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Influence of Coating with Some Natural Based Materials on the Erosion Wear Behavior of Glass Fiber Reinforced Epoxy Resin

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Abstract

In the present study, composites were prepared by Hand lay-up molding. The composites constituents were epoxy resin as a matrix, 6% volume fractions of glass fibers (G.F) as reinforcement and 3%, 6% volume fractions of preparation natural material (Rice Husk Ash, Carrot Powder, and Sawdust) as filler. Studied the erosion wear behavior and coating by natural wastes (Rice Husk Ash) with epoxy resin after erosion. The results showed the non – reinforced epoxy have lower resistance erosion than natural based material composites and the specimen (Epoxy+6%glass fiber+6%RHA) has higher resistance erosion than composites reinforced with carrot powder and sawdust at 30cm , angle 60°, grin size of sand 425µm , temperature 30Ċ , 300 gm salt content in 2liter of water and 15 hour. Coating specimen with mixed epoxy resin -RHA with particles size in the range (1.4-4.2) µm improves erosion wear resistance characteristics of the coated specimen, coating thickness was (16 ± 1) µm and after erosion at (15 hour) the thickness was (10) µm .

Keywords: *Composites, Preparation of natural materials, Erosion wear, glass fiber, Coating.*

1. Introduction

Epoxy resin is widely used in a variety of technical applications such as adhesives, protective coatings, sealants, and matrices for composite materials in aerospace and leisure industries [1]. This wide range of applications arises from characteristics of epoxy resins including high chemical and corrosion resistance, good mechanical and thermal properties, adhesion to various substrates, low shrinkage upon cure, flexibility, good electrical properties, and easy processability [1, 2]. However, despite these advantages, there are also some drawbacks: high water uptake, moisture absorption and brittle nature owing to their highly cross-linked structures, low wear resistance and high friction coefficient. Many of our technologies require materials with unusual combinations of properties that cannot be met by the conventional metal alloy, ceramics and polymeric materials. A composite is a multiphase material that is artificially made and chemically dissimilar and separated by distinct interface. One of these phases is termed the matrix which is continuous and surrounds the other phase often called the reinforcement phase which consists of three main divisions: particles, fibers and structure, which should be much stiffer and stronger than the matrix. Polymeric composite is considered the earliest type of composite that is used in the greatest diversity of composite applications as well as in the largest quantities in the light of

suitable ambient temperature properties, ease of fabrication, low density, good ductility and low cost. Polymeric materials could be classified according to behavior with rising temperature in to (Thermosets, Thermoplastics) [3, 4, and 5]. Fiber –reinforced polymer (FRP) composites are widely used in design due to relatively low-density and reliable tailoring capability to provide the required strength and stiffness. Numerous possible capabilities and low noise make the (FRP) composites as better substitute over conventional metallic materials for tribological application. The different application areas are gears, cams, wheels, impellers, brakes, artificial prosthetic joints, seals, bushes, bearings, ect…. [6]. Solid particle erosion is one type of wear that causes. local damage combined with the progressive loss of original material from a solid surface due to micro mechanical interaction between that surface and solid particles. It has been reported that the surfaces of (FRP) **Aireddy H. and Mishra S.C. (2011)** have studied the effects of impact velocity and erodent particle size on the solid particle erosive behavior of coir dust reinforced polymer composites. The erodent used here is silica sand having the size range 200-600 μm. However it was found that the erosion wear rate was decreased with increasing the coir dust amount because at higher amount of coir dust the mechanism dominated by the fiber material which is soft compare with the matrix material . Decrement of erosion wear has been observed with increasing erodent particle size , the highest erosion wear rate at 90° impingement angle [8].

