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REVIEW- WEAR CHARACTERISTICS OF COMPOSITE MATERIAL

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Abstract:** For all structural application tribological properties of material play most important role in day to day life. Different parameters like sliding velocity, load, sliding speed are influence on the wear rate. The wear characteristics have been estimated by different parameters in a single pin on disc wear testing machine. This paper describe the wear behavior of composite material from the banana fiber. The work herein presented aims to first do a literature review on the main parameters to be controlled in a pin on disc apparatus on the wear of composite (banana fiber) and then discuss test results and analyze the influence of parameters of load, sliding distance, disc speed in a pin on disc wear test.

Keyword: **Tribology, wear, pin on disc machine, composite material**

I INTRODUCTION

Wear is probably the most important yet at least understood aspects of tribology. It is certainly the youngest of the tri of topics, friction, lubrication and wear, to attract scientific attention, although its practical significance has been recognizes throughout the ages. The findings of Guillaume Amontons in 1699 establishing scientific studies of friction are almost of 300 years age, while Petrov, Tower and Reynolds brought enlightenment to the subject of lubrication a century ago in the hectic 1880s. Substantial Studies of wear can be associated only with the five decades that have elapsed since R. Holm explored the fundamental aspects of surface interactions encountered in electrical contacts.

One third of our global energy consumption has been devoured wastefully in friction. In addition to the primary saving of energy, very significant additional economics can be made by the reduction of the cost involved in the manufacture and replacement of prematurely worn out components. The dissipation of energy by wear impairs strongly to the national economy and the life style of most of the peoples. So, the effective decrease and control of wear of metals are always desired.

WEAR: wear can be defined as “The process of removal of material from one or both surfaces when two surfaces are in relative motion with each other.”

A fundamental scheme to classify wear was first outlined by Burwell and Strang. Later Burwell modified the classification to include five distinct types of wear, namely (1) Abrasive (2) Adhesive (3) Erosive (4) Surface fatigue (5) Corrosive.

ABRASIVE WEAR: Abrasive wear can be defined as wear that occurs when a hard surface slides against and cuts groove from a softer surface. It can be account for most failures in practice. Hard particles or asperities that cut or groove one of the rubbing surfaces produce abrasive wear. This hard material may be originated from one of the two rubbing surfaces. In sliding mechanisms, abrasion can arise from the existing asperities on one surface, from the generation of wear fragments which are repeatedly deformed and hence get work hardened for oxidized until they became harder than either or both of the sliding surfaces, or from the adventitious entry of hard particles, such as dirt from outside the system. Two body abrasive wear occurs when one surface cuts material away from the second, although this mechanism very often changes to three body abrasion as the wear debris then acts as an abrasive between the two surfaces. Abrasives can act as in grinding where the abrasive is fixed relative to one surface. According to the recent tribological survey, abrasive wear is responsible for the largest amount of material loss in industrial practice.

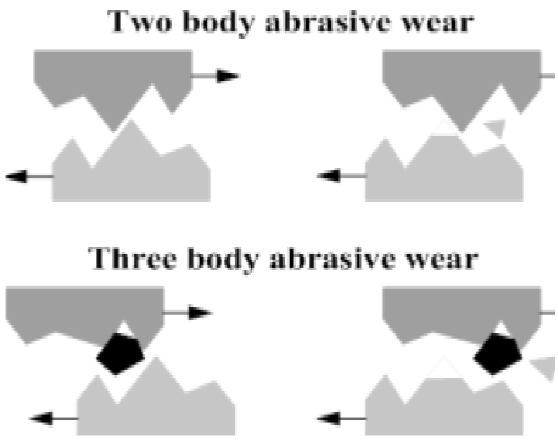

Fig 1.1 Abrasive Wear

ADHESIVE WEAR: Adhesive wear can be defined as wear due to localized bonding between contacting solid surfaces leading to material transfer between the two surfaces or the loss from either surface. For adhesive wear to occur it is necessary for the surfaces to be in intimate contact with each other. Surfaces, which are held apart by lubricating films, oxide films etc. reduce the tendency for adhesion to occur.

