Research Paper Engineering

Enhancement in Mechanical Properties by Vartm Process & Nylon Nanofibers in Advance Composite Materials

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ABSTRACT

Composite material has attracted attention of researchers due to light weight and good mechanical strength. Composition of the matrix and reinforcement will affect the strength of the composite material, as reinforcement i.e fiber contribute to the good mechanical properties as compare to the matrix i.e resin. It is necessary to study the manufacturing process which will give good fiber weight fraction, comparing the process VARTM as proved to be having good fiber weight fraction. Here we have compared the VARTM, & Hand Moulding with three different material systems and found the enhanced tensile and flexural strength of two phase composite by VARTM process due to high fiber weight fraction .Results of these composite processes are compared with results of nanocomposites of nylon. Nanocomposites having better mechanical properties than composites.

Keywords : Composite materials, Nanocomposite, VARTM, Glass epoxy composite.

INTRODUCTION

Composite materials, often shortened to composites are engineered or naturally occurring materials made from two or more constituent materials with significantly different physical or chemical properties. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. The matrix material can be introduced to the reinforcement before or after the reinforcement material is placed into the mould cavity or onto the mould surface. The matrix material experiences a melding event, after which the part shape is essentially set

Hand lay-up method is a least capitally-intensive manufacturing method used for reinforcement parts is to saturate the fabric lay-up with liquid resin by hand. A one-sided mould in the final shape of the part is constructed with the desired surface finish. The mould surface is treated with mould release compounds consisting of wax and/or other chemical compositions. Resin is worked into the fabrics using rollers, squeegees, or brushes either directly onto the mould surface or on a wet-out table. In this method, tooling cost is low & large items can be produced. Generally, VARTM is used to fabricate very large components. VARTM is a closed moulding process which eliminates the VOC emissions as compared to the open moulding process. It has however one primary constraint that is the thickness or final stiffness of the laminates produced generally are too flexible thus added material bulking to increase thickness is needed to make an acceptable laminate.

EXPERIMENTAL:-

Material:-

1) Matrix:-

For material system –I, Epoxy (epon 892 and epicure as hardener) resin use as matrix. Hardener (epicure) is used in resin solution. For material system –II, Unsaturated Polyester Resin (Roof lite) is used as matrix. For material system –III, Vinlyester Resin is used as matrix. Epoxy resin is almost totally transparent when cured. In the aerospace industry, epoxy is used as a structural matrix material.

2) Reinforcement Fibers:-

In this experimentation, glass fiber-92111 having tensile strength 500 N/cm & carbon fiber sheet is used as reinforcement. Economically glass fibers are least expensive than carbon fibers. The E-glass fiber is the most common reinforcement material used. It having good tensile strength & modulus, But the glass fiber strength and modulus can degrade with increasing temperature. Carbon fiber have lower thermal expansion coefficients than glass fiber. The tensile stress-strain curve is linear to the point of rupture.

3)Nano fibers:-

In recent technology, the performance of composite is enhance by adding nanofibers to reinforcement sheet called as nanocomposite. Fibers of Nylon 6 & Nylon 6,6 are deposit on reinforcement sheet by electrospinning process of manufacturing. Nylon 6 fibres are tough, possessing high tensile strength, as well as elasticity and lustre. They are wrinkle-proof and highly resistant to abrasion and chemicals such as acids and alkalis.

Manufacturing of composite:-

There are many methods to manufacture composite but we compare only two methods & result of these methods as follows.

Preparation of resin:-

Same solution of resin is in both hand lay-up and VARTM process. In this matrix solution, Epoxy (epon 892 and epicure as hardener) is used. Both solutions are mixed in proportion 100:30 of its volume & mix with stirrer.

In hand lay-up method,. Six plies of similar dimensions are cut fo every material system. For composite panel, The mould used for the fabrication of the composite panel is glass. Make the thin film on glass of wax, then lay bagging & peel ply on glass. Take six fiber sheets one by one and stacked in the 0° direction. Resin is brushed on peel ply and stack the fiber sheet on peel ply then brush the resin on surface of sheet & repeat it for all six sheet. Then again cover peel ply & plastic bagging. Entrapped air is removed manually with squeegees or rollers to complete the laminates structure.

