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EFFECT OF DATE PALM SEEDS ON THE TRIBOLOGICAL BEHAVIOUR OF POLYESTER COMPOSITES

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ABSTRACT
Natural Fiber Reinforcement Polymeric Composites (NFRPC) used in the recent days in wide range of industrial applications. For its good environmental properties and availability,natural fibers and natural additives used as reinforcing material for most of polymeric composites. In the present work,polyester composites filled by date seeds powder as a natural filling material were proposed as (NFRPC). Effect of different parameters on the tribological behavior of the proposed composite is studied.The proposed variables are; applied normal load, sliding speed, sliding distance and the percentage of filler contents. Pin on Disk tribodevice is designed and constructed for the tribological measurements. Friction coefficient and rate of wear for the proposed composites have been obtained. The results show that; the coefficient of friction for polyester composites filled with date seed powder decreases with increase of filler under high contact pressure, beside the increase of velocity decreases friction coefficient. Rate of wear shows relative increase under high sliding velocity and high pressure. There is a significant effect of the applied load (contact pressure) and sliding velocity on the wear rate of polyester composite filled with date seed.

KEYWORDS
Polymer composites, natural fillers, green composites, friction, wear.

INTRODUCTION

In the recent decades more effortsspent to looking for an alternatives (non conventional) materials for the industrial applications.Many scientific researches employed to find new materials with desirable and Distinctive properties. Polymer composites filled/reinforced with natural fillers/fibers are the proposed materials; these are low weight, easy for manufacturing and fabrication, high resistance for chemicals and friendly environmental materials. Polyester composites are commonly used nowadays in industrial applications such as bearing materials, brake pads materials and flooring materials. It was concluded that using of agricultural wastes as a filling material improve the mechanical and tribological properties of polyester composites, [1 - 4]. Environmental awareness among all over the world also provided reasons for the focus of the attention towards the use of green fiber polymer composites. The availability of the natural fibres of plant origin in abundance has also been a reason for the study in this area. Specific properties of natural fiber composite

such as light weight, low cost, renewable in nature, high specific strength and modulus have widened the usage over other materials. Kumar et al. concluded that; the mechanical behaviour of sundi wood dust reinforced epoxy composite is studied under the variation of filler content and speed. The experimental results support that successful fabrication of sundi wood dust reinforced epoxycomposites is possible and that sundi wood dust possesses good filler characteristics as it improves the tensile andflexural properties of the polymeric resin. Composites based on natural fiber reinforcement have generated wide research and engineering interest in the last few decades due to their small density, high specific strength, low cost, light weight, recyclability and biodegradability and has earned a special category of green composite, [5]. Polymer matrix materials such as unsaturated polyester, epoxy resin, polyethylene and polypropylene reinforced by the commonly available natural plant fibres that are cheap and abundant in nature, [6]. Mirmehdi et al. found that the flexural strength and tensile strength of date wood palm flour based polyethylene composite was decreased by increasing the filler content while the flexural modulus was increased, [7]. Sudheer et al. reported that Dry sliding performance of epoxy/glass composites were poor and it improved after addition of ceramic whiskers and graphite,ceramic whiskers alone has increased the friction coefficient whereas graphite has considerably reduced the friction coefficient of end composites. However both fillers have improved the wear resistance property of epoxy/glass composites, [8]. During last few years, the interest in using natural fibers as reinforcement in polymers has increased dramatically. Natural fibers are not only strong and lightweight but also relatively very cheap. Vivek Mishra et al. were proposeda jute fiber asa new set of natural fiber based polymer composites consisting of bidirectional jute fiber mat as reinforcement and epoxy resin as matrix material, [9]. Jyoti R. Mohanty et al. investigated experimentally the effect of fiber contents on wear behavior of date palm leaf reinforced polyvinyl pyrrolidone (PVP/DPL) composites, and they found that incorporation of date palm leaf fibers leads to significant improvement in the wear resistance of composites up to optimum fiber content and then decreases as fiber content increases. Further, it is found that surface modification has significant effect on wear performance. Worn surfaces of some selected samples were studied by scanning electron microscopy to analyze the wear mechanism, [10]. The increasing demand for greener and biodegradable materials leading to the satisfaction of society requires a compelling towards the advancement of nanomaterials science. The polymeric matrix materials with suitable and proper filler, better filler/matrix interaction together with advanced and new methods or approaches are able to develop polymeric composites which show great prospective applications in constructions and buildings, automotive, aerospace and packaging industries, [11]. Composite materials especially the fiber reinforced polyester (FRP) kind highlight how different materials can work in synergy. Analysis of these properties shows that they depend on (1) the properties of the individual components; (2) the relative amount of different phases; (3) the orientation of various components; the degree of bonding between the matrix and the reinforcements and (4) the size, shape and distribution of the discontinuous phase. The material involves can be organics, metals or ceramics. Therefore, a wide range of freedom exists, and composite materials can often be designed to meet a desired set of engineering properties and characteristics, [12]. J. Sudeepan et al. concluded that the most

