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RECENT TRENDS IN SAFETY MANAGEMENT SYSTEM IN CARBON DISULPHIDE PLANT: A REVIEW

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ABSTRACT

The paper throws light on understanding the vital role of carbon disulphide plant in rayon industry. It focuses on the development of safety management module of carbon disulphide plant and how to mitigate this hazard through the application of various safeties planning in carbon disulphide. It also describes the implementation stages of occupational health and safety management in the process industry. To achieve our ideal state of zero work-related illnesses, injuries, improved health and well-being for all employees, we have a system to assess occupational health hazards and risks comprising of identifying potential risks, planned periodic surveys and monitoring of employees exposed to risks. A case study has been illustrated to understand the consequences of overlooking the safety aspects. The paper concludes that inculcating safety culture right from design to development, results in reduced accident rate and keeps employers and employees safe.

INTRODUCTION

Occupational health and safety

It begins with dedicated and empowered teams for occupational health and safety at each of our units and at corporate. A safety manual covering important safety aspects such as working at heights, hot work permit system, confined space permit, incident investigation and emergency planning is prepared and made available to all employees. Clearance for new projects: A checklist has been developed covering the aspects of environment, occupational health and safety and is used as a part of approval for new projects

(A) Management review: Safety performance is tracked at all levels including the board which receives periodic updates from the concerned functional executives. We track our safety performance data for our permanent employees and contract service personnel. Safety performance during project implementation is also monitored and appropriate actions are planned based on data.

(B) Future plans: While systems and procedures are in place, we definitely see an important area of improvement in terms of behavioral aspects to health and safety. In future, we plan to work more on the behavioral part in our management system framework.

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Monitoring system for Health and Safety

Any management system benefits from periodic review and assessment. To this effect. we have formulated a defined schedule of audit of our Environment, Occupational Health and Safety management system in our units at various levels. The audit findings and recommendations are communicated and actions taken by the concerned departments.

Occupational health management at our units

To achieve our ideal state of zero work-related illnesses, injuries, improved health and well-being for all employees, we have a system to assess occupational health hazards and risks comprising of Identifying potential risks, Planned periodic surveys andMonitoring of employees exposed to risks

Safety and Loss Prevention

Safety is also good business; the good management practices needed to ensure safe operation will also ensure efficient operation. The term "loss prevention" is an insurance term, the loss being the financial loss caused by an accident. This loss will not only be the cost of replacing damaged plant and third party claims, but also the loss of earnings from lost production and lost sales opportunity.

Safety and loss prevention in process design can be considered under the following broad headings:

1. Identification and assessment of the hazards.
2. Control of the hazards: for example, by containment of flammable and toxic materials.
3. Limitation of the loss. The damage and injury caused if an incident occurs: pressure relief, plant layout, provision of fire-fighting equipment.

Basic preventative and protective measures

1. Adequate, and secure, water supplies for fire fighting.
2. Correct structural design of vessels, piping, steel work.
3. Pressure-relief devices.
4. Corrosion-resistant materials, and/or adequate corrosion allowances.
5. Segregation of reactive materials.

Description of carbon disulphide

General description

Carbon disulfide (CS2) in its pure form is a colorless, volatile and inflammable liquid with a sweet aromatic odour. The technical product is a yellowish liquid with a disagreeable odour. Carbon disulfide is used in large quantities as an industrial chemical for the production of viscose rayon fibers. Carbon disulfide is also used as a solvent for fats, lipids, resins, rubbers, sulfur mono-chloride, and white phosphorus.

Identity and physical and chemical properties

Physical properties

Pure carbon disulfide is a colorless liquid with a pleasant odour that is like the smell of chloroform. The impure carbon disulfide that is usually used in most laboratory and industry processes is a colorless to faintly yellow liquid with a strong, disagreeable cabbage-like odour detectable at 0.016 to 0.42 ppm. It is highly refractive. Slightly soluble in water. It is miscible with anhydrous methanol, ethanol, ether, benzene, chloroform, carbon tetrachloride and oils.

Melting Point :111.5°C, Boiling Point : 46.5°C, Specific Gravity: 1.2632,Vapour Density : 2.67, Flash Point : 30°C, 1 ppm = 3.11 mg/m^3.