Mohammed Ismail et. al., (2012) have studied th**e** carbon fabric reinforced epoxy (C-E) composites filled with different weight proportions of fly ash cenosphere (CSP) were fabricated by hand layup technique followed by compression molding. The solid particle erosion characteristics of the (CSP) filled (C-E) composites have been studied and the experimental results are compared with those of unfilled (C-E) composites. For this, an air jet type erosion test rig and Taguchi orthogonal arrays have been used. The findings of the experiments indicate that the rate of erosion by impact of solid erodent has been greatly influenced by various control factors. The tensile modulus and flexural modulus of cenospheres filled (C-E) composites showed good improvement compared with that of the unfilled (C-E) composites. Low density 0.6 g/cm^3 and higher silica content 60% of cenospheres seems to be the reason for this observation. The comparative study indicates that the (CSP) filled (C-E) composites exhibit better equipments operating in erosion environments were impacted by the solid particles contained in the air or water, which destroy the materials. It was widely recognized that polymers and their composites had poorer erosion resistance than metals, and that polymer composites containing reinforcement fiber (FRP) usually erode faster than neat polymers. In other words, the reinforcement fiber could enhance the strength of polymer composites, but reduced the erosion resistance of the polymer composites in generally. In order to reveal the facts about erosion wear of polymer matrix composites, this study investigated some of the physical and mechanical properties of composites materials fiber reinforced polymer; then investigating the erosion behavior of these composites. It was feasible to prepare composites with high strength, low density and excellent erosion resistance by composites structure [7]. There are many studies about erosion wear behavior of composite material erosive wear performance than that of the unfilled (C-E) composites. The (CSP) filled and unfilled (C-E) composites showed ductile erosion behavior, with maximum erosion at 30° impingement angle. Overall the erosion rate was found to increase with impact velocity. Furthermore, the filler content is the powerful influencing factor followed by impact velocity, impingement angle, erodent size and erosion time during the erosive wear process [9].

Kouloumbi N . et. al.,(1996) have studied the steel specimens were coated by a spinning process with particulate polymeric composites consisting of an epoxy resin (DOW 33 1) and iron powder. Applied coatings were roughly 70 pm thick and the contained quantity of iron particles was varied 7.5, 15, 30% wt. The effect of the presence of iron particles in the coatings as well as the influence of their concentration on the evaluation of the coatings' behavior in a corrosive environment 3.5% NaCl . Electrochemical impedance spectroscopy, corrosion potential, corrosion current density (Tafel) and dielectric measurements were performed. Minor differences in the anticorrosive behavior of the coatings were observed irrespective of the iron content in the coating. Effective resistance inhibition action of the composite coatings has been diminished with the increase of exposure time to the corrosive environment being in all cases very close to that of the pure epoxy resin coatings [10].

Amar Patnaik et. al., (2010) have studied the fiber reinforced polymer composites often have to function in severe erosive environment in which they encounter solid particle erosion. In hybrid

composites consisting of reinforcing fibers and particulate filled polymer matrices, the filler material plays a major role in determining the magnitude and mechanism of damage due to erosion. Study of the influence of three different particulate fillers namely fly ash, alumina (Al_2O_3) and silicon carbide (SiC) on the erosion characteristics of glass polyester composites. For this purpose, an air jet type erosion test configuration and the design of experiments approach utilizing Taguchi's orthogonal arrays are used. The wear rates are found to be in good agreement with the theoretical values obtained from an existing prediction model. This study reveals that addition of hard particulate fillers like flyash,(Al_2O_3) and (SiC) improves the erosion resistance of glass polyester composites significantly [11].

Bagci et M. al., (2011) have studied the materials added to the matrix help improving operating properties of a composite. This experimental study has targeted to investigate this aim where (silicon oxide) particles have been added to glass fibre and epoxy resin at an amount of 15% to the main material to obtain a sort of new composite material. Erosive wear behavior of epoxy-resin dipped composite materials reinforced with glass fibre and (silicon oxide) under three different impingement angles 30°, 60° and 90°, three different impact velocities 23, 34 and 53 m/s, two different angular Aluminum abrasive particle sizes approximately 200 and 400 μm and the fiber orientation of 45° (45/-45) have been investigated. In the test results, erosion rates are obtained as functions of impingement angles, impact velocities, particle sizes and fiber orientation. Moreover, materials with addition of (silicon oxide) filler material exhibited lower wear as compared to neat materials with no added filler material. The results show the wear of (GF/EP) (Neat) test specimens is higher than that of (GF/EP) (silicon oxide) test specimens. That is; the added (silicon oxide) particles impose positive effects on erosive wear and thus decreasing the erosion rates, all composites regardless of their different features exhibit maximum erosion rates at 30° impingement angle and thus exhibiting similar behavior as that observed for ductile materials, large abrasive particles lead to an increase in wear. a marked increase in erosion rate was observed as the abrasive particle size increased from 200 to 400μm ,test specimens with (45/-45) fiber orientation are more wear resistant than their counter parts with 0/90 fiber orientation [12].