influential factor which affects the tribological properties is normal load followed by filler content and speed, [13]. Salar report that the usages of fiber reinforced polyesters are in airplanes, electronics components, automotives, rail ways and wagon systems and sporting equipments. Beside their desired mechanical properties, their resistance to corrosion is also a tempting factor to use these composite in different areas. Although they are sensitive to UV light, heat and moisture environments, good maintenance could increase their life time. In this chapter different phases of FRPs, the mechanical relationships between different components of FRPs, the mechanism of degradation and aging of FRPs and application of them is discussing, [14 - 15]. Polyesters are also commonly used as matrix materials, particularly with glass fibre reinforcement. Polyester is an economic material that has high chemical resistance and is resistive to environmental effects. It has high dimensional stability and low moisture absorption. Low volume- fraction glass-fiber/ polyester composites with a wide range of colors have been in use for a long time. The production technologies for thermoset glass/polyester composites are easier and cheaper than those for other glass/resin materials. Glass fiber reinforced polymer with thermoset polyester resin is an attractive material that is economically desirable, [16 - 17].

EXPERIMENTAL

1. Materials

The proposed composite consist of polyester resin as a polymericmatrix and natural filler in form of powder of palm date seeds which has been cleaned, dried and crushed into very fine powder (less than 0.1 mm).

Preparation of test specimens

Polyester resin as a matrix material mixed with the powder of date seeds in volumetric ratio from 0 % to 25 %and then mixed by ratio of 8:1 with its corresponding hardener. After well mixing of the composite contents it poured into cylindrical mold (25 mm height and 4 mm diameter) and left for 24 hours for complete solidification. All test specimens subjectedtosoftsandpaper for cleaning the surfacesand remove irregular layers for performing the tribological measurements.

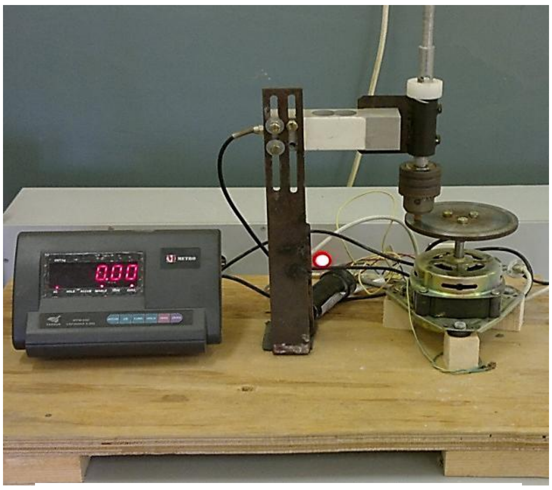

Fig. 1 pin-on-disk tribometer.

Tribological measurements

In the present work, friction coefficient and wear rate were measured for the proposed composites under different conditions of filler contents, applied load and sliding velocity. All measurements performed by means of pin on disk tribometer, Fig. 1, designed and constructed for this work.

