AMT 2106 –AIRCRAFT MATERIALS CONSTRUCTION AND REPAIR II (Composite)

PRELIM PERIOD

LABORATORY MODULE III

MATRIX MATRIALS

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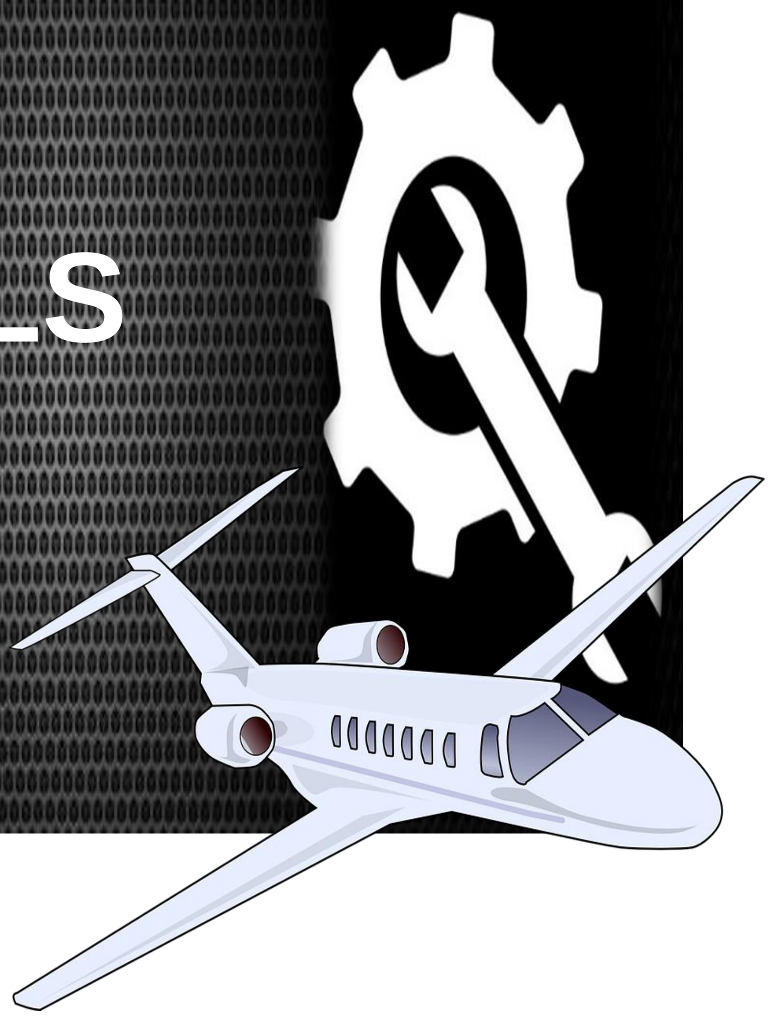
AMT Instructor



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REFERENCES	Ref no.
FIBERMAX(2018) RETRIEVED FROM https://www.fibermaxcomposites.com/shop/index_files/resinsystems.html	**1**
General Plastics Manufacturing (march 2020) retrieved from https://www.azom.com/article.aspx?ArticleID=18971	**2**
Airframe and Powerplant Handbook: Jeppessen	**3**
A&P Technician Airframe Textbook - Jeppesen	**4**

This laboratory module simply discusses the Resin systems in a variety of chemical families, each designed and designated to serve industries providing certain advantages like economic, structural performance, resistance to various factors, legislation compliance, etc.

TIMEFRAME

You should be able to complete this module including all the self-assessments, research works, assignments, and other performance tasks within **3** hours**.**

LEARNING OUTCOMES

Course Learning Outcomes (CLO)

CLO 1. Understand the development of the composite structure and classify its element in terms of properties , advantages and characteristics of each elements.

CLO 2. Formulate effectively the techniques to conduct thorough, independent impartial and awareness regarding safety of an aircraft composite particularly in the composite laboratory or shops.

CLO 5. Analyze the airworthiness standards and practice the basic policies, and procedures for the proper handling of composite materials and follow the basic procedure in specific methods ; repair and assessments .

CLO 9. Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria, methods and techniques.