Chemical properties

Very highly flammable, very low flash point. Carbon disulfide easily forms explosive mixtures with air and catches fire very easily; it is dangerous when exposed to heat, flame, sparks, or friction. Vapours can be ignited by contact with an ordinary light bulb. It is incompatible or reactive with strong oxidizers; chemically active metals such as sodium, potassium and zinc; azides; rust; halogens and amines. When exposed to heat or flame, carbon disulfide reacts violently with chlorine, azides and ethylamine demines, ethylene imines, fluorine, nitric oxide and zinc. When heated to decomposition, it emits highly toxic fumes of sulfur oxide; it can react vigorously with oxidizing materials.

Evaluation of Human Health Risks

Some concentration-response relationships in occupational exposure to carbon disulfide in Table 1.

Commercial Methods related with Carbon Disulphide plant

Study of cs2 plant (Charcoal based) to Reduce Emission and Improve Efficiency in Viscose Fiber/Rayon Industry.

CS_2 is one of the major raw materials for Fiber pro-

Table 1.

S.No.	Carbon disulfide Concentration (Mg/m^3)	Duration of exposure (Years)	Symptoms and signs
1.	500-2500	0.5	Polyneuritis, myopathy, acute Psychosis
2.	200-500	1-9	Increased ophthalmic pressure
3.	60-175	5	Eye burning, abnormal papillary light Reactions
4.	40-80	2	Asthenospermia, hypospermia, Teratospermia
5.	22-44	> 10	Arteriosclerotic changes and Hypertension
6.	10	10-15	Sensory polyneuritis, increased pain Threshold.

duction. It is main Chemical in the reaction with Alkali Cellulose for producing sodium cellulose xanthenes. This intermediate product is soluble in Caustic Soda to form Viscose, which in turn produces Viscose fiber.

CHEMICAL REACTION

Types of Reaction : Endothermic
Reaction : $C + 2S = CS_2$
Molecular Weight : 12 + 64 = 76

Manufacturing Process of CS_2

- Red hot Charcoal is reacted with molten Sulfur inside CS_2 furnace which has graphite electrodes to supply power for maintaining reaction temperature to form CS_2, H_2S gas mixture.
- Vapors of CS_2, unreacted Sulfur and Hydrogen Sulfide (side reaction product) are evolved from furnace as product.
- The product mix is passed through Sulfur separator to remove Sulfur.
- Further CS_2 gas is condensed in various stages of condensers and oil scrubber.
- After condensation liquid CS_2 contains lot of impurities which is further treated in refinery.
- Uncondensed gas mainly H_2S with little amount of CS_2 is sent to Claus plant to recover Sulfur. This Sulfur is then recycled to CS_2 process.

Safety related measures

Safety related measures should be analyzed and a methodology to be devised for the CS_2 handling as it has highly hazardous properties.

Brick Lining

1. Feasibility study to be carried in consultation with brick manufacturer.
2. Auditing of work quality to be done thoroughly.

Safety Training and Development

1. Continuous training to be imparted to the workforce based on the plant requirements.
2. The training plan to be devised so that every worker is skilled in CS_2 handling operation.

Uncertain Events

1. HAZOP Study to be carried out for critical equipment.
2. Case studies to be discussed to avoid similar type of incidents/ accidents.

Human Errors

1. Feasibility study to be carried out for Automation/ indicator system.
2. Lock out/ Tag out during maintenance activities. India's first green energy CS_2 plant in Dahej, Gujarat.

PM Bureau, (2012) investigated the performance of India's first green energy CS_2 plant in Dahej, Gujarat. Indofil Industries Ltd., a K.K. Modi group company, opened its state of the art green energy Carbon disulphide (CS_2) production plant at Dahej, Gujarat.

Indofil has entered into a joint venture with Shanghai Baijin Chemical Group of China for CS_2 manufacturing through a 51:49 partnership in Indo Baijin Chemicals Pvt. Ltd. The approximate $40-million plant would be the first in the country to use eco-friendly technology for CS_2 production. The proposed plant will have 'zero' wastage discharge with no chemical contaminated water as affluent and reduced outlet gas released to atmosphere. The plant will recycle 300 cubic meters of water per day and recover 135 tons steam per day from waste heat. Preliminary evaluations indicate that the project will be entitled for 25,000 tons of carbon credit per year. With this state-of-the-art green technology, charcoal will be replaced by natural gas and this will help us save

50,000 tons of wood per year which is equivalent to 58 sq. km of forest. "Setting up of the manufacturing unit is a key strategic move to ensure consistent supply of CS2, which is a key raw material for our products such as Mancozeb. Through this backward integration, we would strengthen Indofil supply chain laying a great foundation for the company's production capacity for years to come."