Test conditions

Tribological measurements were carried out for test specimens under different conditions as following:

1- Contact area $A = 12.56\ mm^2$

2- Contacts Pressure

P_1 at 4 N = 0.318 MPa

P_2 at 6 N = 0.477 MPa

P_3 at 8 N = 0.636 MPa

3- Sliding Velocity

$V_1 = 3.0\ ms^{-1}$

$V_2 = 3.5\ ms^{-1}$

$V_3 = 4.0\ ms^{-1}$

The proposed composites have been tested under each one of the obvious contact pressure and sliding speed.

RESULTS AND DISCUSSION

Friction coefficient and wear rate of polyester composites sliding at 3 m/s^{-1}.

Figure 2 show that the friction coefficients of polyester composite decreases slightly with increase of date seeds powder, this figure show a little decreases of friction coefficient with increase of contact pressure. Friction coefficient decreases from 1.4 for free polyester to 1.2 for composite filled by 25 % date seed under low contact pressure, for the same composite coefficient of friction decrease to 0.91 with increases of contact pressure.It seems that there is a transfer layer formed on the contact area increases with increase of date seed contents and contact pressure which may be responsible for the friction reduction. The rates of wear for polyester composites have been shown in Fig. 3. Wear rate of polyester composites sharply decreases with increase of date seed contents to 10 % from 32E-05 g/m to 10E-05 g/m under low pressure, then it increases slightly to 31E-05 g/m as the filling powder increases to 25%. Besides, the rates of wear increased under high contact pressure which may be a result of the weak coherent bond between the contents of composites under high loads.

Friction coefficient and wear rate of polyester composites sliding at 3.5 m/s^{-1}.

Friction coefficient of polyester composites decreases under low contact pressure as date seed content increased, Fig. 4. The values of friction coefficients are less than it under low sliding speed (3 m/s) for composites sliding under low contact pressure, but as the contact pressure increase friction coefficient decreases, for example coefficient of friction for polyester composite contains 15 % date seed decreases from 1.2 under low loads to 0.85 with increase of pressure to 0.63 MPa. It was observed that there is an increase in the temperature at the contact region under high contact pressure which may be contributes in the friction reduction.

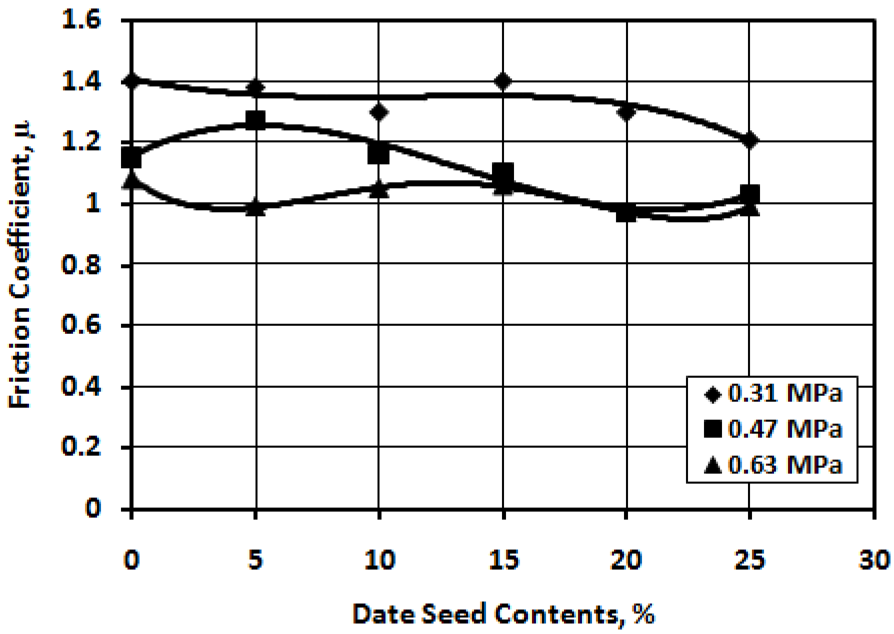

Fig. 2 friction coefficient of polyester composites sliding by 3.0ms^{-1}.

