"Evaluation of Post Curing Effect on Mechanical Characterization of Polymer Matrix Composites"

Dr. C Thotappa[1], Dr.Jagadish S P[2], Virupaksha Gouda H[3], Ramesh B P[4]
[1]Professor & PG Co-ordinator, Department of Mechanical Engineering, RYMEC, Ballari, India.
[2]Associate Professor, Department of Mechanical Engineering, RYMEC, Ballari, India.
[3]Assistant Professor, Department of Mechanical Engineering, RYMEC, Ballari, India.
[4]PG-Student-Production Management, RYMEC, Ballari, Indi.

Abstract: In the area of engineering, it is observed that in the area of automobile sector, aeronautic field the utilization of E-Glass fibre is more. In this paper the polymer based E-Glass fibre reinforced composite materials with different weight fraction of E-Glass fibres as reinforcement material and CE02 (cerium oxide) powder particles are used as filler materials are developed namely Specimen-1RESIN 100% (Lapox L-12); Specimen -2 RESIN 60% (Lapox L-12); + EG 40%; Specimen -3 RESIN 60% (Lapox L-12); + EG 30%+CE02 10% Prof. Specimen -4 RESIN 60% (Lapox L-12); + EG 20%+ CE02 20%; Specimen -5 RESIN 60% (Lapox L-12); + EG 10%+ CE02 30%; Specimen -6 RESIN 60% (Lapox L-12); + CE02 40% and characterized according to ASTM standards like D-3039 for tensile, Wear test G-99 and Hardness test After fabrication of composite materials the different tests like Tensile ,Wear and Hardness tests are carried out at various conditions like a) specimens are without post curing (un heat treated) and b) specimens are with post curing (heat treated) at various temperature and the different tests like Tensile ,Wear and Hardness test carried out .1.The interesting thing is that from the experimental results it conclude that tensile strength of the above mentioned specimens shows that heat treated specimens will have good, high tensile strength and dominate the without heat treated specimens2. Hardness test is carried out for the different proportionate filled of cerium oxide and post curing is done and tested for the without post curing and with post curing. However the due to post curing temperature the strength got increased mean while increase in the cerium oxide percentage the strength also got reduced. 3.From the wear test result itis conclude that Specimen-1RESIN 100% (Lapox L-12); Specimen -2 RESIN 60% (Lapox L-12); + EG 40%; Specimen -3 RESIN 60% (Lapox L-12); + EG 30%+CE02 10% Specimen -4 RESIN 60% (Lapox L-12); + EG 20%+ CE02 20%; Specimen -5 RESIN 60% (Lapox L-12); + EG 10%+ CE02 30%; Specimen -6 RESIN 60% (Lapox L-12); + CE02 40% Wear rate of the above mentioned specimens shows that heat treated specimens will have weight loss more compare to the without heat treated specimens and also heat treated specimens will have Volume loss, Volumetric Wear rate and co-efficient of friction is more compare to the without heat treated specimens and also from the SEM images it is absorbed that due to every Repeated loading causes the generation of micro cracks on the wear specimens. From this paper it is conclude that post curing(heat treated) specimens will have good tensile strength wear properties and Hardness value compare to without post curing (un heat treated). Hence, it is suggested that post curing (heat treated) specimens are suitable for automobile sector or aeronautic field.

Index Terms **- E-Glass fibre, Mechanical Properties, Post curing, automobile sector or Aeronautic field.**

I. INTRODUCTION

This chapter explains about composites and classification of composites.

1.1 The composition of a composite:

Composite a mix of at least two materials, varying in frame or creation on a large scale. The constituents posses their personalities, i.e.., they don't break up. Regularly, the segments can be physically distinguished and display an interface between each other.

1.1.1 The matrix:

The matrices are the solid material into which the reinforcement is inserted, and is totally constant. This means there is a method through the matrix to any point in the material, different to two materials sandwich together. In basic applications, the grid is generally a lighter metal, for example, aluminium, magnesium, or titanium, and gives a constant support to their reinforcement. In high temperature applications, cobalt and cobalt-nickel alloy matrices are common.

These three sorts of lattices create three basic sorts of composites.

Polymer lattice composites (PMCs), of which GRP is the best-known case, utilize artistic strands in a plastic grid. Metal-grid composites (MMCs) ordinarily utilize silicon carbide filaments installed in a support produced using an mixture of aluminium and magnesium, however other lattice materials, for example, titanium, copper, and iron are progressively being utilized. Run of the mill uses of MMCs slot in bikes, golf clubs, and rocket direction frameworks; a MMC produced using silicon-carbide filaments in a titanium lattice is as of now being created for use as the skin (fuselage material) of the US National Aerospace Plane. Ceramic lattice composites (CMCs) are the third real sort and cases slot in silicon carbide fibre developed in a complex produced using a borosilicate glass. The artistic network makes them especially reasonable for use in lightweight, high-temperature segments, for example, parts for plane fly motors.

1.1.2 The reinforcement:

Reinforcement for the most part includes rigidity and incredibly obstructs split spread. Thin strand can have high quality, and gave they are mechanically all around connected to the matrix they can significantly enhance the composite's general properties. Fibre-reinforcement composite materials can be isolated into two principle classifications typically alluded to as short fibre-strengthened materials and continuous fibre-reinforcement materials. Continuous reinforcement materials will regularly constitute a matrix or covered structure. The woven and constant fibre styles are commonly accessible in an assortment of structures, being pre-impregnated with the given lattice, dry, Uni-directional tapes of different widths, plain weave, and saddle silks, twisted, and sewed.