Module Learning Outcome (MLO)

MLO 1. Determine appreciative ideas by comparing, matrix materials by familiarizing their advantages and dis advantages

MLO2. Determine and exhibit safety reminders when working with resin and catalyst.

Topic Learning Outcomes(TLO)

TLO 3. Define appreciative ideas by comparing, matrix materials by familiarizing their advantages and dis advantages and Define and demonstration safety reminders when working with resin and catalyst

LABORATORY MODULE III- MATRIX MATERIALS

TYPES OF RESIN FAMILIES

Introduction

Composites are a combination of fiber reinforcement and a resin matrix. The resin system holds everything together, and transfers mechanical loads through the fibers to the rest of the structure. In addition to binding the composite structure together, it protects from impact, abrasion, corrosion, other environmental factors and rough handling.

Only the most common resins of the thermoset family and the ones mostly used in composite construction are described below. Those are Polyester (orthophthalic and isophthalic), vinyl ester, epoxy, and phenolic.

Polyesters

Premix Polymer Resin R 10-103 4kg with Polymer MEPK Hardener

Unsaturated polyester resins are the simplest, most economical resin systems that are easiest to prepare and show good performance. Millions of tons of this material is used annually around the world.

They are manufactured by the condensation polymerization of various diols (alcohols) and dibasic acids (e.g. maleic anhydride or fumaric acid) to give esters, a very viscous liquid that is then dissolved in styrene, a reactive monomer. Styrene lowers the viscosity to a level suitable for impregnation or lamination.

Generally, polyesters exhibit somewhat limited thermal stability, chemical resistance, and processability characteristics. Applications include transportation markets (large body parts for automobiles, trucks, trailers, buses), marine (small and large boat hulls and other marine equipment), building (panels, bathtub and shower shells), appliances etc.

Orthophthalic. Is also refered to as ortho or General Purpose Polyester (GP) was the original polyester developed. It has the lowest cost and is still very widely used in FRP industry. It is commonly used in applications where high mechanical properties, corrosion resistance, and thermal stability are not required. Although the upper temperature limit is only 50^{o}C, it performs satisfactory in water and sea water. It is normally not recommended for use in contact with chemicals.

Isophthalic. Often referred to as Iso, it is improved polyester. It has a slightly higher cost, improved strength, thermal stability(55^{o}C) and mild resistance to corrosion conditions. Improved resistance to water permeation has prompted its use as a gel barrier coat in marine applications. Improved chemical resistance has led them to extensive use in underground petroleum tanks (in gas stations) with satisfactory service life. They are also used in salts and mild acids.

Vinyl ester. Even further improved polyester, it is bisphenol chlorinated, or a combination of polyester and epoxy. Its curing, handling and processing characteristics are those of polyester, and it exhibits higher test results in corrosion temperature resistance and strength and has higher cost. Modifications of the molecule have produced even higher properties

Phenolic. Phenolic resin is a reaction of phenol and formaldehyde. It can be cured via heat and pressure, without the use of catalysts or curing agents. It is one of the oldest thermosetting resins available and sells at a very reasonable cost. Cured phenolic resins are fire resistant without the use of mineral fillers or fire retardant additives.

Epoxy

Epoxy resins are a broad family of materials. The most common ones are prepared from the reaction of bis-phenol A and epichlorohydrin and contain a reactive functional group in their molecular structure. Epoxy resin systems show extremely high three dimensional crosslink density which results to the best mechanical performance characteristics of all the resins. The most demanding strength/weight applications use epoxy almost exclusively. It has excellent strength and hardness, very good chemical heat and electrical resistance. Disadvantages include higher cost, processing difficulty (quantities of resin and hardener need to be measured precisely. Also, often heat curing is required.) Epoxy systems are used in applications like aerospace, defense, marine, sports equipment, adhesives, sealants, coatings, architectural, flooring and many others.

Gel coat

Gel coats are prepared from a base resin and additives. The base resin can be polyester, vinyl ester, phenolic or epoxy. Additives are thixotropic agents, fillers, pigments and other. The gel coat, as the name implies, has a gel texture. This makes the gel coat capable to "stay" on vertical surfaces of molds without draping. It is placed first in the mold, so it becomes the outer surface of the construction. It is used to replace paint, for cosmetic purposes, and to protect from the environment

SOLVENT SAFETY TIPS: REVIEW

There are many types of solvents used in composite construction today. Solvents are mainly used for cleaning purposes in composite construction. However, most solvents are flammable and must be used with the highest degree of safety in mind. Methyl-Ethyl-Keytone (MEK) and acetone are two common solvents used in composite construction.

