Risk Assessment And Hazard Evaluation For Paper Industries


1PG Scholar, Department of Industrial safety engineering, Knowledge Institute of Technology, Salem, Tamilnadu, India.
2,3,4,5,6 Faculty of Mechanical Engineering, Knowledge Institute of Technology, Salem, Tamilnadu, India

ABSTRACT

The paper industry has an important social role to play for the country. Use of paper is considered as an index of cultural growth. The paper industry is also contributing towards fulfillment of various requirements of the industry as a whole like information dissemination, publicity, etc. Pulp and paper manufacturing can be very hazardous due to massive weight and falling, rolling, and sliding pulpwood loads. Workers may be struck or crushed by loads or suffer lacerations from the misuse of equipment, particularly when machines are used improperly or without proper safeguards. Hazardous chemicals used in pulp and paper mills require careful handling and continuous monitoring to minimize threat to workers, processes, and nearby communities. The production and use of paper has a number of adverse effects on the environment like deforestation, air pollution(NO₂,SO₂,CO₂ emissions), waste water discharge (contains solids, lignin, alcohols, transition metal compounds, nitrogen and phosphorus, etc.), landfills. This project helps to identify various safety and health hazards in the pulp making process and recommend the new suited methods to improve the workplace safety and health in paper industry.


INTRODUCTION

Pulping Process:

Pulping is the major source of effluents in the manufacturing process. This process enables separation of cellulose fibres and removal of impurities. As mentioned earlier, the pulping process employs three types of raw materials viz. i) Hardwood, ii) Agro residues and iii) Recycled fibre/ waste paper. Quality of paper largely depends on the cellulose content in pulp and the fibre length. The raw materials are briefly discussed below.

Hardwoods contain higher proportion of cellulose but shorter fibre length than softwoods, which are more resinous. The removal of lignin by treating the wood chips improves the fibre quality. Generally two approaches are employed for pulping in Indian context, viz. chemical pulping and chemi-mechanical pulping. Approximately 3Mt and 0.05 Mt pulp are made respectively.

A. Bagasse Pulping Process-Soda Process:

The Soda pulping process is employed for pulping of agro residues like wheat and rice straw and bagasse. In this process these raw materials are cooked with caustic soda at a temperature of 150-160°C to separate lignin from the raw material. The pulp is then washed and bleached, if necessary, to make a bleached pulp.
i) **Bagasse Preparation:**

The bagasse fiber reinforced polymer composites performance depends on several factors, including fibers chemical composition, cell dimensions, microfibrillar angle, defects, structure, physical properties, and mechanical properties, and also the interaction of a fiber with the polymer. In order to expand the use of bagasse fibers for composites and improved their performance, it is essential to know the fiber characteristics.

Bagasse consists of approximately 50% cellulose and 25% each of hemicellulose and lignin. Chemically, bagasse contains about 50% α-cellulose, 30% pentosans, and 2.4% ash. Because of its low ash content, bagasse offers numerous advantages in comparison to other crop residues such as rice straw and wheat straw, which have 17.5% and 11.0%, respectively, ash contents, for usage in microbial cultures. Also, in comparison to other agricultural residues, bagasse can be considered as a rich solar energy reservoir due to its high yields and annual regeneration capacity.

ii) **Digester:**

Digestion process carried out in a pandia type digester. The agro residue is chemically digested in a digester at 150 – 160 °C and 6 – 7atm pressure for about six hours. Charging and discharging takes 1.5 hours and 0.5 hours respectively. In this process bagasse are cooked with caustic soda at a temperature of 150-160°C to separate lignin from the raw material.

iii) **Washing:**

The brown stock from the blowing goes to the washing stages where the used cooking liquors are separated from the cellulose fibers. Normally a pulp mill has 3-5 washing stages in series. Washing stages are also placed after oxygen delignification and between the bleaching stages as well. Pulp washers use counter current flow between the stages such that the pulp moves in the opposite direction to the flow of washing waters. Several processes are involved: thickening/dilution, displacement and diffusion. The dilution factories the measure of the amount of water used in washing compared with the theoretical amount required to displace the liquor from the thickened pulp. Lower dilution factor reduces energy consumption, while higher dilution factor normally gives cleaner pulp. Thorough washing of the pulp reduces the chemical oxygen demand (COD).

Several types of washing equipment are in use:
- Pressure diffusers
- Atmospheric diffusers
- Vacuum drum washers
- Drum displacers
- Wash presses

iv) **Screening:**

Screening of the pulp after pulping is a process whereby the pulp is separated from large shives, knots, dirt and other debris. The accept is the pulp. The material separated from the pulp is called reject.
The screening section consists of different types of sieves (screens) and centrifugal cleaning. The sieves are normally set up in a multistage cascade operation because considerable amounts of good fibres can go to the reject stream when trying to achieve maximum purity in the accept flow.