1.1.3 The shape:

The shape of reinforcement particles can be carefulin the order of as a sphere (the powder form of reinforcement) or as a cylinder (fibers). Their size and sharing then conclude the consistency of the composite.

1.1.4 The concentration:

The concentration is a variation in density of reinforcement phase, communicated as volume or the amount of weight. It is a standout amongst the most critical parameters that influence the properties of the composite material.

1.1.5 The orientation:

The orientation of the reinforcing phase affects the isotropy of the system. If the reinforcing particles have the shape and dimensions in all directions about the same (for example powders), the composite behaves principally as an isotropic material, and for that reason its properties are the same in all directions. On the contrary systems reinforced with cylindrical reinforcement (fibres) show anisotropy of properties. The orientation of the reinforcing stage influences the isotropy of the framework. On the off chance that the strengthening particles have the shape and measurements every which way about the equivalent (for instance powders), the composite acts mainly as an isotropic material, and hence its properties are the equivalent every which way. In actuality systems fortified with tube shaped support (filaments) show anisotropy of properties.

II. LITERATURE REVIEW

Literature reviews are important to go forward with any work, as it gives brief idea about the work what has been carried out in the selected area.

A.Mankandan, et. al. have Considered over the mechanical properties of Glass fiber strengthened Epoxy composites with various weight extents. By the assistance of hand lay-up system pursued by solidness shaping strategy, five composites were prepared by inconsistent the Glass fiber from the 15 wt % to 35 wt %.The required mechanical tests were directed according to ASTM norms and surface morphology of the broken surface was analyzed by filtering electron magnifying lens (SEM).As per the got outcomes it is finished that the 25 wt % fiber stacked composite has unrivaled mechanical properties. The results are numerically assessed by embracing blend structure advancement practice. The predicated ethics dispatch that 25 wt % fibers stacking demonstrate great mechanical properties contrasted with different blends [1].

YunfuOu et al have Conducted a scope of exploratory examinations on Unidirectional glass fiber strengthened polymer (GFRP) is solidified at four primer strain rates (25, 50, 100 and 200 s_1) and six temperatures (_25, 0, 25, 50, 75 and 100 _C) on a servo-pressure driven high-rate testing framework to review any conceivable impacts on their mechanical properties and breakdown designs [2]. Rita Roy et al. Studied over stun exhaustion schoolwork has been set aside a few minutes on 63×5% glass fiber fortified vinylester tar indented composites. The schoolwork was directed in a pendulum type rehashed effect contraption specifically structured and manufactured for forming single and rehashed stun qualities. A very much characterized effect weakness (S– N) habits, having a dynamic continuance underneath the limit single cycle sway break worry with diminishing connected pressure has been illustrated[3].

Dipesh Rohan have concluded in his paper that the use of a CFRP wheel rims has the potential to improve the performance of FSAE vehicles by lowering the unsprung mass and the rotational inertia of the wheel assembly [4]. BinParkaEugeneLiha et.al have discussed about biopolymer-based functional composites developed to increase the value of raw biopolymers obtained from natural resources or microbial systems. [5] Yong K. Kim et.al has focused on polyolefin fibre and film in medical applications. The poly fins have a strong growth potential in certain industrial applications by adopting the emerging nanotechnologies to improve performance properties and cost factor over competing rival thermoplastic fibres.[6]

III. PROBLEM FORMULATION

This chapter discusses the formulation of problem after carried out an exhaustive literature survey. After studying literature review, the Cerium oxide is added in Epoxy resin which increases its mechanical properties.

3.1 Problem formulation

From the study of literature review, it was observed that in polymer composite material, The Young's modulus of the natural fibres reinforce polymer composite was increased with increasing fibre percentage. The change in angles of fibres in composite material then reduces natural frequency of composites. The filler (inorganic) particles contribute to enhance the mechanical properties of polymers. Cerium oxide with various percentages is reinforced to the resin in order to increase the mechanical property. Cerium oxide helps the Epoxy resin to improve the hardness to the certain level higher than the individual Epoxy resin. The test specimens are prepared with different composition of Cerium oxide with Epoxy resin and hemp fibre. Then try to increase the strength of PMC by changing different percentage of Cerium oxide. Experimental test will be carried out on polymer matrix composites like, tensile test, Rockwell hardness test and Wear test.

3.2 Objectives of the present work

The primary objectives of the present work are as follows:

- To prepare specimens of different composition of matrix and fibres as per ASTM standards.
- To conduct test such as tensile test specimens using universal testing machine.
- To predict the strength of specimens in different composition of matrix and fibres.
- To carry out the Rockwell hardness test.
- To study the tribological propertied conducting Wear test.

IV. FABRICATION

In this the Matrix and Fibre reinforced materials are selected to develop polymer based fibre composite and compared with mechanical properties of existing material Epoxy.

Methodology :-The composition of Hemp fibre, Graphene and epoxy resin are as follows:

To calculate the rule of mixture by varying percentage of composition to obtain the required composite material.

Composition of matrix and reinforcement according to rule of mixture as given in

Equation $V_c=V_e+ V_h+ V_g$ -----------------(1)

Materials Selection and Preparation:The following materials were used in the homework of epoxy- Cerium oxide composite:

1. Epoxy (L12) (LAPOX L-12): A straightforward thick liquid with high consistency filled in as the lattice in the composite. It is a thermosetting gum with high sub-atomic weight.

2. Hardener (K6): Epoxy relieving operator K-6 is a low thickness room temperature restoring fluid hardener. Being somewhat prompt it gives a short pot life and fast recuperate at standard encompassing temperatures. It has a rack presence of least two years whenever put away in its unique pot far from wetness and warmth. The blend proportion of expansion of epoxy and hardener is fixed as 10:1 by the supplier.

