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The Effect of Time Variation on the Wear Sliding Behavior of Composites

[1]Wafaa M. Salih, [2]Sanaa M. Salih and [1]Myada M. Salih
[1]Center of Training and Work Shops
[2]Department of Applied Science, University of Technology, Baghdad, Iraq

Abstract: Composites materials are widely used in all industries all over the world, replacing many other engineering materials. Reasons for such popularity are many, among such, are their physical and mechanical properties in addition to the simplicity of their manufacturing processes. Machine elements that are made of polymeric materials are usually exposed to different causes of failure such as wear. The time effect on the wear behaviour of some composite materials (polyester-commercially fiber reinforcement named (E-glass) was studied. In this study four type of composite different in number of layers, it had (3-6-9-12) layers (Wear volume 0.48, 0.41, 0.71 and 0.78 respectively). All experiments were conducted under dry condition. Preliminary results show the wear volume increases for all examined composites, as the statically applied load increases. Fourth type has the highest wear resistance, then third type and lastly first type. The wear volume increases for all examined composites, varied of time increases.

Key words: Wear, composite materials, polyester

INTRODUCTION

Due to their good tribological properties, coupled with their high strength-to-weight ratio and ease of manufacture, composites have become very important engineering materials and attractive alternatives for low stress applications involving wear mechanisms[1-3].

Their use is always indicated where fluids are ineffective or cannot be tolerated because of the possibility of contamination of the product or the environment, or lack of opportunity for maintenance[4]. Today they include space and aeronautical technology, automobiles, agriculture machines, vacuum and cryogenic instruments … etc.[5].

In spite of the considerable attention spent on the tribological behaviors of materials in general, the share of polymers was somewhat less. The phenomenon of wear as a collision of two moving Bodies where we have active and reactive forces of large magnitude is commonly encountered in machines such as automobiles, construction machinery and equipment and many others[6]. Literatures and published work are rare. This research is studying the time variation of some composite materials their varied in number of layers

MATERIALS AND METHODS

Experimental details: The experimental work of this research was conducted in the composite Laboratory at the Department of Mechanical Engineering, University of technology under controlled environment of (25°C) temperature and (40%) humidity. The machines and equipment which were employed consist of the following:

Wear test machine: A pin-on-disc wear testing machine of crossed cylinder configuration shown in Fig. 1 has been used to conduct the wear tests. This machine was modified from a simple general lathe and a special mechanism whish is designed and manufactured by the Authors to serve the purpose of this research. The relative motion between the stationary examined polymeric pin 1 and the rotating steel cylindrical counterpart 4, is provided by an electrical motor and a gearbox system. The cylinder is firmly held by the machine jaws 9. The examined pin 1 is held in its position by a pin holder which is, in turn, attached to a horizontal arm. The arm is hinged to the support 6 at one of its two ends and to the static load hanger 2 at the other. The static load 3 is applied to the pin by adding known weights to the static load hanger 2. The vertical impact load 10 is applied to the pin by allowing a solid object of known weight to freely fall, from certain distance, over the pin. Complete information and full description of this modified wear test machine is presented in reference[7].

Corresponding Author: Sanaa M. Salih, Department of Applied Science, University of Technology, Baghdad, Iraq

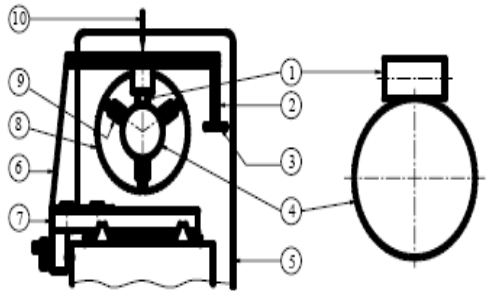

Fig. 1: Pin-on disc wear test machine. (1): Pin, (2): Load hanger, (3): Applied load, (4): Disc, (5): Speed box, (6): Supports, (7): Carriage, (8): Disc holder, (9): Jaws, (10): Impact force

Composites specimens' materials and preparation: one type of composite materials was examined in this research work namely: (polyester-commercially fiber reinforcement named (E-glass)) this type of composite change in number of layers it had (3-6-9-12) layers respectively there are varied in weight, thickness, but they same in properties. All these models are tested, its properties are tabulated in the attached table. The tests specimens were turned from solid bars into a cylindrical shape and cut to the required size, of 30 mm diameter and 50 mm length.

