FLY ASH FILLED POLYACETAL COMPOSITES FOR AUTOMOTIVE APPLICATIONS

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Abstract- Thermoplastics have become essential part of our everyday lives. Our cars and appliances contain more and more plastic every year. In the present work effect of fly ash in different concentrate on such as(5%,10%,15%and20%) with different particle sizes on mechanical, electrical, morphological, rheological properties of POM composites was studied. The mechanical properties such as tensile strength and impact strength is found to be decreasing marginally while flexural strength and elastic modulus is found to be increasing with increase in % loading of fly ash. The dielectric strength of the composite increases with the increase in % loading of fly ash and is found to be higher for smaller particle size. Morphological studies reveals that there is good dispersion of filler in the composite.

Keywords- Fly ash, Polymer composites, Polyoxymethylene (POM)

I. INTRODUCTION

Particulate filled polymer composites have become attractive because of their wide application and low cost. Fillers are used along with various commodity as well as engineering polymers[1].By addition of mineral filler into thermoplastic polymer improves its physical properties[2]. Generally the mechanical, electrical, morphological and rheological properties of particle filled polymer composite depends upon shape, size concentration of filler particles in matrix[9]. Polyacetal is also known as (POM) Polyoxymethylene. This thermoplastic is characterized by high stiffness, good impact resistance, high HDT, good chemical resistance. POM is an engineering plastic and finds its application widely in the automotive and electrical industry. This material is used for commercial as well as industrial purpose[4].POM is one of the few polymers that can withstand permanent contact with the various and increasingly aggressive automotive fuels that are being employed today along with the high temperature encountered in various engine compartments. Also it has resistance to gasoline, diesel and methanol or ethanol based fuels and they can also withstand extremely high temperatures. Along with its use in automotive industry this polymer is also use largely to meet electrical conductivity requirements. POM is a semi crystalline material. Previous research was carried out on by using POM as a matrix for composites by adding Glass fiber [3],Graphite fiber, cellulose fiber[5-6], inorganic filler such as clay. Property performance of composites is not only depend upon the characteristics of the filler, It also depends upon the dispersion of filler and polymer–filler interactions, specifically on the properties and thickness of interface between polymer and filler. In previous study it was reported that by increasing filler content properties are gradually decreased [7-9]. In this research study fly ash mixed with different weight ratios, were added to POM polymer to determine the mechanical, electrical, rheological and morphological properties of of fly ash filled POM composites. Use of fly ash as a filler is not new[10-12]. Advantages of fly ash is that it gives high compression strength, low water absorption, cost effective and fly ash offer significant economy over other fillers. It is a fine byproduct commonly produced by the combustion of coal during the generation of electrical power. The fly ash is separated from the hot flue gasses before this escape into the atmosphere. It is generally spherical in the form. The result of many research study conducted with fly ash which used as a filler in the composites shows that by addition of fly ash in polymer composites increases stiffness of composites but similarly decreases impact as well as tensile strength of composites.in case of electrical properties smaller particle size gives higher dielectical strength compared to higher particle size.

II. EXPERIMENTAL

A. Materials-

Matrix polymer POM injection molding grade with MFI 8gm/10min was obtained from Padmini Innovative Marketing Solutions Pvt Ltd. Fly ash of different particle sizes as given in table 1 was obtained from M/s B.S.Mica, Mumbai, India. Flyash was added to POM in 5, 10,15, 20% wt ratios.

Table 1 Material Used Suppliers list of matrix and filler.

Material Used	Function	Avg Particle size µ	Suppliers
POM (Polyoxymethylne)	Matrix	-	Padmini Innovative solutions Pvt Ltd.
Fly ash	Filler	28-42µm 82-102µm 173-182µ	M/s B.S.Mica, Mumbai

B. Compounding-

In compounding first matrix (POM) and filler (Fly Ash) was preheated prior to the compounding, at 105ºc for 3 hours in an air circulated oven. Then after drying composition of filler (viz.5to20weights %) shown in the below table was mixed and extruded in a co-rotating twin extruder (APV Baker Ltd. England, Model: MP19PC). The L/D ratio of the screw is 25:1. Mixing speed of 40, 60,80rpm was maintained for respective compositions. The strands from the die were quenched in a tank at 20-25ºC and then palletized. For melt blending the temperature profile of the extrusion were, Zone 1: (1700C),

Zone 2: (1800C), Zone3:(1900C), Zone 4: (2100C) and Die (2300C). The strands were pelletized in Boolani's pelletizing machine. The speed of the pelletizer was maintained between the ranges of 2-3 rpm.

