CHEMICAL HAZARDS ASSOCIATED WITH LAMINATION & INFUSION IN MOLDING PROCESS AND THEIR CONTROL MEASURES

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ABSTRACT

The objective of this program is to undertake a study of various critical processes, hazard assessment of critical workplaces and recommend measures to eliminate or reduce the effect of hazards in the workplace through special personal safeguards. A hazard analysis results in the identification of various hazards. Checklists, safety checks are techniques used to identify hazards and eliminate or reduce the risk of injury/illness to workers and damage to property, equipment and the environment. We must update the checklist in the workplace to identify hazards and take action to control them.

It is a step-by-step process that guides responsible persons through effective risk identification, assessment and timely risk control. Steps include:

Risk Management – Controlling hazards and risks associated with risk. Try to eliminate the hazard first. If this is not possible, use substitutions, modifications, isolation or engineering controls to reduce the risk. Back-up restraints such as personal protective equipment should only be used as a last resort. Hazards, risks and hazards to employees affected by hazards This project is concerned with assessing the potential risks associated with humanity. The project also deals with risk management of work processes.

Keyword – *Risk Management, Potential Risks, Hazard Identification, etc….*

1. INTRODUCTION

The company founded in 1968 and has been providing composite wind blades since 2001. Our knowledge and experience of composite materials and manufacturing originates with our predecessor company, Tillotson Pearson Inc., a leading manufacturer of high-performance sail and powerboats along with a wide range of composite structures used in other industrial applications.

We are a leading wind-blade manufacturer and the only independent wind blade manufacturer with a global footprint. We accounted for approximately 32% of all sold onshore wind blades on a MW-basis globally excluding China in 2020. We reached a record high this year with nearly $1.7 billion in net sales and more than 10,600 wind blades produced. We enable many of the industry's leading wind turbine original equipment manufacturers (OEMs), who have historically relied on in-house production, to outsource the manufacturing of a portion of their wind blades, thus expanding their global wind blade capacity.

We are headquartered in Scottsdale, Arizona, and we have expanded our global footprint to include domestic facilities in Newton, Iowa; Warren, Rhode Island; and Santa Teresa, New Mexico, and international facilities in Dafeng, China; Taicang Port, China; Yangzhou, Jiangsu, China; Kolding, Denmark; Chennai, India; Juarez, Mexico; Matamoros, Mexico; and Izmir, Turkey.

Our advanced manufacturing facilities are strategically located around the world to serve the growing global wind market in a cost-effective manner. We also leverage our advanced composite technology and innovation to supply

unique, high-strength, lightweight and durable composite product solutions to the transportation market, including passenger automotive, bus, truck, and delivery vehicle applications.

This study aims to analyze, understand and improve the work atmosphere along with the inherent occupationalhealthhazardsthatitposestoitsworkersintheselectedlamination and infusion process which will be done in Moulding process and consideration to exposure effects on such workers. A hazard analysis is used as the first step in a process used to assess risk. The result of a hazard analysis is the identification of different type of hazards. Checklist, Safety audits are the techniques to identify hazards and eliminate or minimize/reduce the risk of injury/illness to workers and damage to property, equipment and the environment. We must identify hazards and update the checklist in the workplace in order to be able to take action to control them. This is a step-by-step process to guide responsible persons to an effective hazard identification, assessment, and due time to control the hazard.

The steps include: Hazard control - controlling the hazards and the risks associated with the hazard. First try to eliminate the risk. If this is not possible, the risk should be minimized using substitution, modifications, isolation or engineering controls. Back-up controls such as personal protective equipment should only be used as a last option. Providing information, education, training and supervision on the hazards, risks and controls for employees affected by the hazards.