Safety Management plant in Carbon Disulphide

Lewis, *et al.*, (2010) studied the performance of carbon disulfide induces early lesions of atherosclerosis and enhances arterial fatty deposits induced by a high fat diet. Atherosclerotic cardiovascular disease (ACVD) is the number one cause of death in the United States; the effects of environmental toxicants on this process are less well studied than the effects of chemicals on the second leading cause of death, cancer. There is considerable epidemiological evidence that workers exposed to carbon disulfide (CS_2) have increased rates of ACVD, and there is conflicting evidence of the atherogenic potential of CS_2 from animal studies. Chemical modification, such as oxidation of low-density lipoproteins (LDL), is tightly associated with increased LDL uptake by macrophages and the development of arterial fatty streaks. CS_2 has been previously demonstrated to modify several proteins in vitro including LDL, and others *in vivo* through derivatization and covalent cross-linking.

Animals were sacrificed after 1, 4, 8, 12, 16, or 20 weeks of exposure and the rates of fatty deposit formation under the aortic valve leaflets were evaluated. Exposure of mice on the control diet to 500 and 800 ppm CS_2 induced a small but significant increase in the rate of fatty deposit formation over non-exposed controls. Analysis of erythrocyte spectrum for protein cross-linking revealed a dose-dependent formation of alpha - and beta -heterodynes in animals on both diets. These data demonstrate that CS_2 is atherogenic at high concentrations, but more importantly, suggest that, in conjunction with other risk factors, CS_2 at relatively low concentrations can enhance atherogenesis.

Chang, *et al*. (2010) performed the Biological monitoring of carbon disulphide: kinetics of urinary 2-thiothiazolidine - 4 - carboxylic acid (TTCA) in exposed workers. The objectives of this study was to establish the kinetics of urinary 2 - thiothiazolidine - 4 - carboxylic acid (U-TTCA) for workers exposed to carbon disulphide (CS_2) and to investigate the effects of volume and keratinize adjustment methods for urine measurement. Ten workers in the spinning department of a rayon factory were individually monitored for airborne CS2 concentrations, with consecutive urine samples collected for 24-38 hours after termination of exposure. The U-TTCA, urine volume and creatinine level were measured for each sample. A post-shift U-TTCA of 3.0 mg/g Cr. equivalent, 40% below the current BEI setting at nearly PEL exposed level, was found. In conclusion, first-order kinetic response was confirmed for U-ITCA. Both volume- and creatinine-based urine adjustments are satisfactory for TTCA assessment as a biomarker of individual CS_2 exposure although the correlation for creatinine-based measurement was modestly superior to the volume-based analogue. Based on the results of this study, we recommend a re-evaluation of the current biological exposure index of 5 mg/g creatinine at a CS2 exposure level of 10 ppm.

Markku nominee, (2009)studied the Quantitative effect of cs2 exposure, elevated blood pressure and aging on coronary mortality. Risk function analysis was performed in order to clarify the relationship between coronary heart disease death rate and occupational carbon disulfide exposure along with two other important risk factors, elevated diastolic blood pressure and older age, in a data set obtained from a 10-year prospective follow-up of coronary mortality in two cohorts of over 340 male industrial workers in Finland. The sole effect of carbon disulfide on the coronary mortality was statistically significant (relative risk = 2.3), and it was largely independent of the level of the other two risk factors. Log-linear models were fitted to predict coronary heart disease deaths. The analysis identified the dual role of raised blood pressure in the potential mechanism of coronary death. Relative risks ranging up to 48 were obtained for the joint non-synergistic effect of these three factors in the exposed group compared to a subgroup of no exposed, 40-year-old normotensive men. The effect of carbon disulfide exposure on the risk of coronary death, while clearly distinguishable from the effect of hypertension and aging, stayed subordinate to them, but nevertheless remained an important risk element in the work environment.

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