Wear volume measurement: To derive the wear volume for each run, the examined specimen is weighed before and after each run. Then the wear volume was obtained from the difference in weights.

Experimental procedure: Steps of procedure were devised by the authors and strictly followed. All non-related parameters such as: load, sliding distance, sliding speed, counterpart surface roughness, laboratory temperature and humidity were kept constant at: 20 N, 960 m, 1.32 m sec^{-1}, 20 μm, 25°C and 40% respectively.

Procedure steps:

Varied static load: After preparing the cylindrical mild steel counterpart to the required surface roughness and texture, the cylinder was cleaned and thoroughly washed by (Acetone) before each run. To minimize the effect of the plasticization due to the use of the acetone for cleaning from all stains, grease ... etc., each examined polymeric specimen is firstly thoroughly washed by distilled water, then cleaned by a smooth cotton clothe, which is saturated by acetone and then quickly dried. Then the specimen is weighed, placed in the seat of specimen holder and carefully lowered over the cylindrical surface of the counterpart in crossed cylinder configuration. The load is then applied to the load hanger and the machine is started. At the end of each run, the machine is stopped, the specimen is released from the holder, cleaned and weighed again. On restarting the test, the cylindrical counterpart is re-polished again to the same surface roughness and then cleaned from all debris or polymeric fibrils, the wear specimen is replaced by a fresh one and rested on the counterpart. Then all other described steps were repeated. For the accuracy purposes, each experiment was repeated the least of two times and average readings were recorded. The static applied load was varied in the range of (10-50) N at an increment of (10 N) at a constant time. The effect of static applied load on wear volume was in Fig. 2.

Table 1: Manufacturer properties of examined materials

Specimen type	E_1 Mpa	E_2 MPa	E_3 MPa	$\sigma ultt_1$ MPa	$\sigma ultt_2$ MPa	$\sigma ultt_3$ MPa
Fiber glass with	328	328	-	123	123	-
polyester matrix	329	329	-	123	123	-

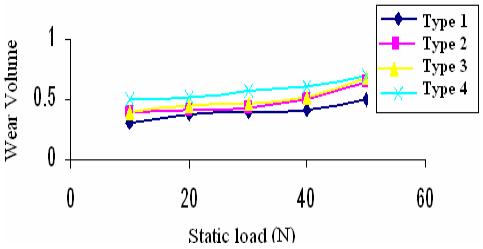

Fig. 2: Variation of wear volume with static load

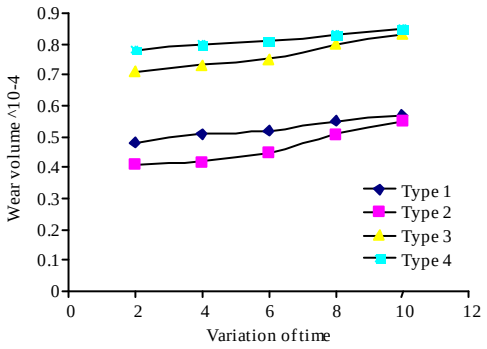

Fig. 3: Comparison of wear variation with time

Varied time: In addition to the above steps, a constant value of (20 N) over all apperiments. The time was varied in (5-20) min at increment of (5) min. The effects of variation of time on the wear volume of all examined materials were established and drawn in Fig. 3.

RESULTS

The effects of statically applied loads on the wear volume and a comparison of the results for the case of static load tests are drawn in Fig. 2 as follows: Figure 2, shows the variation of composite wear volume with the statically applied load It illustrates that the wear volume increases as applied load increase for four types of layers, the wear volume is in lower level in type (1) than type (4).

Figure 3 shows the variation of wear volume with the varied of time and the wear volume increases for all conditions, but at second min. the wear volume increase for four types nearly same (3-layers wear volume is 0.48),(6-layers wear volume is 0.41),(9-layers wear volume is 0.71),(12-layers wear volume is 0.78). However, the presence of type (1) tends to reduce the wear volume to lower level than type (2).

CONCLUSION

In this study studying the time variation of some composite materials their varied in number of layers Based on this study, the following conclusions can be drawn:

- The wear volume increases for all examined composites, as the statically applied load increases
- Fourth Type have the highest wear resistance, then third type and lastly first type
- The wear volume increases for all examined composites, varied of time increases

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