This project deals with the evaluation of the potential hazards related to the mankind. This project also deals with the hazardous management of the work process. Recommendations shall be made to eliminate or control it for all the hazards identified during the hazard assessment. The recommendations should include the specific actions required to correct the problem

2. REVIEW OF LITERATURE

Mr. Bill Said: The development of alternate energy source has provided growth potential for the wind industry. The global wind industry is growing fast, in terms of both number of turbines and their sizes. The modern turbines are 100 times the size of those in 1980 according to Global Wind Energy Council (GWEC). Over the same period, rotor diameters have increased eight-fold, with turbine blades surpassing 60 m in length as per reinforcedplastics.com. By the end of 2007, around 20 GW of capacity had been installed, bringing the world total to almost 94 GW. In its report Global Wind Energy Outlook 2008, GWEC predicts that wind will supply 12% of the world's energy needs by 2020 and could supply 30% by 2050. Wind turbine blades typically consist of reinforcement fibers, such as glass fibers or carbon fibers; a polymer such as polyester or epoxy; sandwich core materials such as PVC, PET or balsa wood; and bonded joints, PU coating and lightning conductors. As the turbines grow in size, so does the amount of material need for the blades. For a 1kilowatt (kW) wind power plant, 10 kg of rotor blade material is needed. For a 7.5-megawatt (MW) turbine, this would translate to 75 tons of blade material. Wind turbine blades are predicted to have a lifecycle of around 20-25 years.

Mr. Joshua said: The wind-turbine industry is relatively young. There is only a limited amount of practical experience on the removal of wind turbines, particularly in respect of offshore wind turbines. At the moment, there are three possible routes for dismantled wind turbine blades: landfill, incineration or recycling. The first option is largely on its way out with countries seeking to reduce landfill mass. Germany has introduced a landfill disposal ban on glass fiber reinforced plastics (GRP) in June 2005, due to their high (30%) organics content such as polymer and wood. The most common route is incineration. In so-called combined heat and power (CHP) plants, the heat from incineration is used to create electricity, as well as to feed a district heating system.

However, 60% of the scrap is left behind as ash after incineration. Due to the presence of inorganic loads in composites, this ash may be pollutant, and is, depending on the type and post-treatment options, either dumped at a landfill or recycled as a substitute construction material. The inorganic loads also lead to the emission of hazardous flue gasses in that the small glass fiber spares may cause problems to the flue gas cleaning steps, mainly at the dust filter devices. Wind turbine blades also have to be dismantled and crushed before transportation to incineration plants, placing further strain on the environment in terms of energy.

The alternative is recycling - either material recycling, or product recycling in the form of re-powering where old turbines are replaced by newer, more efficient ones. At the moment, however, there are few established

methods for the recycling of wind turbine blades, and only 30% of fiber reinforced plastic (FRP) waste can be re-used to form new FRP, with most going to the cement industry as filler material. Several studies are in progress to find the best solution to disposal of blades after their service life. It will take some time before their results bring out a winner for the disposal system. The most promising and mature renewable energy technology appears to be wind power and will contribute to securing energy independence and climate goals in the future, and could turn a serious energy supply problem into an opportunity in the form of commercial benefits

To meet challenges of the energy sector, the number and size of wind turbines has increased strongly in recent years. This development is expected to expand significantly, especially with the installation and operation of very large numbers of wind turbines in offshore wind parks. These will effectively serve as large power plants that produce electric power directly to the grid.

3. METHODOLOGY

At worksite audit or inspection usually, the main aim includes ensuring that the basic responsibilities of employer such as providing a safe system of work at work site, safe plant and equipment is maintained,safeworkenvironmentispresentinthejoblocation.Inordertoensurethatbestindustrial safety practices are incorporated at work site and the deviations or gaps between the standard and the workplace practices is suitably identified. By measuring the key performance indicators which include leading and lagging indicators are suitably incorporated and regularly reviewed to ensure positive safety performance. In order to identify the potential hazards within the task and provide recommendations for subduing the same. As well assess the worksite conditions for ensuring safe workplace activities. In order to identify grievances and feedbacks of workers about the site safety management. In order that the rights of workers is not subdued and to ensure positive culture is prevailing in the work place.

4. DESCRIPTION OF THE WORKPLACE AND ITS ACTIVITIES

The current workplace consists of a infusion readiness of mold, hose connections, connecting resin mix machine system and lamination on the surface of the blade after demolding. After layup operation operators make ready for the infusion process to inject resin and hardener mixture into the mold. The vacuum will be kept tight till the infusion process is over. Resin hose pipe will be connected to the resin mix machine. After mold manufacturing over and inner lamination will do by using glass layer, resin, hardener manually. Operators will apply the chemical on the glass and use roller for sticking of the resin on the glass then they will apply to the blade.