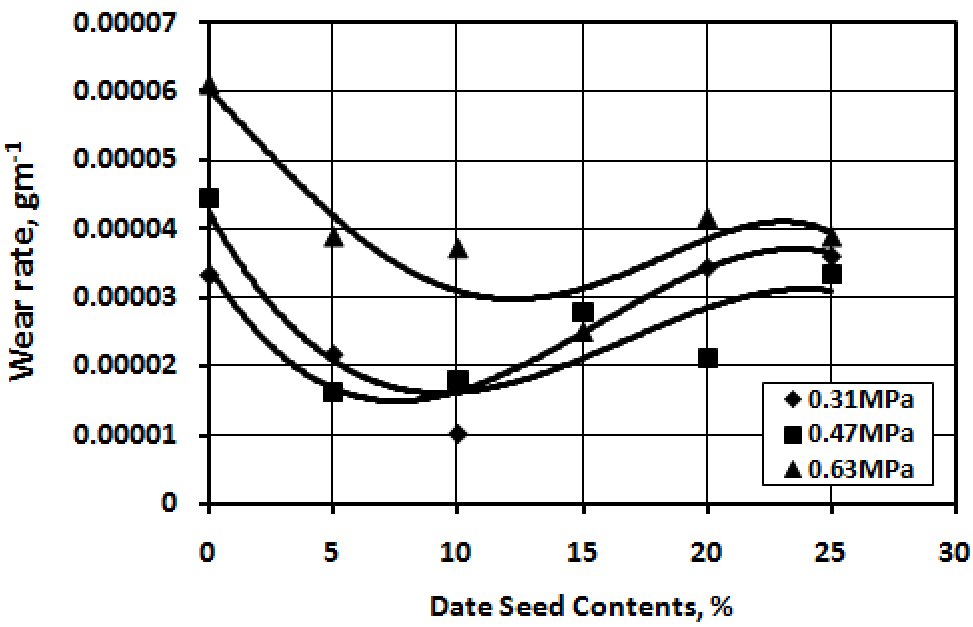

Fig. 3 wear rate of polyester composites sliding by3.0ms^{-1}

Figure 5 shows that wear rate of polyester composites has similar trend for the same composites under low speed but the values of wear rate is less than it under low speed, beside the ate of wear decreases to minimum (17E-05g/m) with increase of fillers to 10 % then it increases as the fillers increase to 20 %. As mentioned before; the rates of wear increases with increase of contact pressure, for composite which filled by 15 % date seed the rate increases to 30E-05 g/m under high applied loads.