2. Erosion Wear

Erosion wear, which arises from solid particle impacting, is one of the major failure modes that cause offshore structure damage. Erosion is found in a wide range of equipments in offshore industry, in which solid particles are entrained into fluid flow in the operating process, such as gas turbine, oil & gas pipeline, drilling platforms, etc [13]. This damage mode affects not only operating process, but also safety and economics as well. Therefore, it is necessary to find a good predictive method to accurately predict the erosion rate for offshore equipment. The erosion mechanism is different in ductile and brittle materials as shows in Fig. (1). A number of studies have been performed to reveal the erosion mechanisms of ductile and brittle materials [14, 15]. It is now known that brittle materials erode by cracking and chipping, while ductile materials erode by a sequence of micro-cutting, forging and fracture, etc [16]. Hence, erosion rate and mechanism are highly dependent on material types. Erosion rate of the volume loss (v) is defined by the following equation [7]

$$V = \frac{\varepsilon}{\rho} = \frac{W_L}{W_s * \rho}$$

where
ε: erosion rate of weight loss.
W_L: weight loss of the specimen (gm).
Ws: total weight (gm).
ρ: density of the tested material (g/cm^3) .

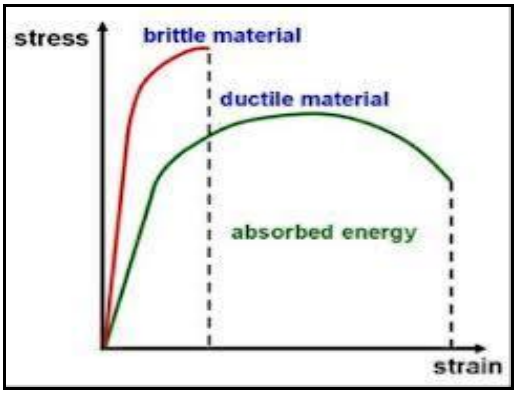


Fig. 1. Behavior of brittle and ductile material.

3. Experimental Work (Preparation of Natural Materials)

a- Carrot Powder

Carrot seeds were purchased locally from vegetable supplier. They were cleaned to remove all foreign matter such as dust, dirt, and stones. The juice was removed from carrot seeds the solid waste from carrot juice is rich in fiber which regarded as a functional fiber source. The waste was dried to a constant weight and then grounded by using a grinder and sieved. Two sizes were obtained, once (fine fiber) is less than 50 µm and the other (coarse fiber) is between 100-150 µm which represent as accumulated fibers [17].

b- Rice Husk Ash

Rice-husk is an agricultural by-product material. It constitutes about 20% of the weight of rice. It contains about 50% cellulose, 25–30% lignin, and 15–20% of silica. When rice-husk is burnt rice-husk ash (RHA) is generated. On burning, cellulose and lignin are removed leaving behind silica ash. The controlled temperature and environment of burning yields better quality of rice-husk ash as its particle size and specific surface area are dependent on burning condition [18, 19]. To produce the best pozzolanas, the burning of the husk must be carefully controlled to keep the temperature below 700°C and to ensure that the creation of carbon is kept to a minimum by supplying an adequate quantity of air. At burning temperatures below 700°C an ash rich in amorphous silica is formed which is highly reactive. Temperatures above 700°C produce crystalline silica which is far less reactive. The presence of large quantities of carbon in the ash will adversely affect the strength; the carbon content of the ash should be limited to a maximum of 10%. There are several designs of small simple incinerators, normally made of fired clay bricks, which are capable of burning ash at temperatures below 700°C and without excessive quantities of carbon [20].