Description of work and the associated hazards:
Infusion Process:
In the infusion system, Resin and hardener mixture go with the certain flow through resin hoses. While injecting the chemicals operators will check the mold weather it is free flow or not. At the time of infusion due to back pressure hose joint may splash the resin over the operator and surrounding area. There may be chance of resin got touch to their skin or body as well as eyes.

Fig 4.1 Infusion process in main molds

Lamination Process:
In the lamination process operators will use the rollers and application of chemicals is in manual. While chemical application chemical may touch to their body and skin may cause allergic reaction of the chemical.
There is curing process for the chemical that would be half an hour to 45 min, chemical will be cured, and exothermic reaction will happen.

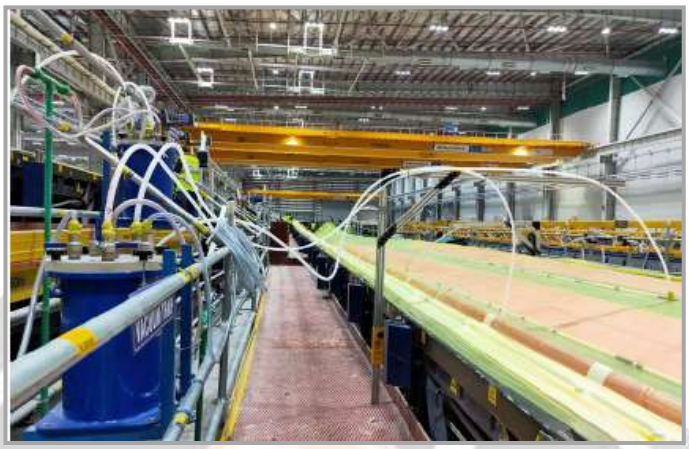

Fig 4.2 Infusion process in main mold

Fig 4.3 Infusion hose connected to machine

5. IDENTIFICATION OF OCCUPATIONAL HAZARDS

Occupational health hazard is defined as that hazard that could affect the health and wellbeing of people at work on realization of the same. As seen earlier, the workplace consists of variety of operations which pose wide variety of health hazards. The identification of hazards is important to ensure that employers present a safe workplace to their employees as defined by their duty of care in the Health and Safety at Work Regulations. A Site Inspection and walk-down was carried out to analyze in depth the activities being carried out on a normal routine and the broad range of hazards that exist. After analysis of the work and its hazards, identification of hazards for both Coal and Fly ash units were done.

5.1 Working at Infusion Process:

In mold resin hoses are connected at several locations to inject the chemicals into the product. Working operators will be standing at the nearest point of resin hose injection points to check the infusion process in the mold.

5.2 Lamination process hazards

The location consists of chemical splash hazards in several locations chemicals touch on the body and eyes of the operators. Locations like screen inspection inside reclaimers during operation work on the bunker platforms are the several locations which turn out to be confined space hazards. These chemical hazards pose various hazards like asphyxiation, oxygen enrichment, engulfment, improper access and egress several forms of energies exist within the working systems

5.3 Resin & Hardener Exposure

A person can meet epoxy resin while she or he is transporting materials, storing materials, mixing the components, spreading epoxy, cleaning tools, and disposing of containers. People are at greater risk of exposure when they are wearing improper gear, using unsuitable tools, or lacking awareness while handling the materials.
Common hazards include skin irritation, eye irritation, skin sensitization, and respiratory tract irritation. Avoid inhaling fumes and wear the appropriate gear to prevent contact. Contact with epoxy may cause allergic reactions to some individuals. They may have swollen areas to parts of their body or may have asthma-like symptoms.
Epoxy products are potent skin sensitizers (allergens). Frequently, skin contact with the individual components or the ready-for-use mixed product gives rise to allergic contact dermatitis (eczema). Workers that have acquired an epoxy-allergy will be faced with an ever-stronger skin reaction after each contact with the products. Avoiding every contact is the only option left in that case.