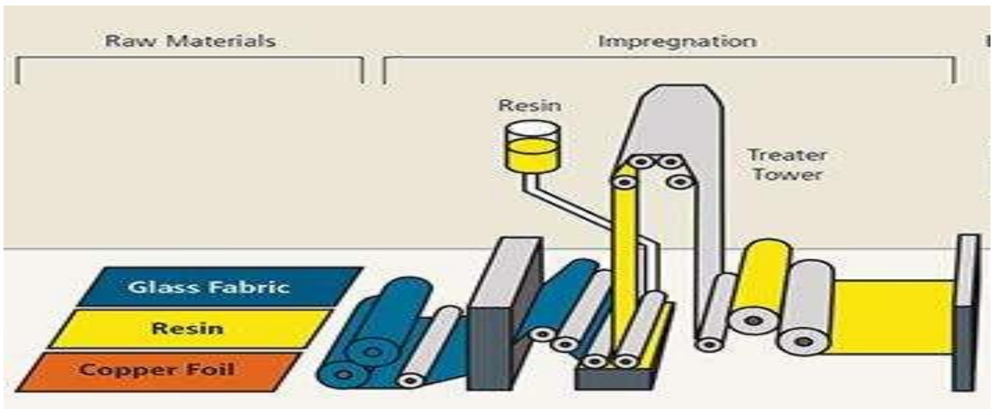
MEK is mainly used for cleaning dust, grease, and mold release agents from composite components. Always use protective gloves and goggles when using it. MEK is an excellent cleaner but also a carcinogen. It can be absorbed directly into the bloodstream through the skin and the eyes. Acetone is used for general equipment and tool cleanup, in addition to cleaning the composite parts after sanding as a pre-bond preparation. Follow the manufacturer's recommendations when choosing the proper solvent.

These safety guidelines should be followed when using all solvents and matrices:

- Do not use solvents in any area that may create a static charge.
- Do not pour solvents onto the part. Instead, use a solvent-soaked soft cloth to apply solvents to the working surface.
- Use solvents in a well-ventilated area and avoid prolonged breathing of the vapors.
- Wear gloves when applying solvents to protect the skin from drying out.
- Never use solvents to clean skin. Use suitable epoxy cleaners that are less dangerous.
- Wear goggles when pouring and working with solvents.
- Store solvents in the original containers so they can be readily identified.

PRE-IMPREGNATED MATERIALS

- Pre-impregnated fabrics or pre-preg are the fabrics that have the resin system already impregnated into the fabric.
- Pre-preg fabrics eliminate the need for mixing, so the technicians do not have to worry about the proper mix ratio was used or if improper amount of resin was applied.
- Pre – preg fabrics are manufacture by dipping the woven fabric into a matrix solution.



Pre-impregnated fabrics, commonly known **as "pre-pregs,"** are fabrics that have the resin system already saturated into the fabric. Because many epoxy resins have high viscosity, it is often difficult to mix and work epoxy resins into the fabric to completely encapsulate the fibers. Fabrics are pre-impregnated with the proper amount and weight of a resin matrix to eliminate the mixing and application details such as proper mix ratios and application procedures.

In addition to woven fabrics, manufacturers also pre-impregnate unidirectional materials. Pre-impregnating unidirectional fabrics involves saturating the fibers with resin directly from individual spools of thread.

Pre-preg materials offer convenience over raw fabrics in many ways. As previously discussed, these materials contain the proper amount of matrix. It does not produce a resin-rich or resin-lean component if cured properly. Before curing, pre- impregnated fabrics generally contain about 50% resin. During the curing process, some of this resin bleeds out of the reinforcing fibers, producing a structure that contains about 40% resin and 60% fibers by weight.

Another advantage of pre-impregnated materials is **that the matrix completely encapsulates the reinforcing fibers**. During hand lay-up, if a resin system has a high viscosity, it is sometimes difficult to incorporate the resin into and around each individual fiber. This is not a problem with pre-impregnated fabrics. In addition, the technician does not have to worry about distorting the weave while working the resin into the fabric.