3. Ceriumoxide (CeO_2): It is a whitish yellow powder with the chemical formula Ceo2. It is asignificantmarketable product and an intermediary in the decontamination of element from the ores.Density : 1.162 gm/cc;Melting point: 7990C;Boiling point: 34260C.

Specimen Preparation:

a) Incorporation: The experimentation has been considered for four unique organizations of Cerium oxide fortifications in epoxy framework for example (10%, 20%, 30%, and 40%). The planned loads of cerium oxide powder are added to the epoxy according to the arrangement. The mix is first mixed physically. In the wake of achieving an almost white semi liquid like material, the blend is exchanged to another mug and is then mixed utilizing a ultrasonic blender (sonicator) for 10 minutes with a heartbeat time of 5 seconds. We get a meager white fluid to which hardener K-6 (10 wt. % of the measure of epoxy) is blended and mixed well physically for around 20 minutes.

Fig.4.1Incorporation

Table 4.1: The amount of Cerium oxide and epoxy used for a batch of each composition

Specimen	Composition		
	Resin(LAPOX L-12)	**Fiber(E-Glass)**	**Filler Material(CeO2):**
1	100%	-	-
2	60%	40%	-
3	60%	30%	10%
4	60%	20%	20%
5	60%	10%	30%
6	60%	-	40%

b) Molding: From the fluctuated creations, tube shaped compacts are made. A barrel shaped kick the bucket is produced using the PVC wiring channels of 150 mm length and 10 mm distance across. The molds are prepared by applying oil on the internal dividers of the kick the bucket and in this manner utilizing mold discharge splash for simple expulsion of the throwing after cementing. In the wake of setting up the form, the blend is filled the channels and is left to harden for 24 hours.

Fig. 4.2 Preparation of cylindrical rods

Fig. 4.3 Preparation of laminates

c) Sample expulsion from the form and machining: The examples adapted are expelled from the shape after cementing by cutting the funnels. The shaped examples are machined by turning and looking to get the ideal breadth and a level base. The examples are swung to 8 mm breadth for grating wear test. The examples are then put away in fixed holders. Powder tests and little broken chips were likewise gathered for every arrangement for the time of machining.

d) Post-relieving of tests: 4-5 tests of every structure were post-restored in a stove for 30 minutes at 1000C. This was done to examine the variety in the warm and pliable properties of the composite with relieving temperature.

Fig. 4.4 Muffle furnace

V EXPERIMENTATION:-In this, discussed about conduction of various experiments such tensile, Rockwell hardness test and Wear test as per ASTM standard requirements.

Material characterization

There are different tests have been conducted on GFRP composites, where different mechanical tests like tensile test, hardness test and impact test have been revealed the information about characterization of a GFRP composites. According to ASTM standards different tests have been conducted in our project, they are as follows: Tensile test; Rockwell hardness test; Wear test.

5.1.1 Tensile test:-Tensile test have been carried out on universal tensile testing machine according to ASTM standards. Initially the composites with and without heat treatment has to be measured by suitable dimensions, i.e. specimen original length, area of the specimen, final length of the specimen after fracture, maximum load rate, maximum ultimate strength of a material, yield strength of a material, % age elongation of a material.The tensile test had been carried out at room temperature and in conformity with ASTM D3039 standards.

Fig. 5.1a: Universal tensile testing machine

Fig. 5.1b: Tensile test specimen

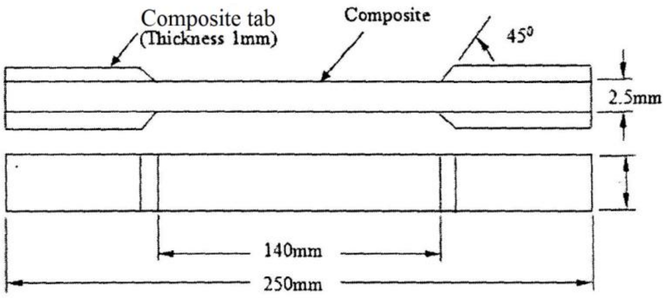


Fig. 5.1c. Tensile test specimen Dimensions as per ASTM

5.1.2 Rockwell Hardness Test

The assurance of the Rockwell hardness of a material includes the utilization of a minor burden pursued by a noteworthy burden, and after that taking note of the profundity of infiltration, hardness esteem specifically from a dial, in which a harder material gives a higher number.

The principle preferred standpoint of Rockwell hardness is its capacity to show hardness esteems straightforwardly, hence forestalling repetitive counts engaged with different hardness estimation procedures. It is ordinarily utilized in building and metallurgy. Its business prevalence emerges from its speed, unwavering quality, strength, goals, and little territory of space.

So as to get a solid perusing the thickness of the test-piece ought to be no less than multiple times the profundity of the space. Additionally, readings ought to be taken from a level opposite surface, on the grounds that round surfaces give lower readings. A rectification factor can be utilized if the hardness must be estimated on a round surface. There are a few elective scales; the most regularly utilized being the "B" and "C" scales. Both express hardness as a self-assertive dimensionless number.