The second step in processing is milling the RHA to a fine powder, and ball or hammer mills are usually used for this purpose. Crystalline ash is harder and will require more milling in order to achieve the desired fineness [21]. Suitability of RHA mainly depends on the chemical composition of ash, predominantly silica content in it. RHA is found to be superior to other supplementary materials like slag, silica fume and fly ash [22, 23].

c- Sawdust (wood powder)

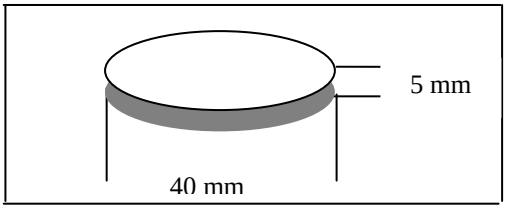
Sawdust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool; it is composed of fine particles of sawdust. It is also the byproduct of certain animals, birds and insects which live in wood, such as the woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of its flammability. Sawdust is the main component of particleboard [24].

4. Specimen Preparation

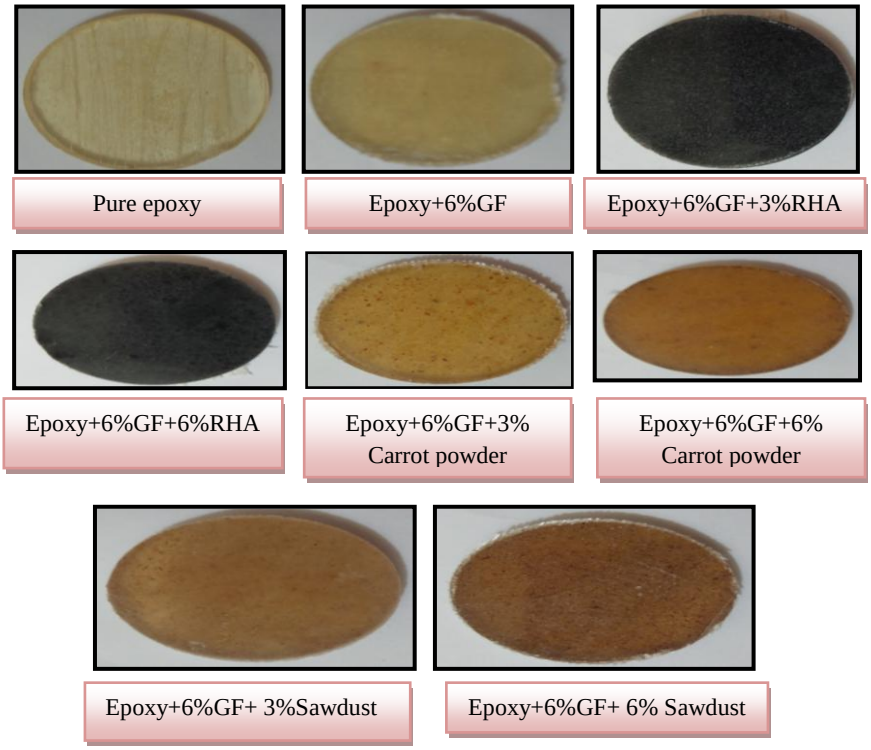
The basic materials used in the preparation of research specimen consisting epoxy resin Quickmast (105) base as the matrix with a density of (1.2 gm / cm^3) with (6%) volume fraction of glass fibers (Woven E- Glass Fiber) and 3% , 6% volume fraction of natural powder (RHA ,Carrot powder ,Sawdust) . All the required moulds for preparing the specimens were made from glass with dimensions of (150×150×5) mm. The inner face of the mould was covered with a layer of nylon (thermal paper) made from polyvinyl alcohol (PVA) so as to ensure no-adhesion of the resin with the mould. The method used in the preparation of the specimen in this research is the (Hand lay –Up) molding.

5. Erosion Wear Test

This test is performed according to (ASTM G76) at room temperature [25, 26]. Samples have been cut into a diameter of (40mm) and a thickness of (5mm). Fig. (2) Shows standard specimens for erosion wear [27].



(a)



(b)

Fig . 2. a.b. Standard specimens.

