DYNAMIC MECHANICAL ANALYSIS OF PHENOLIC COMPOSITES ENHANCED BY FLY ASH FILLED GLASS FIBRE

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Abstract: Glass fiber reinforced polymer composites were prepared by various manufacturing technologies and are widely used for various applications such as automotive fields as aerospace defense industries (busses, railways). Polymer composites were found to have excellent friction and wear performance after modification with functional fillers and reinforcements. This allows them to be flexible. The impact of fly ash on glass fiber-polymer composite laminate has been explored in this research by adding 0 to 15 wt percent fly ash to the fiber-phenolic composite of glass. Using hand-lay method to create the laminated composite, the slurry of fly ash-phenolic resin was impregnated. In hot press, the composite was then cured using Dynamic Mechanical Analysis (DMA) to investigate viscoelastic behaviour. Storage modules, loss modules and damping factors with temperature variation and fly ash content are evaluated. Significant enhancement is noted in the storage and loss module, suggesting that fly ash can be used in glass fiber-phenolic composites as reinforcing filler.

Index Terms - Glass fiber, fly ash, phenolic composite, dynamic mechanical analysis

I. INTRODUCTION

Fiber and matrix have distinct characteristics as an individual material, but the mixed characteristics of the material can be accomplished when strengthened into composite. Particulate filled fiber reinforced composite is commonly used in many engineering applications [1, 2]. Organic, polyester, thermo-stable, phenolic, vinyl ester and epoxy resins were formed by the matrix [3]. The mechanical and tribological characteristics of a composite depend on strength, chemical stability, modulus, matrix and strength of reinforcement and bonding of interference between particulate / matrix / fiber [4]. Various glass fiber (GF) reinforcement such as lengthy and chopped fiber was created to enhance these composite properties [5]. Different strong particulate reinforcements such as fly ash, cenosphere, marble dust, red mud, blast furnaces slag, granite dust, cement kiln dust have been generated in the composite to enhance composite properties [6]. Because of their light weight and because of their corrosion resistance characteristics, polymer composites are appropriate material for cars and for marine applications[7]. Particulate filled glass fiber strengthened polymer (GFRP) materials commonly used in numerous industrial applications, mainly in the marine and piping sectors, owing to improved impact tolerance, high specific strength and stiffness. Phenolic resin matrix-based composite has been commonly used in low molecular weight, high load resistance, high impact resistance and great mechanical resistance binders, surface coatings and impregnates [11]. Particulate strengthened polymer composites are mostly used in many engineering applications owing to their very tiny diameter like few microns, particulate matter carries a large part of the load, nowadays multiple industrial waste products are used with light weight polymer components to increase the modulus, strength and decrease matrix ductility. Fly ash mostly used as a filler with polymer composites. It is a primarily accessible industrial waste in thermal power plants. Smaller particle size increases polymer matrix characteristics due to standardized matrix distribution [13, 14].

2. MATERIALS

2.1Fly Ash

Flyash is a by-product of coal-based energy plants in particular. It becomes the main cause of air and water pollution if fly ash releases into the open atmosphere / land. Nowadays, however, it is used commercially as filler material for multiple structural applications such as the production of cement-based goods: bricks, highways, etc. Fly ash includes many oxide ceramics, predominantly silica and alumina, with very low density (< 0.7 g / cm3) and therefore used to produce composites of light weight polymer matrix [15]. Cenosphere is a lightweight material, so the weight of polymer composites is not enhanced. Cenosphere first used as filler with thermoplastics of plastisols, latex, unsaturated polyester, epoxies, phenolic resin and urethane. Cenosphere reduces resin consumption and enhances polymer matrix flow capacity. Cenosphere addition in the polymer matrix relies on the percentage of matting, size and quantity [16, 17].