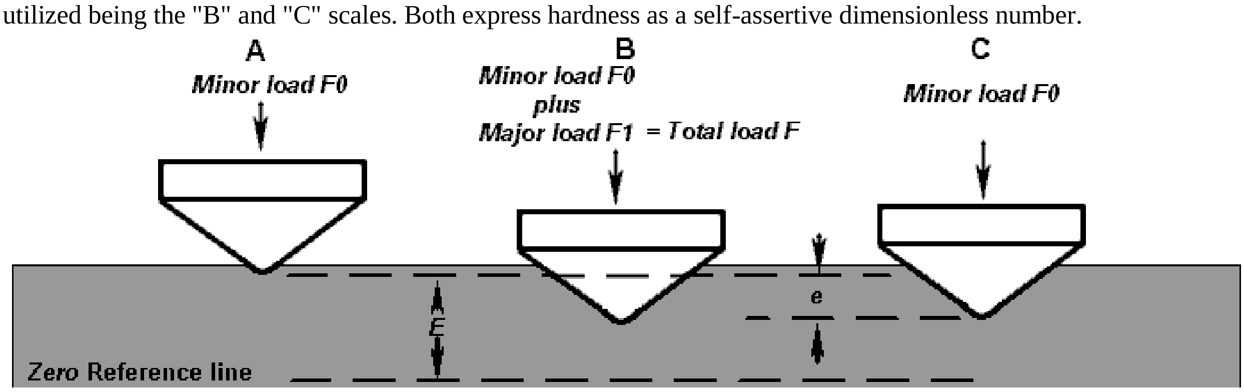


Fig. 5.2 Hardness Test Procedure

Fig. 5.3 Hardness Test Procedure

5.1.3 Wear Test

The wear result is based on the test condition like Load (N), Speed (rpm), Wear track dia (mm), Sliding distance (Km). In this wear experiment the Speed, Track Dia, Sliding speed has been kept constant and Normal Load is 20 N. The wear of the pins was measured by a vertical height loss as a function of time. Frictional force (F) and frictional coefficient (μ) were also reported. Pin-on-disc measurements were conducted using a commercial Wear & Friction monitor TR-20LC by ASTM G-99. In that way we can find how much wear has been obtained by weight loss method. In this test we use one types pin specimens of viz: SP1to SP2of diameter 10. Like this it is discussed on coefficient of friction, Wear rate mm, Frictional force (N),abrasive wear mechanism. Experimental Process:-It is a laboratory process used for finding Wear resistance of a composite material,During sliding by a pin on disc apparatus as per ASTM G 99 standard, the specimen is in cylindrical shape comes in contact with a disc plate based on load or weight attached.

Data Acquisition:-The parameters like co-efficient friction, Sliding distance, Wear rate are extracted from wear testing machine and also these parameters are useful in determining wear properties of a material. The figure shows the pin on disc apparatus

Fig. 5.4 Ducom pin on Disc sliding wear test apparatus

Specifications:

Load Range	Up to 200N
Rotational Speed	200-2000rpm
Frictional Force Measurement	0-200N
Compound Wear Measurement	0-1200μm

Table: 5.1 Untreated composite sample specifications for tests Without Heat Treatment

Specimen	**Composition**
SP-1	RESIN 100%
SP-2	RESIN 60%+ EG 40%
SP-3	RESIN 60%+ EG 30%+CE02 10%
SP-4	RESIN 60%+ EG 20%+ CE02 20%
SP-5	RESIN 60%+ EG 10%+ CE02 30%
SP-6	RESIN 60%+ CE02 40%

Fig. 5.5 Samples without heat treated

Table 5.2 Treated composite sample specifications for tests With Heat Treatment

Specimen	Composition
SPHT-1	RESIN 100%
SPHT-2	RESIN 60%+ EG 40%
SPHT-3	RESIN 60%+ EG 30%+ CE02 10%
SPHT-4	RESIN 60%+ EG 20%+ CE02 20%
SPHT-5	RESIN 60%+ EG 10%+ CE02 30%
SPHT-6	RESIN 60%+ CE02 40%

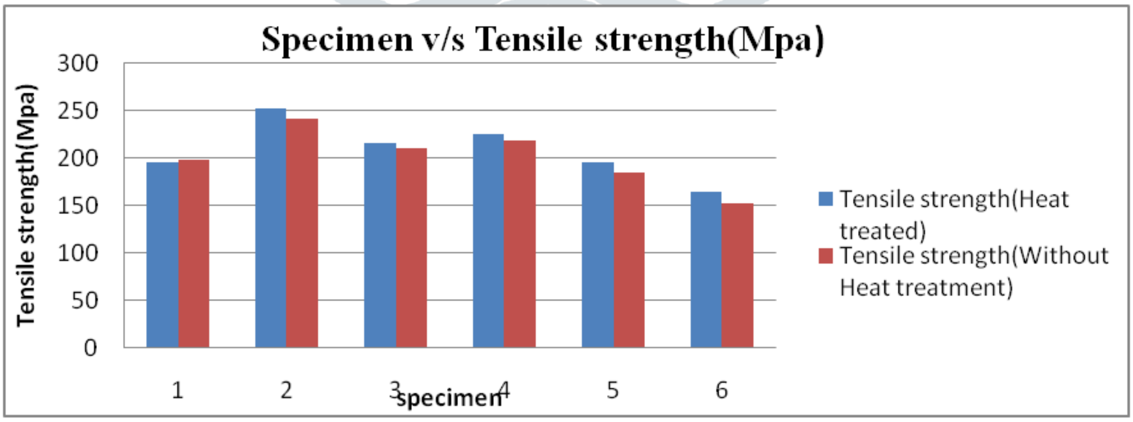
Fig. 5.6 Samples with heat treated

VI. RESULTS AND DISCUSSION

In this investigation, the tensile, hardness and wear tests were done on glass epoxy cerium particulate composites in order to examine the impact of material. In this segment trial result got for ductile; resistance to wear and hardness tests are generally examined. The outcomes were examined by plotting visual diagrams for materials that were having distinctive extents of cerium particulate.

