International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org Volume 2 Issue 7 ǁ July. 2013 ǁ PP.39-43

"Recent Trends in Safety Management System in Carbon Disulphide Plant: A Research"

[1,] Shweta Chittora , [2],Dr. Anjani K. Dwivedi
[1,2,] Department of Chemical Engineering Ujjain Engineering College Ujjain; 456010; India

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.*

KEYWORDS: *Rayon, Carbon disulphide, Viscous staple fiber, Atherosclerotic cardiovascular disease, low-density lipoproteins*

I. INTRODUCTION

Rayon grade pulp is steeped in caustic soda solution and the excess lye is drained in slurry press to obtain a mat of Alkali cellulose. After shredding, alkali cellulose is reacted with carbon disulphide and then dissolved immediately in dilute caustic soda solution to give viscous which is deaerated,filtered and ripened before extrusion through Spinnerettes into a spinning bath containing sulfuric acid, sodium sulphate and a special additives. Cellulose is regenerated in the form of fine filaments and sodium sulphate is produced with the liberation of carbon disulphide, part of which is recovered for reuse. The filaments are cut into the required staple length, washed, desulphurized, bleached, soft finished and dried to obtain Viscous Staple Fiber. Viscous staple fiber (VSF) is an extremely versatile textile fiber that has characteristics similar to cotton. Next to cotton, VSF is the best man-made fiber with durability and luster. It can be used in blends with polyester and other synthetic fibers. Its moisture absorption property renders it ideal for tropical countries like India.

1.1.Description of carbon disulphide:-
1.2.General description:-

Carbon disulfide (CS_2) 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 There installing capacity should be maintained.Required temperature and pressure should be done.It is very necessary to reduce the sulphur emission and to recover and reused the carbon disulphide

1.3.Identity and physical and chemical properties:-
1.4.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 $mg/m^{3.}$

1.5.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.

1.6.Evaluation of Human Health Risks

Some concentration-response relationships in occupational exposure to carbon disulfide

	Carbon disulfide Concentration (Mg/m3)	Duration of exposure (Years)	Symptoms and signs
1.	500-2500 Psychosis	0.5	Polyneuritis, myopathy, acute
2.	200-500	1-9	Increased ophthalmic pressure
3.	60-175 Reactions	5	Eye burning, abnormal papillary light
4.	40-80 Teratospermia	2	Asthenospermia, hypospermia,
5.	22-44 Hypertension	> 10	Arteriosclerotic changes and
6.	10 Threshold.	10-15	Sensory polyneuritis, increased pain

(Table no. 1.1)

1.7.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 production. 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.There installing capacity should be maintained.Required temperature and pressure should be done.It is very necessary to reduce the sulphur emission and to recover and reused the carbon disulphide.

1.8.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 CS2 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.

1.9.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.

1.10.Brick Lining:

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

1.11.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.

1.12Human Errors:
1. Feasibility study to be carried out for Automation/indicator system.
2. Lock out/ Tag out during maintenance activities.

1.13.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.

1.14.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.

1.15.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.

II. INDIA'S FIRST GREEN ENERGY CS2 PLANT IN DAHEJ, GUJARAT.

P M Bureau.,(2012) investigated the performance of India's first green energy CS2 plant in Dahej,Gujarat.Indofil Industries Ltd, a K.K. Modi group company, opened its state of the art green energy Carbon disulphide (CS2) production plant at Dahej, Gujarat.
Indofil has entered into a joint venture with Shanghai Baijin Chemical Group of China for CS2 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 CS2 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."

III. SAFETY MANAGEMENT PLANT IN CARBON DISULPHIDE:-

J G 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 (CS2) have increased rates of ACVD, and there is conflicting evidence of the atherogenic potential of CS2 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. CS2 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 CS2 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 CS2 is atherogenic at high concentrations, but more importantly, suggest that, in conjunction with other risk factors, CS2 at relatively low concentrations can enhance atherogenesis.HY Chang, teal. (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 (CS2) 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 CS2 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.