The used device for erosion is locally manufactured the principal scheme is shown Fig. (3). the Perspex tank is used as a chamber has dimensions of (40) cm in length, (20) cm in height, and (20) cm in width. The pump joints and valves connected to the chamber are made from steel and slurry as well as jet nozzle. The distance between the nozzle and the sample tube are (20, 25, 30) cm, pump diameter is (40) mm and the nozzle diameter (5mm). Erosion tests are performed by changing the angle between the fluid flow and the horizontal axis of the test specimen (α), at three levels (90°, 60°, 30°). It is operating flow rate (35 L⁄min). The fluid used in the erosion tests are sand water contains a solid particles of abrasives with different sizes (425, 600,800) μm .In this work, an orthogonal array of the type (L_{18}) has been chosen since there are eight factors (variables) and three levels [28] as shown in Fig.4(design of the orthogonal array L18) . During the erosion wear test, eight test factors for each type of composites are considered, these are: (1) Test time; (2) Reinforcement volume fraction; (3) Stand-off distance; (4) angle; (5) grin size ;(6) Temperature; (7) salt content; and (8) water content each at three levels.

Fig .3. Erosion wear device.

Experment	P1	P2	P3	P4	P5	P6	P7	P8
1	1	1	1	1	1	1	1	1
2	1	1	2	2	2	2	2	2
3	1	1	3	3	3	3	3	3
4	1	2	1	1	2	2	3	3
5	1	2	2	2	3	3	1	1
6	1	2	3	3	1	1	2	2
7	1	3	1	2	1	3	2	3
8	1	3	2	3	2	1	3	1
9	1	3	3	1	3	2	1	2
10	2	1	1	3	3	2	2	1
11	2	1	2	1	1	3	3	2
12	2	1	3	2	2	1	1	3
13	2	2	1	2	3	1	3	2
14	2	2	2	3	1	2	1	3
15	2	2	3	1	2	3	2	1
16	2	3	1	3	2	3	1	2
17	2	3	2	1	3	1	2	3
18	2	3	3	2	1	2	3	1

Fig. 4. Design of the orthogonal array (L_{18}).

6. Coating

In this work the spin coating used of coating all the specimens that have been erosion will be specifications (mode 410, origin Taiwan), as shown in Fig.5. (Spin coater device). Spin coating is a procedure used to deposit uniform thin films to flat substrates. Usually a small amount of coating material is applied on the center of the substrate, which is either spinning at low speed or not spinning at all. The substrate is then rotated at high speed in order to spread the coating material by centrifugal force. A machine used for spin coating is called a spin coater, or simply spinner. Rotation is continued while the fluid spins off the edges of the substrate, until the desired thickness of the film is achieved. During spin coating, a polymer solution in a solvent is applied to the center of a flat substrate. The spin coater rotates the substrate at high speed in order to spread the fluid by the centrifugal force. Because the solvent is volatile, a thin layer of polymer will be left at the substrate. The thickness and uniformity of such film are greatly affected by the polymer solution and spin speed. The thickness of the film also depends on the viscosity and concentration of the solution and the solvent [29].

Fig . 5. Spin coater device.

7. Spin Coating Process

Spin coating has been used for several decades for the application of thin films. A typical process involves depositing a Small puddle of a fluid resin onto the center of a substrate and then spinning the substrate at high speed (typically around3000 rpm). Centripetal acceleration will cause the resin to spread to, and eventually off, the edge of the substrate leaving a thin film of resin on the surface. Final film thickness and other properties will depend on the nature of the resin (viscosity, drying rate, percent solids, surface tension, etc.) and the parameters chosen for the spin process.

One of the most important factors in spin coating is repeatability. Subtle variations in the parameters that define the spin process can result in drastic variations in the coated film [30].

In this research was the preparation steps for the purpose of coating mixing are the following :

1. Weight 10 gm from epoxy.
2. Weight 7 gm from hardener.
3. Weight 10 gm from rice husk ahs
4. Mixing the epoxy with the hardener continuously and slowly by using a glass rod so as to avoid bubbles. The mixing is carried out at room temperature.
5. Adding the powder (rice husk ash) intermittently in to the mixture and stirring it for a period of (10-15) minutes to obtain homogeneity.
6. Pouring the mixture to the sample (which does not have the resistance of the erosion ware to improve the resistance to wear erosion) is installed in the device (spin coater) slowly , after proving parameter device which is (time ;3000 sec ,speed ;1000 RPM " revolutions per minute" ;& Accelerate ;8 sec) the spin coater distribute the mixing evenly on the sample. Fig.6. shows the specimens after coating by used spin coating.

