

Study on Safety Handling of Hazardous Chemicals in Industries

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Abstract— Anything which has a potential to cause harm resulting in injuries or ill-health, property damage is known as Hazard. In Industries Hazardous chemicals are used for manufacturing, Analysis and research. Many accidents have occurred due to mishandling of hazardous chemicals which are resulted in catastrophic events. Knowing the nature, property of chemicals would help preventing from severe accidents. This paper focuses on the various hazardous chemicals, their handling techniques and prevention to be taken.

Key words: Hazards, Chemicals, Risk Control, Health

I. INTRODUCTION

Hazards due to various chemicals which are hazardous in industries can be identified based on its physical nature such as solid, liquid or gases. Most of the accidents occurs due to improper handling of chemicals. The safe handling methods of various hazardous chemicals are discussed here. Juan et al indicated that there are about 8 major causes for accidents namely mechanical failure, impact, human factors, instrument failures, Service failures, violent reaction, external events, and upset process condition (Sivaprakash & Karthikeyan, 2014). Hazardous chemicals are of various kinds such as flammables materials, explosive chemicals, corrosive materials, toxic substances, heat sensitive materials, oxidizing agents, gases under high pressure, water sensitive chemicals and radioactive materials. In case of handling of hazardous chemicals apart from physical, chemical properties weather condition of the surrounding environment also play a significant role. Chemical hazards are from their flammable, explosive, toxic, carcinogenic or chemical reactive property, their effect on individual may be acute which is short and reversible or Chronic which is long term and irreversible. Chemical accidents during transportation are main issues for a public safety (Ren, Yuan, Wang, Zhang, & Li, 2012)

II. VARIOUS FORMS OF CHEMICALS

There are three different physical forms in which chemicals can exist.

Solid has a definite shape and volume. Solids are divided into subclasses of amorphous (or glassy) solids and crystalline solids. The Arrangements of atoms or molecules in crystalline solids are repeated regularly over a certain long range of millions of atoms, but their arrangements in amorphous solids are somewhat random or short range of say some tens or hundreds of atoms. A liquid has a definite volume but it takes the shape of a container it occupies. There is only one liquid phase of an object. At a definite temperature and pressure, the two phases co-exist. A gas fills the entire volume of a container. All gases behave as do mixtures of gases. Thus, a gas is usually considered as a phase.

III. HANDLING METHODS OF VARIOUS HAZARDOUS CHEMICALS

There are various hazardous chemicals which are used in Industries for various purpose. Out of those this paper focuses on Reactive Chemicals and Corrosive Chemicals, their hazards, Safe handling methods.

A. Reactive Chemicals

Reactive chemical hazards arise from their inherent properties of the chemicals handled, used or disposed of from their admixture or processing. A hazard arise with a chemical because of its tendency to decompose spontaneously or to react violently on contact with other common chemicals. According to William, in Manufacturing industries reactive chemicals accidents have led to numerous losses and have affected the society. (Wei, Rogers, & Mannan, 2004).

B. Water Sensitive Chemicals

Some chemicals are 'water-sensitive' when contacted with water that they can produce flammable or toxic gases and/or undergo a vigorous reaction. Such reactions can cause overpressure in equipment or pipework. Some of the precautions for safe handling are to Store and use in such a way that accidental inlet of water, or contact with it, is avoided. Storing under a chemically-inert medium when appropriate (stocks should be checked regularly to ensure that an adequate level of inert medium is maintained). Separately store it from other flammable materials, e.g. solvents and combustibles. Use appropriate eye/face protection, overalls and gloves.

C. Explosive Chemicals

Certain chemicals may explode as a result of violent self-reaction or decomposition when subjected to mechanical shock, friction, heat, light or catalytic contaminants. Collection of the waste should be in well labelled, clearly and specially designed containers. Cleaning and decontamination of plant comprises removal of gross contamination under wet or solvent conditions using tools made of soft material, final cleaning with solvent or chemical reagent, and finally 'proving' of the equipment by heating to temperatures exceeding those for decomposition of the contaminant.

D. Reactive hazards from Mixtures

Many chemicals are 'incompatible' because a violent reaction may occur on contact. This can, in some conditions, result in an explosion due to its reaction. Safe handling involves the following steps

- Handle and store the minimum quantities for the process or experiments in progress
- Segregate the materials from other chemicals such as from reducing agents, paper, straw, cloth or materials of low flash point.
- Handle in diluted form possible in clearly designated areas, away from ignition sources.

- Use appropriate eye/face protection, overalls and gloves.

Hazards arising from the oxidation of organic compounds are greater when the reactants are volatile, or present as a dust or an aerosol. Liquid oxygen and various concentrated acids, e.g. nitric, sulphuric or perchloric acid, and chromic acid are strong oxidizing agents. The use of perchloric acid or perchlorates has resulted in numerous explosions; their use should be avoided when possible

In these cases Compatibility Chart must be used and known to avoid miserable reaction leading to Fire and explosions.

