Basis of hazardous chemical interactions argumentative essay examples

Business, Management

\n[toc title="Table of Contents"]\n

\n \t

\n[/toc]\n \n

Interactions with hazardous materials

Chemical reactions or interactions are key to the production of various useful chemical products including polymers, fuels, paints, adhesives etc. When the reactants, catalysts, mechanism of reaction, reactor operation, temperature, pressure and other parameters are known, as well as kept under control, the products or outcome are as expected. On the other hand when chemical interactions are unexpected and lead to unknown products, consequences could be disastrous leading to severe loss. Such hazardous material interactions are more common in chemical manufacture, processing, refining and storage facilities.

Reactive hazards are a serious concern since the magnitude of loss could be enormous and the primary responsibility of preventing such incidents lies with the corporation or management that runs the chemical industry. Regulating bodies also have to strictly monitor adherence of chemical industries to safety norms and standard operating procedures (SOPs) to prevent reactive hazards. However, different materials or their combinations could react in various ways based on the environmental conditions. It is very complex and extensive research is essential to completely understand the associated hazards. Also, findings from previous reactive hazard incidents are not properly documented in a coherent fashion to adopt effective precautionary measures. Thus reactive hazards remain a cause of very serious concern in chemical processing industries.

Chemical reactions are called endothermic if energy is absorbed during the reaction and exothermic when energy is released from the reaction. Also, these reactions could involve only a single reactant or they could be multi-component interactions (Bretherick, 1999). Based on these factors, reactive hazards can be classified into runaway reactions, hazards due to impact sensitivity, thermal sensitivity or self-reactivity of materials and chemical incompatibility hazards (U. S. Chemical Safety and Hazard Investigation Board [CSB], 2002).

Runaway reactions

When, energy release from an unexpected exothermic chemical interaction is too high, temperature and pressure in the reaction vessel continues to increase. When this is coupled with failure in the cooling system or pressure relief system, heating rate exceeds the cooling rate and the reaction becomes uncontrollable. Such chemical mix runaway reactions, could lead to reactive hazards such as fire, explosion or release of toxic gases. Runaway chemical reactions are the most common form of reaction hazards. A typical example of this type of reactive hazard is explosion at T2 Laboratories, discussed in case study-1.

Sensitivity or self-reactivity hazards

Certain highly unstable or sensitive materials could react violently even to slight change in temperature or impact. For example, inflammable substances catch fire immediately when there is elevation in temperature. Reactive hazards such as explosions could occur due to such endothermic decomposition of sensitive materials. A reactive hazard of this type occurred in Barlto Packaging, Inc. and details are discussed in case study-2.

Chemical incompatibility hazards

When individual materials that are inherently stable react violently once brought into contact with each other, such materials are termed incompatible substances. In a chemical industry, several solvents and gases could be used for various purposes. When, properties of all materials being handled in a facility are not completely understood, two incompatible materials could accidentally be brought together. This could lead to reactive hazards such as explosion, fuming, heat generation, acid or alkali formation etc.

On December 19th 2007, there was a major explosion at T2 Laboratories in Jacksonville, Florida, USA. The chemical industry was involved in manufacture of methyl cyclopentadienyl manganese tricarbonyl (MCMT), a fuel additive that increases octane number of gasoline. MCMT was manufactured in batches and the reactors were controlled from a control panel situated in a room adjacent to the batch reactor. On the day of the explosion, an operator monitoring the batch process from the control room noted that the reactor temperature increased beyond the recommended limit and the cooling system failed to control it. Later it was found that the temperature rise was due to failure of a pressure relief valve. The reactor thus exploded, four T2 employees were killed, 32 were severely injured and there was severe damage to property as well (CSB, 2009).

Investigations revealed that T2 laboratories tested the process in small glass reactors of 1L capacity only, while the actual batch reactor's capacity was 2450 gallons. Also, it was a refurbished pressure vessel, with its pressure relief valve designed to withstand only normal operating temperature and not the very high temperature rise caused by the exothermic runaway reaction. Exothermic high temperatures were reached in the reactor several times prior to the actual incident but there was no proper procedure provided to the employees to handle such a situation. Additionally, the chemical processed by T2 laboratories was not covered under the definition of " flammable liquid" according to Occupational Safety & Health Association (OSHA) Process Safety Management (PSM) standard. OSHA PSM applies only to facilities handling 10, 000 pounds of flammable liquids or gases (CSB, 2009).

Barlto Packaging, Inc. is an organic pesticide bulk storage and distribution facility located in Arkansas. On May 8, 1997 when pesticide was being offloaded into a warehouse, employees noticed smoke and immediately notified the emergency response team. But, a building collapse occurred killing three firefighters. The cause of the incident was later found to be decomposing sacks of pesticide, left unattended adjacent to a pipeline carrying hot discharge from a compressor. While the facility did not involve in any processing activity, simple handling and storage of chemicals itself was not carried out as per standards of OSHA PSM. Also, National Fire Protection Association (NFPA) that provides reactivity rating for various chemicals did not cover the particular pesticide being handled at Barlto Packaging (CSB, 2002). So, both the chemical industry’s management and the regulatory agency are at fault for allowing this particular incident to occur. Also, this particular incident demonstrates how existing regulations have gaps and there is no single comprehensive standard that covers all types of hazardous chemical interactions.

Limitations in regulating hazardous material usage

Data sources on reactive hazard incidents are not comprehensive and several hazards go unreported. According to U. S. Chemical Safety and Hazard Investigation Board (CSB) 167 reactive hazard incidents have occurred in 22 years i. e. from 1980 to 2001. A major share i. e. 42% of these incidents are fire/explosions, 37% of incidents are toxic gas releases, 16% are combined incidents of fire/explosion and toxic gas releases and only 5% are hazardous liquid spills. This data is only based on those cases investigated by CSB and it does not give the whole picture. Further, it is not mandatory for chemical industries to perform a reactive hazard analysis during routine process hazard analysis as per OSHA PSM standard or Environmental Protection Agency’s (EPA’s) risk management program. Thus, the existing regulations are not stringent enough and their enforcement is insufficient.

Additionally, chemical industries fail to invest in essential research activity, laboratory tests and pilot scale operations before scaling up to large-scale production activity. Thus, possibility of certain hazardous chemical interactions may not be known until an accident occurs. Development of SOPs, training to employees on adoption of proper safety measures as well as emergency procedures are also the responsibilities of top management, which are often neglected.

Thus it is evident that reactive hazards are very difficult to identify and control, but it is very essential to do so in order to prevent major loss to chemical industries. Both the industries and regulatory authorities have a shared responsibility in preventing these hazards.

References

Bretherick, L. (1999). Bretherick's Handbook of React (Peter. Urben, Ed.). San Diego, Butterworth-Heinemann.

CSB. (2009). In Investigation Report T2 Laboratories, Inc. Runaway Reaction. Retrieved May. 18, 2014, from http://www. csb. gov/assets/1/19/T2_Final_Copy_9_17_

CSB. (2002). In Hazard Investigation - Improving Reactive Hazard Management. Retrieved May. 18, 2014, from http://www. csb. gov/assets/1/19/ReactiveHazardInves