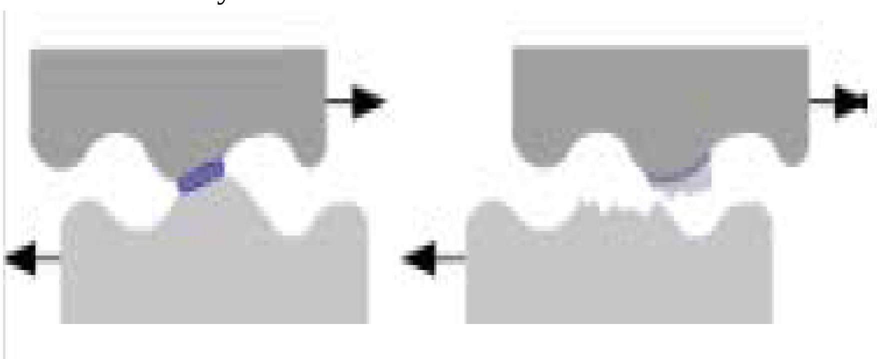

Fig: 1.2 Adhesive Wear

EROSIVE WEAR: Erosive wear can be defined as the process of metal removal due to impingement of solid particles on a surface. Erosion is caused by a gas or a liquid, which may or may not carry, entrained solid particles, impinging on a surface. When the angle of impingement is small, the wear produced is closely analogous to abrasion. When the angle of impingement is normal to the surface, material is displaced by plastic flow or is dislodged by brittle failure.

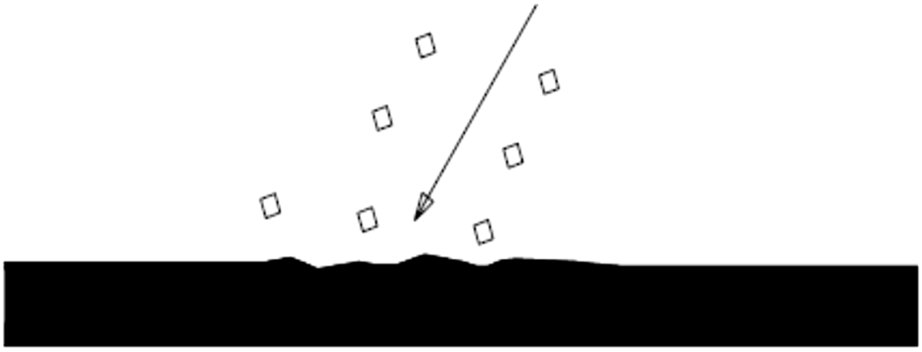

Fig: 1.3 Erosive Wear

SURFACE FATIGUE WEAR: Wear of a solid surface caused by fracture arising from material fatigue. The term fatigue is broadly applied to the failure phenomenon where a solid is subjected to cyclic loading involving tension and compression above a certain critical stress. Repeated loading causes the generation of micro cracks, usually below the surface, at the site of a pre-existing point of weakness. On subsequent loading and unloading, the micro crack propagates. Once the crack reaches the critical size, it changes its direction to emerge at the surface, and thus flat sheet like particles is detached during wearing. The number of stress cycles required to cause such failure decreases as the corresponding magnitude of stress increases. Vibration is a common cause of fatigue wear.

CORROSIVE WEAR: Most metals are thermodynamically unstable in air and react with oxygen to form an oxide, which usually develop layer or scales on the surface of metal or alloys when their interfacial bonds are poor. Corrosion wear is the gradual eating away or deterioration of unprotected metal surfaces by the effects of the atmosphere, acids, gases, alkalis, etc. This type of wear creates pits and perforations and may eventually dissolve metal parts.

Literature available on the rate of controlling abrasive wear mechanism demonstrate that it may change abruptly from one another at certain sliding velocities and contact loads, resulting in abrupt increases in wear rates. The conflicting results in the abrasive wear literature arise partly because of the differences in testing conditions, but they also make clear that a deeper understanding of the abrasive wear mechanism is required if an improvement in the wear resistances of the polymer matrix composites is to be achieved. This in turn requires a systematic study of the wear under different loads and velocities. It is generally recognized that abrasive wear is a characteristic of a system and influenced by many parameters. Laboratory scale investigation if designed properly allows careful control of the tribo system whereby the effects of different variables on wear behavior of PMCs can be isolated and determined. The data generated through such investigation under controlled conditions may help in correct interpretation of the results.