II. CHARACTERIZATION

A. Mechanical Properties

Tensile strength,% elongation, elastic modules were calculated according to ASTM D 638 M91, the cross head speed was 50mm/min maintain for 50kn load cell. Flexural strength and modulus were calculated by ASTM D 790 jaw speed of 0.08mm/min was selected for three point bending.

This above were carried out by using universal testing machine LR 50 K from Lloyd instrument ltd. U.K. izod impact strength were calculated by ASTM D 256 using Avery Denison's pendulum impact strength tester with 2.7J striker. The results reported are the average values of at least 3 specimens.

B. Electrical properties

Dielectric strength were determined according to ASTM D 149 Using S.C Dye & Co. (Input 260v; Output0-15 kv Class A(1.0) S No 77194;IS 1248-68 test 2000v).

C. Rheological Properties

Rheological properties were checked by rotoplusmcr 101 Anton Paar Rheometer. MCR101 SN80709145; FW3.40D090210; Slot2; Adj1153d.Oscillatory modes were performed for rheological study using parallel plate assembly.

D. X-ray Diffraction

X-ray diffraction was done by using Rigakuminiflex. This test were performed for determine the Degree of crystilinity.

E. Morphological Properties

Scanning Electron Microscopy- A JEOL, JSM-6380 scanning electron microscopy was used to evaluate the micro particle dispersion in polymer matrix. The cryogenic fracture surface was used to take SEM.

III. RESULT AND DISCUSSION

A. Tensile properties

Fig 1, shows that variation of tensile strength with the change in the % loading of the fly ash . It was observed that tensile strength of composites was found to be decreasing with increased in % loading of fly ash. In this the rate of decrease of tensile strength was higher when larger particle size was used. It is oberverd that fly ash with smaller particlesize showed higher value of tensile strenght than larger particle size. The tensile strength for the smaller particle size of fly ash is higher may be due to uniform dispersion of fly ash in the polymer matrix. The rate of decreased in tensile strength for the larger particle sizes with higher % loading of fly ash is found to be greater may be due to agglomeration of fly ash in the polymer matrix at higher loading.as the agglomeration tends to reduce the strength of a material because the agglomerates are weak point in material and break easily when a stress is applied to them (8). Fig. 2 shows the variation in the % elongation of composites with change in the % loading of fly ash.it is found that the% elongation of composites decreases with the increased in the loading of fly ash for all particle sizes. This is because of the interference of filler in the mobility or deformability of the matrix. In this Fly ash with smaller particle size show lower values of elongation at break.(1)

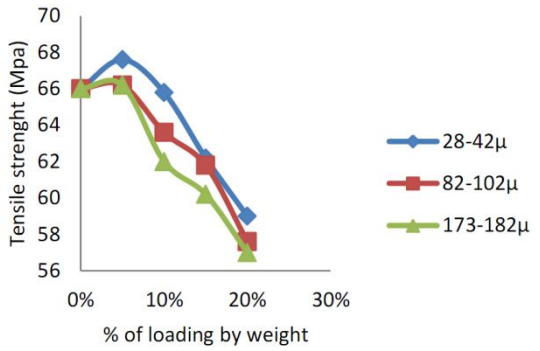

Fig 1.Tensile strength of fly ash filled polyacetal composites.

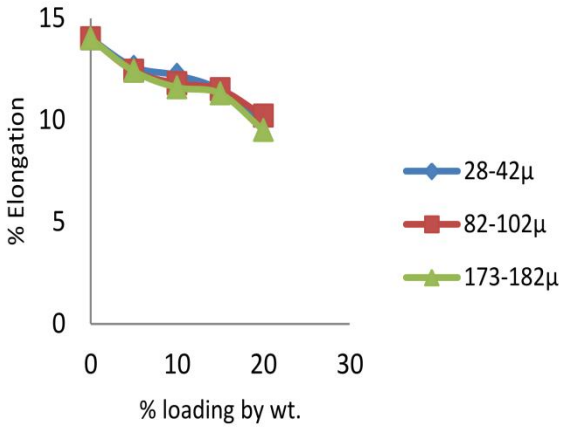

Fig.2 % Elongation of Fly ash filled polyacetal composites

B. Flexural properties

Fig 3 shows the variation in flexural strength of composites with change in the % loading of fly ash. It is observed that the flexural strength of composites increases with the increase in concentration of filler. It is also observed that the flexural strength of composites is higher for smaller particle size as compared to lager particle size of the fly ash. the arte of increased in flexural strength for the smaller particle size is higher because of uniform dispersion of filler in the polymer matrix and increased surface area of filler.

