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Tribological test of polymer composite material with different filler materials: A Review

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Abstract*: The aim of this paper is examine the positive influence of the commercially available nano–additives on tribological properties of the polymer composite. The experiments describes the development of tribological behavior of different types of composites with glass, jute, metal powder as filler material , epoxy resin and different types of filler ranging from particulates ,flakes and chopped strands. Experiment was carried to evaluate wear characteristics of composites materials particularly two body and three body abrasive wear. This study is related to wear and its properties on polymer composites to analyses the different parameters effecting wear characteristics.*

Keywords – Composite materials, tribological properties, fillers, epoxy resin, natural fibres.

1. INTRODUCTION

Over the past decades, polymer composites have been increasingly used as structural materials in aerospace, automotive and chemical industries, because they provide potential lower weight alternatives to traditional metallic materials. Among these applications, numerous are related to tribological components such as gears, cams, bearings and seals etc., where the self-lubrication properties of polymers and polymer based composites are of special advantage. The feature that makes polymer composites promising in industrial applications is the possibility to tailortheir properties with special fillers with different volume fraction, shape and size [5]. The wear and friction of non-metallic solids have some significant differences to that of metals: the wear mechanisms involved and the level of friction or wear which occurs. The most important factors which determining level of wear due to sliding friction and magnitude of the coefficient of sliding friction are hardness and surface roughness of the paired materials, contact pressure, traversed distance, temperature of the sliding surfaces and lubrication.[1]. The reinforcing fillers range from particulates of metals, oxides, nitrides, carbides and also solid lubricants such as graphite, mica, PTFE and nano size fillers. Addition of metallic fillers improves wear resistance of epoxy [2]*H. Aireddyet al*[3], found that bio-waste coir dust reinforced Polymer composites in erosive and abrasive mode, in that, coir dust loading influences the erosive and abrasive wear behavior of the composite. The erosion wear resistance has increased with increasing

Volume fraction of the coir dust because of the softness of coir dust compare with the matrix material. *Madhusudhan T et al [4*], in the present study an effort is made to understand the behavior of polymer composite with different filler material. Experiment concluded that the hybrid composite with 2 different fibre material and tungsten carbide as a filler material has higher tensile strength and hardness when compared to material with 3 fiber and silicon carbide as filler material.

1.1Filler

To enhance the strength and to reduce the cost of manufacturing the polymer composites certain additives in the form of fillers and flakes are used. Filler forms the addition strength to the mechanical properties of the composite materials. Fillers are the particles added to material to lower the consumption of more expensive binder material or to better some properties of mixed material. Many filler materials are available ranging from metallic, nonmetallic, ceramic and organic filler material, among that calcium carbonate has largest market volume. Wood flour and saw dust used as filler in thermosetting of plastic. Silicon carbide, tungsten carbide, graphite particles, zinc oxide, magnesium oxide, alumina etc are the commonly used filler materials in the composites. Fillers when used as reinforcement it will increase the properties like tensile strength, Young's modulus, ultimate tensile strength, hardness of the entire composite material.

2. LITERATURE SURVEY

Stephan Sprenger **[6],** found that epoxy resins are inherently brittle, thus they are toughened with reactive liquid rubbers or core shell elastomers. In addition to this silica nano particles are added as a surface modifier or to improve the material properties. Conclusion for above work is that, the combination of rubber and silica particles offers tough and stiff epoxy resin. Even with addition of nano silica material may lose its strength and lower modulus. But in this work there will be increase in the toughness and fatigue performance of material.

PetrHrabě et al **[7]**, this paper deals with composite material based on Jatropha oil cake. The researcher used Jatropha oil cake as filler in epoxy adhesive on hardness and abrasion resistance. In the experiments fillers mass concentration are varied from 5 to 30%.Composite material were subjected to the measurement of hardness and abrasion resistance of three point method according to ASTM –G65. The conclusion from experiments are, composite material have higher weight loss than the matrix if free abrasive are applied. Using of filler had no effect on the hardness of material. Using a filler in composites may reduce the cost of manufacturing.

