Health and Safety in Composite Manufacturing

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Abstract:
While students may be hoping to make a composite structure, the use of chemicals and fibers in the manufacturing processes makes it a requirement to first understand the critical health and safety issues associated with working with composite materials. Instructors need to stress this requirement with the students. Our process for this is to require that students sign a Student Safety Practice Contract is included in the Appendix to this module for instructor use to ensure student safety. It is also recommended that the Module:

Student Learning Objectives:

● Recognize the different health and safety precautions needed when working with composites in these modules.
● Review all needed safety factors involved in composite manufacturing as discussed.
● Illustrate appropriate work procedures needed to protect the health of individuals during composite manufacture.
● Be able to interpret SDS – safety data sheets.

MatEdU Core Competencies Covered:

OC Demonstrate good workplace safety skills
OD Demonstrate good technical competence

Key Words: Composites, materials, manufacturing processes, health, safety
Type of Module: Intermediate
Time Required: Health and Safety, 50 min in-class discussion
Pre-requisites: intermediate level knowledge of material science
Target Grade Level: grades 9 – 12, and introductory course for Community College

Instructor Notes and Slide Information:
This module is focused on composites safety specifically while performing a hand layup experiment appropriate for high school level. The safety component is critical both because chemicals used in composite processes require skin and eye protection and because the fibers used can cause problems by breathing in these fibers if precautions are not taken.
Health and Safety (see accompanying PowerPoint presentation) - (slides 1 – 22)

Student Conduct in the Lab – (slide 2 – 5)
A student safety practices and contract is included in this module as an Appendix. It promotes good practice and its use is highly recommended as safety is huge in industry.

Composites Safety Concerns: - (slide 6 – 15)
Instructor should explain the following terms to students and they should be aware of the hazards involved with the production of composites:

- Solvents - recognize and identify the highly reactive chemicals such as catalysts and curing agents that can react with the human body in a harmful way.
- Airborne dust - during the fabrication of a composite part, fibers are often cut, and sanded during processes. This forms fine dust particles and can be irritating to the skin, and inhaled.
- Equipment hazards – know how to use all equipment and tools with proper personal protective equipment (PPE).
- Fire hazards – solvents and resins can be flammable, and flashpoints vary. Use should be only used in well ventilated approved areas. No solvents being used where composites are being sanded.
- Waste disposal – fibers and resins must be disposed of properly in approved containers.
- Eye wash station and sink – solvents can cause blindness
- Safety Data Sheets (SDS)—Federal law requires that SDS be sent with, or before, all hazardous chemicals the first time they are ordered by a facility. SDS must be available to all employees and students at the workplace. These detail the potential hazards associated with the specific material.

Routes of exposure –
- Absorption – use gloves, glasses, appropriate clothing
- Inhalation – use dust masks to protect against dust
- Ingestion – never eat in work area while performing processes, and wash hands before eating
- Injection – fiber particles and splinters, cover any open wounds

Work environment –
- Know where safety equipment is
- Good housekeeping - keeping areas clean as you go
- Wipe up spills
- Keep tools clean
- Keep fabric remnants swept up
- Properly dispose of mixing containers

Allergic Reactions – can be caused by any of the following:
- Resins
- Fibers
- Hardeners and curing agents
- Solvents

PPE – Personal Protection Equipment – (slide 16 – 18)
OSHA requirement, and protects users against health or safety risks associated with each process. All persons, including visitors, who enter areas where hazardous chemicals are used or stored, must wear the appropriate Personal Protective Equipment (PPE). Know where all PPE in your lab space is stored and how to properly dispose of, maintain, or clean the PPE. PPE must be kept inside the work area (i.e.
do not wear it on a trip to the restroom or outside class room). Good practice – never eat while working with composites, and shower after working with composite materials. PPE that must be worn:

- **Eye protection** – safety glasses and goggles, face shields
  - Use safety glasses whenever there is a chance of solid objects striking the eye. They are not appropriate protection from chemical splash so then must use splash goggles. Wear a face shield when splash hazard is high or the chemicals are particularly dangerous.

- **Skin Protection:**
  - Appropriate clothing – shop/lab coat, aprons, coveralls, long sleeve shirts to minimize particles entering skin, long pants (no spandex/rayon materials as it can melt easily due to heat/chemical exposures and will end up burning and attaching to the skin)

- **Gloves** – latex, rubber gloves (no one type of glove protects against all types of chemicals; gloves have different chemical resistances and breakthrough times based on thickness and the materials they are made from. Check SDS for suggestions. Check gloves for tears, holes and use.

- **Footwear** – approved close toed safety shoes

- **Mask and Respiratory Protection**—Certain jobs like sanding may only call for a dust mask. Some mixing of hazardous chemicals may call for a more protective mask like an N95. Some situations may call for a fume hood or respirator (highest exposure cases). Fume hoods are preferred to wearing respirators, however, when they are not enough to protect workers in the area adequately, respirators must be used. The selection and fitting of respirators requires special training.

- Long hair should be tied back and out of face as we don't want it to get into chemicals or near a fire hazard or heavy machinery that could catch it.