2.2Glass Fiber

Today, glass fibers, made from raw materials, are among the most adoptable industrial materials. They demonstrate helpful bulk characteristics like hardness, speed and cohesion, as well as advantageous fiber characteristics like strength, flexibility and rigidity. It is used primarily in bathrooms, ships, aircraft, roofing and other applications. Table 1 shows the chemical composition of different kinds of glass fibers. In each glass fiber, SiO2 was the primary element

TABLE 1. Types and Chemical compositions of glass fibers (According to Vikas Sharma et. Ol 2019)

Type	SiO_2	Al_2O_3	TiO_2	B_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3
E-glass	55	14	0.2	7	22	1	0.5	0.3	-
C-glass	64.6	4.1	-	5	13.4	3.3	9.6	0.5	-
S-glass	65	25	-	-	-	10	-	-	-
A-glass	67.5	3.5	-	1.5	6.5	4.5	13.5	3	-
D-glass	74	-	-	22.5	-	-	1.5	2	-
R-glass	60	24	-	-	9	6	0.5	0.1	-
EGRglass	61	13	-	-	22	3	-	0.5	-

2.3Phenolic Resin:

The synthetic heavy polymers are formaldehyde phenol. These are created by the response with phenol and replacement phenol with formaldehyde The formaldehyde phenol has increased strength and dimensional stabilization and enhanced impact resistance.

3. COMPOSITE MATERIALS:

Composites are among the most sophisticated and adaptable products known to men in engineering. These intriguing and beautiful materials have been born by advances in the field of materials science and technology.

Composites are inherently heterogeneous, produced by assembling two or more parts with fillers or reinforcing fibers and a compact matrix[18]. The matrix may originate from metal, plastic or polymeric. It provides the composites their shape, surface appearance, environmental tolerance and general durability, while the fibrous strengthening carries most structural loads, providing macroscopic stiffness and strength [19]. A composite material can provide superior and distinctive mechanical and physical characteristics as it combines its constituents ' most desirable characteristics while suppressing their least desirable characteristics. Composite materials currently play a main role in the aerospace, automotive and other engineering applications Weight strength and weight-to-weight module ratio. High performance rigid composites made of glass, graphite, kevlar, boron or silicon carbide fibers in polymer matrices have been widely researched due to their use in aerospace and space vehicle technology[20,21]. The composites are broadly classified into composites of metal matrix (MMC), ceramic matrix (CMC) and polymer matrix (PMC), based on the matrix material that forms the continuous phase. Of these, composites of the polymer matrix are much to make than MMC and CMC. This is due to the comparatively small temperature needed to manufacture composite polymer matrix PMCs are generally made up of synthetic fibers such as carbon, nylon, rayon or glass embedded in a polymer matrix that surrounds and binds the fibers tightly. The fibers typically make up about 60 percent of a volume-by-volume polymer matrix. The structure, properties and applications of various composites are being investigated world wide by several researchers [22 -23].

4. IMAPCT OF FLY ASH ON DIFFERENT FACTORS

4.1 Viscoelastic Properties.

DMTA is very helpful for understanding the mechanical habits of polymer composites such as glass fibre based on time and temperature. It can also be useful to show the potential relationship between structure and ownership, and it can also be used to correlate the dynamic mechanical characteristics with the general composite performance[24. Mainly three parameters are used in this research: storage module, loss module and loss factor.

4.2 Storage Modulus (E').

It is the measure of maximum energy stored in the specimen during sinusoidal loading. It can be related to the stiffness and elasticity of polymeric materials and their composites [24]. Storage modulus increase by using fly ash.

4.3Loss Modulus and Loss Factor

Loss module (E'') is the quantity of energy wasted during cyclic loading of the specimen in the form of heat. DMTA also offers loss module and loss factor data (tan π)[24,25]. Due to the breakdown of soft polymer-filler relationships and frictions between the reinforcement layers within the composites, the loss of energy rises in the form of heat. The stiffness rises or the flexibility of composites decreases at the relaxation temperature by introducing restrictions on the segmental mobility of polymeric molecules.

5. CONCLUSION

There has been much study and advancement over the previous decade in the literature on strength and modulus characteristics of unfilled and particulate filled glass fiber strengthened polymer composite. Mechanical characteristics of polymer matrix composite strengthened with glass fiber improved. With growing particulate charge, the mechanical characteristics of strong particulate filled glass fiber filled polymer matrix composite declined. Fiber and matrix were treated with chemicals to make the glass fiber reinforced polymer composite in the future to improve the properties.
In this study ,it is concluded that use of fly ash is better idea on the place of jute and rice husk.

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