TENSILE TEST:-Table 6.1Shows the Tensile Strength (MPa) of Heat treated Specimen (with post curing) and Tensile Strength (MPa) of Un Heat treated Specimen (without post curing)

Sl.No.	Heat treated Specimen	Without Heat treated Specimen	Tensile Strength(MPa) of Heat treated Specimen(with post curing)	Tensile Strength(MPa) of Un Heat treated Specimen (without post curing)
1	RESIN 100%	RESIN 100%	190	180
2	RESIN 60%+ EG 40%	RESIN 60%+ EG 40%	250	230
3	RESIN 60%+ EG 30%+ CE02 10%	RESIN 60%+ EG 30%+ CE02 10%	220	210
4	RESIN 60%+ EG 20%+ CE02 20%	RESIN 60%+ EG 20%+ CE02 20%	230	220
5	RESIN 60%+ EG 10%+ CE02 30%	RESIN 60%+ EG 10%+ CE02 30%	180	170
6	RESIN 60%+ CE02 40%	RESIN 60%+ CE02 40%	160	150



Graph 6.1 comparison of tensile strength Heat treated Specimen(with post curing) and Tensile Strength(MPa) of Un Heat treated Specimen (without post curing).

Tensile test is carried out for the various proportionate filled of cerium oxide and post curing is done and tested for the without post curing and with post curing the result reveals that unfilled of cerium oxide and without post curing i.e. at 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin higher value compared with the other samples as shown in the figure above.

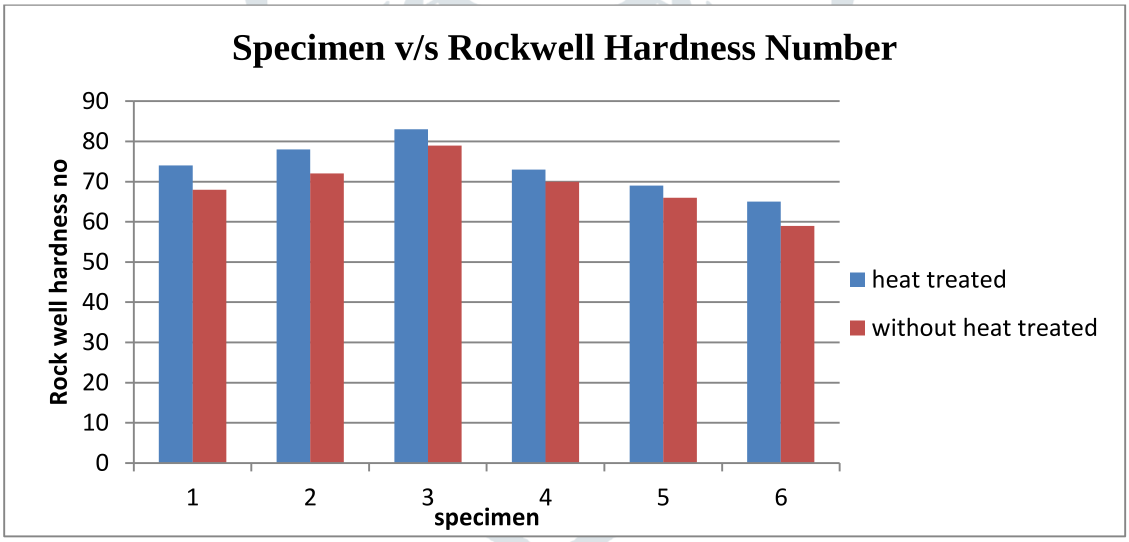
When other composites tensile strength can be compared the with composite of 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin, then the comparison reveals the promising results. The composite of 20 wt% of E-glass fibre,20 wt% of cerium oxide and

60 wt % of Lapoxl-12 resin compared with 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin the strength is about 89.64% and 90.83 % with and without post curing respectively. Hence, the composite of 20 wt% of E-glass fibre,20 wt% of cerium oxide and 60 wt % of Lapoxl-12 resin can be utilized and also reduce the usage of the fiber, when compared with 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin.

6.2 Rockwell Hardness Test results:

Table 6.2 Shows the Rockwell Hardness No of Heat treated Specimen (with post curing) and Un Heat treated Specimen (without post curing)

Sl. No.	Heat treated Specimen	Without Heat treated Specimen	Rockwell Hardness No of Heat treated Specimen(with post curing) or depth of penetration or hardness value directly from a dial	Rockwell Hardness No of Un Heat treated Specimen (without post curing) or depth of penetration or hardness value directly from a dial
1	RESIN 100%	RESIN 100%	75	68
2	RESIN 60%+ EG 40%	RESIN 60%+ EG 40%	78	72
3	RESIN 60%+ EG 30%+ CE02 10%	RESIN 60%+ EG 30%+ CE02 10%	82	79
4	RESIN 60%+ EG 20%+ CE02 20%	RESIN 60%+ EG 20%+ CE02 20%	74	70
5	RESIN 60%+ EG 10%+ CE02 30%	RESIN 60%+ EG 10%+ CE02 30%	69	67
6	RESIN 60%+ CE02 40%	RESIN 60%+ CE02 40%	65	58



Graph 6.2 comparison of Rockwell Hardness No Heat treated Specimen (with post curing) and Un Heat treated Specimen (without post curing)

Hardness test is carried out for the different proportionate filled of cerium oxide and post curing is done and tested for the without post curing and with post curing the result reveals that unfilled of cerium oxide and without post curing (i.e. at 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin) has higher value compared with the other samples as shown in the figure above. It is revealed that fracture is due to weak bonding and increases in ductility between the filler material, fiber and resin. The fracture due to delimitation of the fibre decreased as the percentage of cerium oxide is increased because cerium oxide is layed up along with epoxy as the percentage of cerium oxide increases E-glass fibre percentage decreases this is done to maintain constant volume of 300mmx300mmx3mm. However the due to post curing temperature the strength got increased mean while increase in the cerium oxide percentage the strength also got reduced as temperature is increased the viscosity got decreased and most of the resin is been consumed with cerium oxide, hence there is decrease in strength.