Lingaraju.D et al **[8],** this paper presents the effect of reinforcing epoxy polymer with Halloysite nanoclay on mechanical properties. In the experiment the fillers are varied in 1, 2, and 3 percent by weight with suitable silane agent. Characterization of nanoclay was done by X ray diffraction and SEM. ASTM standards have been employed for investigating hardness, wear, and dynamic mechanical properties. Conclusion from the work is that, there will be an increase in mechanical properties like hardness and strength etc , whereas wear rate decreased by 14%, 82% and 33% over pure FRP at 1wt%, 2wt% and 3wt% nanoclay respectively.

K.Srinivas et al **[9],** this paper gives the tribological behavior of epoxy composites with three different particulate fillers. Micro particulates of SiC size less than 60 µm and Gr particulates of size 20 µm were the reinforcements. The results showed that epoxy hybrid particulate composite containing SiC/Gr exhibits lowest specific wear/highest wear resistance among the composites. The improvement in wear resistance for the composite containing 5% SiC 35% graphite is 85% when compared with epoxy, 25% over composite containing 40% Gr and36% over 40% SiC. The composite has 5% Gr and 35% SiC offers greatest wear resistance.

T.Madhusudhan et al **[10]** **,**in this paper Investigation was carried out through experimental study on Silicon Carbide (SiC) as a filler material , different combination of hybrid composites to determine the 'two body' abrasive wear behavior. Freshly fabricated Glass-Jute-Epoxy, Glass –Sisal-Epoxy and Glass-Rubber-Epoxy composites with different weight percentage of silicon carbide filler was subjected to two body abrasive wear test under normal room temperature in dry condition on pin-on-disc. The study concluded that un filled polymer composite shows higher material loss when compared with SiC filled composite material. The wear resistance of material increases with increase in filler content. The material combination with Sisal and Glass fibre shows maximum wear loss when compared all other combination for same testing condition.

Shakuntala Ojha et al **[11],** an experimental study was conducted to compare the erosive wear of both raw and carbon black wood apple shell particles filled epoxy resin matrix composite. The effect of filler material with different concentration, with different impingement angles (30, 45, 60, and 90) at constant velocity 48 m/s on erosion rate of composite analyzed. The study concludes that the peak erosion rate is found to be occurring at 45° to 60° impingement angles for both raw and carbon black filler composite under various experimental conditions irrespective of filler loading. But the minimum erosion wear occurred for carbon black composite at 20 wt. % filler as compared to raw 10 wt. % filler composite.

Rahul Kumar et al **[12]**, in this paper, sundi wood dust reinforced epoxy composite were mixed with 7 different % filler weight. The tensile and flexural test was conducted to study the mechanical behavior of composites. The maximum load, tensile stress and strain, and flexural stress and strain values are found to be maximum and minimum at the filler wt. of 10 % and 15 % respectively. The best mechanical properties were observed for 10 % filler wt. and speed of 1 mm/min and 2 mm/min speed.

J Sudeepana et al **[13],** the tribological properties of acrylonitrile-butadiene-styrene (ABS) polymer filled with micron-sized calcium carbonate (CaCO3) are studied in this paper. Filler content, normal load and sliding speed are considered as design parameters and coefficient of friction (COF) and specific wear rate are considered as the responses The experiments are conducted on multi-tribotester (block on- roller configuration) based on L27 orthogonal array (OA). The optimum design parameter combination for minimum coefficient of friction and specific wear rate are found using grey relational analysis. The experiment concludes that 5% of filler content, 35N load and 120 rpm of speed give the optimum values of gray relational grade of ABS / CaCO3 composites. In can be concluded that with the addition of micro sized CaCO3 at right combination of design parameter, tribological properties get improved.

R.V. Kurahattia et al **[14],** a systematic study has been conducted to investigate the matrix property by adding nano size ZrO2 (60-100 nm, 0.5-10 wt. %) fillers in to an epoxy resin. The experimental results showed that nano ZrO2 particle prove to be quite effective in reducing friction coefficient and wear rate of epoxy composite sliding against the steel. The wear resistance of epoxy nano composites considerably increases with increasing content of nano-ZrO2. An optimum wear resistant composition was found to be epoxy with 0.5 wt. % nano-ZrO2 particles.