Hazard: A hazard means anything that result in injury or harm to the health of a person i.e. it can be activity or condition which poses threat of loss or harm. The following main hazards may exist in the factory under the situations given below-High temperature and pressure,Fire & explosions (due to inflammable / combustible materials),Toxic and corrosive chemicals,Toxic and poisonous gases and dust,Electricity (Receiving / Clue ration / Distribution),Disposal of wastes,Work at heights,Work in confined spaces / vessels / tank etc., Failure of boilers etc. , Hazards during heavy equipment handling (Crane, etc.) and Road accidents etc.However, the threats posed to the aforesaid hazards may be on account of (i) Fire or (ii) explosion or (iii) Release of toxic or corrosive liquid / gas from their confinement.

A hazard and operability study (HAZOP) is a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation.. A HAZOP is a qualitative technique based on guide-words and is carried out by a multi-disciplinary team (HAZOP team) during a set of meetings. A hazard and operability study is a procedure for the systematic, critical, examination of the operability of a process. When applied to a process design or an operating plant, it indicates potential hazards that may arise from deviations from the intended design conditions. The term "operability study" should more properly be used for this type of study; thought is usually referred to as a hazard and operability study, or HAZOP study. This can cause confusion with the term "hazard analysis", which is a technique for the quantitative assessment of a hazard, after it has been identified by an operability study, or similar technique Risk: Risk can be defined as the probability of hazardous situation resulting into an accident.

Risk assessment is a step in a risk management procedure. Risk assessment is the determination of quantitative or qualitative value of risk related to a concrete situation and a recognized threat (also called hazard). Quantitative risk assessment requires calculations of two components of risk (R):, the magnitude of the potential loss (L), and the probability (p) that the loss will occur.. Methods for assessment of risk may differ between industries and whether it pertains to general financial decisions or environmental, ecological, or public health risk assessment.The assessment of management and risk is an activity that has growing interest. Risk assessment result in list of potential injury or harm and the likelihood of these occurring arising from the hazard identified. Hazard identification and risk assessment goes hand in hand.

REFERENCES

[1] Bureau PM, "India's first green energy CS2 plant in Dahej, Gujarat"2012

[2] Cassitto MG, Camerino D, Imbriani M, Contardi T, Masera L, Gilioli R, "Carbon disulfide and the central nervous system: a 15-year neurobehavioral surveillance of an exposed population, 2009

[3] Chang HY, Chou TC, Wang PY, Shih TS, "Biological monitoring of carbon disulphide: kinetics of urinary 2-thiothiazolidine-4-carboxylic acid (TTCA) in exposed workers,"vol 23,issue 67,2010.

[4] Drexler H, Göen T, Angerer J., "Investigations on the uptake of CS2 and the excretion of its metabolite 2-thiothiazolidine-4-carboxylic acid after occupational exposure"2009

[5] Egeland GM, Burkhart G A, Schnorr T M, Hornung R W, Fajen J M, and Lee S T, "Effects of exposure to carbon disulphide on low density lipoprotein cholesterol concentration and diastolic blood pressure",vo 89,issue 4,2008

[6] Kotseva K, "Occupational exposure to low concentrations of carbon disulfide as a risk factor for hypercholesterolaemia,2005"

[7] Kuo HW, Lai JS, Lin M, Su ES, "Effects of exposure to carbon disulfide (CS2) on electrocardiographic features of ischemic heart disease among viscose rayon factory workers",2008

[8] Lewis J G, Graham D G, Valentine W M, Morris R W, Morgan D L ,Sills R C, "Exposure of C57BL/6 mice to carbon disulfide induces early lesions of atherosclerosis and enhances arterial fatty deposits induced by a high fat diet" vole 49,issue 1,2010

[9] Markku nurminen, "effects of cs2 exposure and aging on coronary mortality", 2009

[10] Soderlund C.A., (1996) Svenska-Rayon initiates new electron radiation technology in pulp processing. Svensk Papperstidning-Nordisk Cellulosa vol 99, 27-30.