Fig 4 shows the variation in elastic modulus of composites with change in the % loading of fly ash. It is observed that elastic modulus of the composites increases significantly with increase in concentration of filler. The increase in elastic modulus with the filler concentration clearly indicates their dependence on particle size and dispersion of filler in matrix.

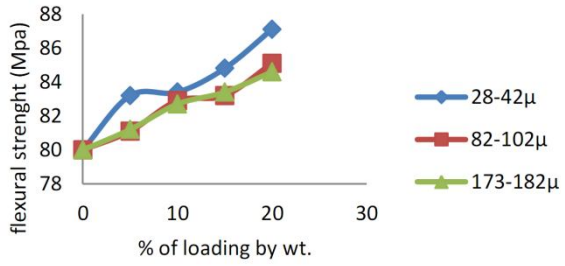

Fig 3 flexural strength of fly ash filled polyacetal composites

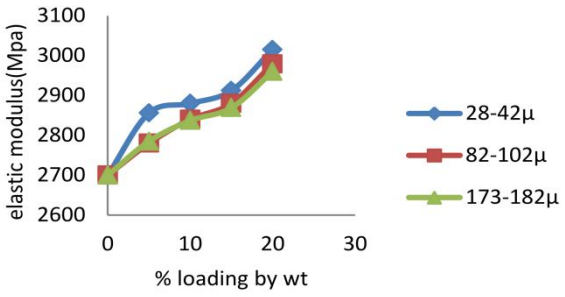

Fig 4 Modulus of fly ash filled polyacetal composites

C. Impact strength

Fig 5 shows the variation in Impact strength of composites with change in the % loading of fly ash.it is observed that the impact strength decreases with increasing filler loading. This is mainly due to the reduction of elasticity of material due to filler addition.[1].

Increase in concentration of filler reduces the ability of matrix to absorb energy thus reducing the toughness and impact strength. The rate of decrease of impact strength is lower in case of smaller particle size than larger particle size of fly ash.

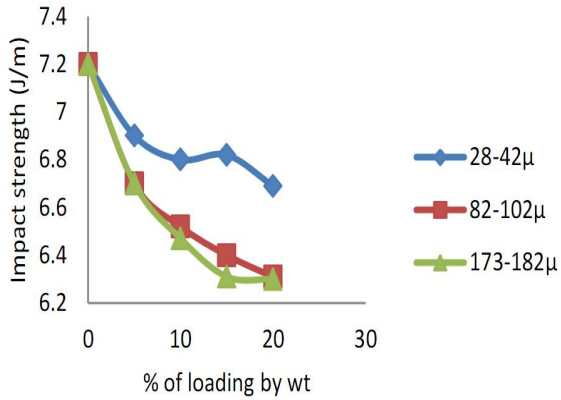

Fig 5 Impact strength of fly ash filled polyacetal composites.

D. Electrical Properties

Fig 6 shows the variation in dielectical strength of composites with change in the % loading of fly ash.it is observed that the dielectical strength increase significantly up to 5% loading of fly ash and then remain constant for smaller particle size and it increases marginally up to 10% loading and then remain constant for higher particle size. At higher loading of mica the resin is densely packed and at low loadings of mica, the resin is relatively loosely packed. Since dense packing will hinder displacement of the dipoles and also hinder the accumulation of charges at the filler resin interface, and since dielectric strength is directly related to these factors the rate of increase is observed.

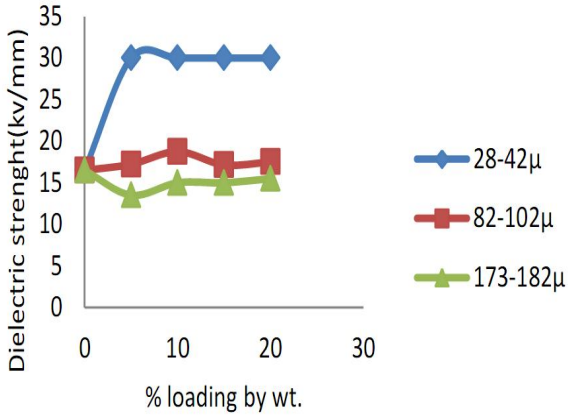

Fig 6 Dielectric strength of Fly ash filled polyacetal composites

E. Rheological Properties

Storage modulus (G') as a function of frequency was calculated to determine the degree of crosslinking of the composites Fig. 6 shows storage modulus of 28-42µm size. It has been clearly observed that the composites containing 5% loading of Fly ash shows higher value of storage modulus (G') than that of other concentration. this may be because of more cross linking in the structure. In case of loss modulus Significant increment was also determined, and viscosity behavior shows that as viscosity decreases with increasing strain rate as shown in figures.