If relatively volatile polyamine hardeners are still used (e.g.ethylenediamine), or if the product is applied by spraying, the airways may be affected as well. Workers may be at risk of strong airway irritation as well as (allergic) occupational asthma. Epichlorohydrin, one of the constituents of the epoxy resin monomer is a skin sensitizer. In addition, epichlorohydrin is classified as carcinogenic in the category 'presumed human carcinogen' . In the epoxy resin, prior to curing generally only a very low amount of residual epichlorohydrin is present. Manufacturers that are member of the European association Plastics. The other constituent of the epoxy resin monomer, bisphenol A, is a skin sensitizer too, as well as reproduction toxic class 2, and weakly estrogenic, i.e., showing effects mimicking those of the female estrogen hormones. No information is known on the presence of bisphenol-A in final epoxy products. However, in the manufacture of epoxy resin monomers, bisphenol-A is one of the reactants used, and exposure should be prevented by means of proper maintenance of the closed production equipment that is generally used.

6. PRIORITIZATION OF HEALTH HAZARDS

Out of the existing hazards, depending upon the number of people exposed and the frequency of exposure following health hazards are classified to be of higher importance compared to others.
Exposure to dust, working in noisy atmosphere and heat stress are the three Health stresses which should be given high priority.

The prioritization of risks are done considering the frequency of tasks being carried out, the total exposure of various working groups to those hazards and the effects that may induce on them after exposure. Exposuretochemicalsisamajorhealthconcerninthissitesinceitisinevitable.Inthecurrentworkplaceit is evident that most of the workers are exposed to respirable moisture. The chemicals exist majorly in every form in the plant.

The work atmosphere has several molds and heating sources on the mold during infusion activity, Since the above-mentioned hazards are built into the work atmosphere and cannot be avoided, it becomes necessary to study the possible measures to minimize the hazards from these. Hence these should be considered with high priority.

7. BACKGROUND RESEARCH

Chemical hazards and toxic substances pose a wide range of health hazards (such as irritation, sensitization, and carcinogenicity) and physical hazards (such as flammability, corrosion, and explosibility). While not all hazards associated with every chemical and toxic substance are addressed here, we do provide relevant links to other pages with additional information about hazards and methods to control exposure in the workplace.

Chemical substances that have the ability to create a physical or health hazard are considered hazardous. Due to their properties chemical hazardous substances may be, but are not limited to being toxic, explosive, flammable, self-reactive, oxidizing, or corrosive. Exposure to these substances by different routes including inhalation, dermal absorption, or ingestion can lead to adverse health effects, enhancing the need to know about the hazards associated to these substances beforehand

Chemical ingredients found in everyday products are sometimes criticized as being harmful to human health. But even though all chemicals can be described by inherent hazard, even water and oxygen, the mere presence of a chemical ingredient does not automatically mean it will cause harm.

The actual chance of harm from exposure to a chemical ingredient depends on a variety of factors – including how much of the chemical ingredient is in a product; how the product is used; and what kind of exposure to the chemical typically occurs from using a product that contains the chemical.

8. RISK ASSESSMENT

It is a basic and fundamental duty of every employer to carry out a Risk assessment of the premises and its associated risks. The MHSWR (Management of Health and Safety at Work Regulations 1999) places a legal duty on the employers to present to employees as far as is reasonably practicable, a safe workplace and premises. Hence in this regard along with being a legal responsibility, it becomes the duty of every employer to carry out a risk assessment of all activities to ensure that they present a safe workplace.

Step 1: Identification of Hazard:

In general process of Hazard Identification, only the identification of “chemical exposure” as the hazard becomes sufficient. But in this case, it is necessary to identify what kind of chemical ingredients is acting as health hazard. In this case, the presence of Epoxy resin and hardener is the identified hazard.
The Resin and Hardener present in almost all work locations within the scope

Step 2: Identification of who might be harmed by the hazard:

When a hazard is identified it becomes important to know the effected working classes so as to take appropriate actions. Identification must refer both to the people exposed and the high priority areas also wherever necessary.

For ex: Identification should include also places or equipment which have highest dust potential. In turn it becomes necessary to identify who will be harmed on operation of these machineries.

In this process identification of the effected people becomes important in order to define an action plan for the same. In the present work location, the effected people include operators, workers who are associated with lamination and infusion of chemical added with hardener. The working groups and the operators are exposed at a higher frequency whereas the supervisors and the management people were exposed at a lower level.