When other composites strength can be compared the with composite of 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin, then the comparison reveals the promising results. The composite of 20 wt% of E-glass fibre,20 wt% of cerium oxide and 60 wt % of Lapoxl-12 resin compared with 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin the strength is about 87.95% and 88.65 % with and without post curing respectively. Hence, the composite of 20 wt% of E-glass fibre,20 wt% of cerium oxide and 60 wt % of Lapoxl-12 resin can be utilized and also reduce the usage of the fiber, when compared with 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin.

6.3Wear test Results:-Table 5.3 shows the wear test results of weight loss of different composition of composite materials.

specimen code	composition	Load (N)	sliding velocity in (m/sec)	speed (RPM)	Time (min)	Initial weight (gm)	Final weight (gm)	Weight loss
SP 1	RESIN 100%	20	2.45	669	6.8	1.6583	1.6572	0.0011
SP 2	RESIN 60%+ EG 40%	20	2.45	669	6.8	1.7798	1.7772	0.0026
SP 3	RESIN 60%+ EG 30%+CE02 10%	20	2.45	669	6.8	1.7271	1.7194	0.0077
SP 4	RESIN 60%+ EG 30%+CE02 20%	20	2.45	669	6.8	1.8596	1.8591	0.0005
SP 5	RESIN 60%+ EG 30%+CE02 30%	20	2.45	669	6.8	1.8206	1.8106	0.01
SP 6	RESIN 60%+ CE 40%	20	2.45	669	6.8	1.6615	1.6569	0.0046
SP HT 1	RESIN 100%	20	2.45	669	6.8	1.6132	1.61	0.0032
SP HT 2	RESIN 60%+ EG 40%	20	2.45	669	6.8	1.6572	1.6525	0.0047
SP HT 3	RESIN 60%+ EG 30%+CE02 10%	20	2.45	669	6.8	1.8079	1.801	0.0069
SP HT 4	RESIN 60%+ EG 30%+CE02 20%	20	2.45	669	6.8	1.7772	1.7765	0.0007
SP HT 5	RESIN 60%+ EG 30%+CE02 30%	20	2.45	669	6.8	2.047	2.0304	0.0166
SP HT 6	RESIN 60%+ CE 40%	20	2.45	669	6.8	1.867	1.8305	0.0365

Table 6.4 shows the wear test results of Volume loss, Volumetric wear rate ,Co-efficient of friction of different composition of composite materials.

specimen code	composition	Frictional force (N)	Surface roughness (microns)	Volume loss	Normal pressure (Mpa)	Volumetric wear rate (mm3/m)	Co-efficient of friction
SP 1	RESIN 100%	15.2	2.07	0.874825	0.396106	0.000874825	0.76
SP 2	RESIN 60%+ EG 40%	15.2	2.133	1.897831	0.38641	0.001897831	0.76
SP 3	RESIN 60%+ EG 30%+CE02 10%	11.6	2.53	5.632211	0.396106	0.005632211	0.58
SP 4	RESIN 60%+ EG 30%+CE02 20%	8.5	6.853	0.343066	0.392184	0.000343066	0.425
SP 5	RESIN 60%+ EG 30%+CE02 30%	11.7	2.833	6.333469	0.416626	0.006333469	0.585
SP 6	RESIN 60%+ CE 40%	11.4	2.626	3.599638	0.38641	0.003599638	0.57
SP HT 1	RESIN 100%	14.7	3.36	2.651317	0.390245	0.002651317	0.735
SP HT 2	RESIN 60%+ EG 40%	14.4	2.196	3.525962	0.38641	0.003525962	0.72
SP HT 3	RESIN 60%+ EG 30%+CE02 10%	11.1	2.503	4.797463	0.398089	0.004797463	0.555
SP HT 4	RESIN 60%+ EG 30%+CE02 20%	10.4	4.17	0.477499	0.396106	0.000477499	0.52
SP HT 5	RESIN 60%+ EG 30%+CE02 30%	14.4	2.49	10.39669	0.392184	0.010396694	0.72
SP HT 6	RESIN 60%+ CE 40%	13.3	3.066	25.69284	0.380762	0.02569284	0.665