E. Corrosive Chemicals

Corrosive chemicals like acids and alkalis react vigorously with metals and organic substances according to concentration. And concentrated sulphuric acid can be handled through iron pipes in larger quantity and ceramic pots in lower quantity, phosphoric acid can be handled through rubber lines, pipes and tanks. Dilute sulphuric acid reacts with metals and produces hydrogen and thus it easily corrodes the metals and pipelines which leads to Unknown hazard. Acid line leaks cannot be predicted easily so periodic inspection of acid handling equipment is required. While handling acid and alkali equipment like Polyvinyl Chloride (PVC) overalls, PVC gloves, PVC gum boots, PVC hoods are to be worn. Emergency eye wash fountains, safety showers are to be provided in the acid and alkali handling areas to reduce severe impacts. Spillage of acid, can be neutralized with lime powder and washed with water. Washable and drained liquids are to be routed to effluent pit through well protected channels and gutters. There are limited chances for entering toxic chemicals through ingestion as workers may take chemicals through mouth by mistake. This can be avoided by proper label, writing the toxic effect of the chemicals in local languages, displaying warning symbols. Workers should be aware of Material safety data sheet to have clear idea of the chemicals characteristics and preventive measures. Other chances through mouth is through food stuff, water which are contaminated by toxic chemicals while handling. This can be avoided by proper testing food stuff and water for any contamination and adulterations, if any, when doubt arises. Toxic chemicals entering into the body through skin absorption is very less and can be avoided easily by adopting safety methods of chemical handling. Proper clothing is to be worn to avoid the contact of chemical with the body. Proper gloves are to be used while handling hazardous chemicals to protect hands. Hayashi explained that to avoid the corrosive condition the chemical contaminations in the water should be monitored periodically(Hayashi, Itoh, Kobayashi, Isobe, & Nishi, 2006)

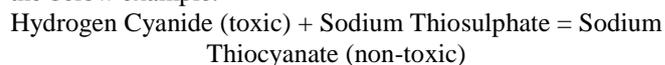
IV. PREVENTIVE MEASURES FOR HAZARDOUS CHEMICALS

According to Jaeger, explosion hazard may exist when the dust materials are produced, stored or processed and these materials are present as a mixture of air(Jaeger, 2001). Some of the preventive measures to avoid pollution of toxic chemicals are

A. Solid Hazardous Chemicals

Formation of dust in hazardous chemicals must be stopped at the source. The dust has to be collected by vacuum entrapped

in cyclones. The toxic chemicals can be reduced to form non-toxic chemicals by reacting with other chemicals. Consider the below example.



Arsenic and its compounds are toxic, that no other method is present to change the toxic arsenic to nontoxic arsenic. Almost many pharmaceutical products are very much sensitive to temperature and many of the chemicals undergo decomposition at moderate temperature and release toxic gases. Low temperature should be maintained while they are handled and stored.

B. Liquid State Hazardous Chemicals

According to Wanda, very dangerous chemicals involved in major accidents are sulfuric acid, hydrochloric acid, ammonia, sodium hypochlorite, and carbon monoxide (Welles, Wilburn, Ehrlich, & Florida, 2004). Also Marlair described that, in Solid physical state, at normal temperature and pressure ammonium Nitrate is chemically stable(Marlair & Kordek, 2005). Its melting point of 170C. Ammonium Nitrate has major hazards in relation with fire and explosion risk. Spillages are to be avoided by just draining the hazardous liquid into the ground. Draining and washings are to be properly collected in suitable containers. Toxic liquid should not be contaminated with drinking water, reverse etc. During the handling of oxidizing chemicals, they come into contact with combustible materials causing fires and explosives. In case of spillage, they can mix with other compatible materials and cause fire and explosion. These chemicals are to be kept in cool place as they are heat sensitive. In case of spillage, these chemicals should never be washed with water. If there is any fire while handling such chemicals, water should not be used as firefighting. Only dry chemicals powder should be used to extinguish the fire.

C. Hazardous Gases

Exhausting to open atmosphere must be prohibited. Never allow pressure safety relief valves to pop to the atmosphere. Hazardous gases must be vented through flare system. Gas stack effluent is to be controlled by providing continuous stack monitoring system. In Industries, gases such as hydrogen, nitrogen, oxygen, chlorine, ammonia, acetylene, ethylene, argon etc. are used widely. More care should be taken while handling and storing of such cylinders. Nitrogen and carbon monoxide are the two industrial gases which may give harm to human life silently because of their no odour characteristic to give warning of their presence. Rigas et al stated that working with the organic material contents with nitration is a potentially dangerous process, because nitration performs exothermic reactions under suitable conditions with explosive substances (Rigas, Sebos, & Doulia, 1998). In gold and silver mine, the safety precautions are important to have a safe working environment. Akcil denoted that staff members working in mines has continuously plan and provide detailed accounts of the management practices and initiatives being undertaken with regard to handling hazardous substances (Akcil, 2006). Fabiano et al noted that economic factors, technology based job design, organization of work or environmental conditions and human factors are the several factors that can affect the occupational accidents

frequency (Fabiano, Currò, Reverberi, & Pastorino, 2010). To prevent human entrap in such atmospheres, workers should have proper knowledge about the sources of the hazardous gases present in the process and sufficient precaution is to be taken by wearing appropriate breathing apparatus

V. CONCLUSION

Hazardous chemicals must be handled properly as little carelessness might lead to catastrophic accidents. In addition, certain documents such as material safety data sheet, compatibility chart, hazardous material information system and many more must be provided to workers while handling of chemicals. This paper focuses on the various methods of safe handling of hazardous chemicals particularly Corrosive and reactive chemicals. Improper handling of chemicals must be avoided through proper training, regular supervision to have a safe working environment.

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