-In VARTM method, here also mould of glass is used and fabric lay-up as like hand lay-up but without resin. The distribution medium is yellow mesh laid on top of the top release fabric. A PE Spiral Wire Wrap tube of ¼" outer diameter was cut to 38" in length and is used as the resin distribution tube. This tube extends approximately 2" over the longest edge of the stacked layers. Another tube of similar dimensions is cut and is used as the vacuum line. Mould is sealed to restrict air and create a vacuum by vacuum pump. The flow of resin is controlled with the help of a peristaltic pump in such a way that it is allowed to flow in the distribution medium for some distance and then the resin inlet is shut off to enable

Fig.1 VARTM setup

the resin flow through the thickness. Once the entire perform and all components in the vacuum bag have been wet or impregnated the resin line is shut off. longer till there are no more air bubbles in the resin ejection line. The mould is kept at room temperature for the next 24 hours. This is termed green cure.

Nanocomposites are formed by any of composite fabrication method, generally VARTM. There is addition of nylon fibers deposited on glass fiber sheet. First have to make solution of Nylon granules in formic acid at 20-25% concentration of nylon. Prepared solution is fill in to the syringe of electrospinning machine. Using optimum parameters as voltage 15 KV, flow rate 0.2ml/hr & distance between syringe and rotating drum is 15 cm. Nylon fibers are collected on glass fiber sheet which is wound on rotating drum collector. Nylon fibers are deposited on glass fiber sheet amount of 5% weight of glass fiber sheet. VARTM process is used on that glass fiber sheets and forms nanocomposite.

Fig 2 Electrospinning process

Sr no.	Before weight of each layer(gm)	After deposition (gm)
1	5.380	5.8624
2	5.370	5.8524
3	5.430	5.9124
4	5.230	5.7124
5	5.320	5.8024

Table 1 deposition of nylon fiber

RESULTS:-

1) Nanocomposite :-

	Glass fiber 7781 + epolam	Glass fiber 7781 + epolam + Nylon66 nano fiber (5%)
Flexural strength	86.904	175.340

Table 2 results of Nylon nanocomposite

TESTING :-

The testing is carried on composite panel the dimensions of which are specified by ASTM standards for a particular testing machine. The tensile properties of the samples were measured using a shimadzu autograph universal testing machine according to ASTM D638 & Flexural strength is measured according to ASTM D7264.

Fig 3 Tensile test

2) Composite:-

	VARTM	HAND MOULD	ASTM Standards
Material system I –Glass fiber and Epoxy (epon 892 and epicure as hardener)6 Layers			
Tensile strength	422.42 MPa	316 MPa	(D638)
Flexural strength	97.46 MPa	55.56 MPa	(D7264)
Material system II- Reinforcement = Triaxial Glass fiber & matrix = Unsaturated Polyester Resin (Roof lite) 6 layers			
	VARTM	HAND MOULD	ASTM Standards
Tensile strength	434.27 MPa	358.4 MPa	(D638)
Flexural strength	531.16 MPa	435 MPa	(D7264)
Material system III- Reinforcement = Biaxial Glass fiber & matrix = Vinlyester Resin 4 layers			
Tensile strength	273.5 MPa	236 MPa	(D638)

Table 3 results of composite

CONCLUSION:-

In composite system, mechanical properties are investigated by both VARTM & hand lay-up method. From above results, it is prove that the mechanical properties of composite formed by VARTM process is much more enhances than hand lay-up method. In material system-I, tensile strength increases by 25.2% & flexural strength increased by 43% due to VARTM process. In material system-II, Tensile & flexural strength

increases by 18.1%. In material system-III, tensile strength increases by 13.7% due to VARTM process. In nanocomposite, the tensile strength of nylon nanocomposite material is increased by 50% than composite material of same matrix & reinforcement.

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