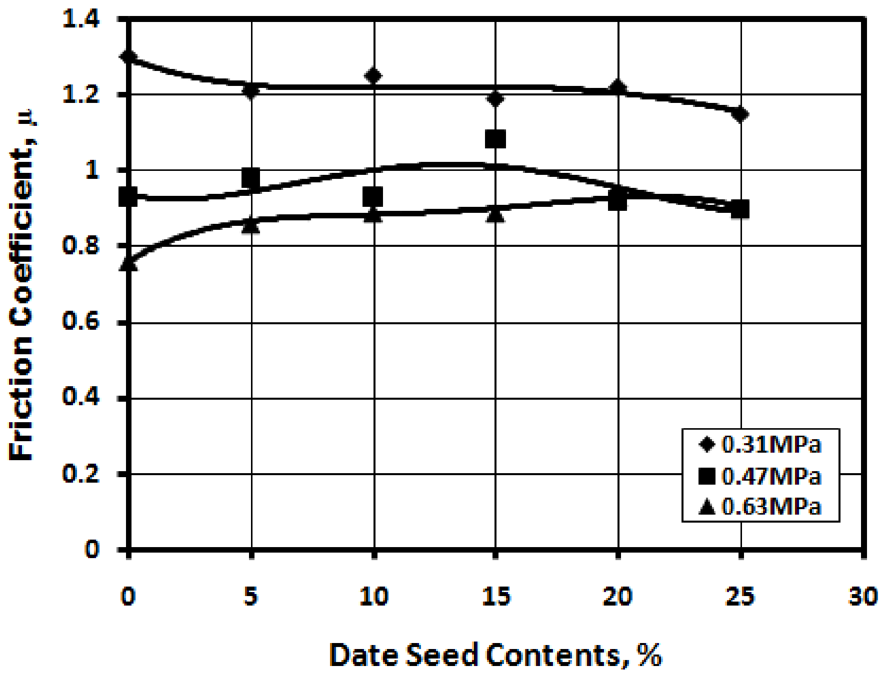

Fig. 4 friction coefficient of polyester composites sliding by 3.5 ms^{-1}.

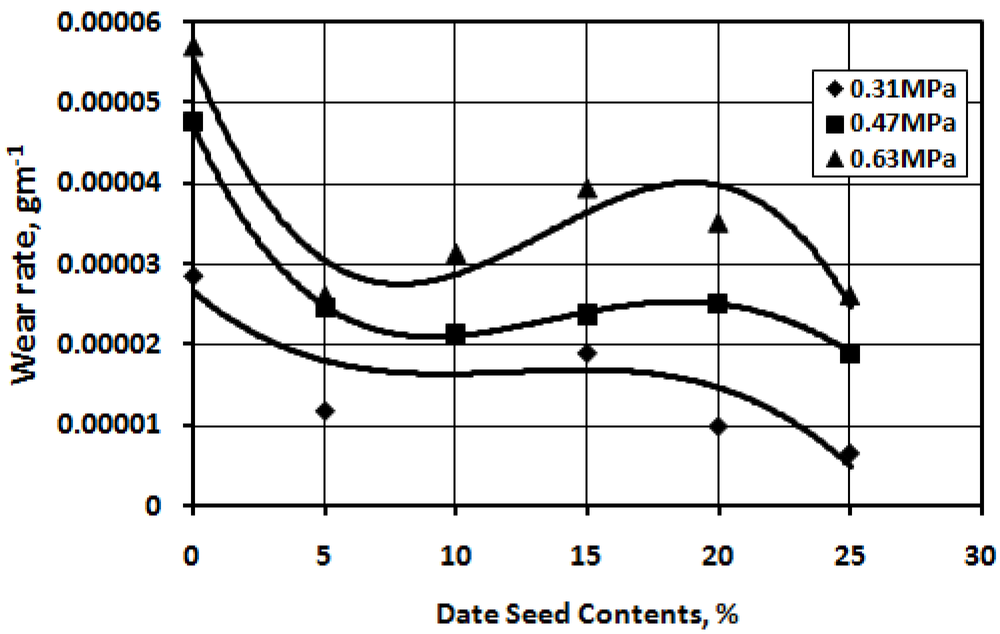

Fig. 5 wear rate of polyester composites sliding by3.5ms^{-1}.