T. Madhusudhan et al **[15]** , in this work two body abrasive wear test carried with different loading and abrading distance were performed at room temperature by using pin – on disc apparatus to determine the surface hardness strength of SiC filled Glass fibre reinforced with epoxy resin hybrid composites. The results showed that wear volume increased with increasing abrading distances and specific

wear rate decreased with increasing abrading distance and increased with load for SiC particle filled Hybrid composites. The least wear rate was the found for the material with10%SiCG-R-E with load of 40N speed 300rpm and abrading distance of 75m.

***Binu P Pa et al* [16]** , in this experiment a series of glass fibre reinforced polyester nanocomposites have been prepared with varying composition 0 ,0.5, 1 , 1.5 and 2 wt.% Cloisite 15A as nano filler. The effect of nano clay content on mechanical, dynamic mechanical and thermal properties of nano composite were studied. The experimental results showed that highest tensile modulus and tensile strength obtained at 0.5 to 1 % nanoclay filled samples. The impact strength is also high about 1 % of nanoc lay.

***P.Rajasekhar et al* [17] ,** in this study ,the tribological performance of Polyamide (PA) based hybrid composite have filled with short jute fibre and nano ZnO particles are manufactured with different mass concentration. Wear test were conducted on pin – on – disc (POD) test rig , is an new test set up for online measuring of wear rate and friction coefficient. The optimum values obtained through RSM were WR is 0.6499 mm3/Nm and COF is 0.1044μ, and the relevant parameters normal force, sliding velocity and reinforcements are 2.0 N, 0.2970 m/sec and 3.5707Vf respectively. By increasing the volume fraction of nano filler a better wear resistance can be achieved.

***Naga Raju B et al* [18],** the tribological behaviour of polyester filled with ZnO nano particle were studied. For the study purpose ZnO nano particles were synthesized and size was found to be 34nm. The wear samples were prepared by mixing 1wt%, 2wt%, and 4wt% and 6wt% ZnO nano particles with polyester resin. Conclusion from the experiments was the wear rate obtained is very less for polyester composite by reinforcing 1wt% ZnO nano particles in comparison with other polyester composites. So it indicates that polyester/1wt% ZnO nano composite possess best anti-wear properties in comparison with pure polyester composite and 2wt%, 4wt% and 6wt% nano ZnO filled polyester composites.

3. CONCLUSION

The following may be concluded on this review

- The combination of the useful properties of two different materials, make them as a versatile material in the field of engineering and technology.
- By adding the filler material to the polymer composite, tribologiacl properties get enhanced.
- Commonly used filler materials are silica, Sic, Gr, carbon black, wood dust, ZrO2, ZnO, CaSiO3, Tungsten carbide etc. Out of all Tungsten carbide gives greatest of strength to the composite material.
- By adding filler material with different mass concentration, we can reduce the wear rate of material.
- In all the material combination selected the increase in filler material content increase the wear resistance of polymer composites.

REFERENCES

[1]. R.V. Kurahattia*, A. O. Surendranathanb, A.V. Ramesh Kumarc, C. S. Wadagerid,V. Auradie and S. A. Korif, 2014. Dry Sliding Wear behaviour of Epoxy reinforced with nanoZrO2 Particles. Procedia Materials Science 5 (2014) 274 – 28.

[2] A Review On Mechanical Properties Of Natural Fibre Reinforced Hybrid Composites by Prof T. Madhusudhan, KeerthiSwaroop G , International Research Journal of Engineering and Technology (IRJET)e-ISSN: 2395 -0056

[3] Lingaraju.Da,*, Ramji.Kb, N B R Mohan Raob, RajyalakshmiUa, 2011. Characterization and prediction of some engineering properties of polymer - Clay/Silica hybrid nanocomposites through ANN and regression models.