The fibber containing shives and knots are separated from the rest of the reject and reprocessed either in a refiner and/or is sent back to the digester. The content of knots is typically 0.5 - 3.0% of the digester output, while the shives content is about 0.1 - 1.0%.

v) Bleaching Process:
Bleaching process is carried out to improve the brightness of the pulp. The type of pulp involved and the destined end use are important factors in the actual process. Some of the bleaching agents used are chlorine (Cl₂), chlorine dioxide (ClO₂), hydrogen peroxide (H₂O₂), caustic, oxygen, ozone, hypochlorite, sodium-bisulphite.

vi) Chemical Recovery:
A variety of chemical processes are used to recover the chemicals used at various stages of the process. The dilute liquor from the pulp washing (containing the dissolved inorganic and organic solids) is called "black liquor". The dissolved organics have to be removed for environmental reasons, and their burning also generates most of the heat energy required by the Kraft mill. The dissolved sodium hydroxide and sodium sulphide are regenerated so that they can be reused in the white liquor, and thus the escape of an environmental pollutant is prevented.

The four steps involved in chemical recovery are outlined below.
- Concentration – Evaporator
- Combustion – Chemical Recovery Boiler
- Causticizing – Causticizer
- Calcination – Lime Kiln

Literature Survey:
A bio composite is a material formed by a matrix and a reinforcement of natural fibers like Jute, Coir, Sisal, Pineapple, Ramie, Bamboo, Banana and Bagasse, etc. Such natural fibers composites are low-cost fibers with high specific properties, low density and eco-friendly. The development of advanced bio composite materials made is increasing worldwide. It will be an alternative way to develop the bio composites which can be particularly used for daily needs of common people whether it is household furniture, house, fencing, decking, flooring, and light weight car components or sports equipment’s. This effort to develop bio composite materials with improved performance for global applications is an ongoing process. Thousands of tons of bagasse is produced but most of their wastes do not have any useful utilization. These bagasse wastes can be used to prepare fiber reinforced polymer composites for commercial use. This review paper discusses about recent development of bagasse fibers reinforced polymer composites, types of matrix, processing methods, and any modification of the fiber and its applications.

Bagasse Packaging Board by Cold Soda Pulping Methods Mohamed El-Sakhawy, Mona Abdelkader Nassar, Hassan M.F. Madkour, Ahmed K. El-ziaty and Salah A. Mohamed:
Bagasse was cooked in plastic bag or in autoclave using cold soda pulp method with/without NH₄NO₃ at different degrees of temperatures and different periods of times. The pulping liquor was in the ratio of 1:6 based on bagasse. The effect of pulping processes variables was investigated. Bagasse produced acceptable unbleached pulp at 80°C in plastic bag and at 105°C in autoclave, with different yield % from 43% - 61%. The mechanical and physical properties of bagasse pulp sheet using different concentrations ratios of starch and/or borax as added filler during sheets making were investigated. The prepared sheets have been characterized by breaking length, tear index, burst index density and air permeability tests. Starch and/or borax filler added during sheet making improved the mechanical and physical properties of bagasse pulp sheet.

Problem Identification:
Bagasse Pulping Process Hazards:
Bagasse pulping process is a large integrated sector. This sector employs lot of conventional technologies and also it’s an old pulp mill process in SPB mill. In this area, found a more number of medical aid injuries due to lack of attention in safety system. The following hazards are commonly associated with the bagasse pulp mill such as

- Physical Hazards
  - Slip and fall
  - Caught between belt and conveyor system
• Electrical shock during starting of digester
• Explosion to oil splash
• Hit injury due to moving parts
• Noise level is high during starting of vacuum pump
• Hot surface area.
• Trapping contact with rotary parts.

Chemical Hazards:
• Burn injury due to contact with hot pulp
• Chemical burn due to liquor splash
• Hot steam and white liquor splash on skin they cause severe burn injury

Ergonomical Hazards:
• Body strain due to repetitive work
• Unpleasant work area due to machine vibration.

Biological Hazards:
• Skin irritation due to contact with wastewater from washing of pulp.