As new developments are still under way to explore innovative fields for tribo-application of natural fiber base materials, in this chapter an attempt has been made to study the potential of using Rice husk ceramic fiber (RHC) for tribological applications. In the current study the effect of fiber loading, sliding velocity and normal load on abrasive wear

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behavior of carburized rice husk ceramic field epoxy composite has been evaluated and possible wear mechanism has been discussed with SEM observation.

TYPES OF FIBER COMPOSITE

There are mainly two types of fibers use in the composite material: natural fiber and synthetic fiber.

NATURAL FIBER COMPOSITES: Fibers are a class of hair-like material that are continuous filaments or are in discrete elongated pieces, similar to pieces of thread. They can be spun into filaments, thread, or rope. They can be used as a component of composites materials.

Animal Fiber: contains wool, silk, avian fiber. It includes sheep's wool, goat hair, horse hair, feathers and feathers fiber.

a) **Mineral Fiber:** Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals.

b) **Plant Fiber**: plant fibers are generally comprised mainly of cellulose. This fiber can be further categorizes into following.

- **Seed Fiber:** Fibers collected from the seed and seed case e.g. cotton and kapok.
- **Leaf Fiber:** Fibers collected from the leaves e.g. sisal and agave.
- **Skin Fiber:** Fibers are collected from the skin or bast surrounding the stem of their respective plant. These fibers have higher tensile strength than other fibers. Therefore, these fibers are used for durable yarn, fabric, packaging, and paper. Some examples are flax, jute, banana, hemp, and soybean.
- **Fruit Fiber:** Fibers are collected from the fruit of the plant, e.g. coconut (coir) fiber.
- **Stalk Fiber:** Fibers are actually the stalks of the plants such as straws of wheat, rice, barley, and other crops including bamboo and grass. Tree wood is also such a fiber.[10]
  The some images of the natural fibers shown in the figure 1.4

(a) Banana (b) Sugarcane Bagasse (c) Curaua (d) Flax

(E) Hemp (F) Jute (G) Sisal (H) Kenaf

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Figure 1.4 Lignocellulosic reinforcements. (a) Banana; (b) sugarcane bagasse; (c) curaua; (d) flax; (e) hemp; (f) jute; (g) sisal; (h) kenaf

SYNTHETIC FIBER COMPOSITES: Synthetic fibers are the result of extensive research by scientists to improve upon naturally occurring animal and plant fibers used in making cloth and rope. A large number of synthetic fibers with a variety of properties have been produced from polymers by various spinning techniques, including melt, dry, wet and emulsion spinning. Before synthetic fibers were developed, artificial (manufactured) fibers were made from cellulose, which comes from plants. At the beginning of the twentieth century, synthetic fibers started supplementing and replacing natural fibers. The first truly synthetic fiber was nylon, followed by polyesters, poly acrylics and polyolefin. Also synthetic elastomeric, glass and aramid fibers became important commercial products.

Synthetic fibers are now available, ranging in properties from the high elongation and low-modulus elastomeric fibers, through the medium-elongation and medium modulus fibers such as polyamides and polyesters, to the low-elongation, high modulus carbon, aramid and inorganic fibers. With such a wide variety of synthetic fibers available, the volume of synthetic fibers consumed in worldwide is now greater than that of natural fibers. Most synthetic fibers have relatively smooth surfaces and they are frequently subjected to various mechanical and heat-setting processes to provide crimp.

II. LITERATURE REVIEW

N. Radhika, R. Raghu[1] The paper labels the wear behaviour of the manufactured LM 13 aluminium/B4C metal matrix composites. The influence of the parameters on the wear rate was known through analysis of variance. The parameters such as load, velocity, sliding distance and wt-% of the reinforcement. The sliding wear characteristics of the unreinforced alloy (0 wt-%) and the composites (4, 8, 12 wt-%) were studied at room temperature utilising pin-on-disc machine in dry condition. The cylindrical test pins of length 35 mm and diameter of 12 mm. and tested against rotating steel disc by applying the load. The wear behaviour of the composites was investigated as per the plan of experiments generated through the Taguchi's design and results were analysed employing the statistical software Minitab 15. The wear rate was studied. The wear behavior increases with increasing load and decreases with increasing velocity, sliding distance and wt-% of reinforcement.