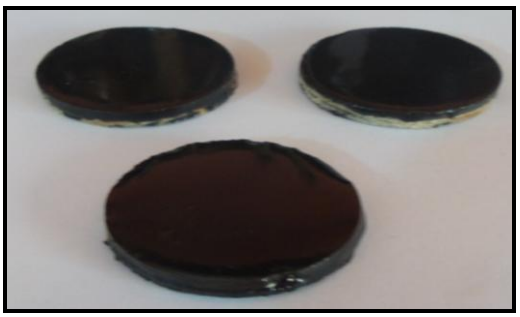


Fig .6. Some of specimens after coating.

8. Results and Discussion

8.1. Erosion Wear

The results of erosion wear for the pure epoxy and nature based material composites are illustrated in Fig .7. Particle impingement produces rise in temperature of the surface which makes the matrix deformation easy because the high temperature known to occur in solid particle erosion invariably soften the matrix [31]. On impact the erodent particle kinetic energy is transferred to the composite body that leads to crater formation and subsequently material loss [32]. The results show, the nature based material composites give the lower erosion wear when they are compared with the other (Pure Epoxy and Epoxy +6%Glass Fiber) composite. The reason is that the presence of reinforcement and filler powder in the matrix helps in absorbing the kinetic energy produced by the impacted erodent particles and therefore making the energy available for the plastic deformation of the matrix to become less [32]. It is clear from Fig .7. That addition of powder fillers significantly reduces the rate of material loss. From the Fig .7. it is clear that there is a pronounced effect of the addition of 6% glass fiber with 3% and 6% volume frication from (natural powder) percents on the erosion wear ,it can seen the specimen (Epoxy +6% Glass Fiber +3%,6% RHA) give better erosion resistance than the composites filled with (3% and 6% for Carrot powder and Sawdust) at (15 hour) time , (30 cm) stand-off distance, (60°) angle, (425µm) grin size of sand ,(30c°) temperature,(300 g) salt content in (2 liter) water content. Which may be related to its lower grain size with a good distribution and bonding and since RHA is hard, wear-resistant and has high strength and stiffness. Thermoplastic matrix composites usually show ductile erosion while the thermosetting ones erode in a brittle manner. Thus the erosion wear behavior of polymer composites can be grouped into ductile and brittle categories although this grouping is not definitive because the erosion characteristics equally depend on the experimental conditions as on composition of the target material [32]. In the present study the results show the peak erosion taking place at an impact angle of 30° and 90°. This clearly indicates that nature based material composites respond to solid particle erosion not in neither a purely ductile nor a purely brittle manner. This behavior can be termed as semi-ductile in nature. The loss of ductility may be attributed to the incorporation of glass fibers and natural powder both of which are brittle, therefore the used glass fiber and filler (RHA) they give the lower erosion wear rate at an impact angle of 30°. This indicates that bonding in between composite constituents is also an important factor in determining and giving lower erosion. The high erosion wear of (Sawdust) in nature based material composites may be related to the poor linkage between matrix material and fillers with the matrix.

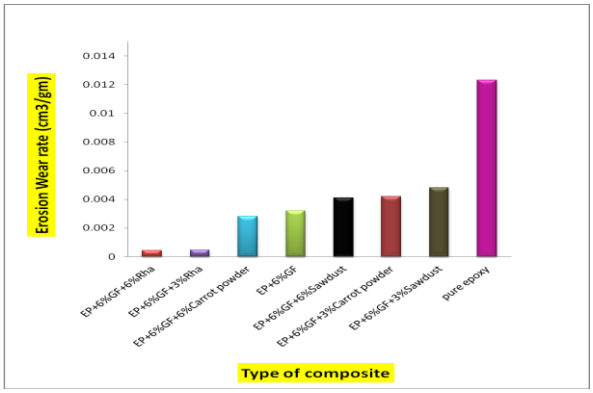


Fig. 7. Erosion wear of natural composites materials for 15 hours.