Oh&S Monitoring On Spb Mill:

Table 1: Bagasse pulp chemicals

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Location</th>
<th>CHEMICALS</th>
<th>Material phase</th>
<th>Target Organ</th>
<th>Method of handling by</th>
<th>Purpose of Usage</th>
<th>No.of person involved</th>
<th>Health Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H2SO4</td>
<td>Solid</td>
<td>Heart, Skin, Respiratory System</td>
<td>Transfer by pump (unloading by employee)</td>
<td>To maintain pulp Ph.</td>
<td>4</td>
<td>Hematology, PFT, X-ray Chest</td>
<td>Annual</td>
</tr>
<tr>
<td>2</td>
<td>H2O2</td>
<td>Gas</td>
<td>Skin, Eyes, Mucous membranes, Respiratory System</td>
<td>Transfer by pump (unloading by employee)</td>
<td>To increase pulp brightness</td>
<td>4</td>
<td>PFT, X-ray Chest</td>
<td>Annual</td>
</tr>
<tr>
<td>3</td>
<td>Chlorine dioxide</td>
<td>Gas</td>
<td>Skin, Mucous membranes, Respiratory System</td>
<td>Supply from K/8 plant</td>
<td></td>
<td></td>
<td>PFT, X-ray Chest</td>
<td>Annual</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Location</th>
<th>CHEMICALS</th>
<th>Material phase</th>
<th>Target Organ</th>
<th>Method of handling by</th>
<th>Purpose of Usage</th>
<th>No.of person involved</th>
<th>Health Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H2SO4</td>
<td>Solid</td>
<td>Heart, Skin, Respiratory System</td>
<td>Transfer by pump (unloading by employee)</td>
<td>To maintain pulp Ph.</td>
<td>4</td>
<td>Hematology, PFT, X-ray Chest</td>
<td>Annual</td>
</tr>
<tr>
<td>2</td>
<td>H2O2</td>
<td>Gas</td>
<td>Skin, Eyes, Mucous membranes, Respiratory System</td>
<td>Transfer by pump (unloading by employee)</td>
<td>To increase pulp brightness</td>
<td>4</td>
<td>PFT, X-ray Chest</td>
<td>Annual</td>
</tr>
<tr>
<td>3</td>
<td>Chlorine dioxide</td>
<td>Gas</td>
<td>Skin, Mucous membranes, Respiratory System</td>
<td>Supply from K/8 plant</td>
<td></td>
<td></td>
<td>PFT, X-ray Chest</td>
<td>Annual</td>
</tr>
</tbody>
</table>

Methodology:

"What If" Analysis"

The "What If?" analysis technique is an approach to hazard analysis that is directly reflected by its name. In using a “What if...?” analysis, the team or facilitator uses questions posed in the form of “What if...?” statements, such as; “What if the cooling water to the chamber stops?”

Purpose:

The purpose of the What-If Analysis methodology is to identify hazards, hazardous situations, or specific accident events that could produce an undesirable consequence. The What-If Analysis methodology is described in more detail in the first and second references at the conclusion of this discussion.

The What-If Analysis technique is a brainstorming approach in which a group of experienced individuals familiar with a process ask questions or Voice concerns about possible undesired events in the process. It is not inherently structured as some other techniques, such as the Hazard and Operability Study (HAZOP) or a Failure Mode and Effects Analysis (FEMA) which are also presented in this section. Rather, it requires the analysts to adapt the basic concept to the specific application. The What-If Analysis Concept encourages an analysis team to think of questions that begin with “What If.” Through this questioning process, an experienced group of
individuals identify possible accident situations, their consequences, and existing safeguards, then suggest alternative for risk reduction.

**“HIRA” – HAZARD IDENTIFICATION, RISK ASSESSMENT**

The provision and maintenance of plants and systemsofworkthat are, so far as is practicable, safe and without risks to health.

**Risk Assessment:**

The process of evaluating the risk to safety & health from hazards at work.

**Suggestions For Bagasse Pulping Process:**

- In bagasse pulping area there is a large amount of water and chemicals used for pulping and screening process so there is an highly possible for slip and fall hazards so proper housekeeping is mandatory for avoiding the these type of hazards.
- Highly skilled person only allowed for handle the digester operation.
- Provide required PPE’s for all employees in pulping process because there is a possible for hit injury and oil splash in pulping operation.
- Conduct an audiometric testing in bagasse pulp mill at every period of six months. In order to regulate the noise level.
- Conduct an annual medical check-up for employees in pulping area for identifying the health issues.
- Provide an guarding for rotary parts in order to avoid the contact with men and materials.
- Provide a Material safety data sheet in chemical handling area.
- Provide a safety induction training for contract employees in every period of six months.
- Importance of safety measures while loading and unloading of chemicals /acids / furnace oil etc.,
- Fire hydrant provision and their coverage of the plants.

**Conclusion:**

Pulping process in paper industry is complex activity. From this project thus the various activities in bagasse pulp mill for paper industry HIRA & WHAT IF is taken to risk assessment and identify the hazard and Prepare the questionnaire and corrective action should be taken to reduce the risk to a tolerable limit in order to ensure the safe working environment for an employee. And future work is to achieve zero level of risk and hazards in the required bagasse pulping process by improving safety and by satisfying the peoples involved in the company.

**REFERENCES**

3. Liziane da Luz Seben, IstefaniCarisio de Paula, 2012. Cellulose pulp extraction from vegetable wastes: considerations about environmental and economic sustainability criteria, ICIEOM.