editorial

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Dap-1 ammonia tank explosion: safety and security concerns in chemical process plant in Bangladesh

Editorial

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A large amount of toxic ammonia gas was released around 10 PM, 22 August 2016 due to overpressure explosion of a 500 ton ammonia tank from the Di-ammonium Phosphate Factory Limited known as DAP-1. It was established in 2006 on the premises of the Chittagong Urea Fertilizer Limited (CUFL) on the south bank of the Karnaphuli river, Bangladesh. DAP-1 has a production capacity of 1600 ton diammonium phosphate per day. It has two 500 ton ammonia tanks which supply ammonia to the process through pipeline during the operation. One of the tanks which exploded was partially full containing 325 ton of anhydrous ammonia at the time of the incident, completely rift from its base and landed about 35 ft away from its base. Consequently a huge gas cloud is formed and dispersed into the air. The toxic ammonia gas spread over several kilometers and wind carried away the gas to the other bank of the Karnaphuli River leaving nearly 250 people fell sick inhaling the toxic ammonia gas. 52 of them were required hospitalization during the same night. Locals in the affected area were advised to stay home but they were filling uncomfortable even in staying inside the home shutting down the doors and windows. Many of them were filling ill, having severe eye irritation and respiration problem.

Di-ammonium phosphate is very popular as agriculture fertilizer and an excellent source of Nitrogen and Phosphorus for plant nutrition. Liquid anhydrous ammonia, phosphoric acid and sulfuric acid are used as raw materials which are toxic and corrosive. The production process is also hazardous and any accidental release of toxic ammonia gas can be disastrous. Thus, process hazard analysis, risk evaluation and mitigation are required to avoid any potential accidental release. The process includes a controlled reaction of phosphoric acid with ammonia, where the hot slurry is then cooled, granulated, and sieved. The toxic ammonia can be release from the leakage of the pipe line or liquid ammonia tank rapture or from the decomposition of ammonium phosphate. In addition, ammonium phosphate is highly unstable and can release ammonia gas by decomposition.

Ammonia gas is toxic, corrosive and can rapidly penetrate the eye even in low concentration (below 20 PPM-parts per million). The degree of damage for individual depends on the toxicant concentration and length of the exposure. At high enough concentrations, it can react with moisture in the skin, eyes and respiratory systems to cause tissue burns, blindness or potentially-fatal pulmonary edema. It can be fatal if the concentration exceeds 2500 PPM for 2 hours of exposure. The tolerable limit for most individual is as high as 250 PPM for 30 minutes exposure. The maximum exposure limit of ammonia gas is recommended by ACGIH as 25 PPM (17mg/m^3) for 8 hours and short term exposure limit is 35 PPM (24mg/m^3) for 15 minutes.

Firefighters were trying to contain the emission by water spray dissolving ammonia into water. Based on the published report, the concentration of ammonia gas was recorded 600 PPM in the adjacent area after 5 hours of the incident occurred which was still far beyond tolerable level or threshold limit value (TLV). This indicates that the concentration was quite high at the time of the incident. It is also worth noting that the toxic gas released from the explosion is dispersed to the atmosphere and move in the direction of the wind. So it is rather important to estimate the downwind concentration of toxic gas and the total affected area. The area should be evacuated where the concentration exceeds maximum exposure limit. However, the concentration of ammonia gas was unknown in the affected area during the incident. No prior study has been conducted to estimate the concentration and area that can be affected if any accident occurred. Thus, this is alarming if the people and workers are overexposed at a high concentration which can cause irreversible health effect even the treatment is performed.

The release of toxic anhydrous ammonia is harmful for workers, public as well as the environment. Ammonia that diffused into water bodies would increase pH and have an adverse impact on overall aquatic ecosystem. Fishermen already found plenty of dead fish from nearby contaminated pond. The industries which are dealing with hazardous materials or toxic chemicals should perform risk evaluation and consequences analysis for worst possible scenario. Based on atmospheric conditions, wind direction and wind velocity; it is possible to estimate the affected area that reached maximum exposure limit for a certain amount of chemical release. This helps to identify potential emergency scenarios and develop a proper emergency response plan. Public should be aware of the potential hazard that exits in their close proximity.

Deficiencies at many level often hold responsible for any catastrophic incident occurring. Failure of safety instrumentation, lack of layer of protection, lack of risk understanding, mechanical integrity failures and absence of safety culture often lead to a safety incident. Therefore, it is recommended to conduct a thorough process safety analysis, risk evaluation and consequence analysis for the industries dealing with hazardous materials. Process safety analysis and proactive action is necessary to avoid any potential incident occurring.

There are many possible causes that can lead to an explosion of a pressurized tank, i.e. faulty tank, internal corrosion, external corrosion, flow interruption, failure of control valve, failure of relief valve, increase of temperature/pressure and/or human error. However,

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the way tank explodes indicates that the tank was over pressurized due to operational error or mechanical integrity failures. In addition, there was no additional layer of protection that can contain the released ammonia and minimize the consequences. Process hazard analysis should be conducted to identify all causes, estimate the risk and develop strategies to address the risk and install additional layer of protection to minimize the consequences if accident occurs. Continuous risk monitoring, inspection, proactive mitigative action and risk communication among employees can prevent such accident occurring in the future.

Furthermore, it is also important to enhance the security of the chemical process plant and limit the access of unauthorized personnel in the sensitive area of such facilities to avoid any intentional sabotage or deliberate criminal/terrorist attack. Tagging such incident just as "an accident" is not enough. Authority should thoroughly investigate the incident to find out all the root causes and take necessary steps to ensure safety and security of chemical process plant or similar facilities.

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Conflict of interest

The authors declare no conflict of interest.

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