These fabrics also eliminate the manual weighing and mixing requirements of the resin and catalyst, which not only saves time during the lay-up process, but also helps ensure the quality of the lay-up. In many cases, **pre-impregnated materials produce stronger components and repairs, assuming the lay-up processes are strictly followed**.

One limitation to pre-impregnated materials is that **they must be stored in a freezer to prevent the resin from curing**. Pre-preg fabrics cannot be left out of the cold for prolonged periods, and must be warmed slightly before use to achieve better workability. Accordingly, with many of these materials, **it is necessary to maintain an accurate log of the "out-of-freezer life limit" (how long the material has been exposed to temperatures above freezing)**. Keep in mind that, although cold storage of a pre-impregnated fabric helps increase its life limit, most materials still have a shelf life regardless of the storage condition.

Another disadvantage associated with pre-impregnated materials is that they are **usually purchased in full roll quantities**. Unless a large number of repairs are made, the roll may exceed its shelf life before being used. Although the material may appear to be in good condition, it cannot be used for aircraft applications once the shelf life has expired.

PRELIM LABORATORY ACTIVITY 3

Name			**Instructor**		
Section		**GROUP NO.**		**Date:**	
				Rating:	

MODULE III-MIXING RESIN TO HARDENER: AN OBSERVATION

LABORATORY OBJECTIVE:

- The students determine and exhibit safety reminders when working with resin and catalyst and able to know to get the simplest way to get the exact weight for a given ratio.

TOOLS NEEDED:

- Activity sheet
- Pen

Time Limit: 30-45 minutes

Instruction

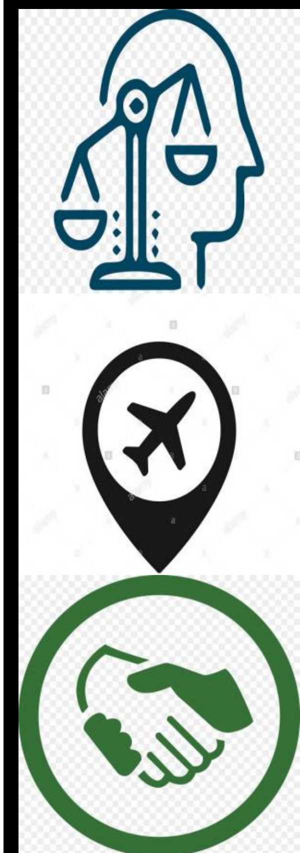
Here's a quick video how to on mixing epoxy for carbon fiber infusion. To cover how to convert the mix ratios into weights to accurately mix the resin and the hardener. Materials supplied by Composite Envisions. This is the link : https://www.youtube.com/watch?v=H29O3FjFc3o entitled “Mixing Epoxy Resin for Carbon Fiber Infusion”.

Part I- Safety Awareness through observation

Safety related Questions	Answer 2 points each
1. Based on your observation, what are the PPE being used.	
2. Is the PPE is important in working resin and other matrices? Explain why?	
3. Since resin and hardener is a liquid material for composite. How did you get the exact ratio? By volume or by weight?	
4. Is the working area is appropriate in working composite? Explain?	
5. Why working environment is very important in composite workshop?	

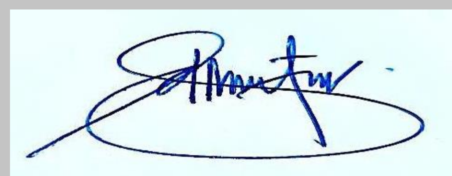
Part II: Finding Resin and Hardeners Weight.
Using the different RESIN and hardener ratio, Find he exact weight of each materials in gram?

Given Resin ration : 1	FIND THE FOLLOWING 5 point each
3.65 4000kg of fabric	Amount needed of Resin and Hardener in gram Solutions:
4.45 3000 kg in fabric	Amount needed of Resin and Hardener in gram Solutions:



HONESTY CLAUSE

My signature below constitutes my pledge that all of my writing is my own work, with the exceptions of those portions which are properly documented



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Subject Instructor

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Student Signature

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Parent Signature