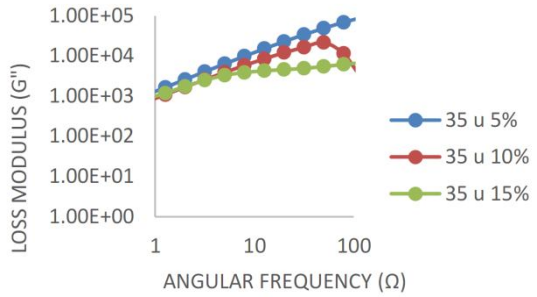

Fig 7 Storage modulus of fly ash filled polyacetal composites

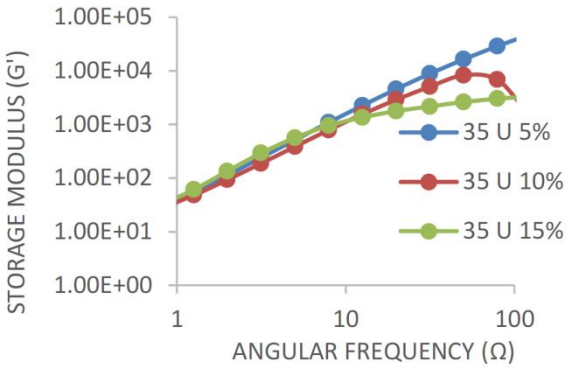

Fig 8 Shows loss modulus of fly ash filled composites

F. X-ray diffraction technique

Table 2

Size of fly ash	Composition	Gross Intensity	Integral Intensity	Degree of Crystilinity
82-102µm	5%	156190.80	433278.19	0.360
	10%	110373.92	341444.22	0.323
	15%	93603.55	254365.45	0.367

Table 3

Size of fly ash	Composition	Gross Intensity	Integral Intensity	Degree of Crystilinity
178-182µm	5%	122381.34	292362.41	0.418
	10%	162347.63	473456.53	0.342
	15%	116280	284729.75	0.408

Table 2 and 3 shows the variation in degree of crystilinity with change in % of loading of fly ash. It is observed that the degree of crystilinity increases with increasing % of loading of fly ash. G. Scanning Electron microscopy (SEM)

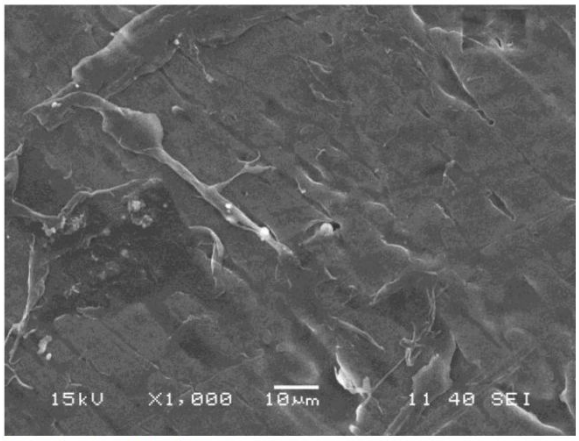

Fig 9 shows SEM of 28-42µm Size

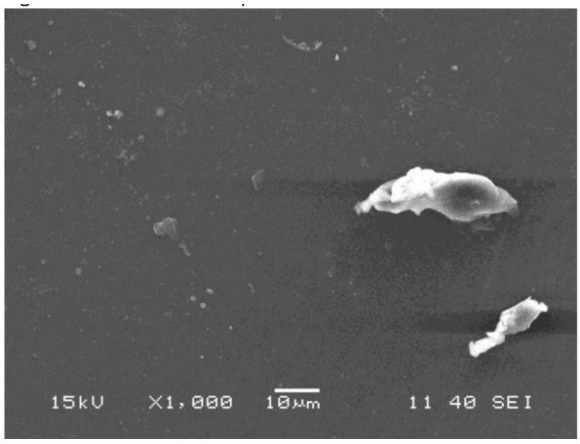

Fig 9 shows SEM of 28-42µm Size

Scanning electron microscopy used determine the morphological properties of POM composites

CONCLUSION

In this research work it has been observed that mechanical properties such as tensile strength, % elongation, impact strength decreases with increasing concentration of fly ash and dielectical properties are increases with increasing concentration of fly ash. So,it has been clearly seen that fly ash is cost effective for Polyoxymethylene and can be used in automotive industries.

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