**SDS – Safety Data Sheets – (slide 19 – 22)**

Instructor note – all manufacturers should provide Material Safety Data Sheets, now called Safety Data Sheets, with all products that are classified as a hazardous substance. This document provides all health and safety information about the product. Safety Data Sheets are a summary of the health hazards of the material and associated recommended safe work practices. SDS are required by OSHA, manufacturers should send with the product to the purchasers of their products. If you work in a lab, then OSHA says you should: be aware of what a Safety Data Sheet (SDS) is, its relevance to health and safety, and how to access SDS for your work. Manufacturers should ensure that they are readily accessible to lab employees during each work shift.

**SDS Terminology** -

- **Acute Exposure** -An intense exposure over a relatively short period of time (carbon monoxide poisoning, cyanide inhalation, etc.)
- **Asphyxiate** - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation.
- **Carcinogen** - A substance or physical agent that may cause cancer in humans or animals.
- **Chronic Exposure** - A prolonged exposure occurring over days, weeks or years. A prolonged chemical exposure that does not cause immediate, obvious harm, or make you feel sick right away. You may not feel, smell or see the danger (e.g. mesothelioma from asbestos exposure, lung cancer from smoking, etc.)
- **Combustible Liquid** - Liquids having a flash point at or above 100 degrees. Not as ignitable as Flammables.
- **Corrosive** - A substance that causes visible destruction or permanent changes in human skin tissue at the site of contact, e.g. acids and bases.
- Flammable Liquid - A liquid having a flash point below 100 degrees; more ignitable than combustible liquids.
- Flash Point - The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture and will burn when a source of ignition is present.
- Hepatotoxic, Nephrotoxic, Neurotoxic - Substances which are toxic to the liver, kidneys and nervous system, respectively.
- Incompatible - The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous such as fire, explosion or release of toxic vapors.
- Irritant - A substance that produces irritating effect when it contacts skin, eyes, nose, or respiratory system.
- Lethal Concentration (LC50) - The concentration of air contaminant that will kill 50% of the test animals in a group during a single exposure (inhalation exposure). Generally expressed in units of parts per million or mg of contaminant m3 of air.
- Lethal Dose (LD50) - The dose of a substance that will kill 50% of the test animals in a group over a specified period of time following exposure. Generally, in units of mg of material per kg of subject body weight.
- Mutagen - Anything which can cause a mutation in genetic material of a living cell. All mutagens are not carcinogens.
- Oxidizer - A substance that readily gives up oxygen to stimulate combustion of an organic material.
- Permissible Exposure - A human exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either time-weighted-average (TWA). Limit: Exposure limit (8 hours), a 15 minutes short term exposure limit STEL, or ceiling © limit. Expressed in ppm or mg/m3.
- Sensitizer - A substance which may cause no reaction in a person during initial exposures, but upon a later exposure will cause an allergic response to the substance.
- Teratogen - A substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.
- Threshold Limit Value - Similar to PEL above but are not legal standards for human exposure. Determined and published by the American Conference of Government Industrial Hygienists (ACGIH).

Reference:
Safety Data Sheets are available at [www.msds.com](http://www.msds.com)

Appendix: Student Safety Practices Contract (attached)
It is strongly recommended that each student read, study and understand each point in this Contract, and that each student sign the contract prior to entering the laboratory.

Student Evaluation
1. What is an SDS and where would you find one?
2. Why are there so many safety precautions when working with composites?
3. What PPE should be worn during the hand layup method?
4. Where would one find the correct PPE to wear when mixing epoxy resins?
Student Safety Practices Contract

I certify that I will follow the following safety practices at all times in the laboratory:

1. Never perform any lab work unless the instructor is present.
2. Know the safety rules and procedures that apply to each lab exercise. Be sure to ask your instructor if you do not understand anything explained to you about the procedure.
3. Know the location and use of emergency equipment (fire extinguisher, eyewash station, fire blanket) and emergency exits.
4. Check all lab equipment before using.
5. Consuming food or beverages in the lab is prohibited.
6. Avoid distracting or startling anyone in the lab. Misbehavior will not be tolerated.
7. Report any spill, injury, or unsafe condition to the instructor immediately.
8. Use equipment and chemicals ONLY for their designated purposes.
9. Always wear appropriate PPE - Personal Protection Equipment
   - Use caution when using any cutting utensils, wear gloves.
   - Always wear appropriate eye protection during lab exercises.
   - Wear lab aprons during lab exercises.
   - Wear appropriate shoes – no open toed shoes, and do not remove your shoes.
10. Read MSDS – Material Safety Data Sheets – that may accompany any chemicals for assigned materials. Ask instructor if unsure.
11. Work areas should be kept clean and free from obstructions.
12. Tie back hair and tuck in any loose clothing.
13. Clean your lab area when you have completed your work.
14. Wash your hands thoroughly after you have completed lab work.
15. Follow the lab procedure as either explained on handout or approved by your instructor. Never try an experiment on your own.
16. Avoid personal contact (through smelling, tasting, touching) with hazardous chemicals.
17. If a hazardous chemical gets on your person or clothing, rinse with water immediately and tell your instructor.

I have read the above concerning safety practices and understand what is meant by each of them. I have had an opportunity to ask questions, and will continue to ask questions if unsure.

I understand that unsafe activity can result in removal from this course.

_________________________________________   __________________
(Student print and signature)                       (date)

_________________________________________   _________
(Parent signature—if needed)                       (date)