8.2. Coating

The results of coating and erosion wear after coating for the pure epoxy and natural composites are illustrated in table (1). It is proposed to use the RHA with (particle size 1.4-4.2 µm) natural waste in industry as additive to epoxy resin as coating of thermosetting specimen. Erosions characteristics of uncoated samples are depicted in fig.(7). The (epoxy+6% glass fiber + 6% RHA) experiment showed the best resistance to erosion among the natural-based materials. The (pure epoxy) experiment (10) has been characterized by the following parameters; erosion time of (15 hours), distance of (20 cm), (90°) of impingement angle, (850 µm) grain size, (30 Ċ) temperature, (200 gm) salt in (2 liters) of water. The weight of the investigated sample of experiment (10) before coating has been equal to (7.5743 gm), after coating the total weight amounted to (7.9042 gm) which corresponds to a coating thickness of (16 ± 1) µm. After erosion, the sample weight has been found equal to (7.9030gm) with a loss of (0.0012 gm) from the coating layer only. This has been verified under the optical microscope where the coating layer after erosion was measured equal to 10 µm as shown in fig.(8). The (epoxy+6% glass fiber) experiment (13) has been characterized by the following parameters; erosion time of

(15 hours), distance of (20 cm), (60°) of impingement angle, (850 μm) grain size, (25 Ċ) temperature, (300 gm) salt in (2.5 liters) of water. The weight of the investigated sample of experiment (13) before coating has been equal to (8.3234gm), after coating the total weight amounted to (8.6623 gm). After erosion, the sample weight has been found equal to (8.6614 gm) with a loss of (0.0009 gm) from the coating layer only.

The (epoxy+6% glass fiber +3%RHA) experiment (17) has been characterized by the following parameters; erosion time of (15 hours), distance of (25 cm), (30°) of impingement angle, (850 μm) grain size, (25 Ċ) temperature, (200 gm) salt in (3 liters) of water. The weight of the investigated sample of experiment (17) before coating has been equal to (8.4530 gm), after coating the total weight amounted to (8.7915 gm). After erosion, the sample weight has been found equal to (8.7913 gm) with a loss of (0.0002 gm) from the coating layer only.

The weight of the (epoxy+6% glass fiber +6% RHA) sample before coating has been equal to (8.7432 gm), after coating the total weight amounted to (9.0725 gm). After erosion, the sample weight has been found equal to (9.0724 gm) with a loss of (0.0001 gm) from the coating layer only. The weight of the (epoxy+6% glass fiber +3% carrot powders) sample before coating has been equal to (8.7630 gm), after coating the total weight amounted to (9.1025 gm). After erosion, the sample weight has been found equal to (9.1020 gm) with a loss of (0.0005 gm) from the coating layer only.

The weight of the (Epoxy+6%G.F+6% Carrot powder) sample before coating has been equal to (9.0170 gm), after coating the total weight amounted to (9.3468 gm). After erosion, the sample weight has been found equal to (9.3464 gm) with a loss of (0.0004 gm) from the coating layer only.

The weight of the (epoxy+6% glass fiber +3% Sawdust) sample before coating has been equal to (8.2200 gm), after coating the total weight amounted to (8.5589 gm). After erosion, the sample weight has been found equal to (8.5581 gm) with a loss of (0.0008 gm) from the coating layer only.

The weight of the (epoxy+6% glass fiber +6% Sawdust) sample before coating has been equal to (8.5590 gm), after coating the total weight amounted to (8.8885 gm). After erosion, the sample weight has been found equal to (8.8879 gm) with a loss of (0.0006 gm) from the coating layer only.

Table 1,
Coating and erosion wear after coating for the pure epoxy and nature based material composites.