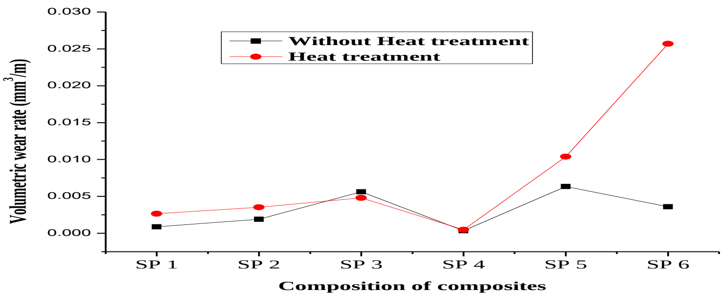


Fig: Effect of composition on volumetric wear rate

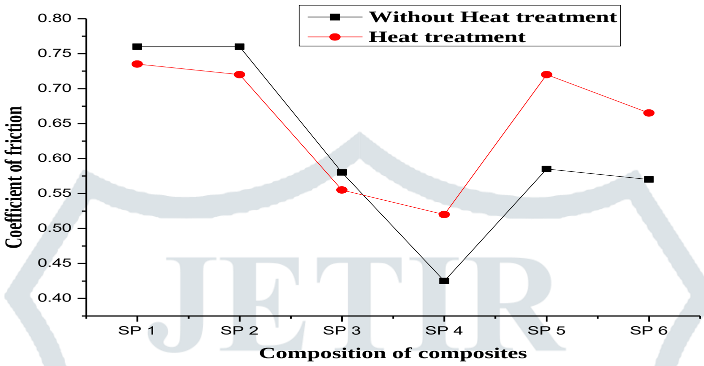


Fig 6.1: Effect of composition on coefficient of friction

From the fig. it is understood that increase in filler content decreases the volumetric wear rate up to 20% filler addition then it increases with increase in the filler content. The corresponding coefficient of friction decreases with increase in the filler content and later with increase in the filler content increases the coefficient of friction. With increase in the filler content, the volumetric wear rate is decreased due to the hardness of the filler content later it is decreases due to the increase in the volume fraction of the filler content. The coefficient of friction is decreased with increase in the filler content. Due to coefficient of friction is inversely proportional to the frictional force. As frictional force increases the corresponding coefficient of friction decreases.

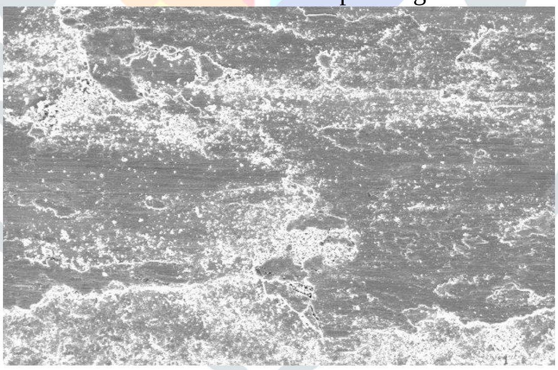


Fig 6.2. SEM micro graph of Sp-3, Speed-2.45m/s, applied load 20 N.

The increase in noise and friction coefficient was associated with grooving and progressive oxidation of the metal surface. A typical view of the worn surface after extensive sliding under steady state conditions is given in fig., which shows a prow at the end of a groove. The prow was believed to consist of a mixture of heavily deformed metal and metal oxide. Adhesive wear: adhesive wear is that during wearing plastically deformed asperities will get weld with the sliding disc and the same is separates by tearing action. The shallow treated surface appeared rough and wear loss takes place. Due to its shallow depth the mild wear occurs in fig

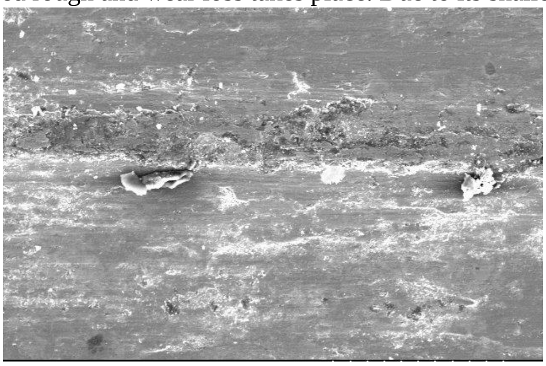


Fig 6.3. SEM micro graph of Sp-4, Speed-2.45m/s, applied load 20 N.

The term exhaustion is comprehensively connected the disappointment marvel where a strong is exposed to cyclic stacking including strain and pressure over a specific basic pressure. Continued stacking causes the age of miniaturized scale breaks, for the most part underneath the surface, at the site of a previous purpose of shortcoming. On resulting stacking and emptying, the smaller scale split engenders. When the split achieves the basic size. It alters its course to rise at the surface, and in this way level sheet like molecule is disengaged amid wearing. In fig.. This is like fretting wear but the flake will separates in fatigue wear whereas small

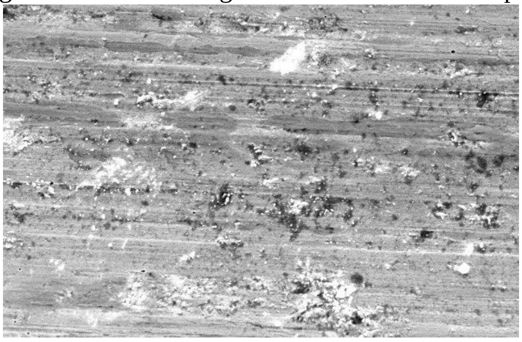


Fig 6.4. SEM micro graph of Sp-5, Speed-2.45m/s, applied load 20 N.

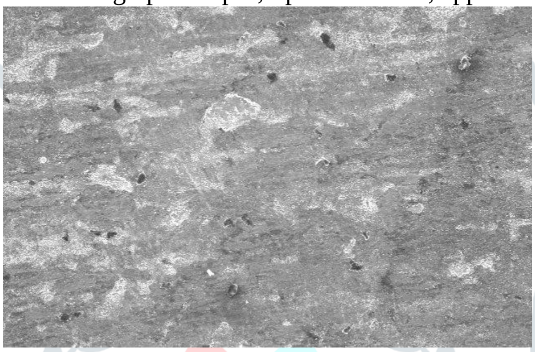


Fig 6.5. SEM micro graph of Sp-6, Speed-2.45m/s, applied load 20 N.