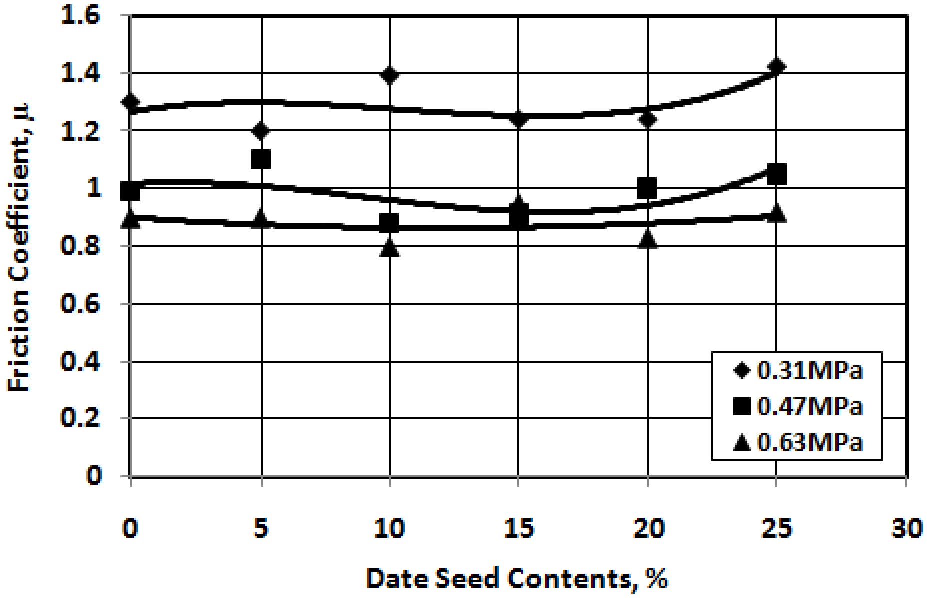

Fig. 6 friction coefficient of polyester composites sliding by4ms^{-1}.

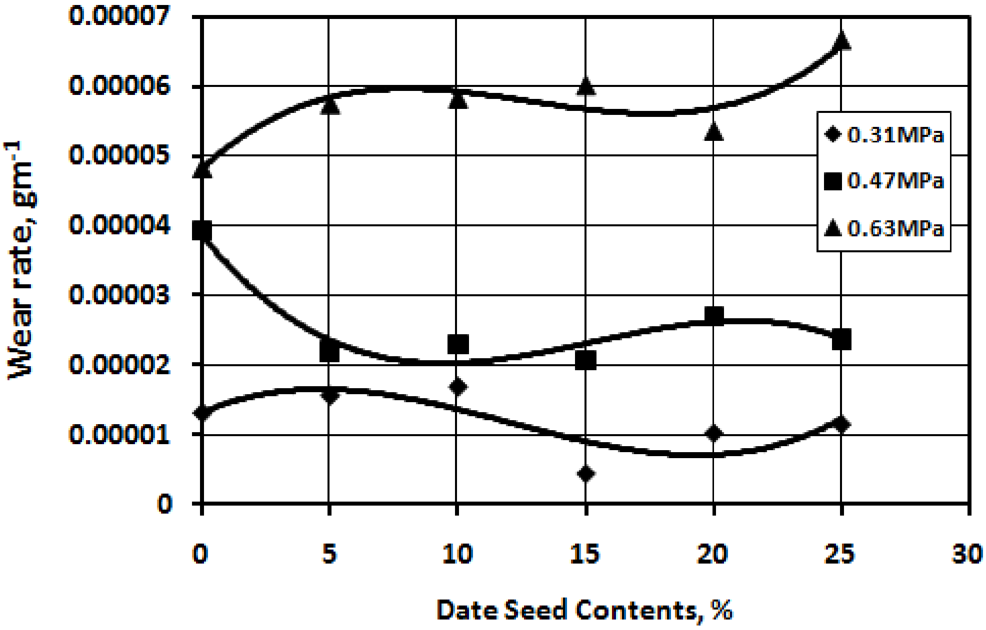

Fig. 7 wear rate of polyester composites sliding by4ms^{-1}

Friction coefficient and wear rate of polyester composites sliding at 4 m/s^{-1}.

Figure 6 shows little change in the friction coefficient with increase of date seed powder contents under high sliding speed (4m/s), it seems that there is low effect of the sliding speed on the friction coefficient for these composites. Beside; Fig. 7 shows that there is a high significant effect of contact pressure and sliding speed on the rates of wear for the proposed composites. This figure also shows that wear rate increases dramatically under high contact pressure with increases of filling powder contents. It seems that there is a surface (distortion) failure occurred under high speed and high loads for the polyester composite.

CONCLUSIONS

From the current work, it can be concluded that:

1. Friction coefficient decreases slightly with increase of date seed content in polyester composites.

2. Rate of wear of polyester composite decreases with increase of date seed to 10 %.

3. Coefficient of friction of polyester composites decreases with increase of sliding speed.

4. Increase of contact pressure decreases the friction coefficient but sharply increases the rates of wear for polyester composites filled with date seed powder.

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