Deepak Bagale, Sanjay Shekhawat, Jitendra Chaudhari[2] The effects of load, velocity of sliding and sliding distance on sliding friction and sliding wear of polymer material made (PTFE) and PTFE composites with filler materials such as 40% bronze and 40% carbon are studied. The experimental work is performed on pin-on-disc apparatus and analyzed with the help of Design-Expert 7 software. From the observation Load and sliding distance increases wear of all material goes on increasing where as velocity of sliding increases wear of all material goes on decreasing. The results of experiments are indicates that the addition of bronze and carbon filler to the PTFE decreases wear rate significantly and there is marginal increase in coefficient of friction. The addition of carbon filler to plain PTFE improves wear resistance significantly as compared to bronze filler.

Alveera Khan,M. Ayaz Ahmad, Shirish Joshi, Said A. F. Al Said[3] In the present paper, the "two body abrasive wear characteristics" have been studied for the cylindrical samples of pure epoxy and chemical treated coir fibre filled epoxy polymer composites of the size of 10 mm and 32 mm at different sliding speeds in multiphase conditions. The wear characteristics have been estimated by two parameters, the sliding speed and normal load in a single pin-on-disc wear testing machine. It has been found that the wear characteristics decreases by increasing the sliding speed in both the cases, pure epoxy and treated coir fibre filled epoxy respectively. The effect of various test parameters and their interactions have been admired to find out optimal parameter setting for minimum wear The abrasive wear behavior has been changed with respect to sliding speed and also found that on increasing the sliding speed the wear behavior decreases. Abrasive behavior of chemically treated coir fibre reinforced epoxy composite has less rate of abrasion as compared to pure epoxy composites.

Ashok Kr. Mishra *et.al* [4] considered the tribological behavior of Al-6061being Silicon carbide particles with a weight percentage of 10 and 15 as reinforcement. The composite is manufactured using stir casting process. The pin on disc is used for the dry sliding wear test of the composite. The objective of this paper is to study the influence of applied load, sliding speed and sliding distance on the wear rate. Finally the answers evidenced that the wear rate is extremely found out by the sliding distance followed by a load and sliding velocity. The applied load has also a higher impact on the coefficient of friction.

Sanjeev Das *et. al* [5] has concluded that wear resistance properties of Al–4.5 wt% Cu alloy improves significantly after addition of alumina and zircon particles. Decrease inparticle size improves wear resistance property for both alumina and zircon reinforced composites as smaller particle reinforced composite has higher hardness and is more efficient in blunting SiC abrading surface. Zircon reinforced composite shows better wear resistance than alumina reinforced composite due to its superior particle–matrix bonding.

Jaspreet Singh *et.al*[6] presented the Mechanical and Tribological behavior of Al matrix composites reinforced with SiC and Gr particulate up to 10%. Parametric studies indicate that the hardness, tensile strength of Al-SiC composite is more than that of Al-Gr composite because of high hardness of SiC particulates. As graphite being self solid lubricant property, the excess percentage reinforcement of Gr leads to decrease in wear characteristics. In this report the results depict that the either increasing of load or sliding distance or both enumerates to increase in wear. The wear is also affected by the hardness and the tensile strength of the composite.

Unal *et al* [7] studied abrasive wear behavior of polymeric materials. They concluded that the specific wear rate decreases with the decrease in abrasive surface roughness. They also concluded that, the abrasive wear include micro-cracking, micro-cutting, and micro-ploughing mechanisms. Whereas in another investigation they concluded that the sliding speed has stronger effect on the specific wear rate.

III. CONCLUSION

Following conclusions are derived from above literature survey

- The investigation on the wear behavior of the composites as the function of load, velocity, sliding distance of experiments was carried out successfully.
- Also the effect of various test parameters and their interactions have been admired to find out optimal parameter setting for minimum wear rate for characteristic of composite material.
- The wear resistance is improved by the addition of reinforcement compared to the base alloys.

- After studies some research papers of based on wear characteristic of composite material Design of experiment methods like TAGUCHI, ANOVA, Response surface method (RSM) are very effectiveness to decrease the wear rate.

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