Composites	Weight before erosion	Weight after erosion at 15 hour	Weight after coating	Weight after erosion at 15 hour
Pure epoxy	7.7006	7.5743	7.9042	7.9030
Epoxy+6% glass fiber	8.3645	8.3234	8.6623	8.6614
Epoxy+6% GF+3%RHA	8.4597	8.4530	8.7915	8.7913
Epoxy+6% GF+6%RHA	8.7495	8.7432	9.0725	9.0724
Epoxy+6% GF+3% Carrot powder	8.8148	8.7630	9.1025	9.1020
Epoxy+6% GF+6% Carrot powder	9.0497	9.0170	9.3468	9.3464
Epoxy+6% GF+3% Sawdust	8.2750	8.2200	8.5589	8.5581
Epoxy+6% GF+6% Sawdust	8.6127	8.5590	8.8885	8.8879

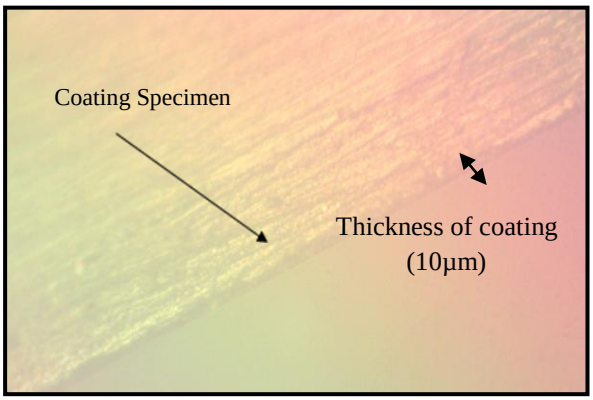


Fig . 8. Specimen after Coating and erosion wear at 15 hour .

9. Conclusions

The conclusions drawn from the present work are:

The natural composites give the lower erosion wear than (pure epoxy and epoxy +6% glass fiber) composite material. Composites with (epoxy +6% glass fiber +6%RHA) give better erosion resistance at (30 cm) stand – off distance , (60°) angle , (425µm) grin size of sand , (30Ċ) temperature , (300 gm) salt content in (2liter) of water and (15hours) time , while the higher erosion wear is for the (epoxy +6% glass fiber+6% sawdust) .The loss of weight of pure epoxy (0.1%) for (epoxy+6%glass fiber) (0.04%) for (epoxy+6%glass fiber+6%RHA) (0.006%). Results that coating specimens with RHA-mixed epoxy resin improve erosion wear resistance characteristics of the coated specimens**.**

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تأثير الطلاء لبعض المواد المتراكبة التي اساسها مواد طبيعية على سلوك بلى التعرية لراتنج الايبوكسي المدعم بالالياف الزجاجية

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الخلاصة

تم في هذا البحث تحضير المواد المتراكبة بوس اطة طريقة القولبة اليدوية . تتكون المواد المتراكبة من راتنج الايبوكسي ماده اساس والياف الزجاج مادة تقوية بكسر حجمي ٦% و مساحيق طبيعية محضرة (رماد قشور الرز و مسحوق الجزر و بودرة الخشب) بكسر حجمي (٣% ، ٦%) . دراسة سلوك بلى التعرية والطلاء بو ساطة النفايات الطبيعية (رماد قشور الرز) مع راتنج الايبوكسي بعد التعرية . النتائج اظهرت بان الايبوكسي غير المقوى يمتلك مقاومة للتعرية قليلة من المواد المتراكبة التي اساسها مو اد طبيعة والعينة (الايبوكسي + ٦%الالياف زجاج + ٦% رماد قشور الرز) تملك مقاومة للتعرية من المواد المتراكبة المدعمة بمسحوق الجزر وبودرة الخشب عند٢٥ سم ، زاوية ٣٠°، حجم دقائق تعرية ٨٥٠ مايكرون ، ودرجة حرارة ٢٥Ċ ، ٢٠٠ غم ملح في ٣ لتر من ماء ١٥ ساعة . طلاء العينات براتنج الايبوكسي مع رماد قشور الرز مع حجم حبيبي ضمن المدى (١.٤-٢.٤) مايكرون لتحسين خواص مقاومة التعرية للعينات التي تم طلائها ، وسمك الطلاء كان (1 ± 16) مايكرون وبعد التعرية عند ١٥ ساعة اصبح سمك الطلاء (١٠) مايكرون .