From the figures it is seen that with increment in the typical burden at the specific sliding rate, the volumetric wear rate is expanded for every one of the examples. An expansion in the wear rate happens with an expansion in burden and unrelated speed, achieving a most extreme esteem and prompting an adjustment in wear surfaces and wear flotsam and jetsam from the nearness of oxide to the nearness of metallic particles. For stacking conditions over the greatest in wear rate, plastic disfigurement of the sliding surfaces is prevalent.

VII CONCLUSIONS

In this section conclusions are drawn as follows by observing the results obtained from the experiments like tensile, Rockwell hardness test and Wear test as per ASTM standard requirements.

1. From the experimental results it is concluded that the tensile, hardness and wear tests were done on prepared composites.

2. Tensile Strength:- From the graph it is conclude that Specimen-1RESIN 100% (Lapox L-12); Specimen -2 RESIN 60% (Lapox L-12); + EG 40%; Specimen -3 RESIN 60% (Lapox L-12); + EG 30%+CE02 10% Specimen -4 RESIN 60% (Lapox L-12); + EG 20%+ CE02 20%; Specimen -5 RESIN 60% (Lapox L-12); + EG 10%+ CE02 30%; Specimen -6 RESIN 60% (Lapox L-12); + CE02 40% tensile strength of the above mentioned specimens shows that heat treated specimens will have good, high tensile strength and dominate the without heat treated specimens.

3. From the graph it is conclude that Specimen -2 RESIN 60% (Lapox L-12); + EG 40%; will have good, high tensile strength when compare to the other specimens because Weight fraction of EG fibre content is more and there is no CE02 (cerium oxide).

4. Hardness test is carried out for the different proportionate filled of cerium oxide and post curing is done and tested for the without post curing and with after drying the outcome discloses that unfilled of cerium oxide and without post curing (i.e. at 40 wt% of E-glass fibre and 60 wt % of Lapoxl-12 resin) has greater value related with the supplementary tasters. However the due to post curing temperature the strength got increased mean while increase in the cerium oxide percentage the strength also got reduced.

5.From the wear test result itis conclude that Specimen-1RESIN 100% (Lapox L-12); Specimen -2 RESIN 60% (Lapox L-12); + EG 40%; Specimen -3 RESIN 60% (Lapox L-12); + EG 30%+CE02 10% Specimen -4 RESIN 60% (Lapox L-12); + EG 20%+ CE02 20%; Specimen -5 RESIN 60% (Lapox L-12); + EG 10%+ CE02 30%; Specimen -6 RESIN 60% (Lapox L-12); + CE02 40% Wear rate of the above mentioned specimens from the results it table shows that heat treated specimens will have weight loss more compare to the without heat treated specimens.

6. From the wear test result itis conclude that Specimen-1RESIN 100% (Lapox L-12); Specimen -2 RESIN 60% (Lapox L-12); + EG 40%; Specimen -3 RESIN 60% (Lapox L-12); + EG 30%+CE02 10% Specimen -4 RESIN 60% (Lapox L-12); + EG 20%+ CE02 20%; Specimen -5 RESIN 60% (Lapox L-12); + EG 10%+ CE02 30%; Specimen -6 RESIN 60% (Lapox L-12); + CE02 40% from the results it table shows that heat treated specimens will have Volume loss,Volumetric Wear rate and co-efficient of friction is more compare to the without heat treated specimens.7. From the SEM images SEM micro graph of Sp-6,Constant speed is maintained ie Speed-2.45m/s and applied load 20 N.

VIII SCOPE OF FUTURE WORK

It is proposed to conduct the following test for the future developments as follows:
1. DMA analysis is carried out
2. Thermal properties also analyze by using FEA analysis.
3. Fatigue test carried out4.Compression, Bending, Fatigue test can be carried out.

IX ACKNOWLEDGMENT

Express sincere gratitude to all the faculties of Department of Mechanical Engineering for their guidance, regular source of encouragement and moral support rendered and facilities provided towards completion of this work in a systematic manner & express our sincere thanks to Project Guide & PG Coordinator Dr. C Thotappa for his moral support towards completing our work.

References

[01] A.Mankandanetal and R.Rajkumar, “Evaluation of mechanical properties of synthetic fiber reinforced polymer composites by mixture design analysis”, Polymers and polymer composite vol 24, no 7, 2016.

[02] YunfuOuetal,Deju Zhu Huaian ,Zhang Liang Huang ,Yiming Yao , Gaosheng Li and BarzinMobasher “Mechanical Characterization of the Tensile Properties of Glass Fiber and Its Reinforced Polymer(GFRP) Composite under Varying Strain Rates and Temperatures”.www.mdpi.com/journal/polymers Polymers 2016, 8, 196; doi:10.3390/polym8050196

[03] Rita Roy, B K Sarkar and N R Bose“Behaviour of E-glass fibre reinforced vinylester resin composites underimpact fatigue”. Indian Academy of Sciences. Bull. Mater. Sci., Vol. 24, No. 2, April 2001, pp. 137–142

[04] DipeshRoha, Design and Analysis of a Composite Wheel Rim, Journal of Material Science and Mechanical Engineering (JMSME), KrishiSanskriti Publications Print ISSN : 2339-9095; Online ISSN : 2393-9109; Volume 2, Number 6; April – June, 2015 pp 50 – 56

[5] Lightweight Materials from Biopolymers and Biofibers, January 1, 2014, DOI:10.1021/bk-2014-1175

[6]Yong K Kim Li, Yiu-Wing Mai, Lin Ye, Sisal fiber and its composites: A review of recent developments, Composites science and technology;2000;60:2037-2055.