[4] H. AIREDDY* and S.C. MISHRA, Tribological behaviour and mechanical properties of Bio-waste reinforced polymer matrix composites. Journal of Metallurgy and Materials Science, Vol. 53, No. 2, April-June 2011, pp. 139-152Printed in India, © NML, ISSN 0972-4257

[5] Comparison of Hybrid Composites with Different Filler Material by Madhusudhan T, SenthiL Kumar M, International Journal of Engineering Research and General Science Volume 4, Issue 2, March-April, 2016 ISSN 2091-2730

[6] Epoxy resins modified with elastomers and surface-modified silica Nanoparticles by Stephan Sprenger, Polymer 54 (2013) 4790e4797

[7] Three-body abrasive wear of polymer matrix composites filled with JatrophaCurcas L. by PetrHraběa, MiroslavMüllera, Procedia Engineering 136 (2016) 169 – 174.

[8] Lingaraju.Da,*, Ramji.Kb, N B R Mohan Raob, Rajyalakshmi Ua , Characterization and prediction of some engineering properties of polymer - Clay/Silica hybrid nanocomposites through ANN and regression m , Procedia Engineering 10 (2011) 9–18.

[9] Wear Behaviour of Epoxy Hybrid Particulate Composites by K.Srinivasa*, M.S.Bhagyashekarb, Procedia Engineering 97 (2014) 488 – 494.

[10] Investigation on wear resistance behaviour of SiC filled hybrid composites by T. Madhusudhan, Dr. M. Senthil Kumar, International Journal of Mechanical Engineering and Technology (IJMET) Volume 8, Issue 2, February 2017, pp. 82–92 Article ID: IJMET_08_02_010.

[11] Shakuntala Ojha, Samir Kumar Acharya, Raghavendra Gujjala, Characterization and Wear Behaviour of Carbon Black Filled Polymer Composites, Procedia Materials Science 6 (2014) 468 – 475.

[12] Rahul Kumara, Kausik Kumarb, PrasantaSahooc and Sumit Bhowmika, Study of Mechanical Properties of Wood Dust Reinforced Epoxy Composite , Procedia Materials Science 6 (2014) 551 – 556.

[13] Study of tribological behaviour of ABS/ CaCO3 composite using grey relational analysis by J Sudeepana, K Kumarb, T K Barmanc, and PSahooc, Procedia Materials Science 6 (2014) 682 – 691.

[14] M. Sudheera,*, K. Hemantha, K. Rajua, Thirumaleshwara Bhata , Enhanced Mechanical and Wear Performance of Epoxy/glass Composites with PTW/Graphite Hybrid Fillers , Procedia Materials Science 6 (2014) 975 – 987.

[15] Experimental study on wear behaviour of Sic filled hybrid composites using taguchi method by T. Madhusudhan and M. SenthiL Kumar , International Journal of Mechanical Engineering and Technology (IJMET) Volume 8, Issue 2, February 2017, pp. 271–277 Article ID: IJMET_08_02_033.

[16] Binu P Pa, K.E. Georgeb, M.N. Vinodkumara , Effect of nanoclay, Cloisite15A on the Mechanical Properties and Thermal behavior of Glass Fibre Reinforced Polyester , Procedia Technology 25 (2016) 846 – 853.

[17] P.Rajasekhar1*, G.Ganesan1, C.Senthilkumar1, Studies on Tribological Behaviorof Polyamide Filled Jute Fibre-Nano-ZnO Hybrid Composites, Procedia Engineering 97 (2014) 2099 – 2109.

[18] Studies on tribological properties of ZnO filled polymer nano composites by Naga Raju B., Ramji K. and Prasad V. S. R. K., ARPN Journal of Engineering and Applied Sciences ISSN 1819-6608.

[19] Madhusudhan T , SenthiL Kumar M , Mechanical Characterization of Jute and Rubber Particles Reinforced Epoxy Polymer Composites , IOSR Journal Of Pharmacy www.iosrphr.org (e)-ISSN: 2250-3013, (p)-ISSN: 2319-4219 Volume 6, Issue 12 Version. 1 (Dec 2016), PP. 23.

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