The High chemical prone areas are the mold and small part mold infusion, paint preparation, putty, lamination of inner and outer of the blade. the transfer of the resin and hardener flow into the mold machine for the free flow. Other areas like paint preparation, putty operation, inner and outer lamination, final finishing &painting activities units have relatively equal amount of chemical hazard compared to the rest.

Step 3: Assessment and Evaluation:

The assessment needs to be done in detail with respect to the existing risk, the potential exposure of people to the dust, the existing control measures, and the actions to be taken.
The assessment of the present work location is as below:
Type of Hazard: chemical splash Locations where hazard exist: Inner lamination, outer lamination, final finishing, small parts infusion, Mold infusion, main mold bonding Exposed people: Operators, workers, supervisors, Engineers, helpers Probability of Exposure: Medium Severity: High Risk Rating: High

9. CONTROL MEASURES

When a risk has been identified and it is established that there is a necessity to control the same, Hierarchy of controls has to be applied to reduce the residual risk level to ALARP.
The control measures to reduce the health effect of dust to working groups can be defined and discussed based on the Hierarchy of the control measures.

Possibility of Elimination of Risk:
On a broader perspective, it becomes impossible to eliminate the dust source. Since the work scope of the company is entirely associated with handling of chemicals like resin, hardener, it becomes impossible to avoid the exposure of toxic generating from the sources.
Substitution:

Engineering controls:
There is vast scope to develop and implement engineering control systems in the current workplace. The details are as below: All the hose joints to be fitted and tighten by using special pneumatic tool, to avoid the back pressure of the machine. Full armed latex gloves to be provided to the infusion and lamination team.
Anti-splash goggles can be provided to the lamination and infusion team,
Full body chemical suit can be provided for the lamination and infusion activities

Administrative Controls:
Several administrative controls can be incorporated to reduce the risk level. Limiting the exposure timing by providing work rotations or engaging work shifts Reducing the maximum exposure time to be lesser than 8 hours to be on a safer side Incorporating and planning spray schedules and plans to reduce the dust levels
Providing training and conducting awareness sessions on dust minimizing methodologies Incorporating health assessment surveys and health checks to ensure the employers are free of any risks.

Personal Protective equipment:

Risk reduction can also be achieved using proper personal protective equipment. This is the last line of control that can be exercised The personal protective equipment that must be used must not be normal goggles, but it should be in line with the material specification data sheet. For lamination and infusion, the normal gloves to be replaced with anti-splash goggles, and chemical suit can be used for controlling of exposure Additional controls that need to be incorporated other than the above are as below: Incorporating Health Surveillance Programs Incorporation of training sessions for awareness Conducting Air quality monitoring at fixed intervals to determine the level of air borne particles.

The performed Health Hazard analysis and the existing control measures show that a relatively higher level of Health Hazard still exists in the workplace. The control measures are neither properly defined nor implemented. The existing line of defense is the last line of defense that is least effective. Hence in this regard, OPG needs to provide prime importance to implement better line of defense against the health hazard.

OPG needs to engineer several changes to its processing and handling systems. This ranges from allocation of resources to automate processes wherever possible and to introduce other methods of engineered solutions to reduce the risk level. This includes automating the crushing section, introduction of water spray systems, providing proper enclosure, introduction of sealing systems for high dust prone areas.
There is also a necessity to include administrative controls such as allocating proper schedules and teams to maintain a fixed spraying schedule at regular intervals for a better and effective dust control. The organization needs to

restrict working hours to limit exposure to the dust in order to reduce the risk to a reasonable level. Along with this the organization needs to improvise the protective equipment level in order to ensure better protection to employees.

10. CONCLUSIONS

In my projects, there are few activities that involve high risk. The activities like infusion, inner lamination, outer lamination, paint preparation, bonding application by using adhesive paste; has the residual risk of more than acceptable level which has to stopped and rectified immediately and further improved control measures are needed to bring down the risk level to an acceptable level. Once obtaining the improved risk level these works can be started. All the above said precaution has been implemented and stated using in the manufacturing process I.e lamination and infusion process

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