The effect of dates palm trunk particles as improvement reinforcement material of polymeric composites and sustainable environmental material

Cite as: AIP Conference Proceedings **2123**, 020095 (2019); https://doi.org/10.1063/1.5117022
Published Online: 17 July 2019

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The Effect of Dates Palm Trunk particles as Improvement Reinforcement Material of Polymeric Composites and Sustainable Environmental Material

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Abstract

For a sustainable environment and minimizing pollution, dates palm trunk residues were used as natural strengthening (reinforcing) particles to improve the mechanical properties of silicone rubber as the matrix material, The particles of the palm trunks were used in three sizes and three concentration concentrations of 1% 3% and 5%, where the reinforced with the particles increases the tensile strength from $1 MPa$ to be about $2 MPa$, and the hardness value raised from about 32 MPa to be about 39 MPa, in addition to that the reinforcing particle of dates palm trunk exhibit high resistant to moisture absorption. The results of the search clarify that the composite samples reinforced at 1% and 75 particle size gives the best results for tensile and hardness tests in addition to moisture absorption test.

Keywords: dates palm waste, silicone rubber, mechanical properties, composite

INTRODUCTION

Composites materials can be defined as The materials physically composed of two or more different materials with resultant material features being superior to the features of individual material that make up the composites [1,2].

The word “waste” presents readily to mind any unwanted, unuseful thing that has outlived its advantage and needs to be disposed instantly not minding the effects of such disposal practices on the environment. Some of these waste materials can be recycled into new products that are more environmentally friendly which equally add worth to the economic development of any society [3-5].

The gradual gathering of agricultural wastes considered as an important environmental dangerous in many countries, where there are no waste recycling implants, or there is not existing the efficient means or system that can perfectly the process of recycling, and one of these types of plant waste is the dates palm [6]. Dates Palm Trunk are considered as a dry waste, which has low quality and density (large size and lightweight), these wastes gather together in large amounts which give rise to an actual problems because it is seems as one of the pollution materials when burned, in addition to being a refuge for snakes, rodents, and insects [7-9]. Therefore, it is important to know the way of using these wastes in the sustainable products applications, such as composite materials as a emulator environmental and economic alternate for coating, sound isolated, and painting materials [4, 7, 8, 10].

Using of these wastes for sustainable or green works to obtain sustainable development, considered as the real development, has the ability to communicate and stability from the perspective of their use of natural resources and take the environmental equilibrium as the essential rule and in the same time use them in many purpose (objective) instead of chemical materials [4,7].

Transition of industries towards production of green composite is taking place due to the increasing request of consumer, to reduce the use of synthetic material, higher sustainability, bio degradability, friendly to environment and recyclability, inexpensive, low density etc [10-12].

Composite material has wide range in industrialization and engineering fields using appropriate material such as metal, polymers and ceramics so as to obtain optimum features, these materials are being used according to the growing need of the society [2, 7, 10, 13].

Bio-composite have one or more material compounds that derived from natural origin. In terms of the reinforcement, this could include plant particles or particles from recycled plants, waste paper, or even from food crops [4, 12, 14].

Technologies and Materials for Renewable Energy, Environment and Sustainability
AIP Conf. Proc. 2123, 020095-1–020095-7; https://doi.org/10.1063/1.5117022
Published by AIP Publishing. 978-0-7354-1863-9/$30.00

The demand for wood composites from plants waste has been increasing as timber resources in natural forests decline. The use of renewable biomass as a raw material in composites products has been under taken as an alternative source that may result in several environmental benefits [[2,10,15].

Being a possibility source of the uses of plants-wastes and their capability to reuse products, dates plants have particular applications as in flooring, wall and ceiling panels, furniture, cabinets, counter tops, and desktops. The production of particle board composite from recycled dates plant-based wastes supply the most reasonable way to reuse these waste materials [2, 16-18].

Composite industries of plants require more wood raw material in spite of the fact that the forestry resources are diminishing. The continuous loss in wood material source has led researchers to study alternative cellulosic biomass resources utilization in composite manufacturing including plant particle board. Agricultural waste materials and annual plant have become alternative raw materials for the production of particle composite materials. The most frequently preferred alternative to non-wood materials are Reeds, papyrus, rice plant waste and wheat straw [2, 16, 18, 19].

Today chemical essence and products using straw of wheat and other annual crops waste are being commercially fabricated in a number of countries around the world. Now day there are growing needs to detect and use natural alternative sources of raw materials for composite manufacturing [15-17].

In the current research, the effect of the particles of the waste of the dates palm trunks has been investigated as a polymer composite reinforcement (which are disposed of by burning them, due to increasing the pollution rates) and improve the mechanical and thermal and physical features of the silicone rubber for use as coating layers of the walls instead of paints and chemical materials (which represents dangerous to humans and polluting the environment at the same time).

Tensile and hardness tests were examined, the moisture content test was examined too because it plays a very important effect on the mechanical and physical features of the composite fabricated specimens.

SAMPLE PREPARATION

The dimensions and shapes of molds have been fabricated according to the sizes and shapes of the samples as per ASTM Standard D 638 for tensile test, hardness samples are fabricated according to ASTM-D790.

The first step in the work was to select a dry palm trunk and then cut it into small pieces and grind it using a mill for six hours. The powder was then washed using distilled water and then using alcohol to remove dust and dirt from it.

The next step was drying the powder at 50 ℃ for 48 hours in a furnace (British-type carbolite) to remove the moisture and in the same time preventing the powder from being burned. The powder was then remiled using a ceramic mortar and then the powder was sifted using an electric vibrator and three sieves 75, 150 and 300 μm respectively to obtain three granular sizes of powder.

The following step was to fabricate, wash, dry, and then lubricate the molds for casting to prevent the casts from sticking with the mold, where Teflon material has been used to manufacture the molds.

The mixtures have been weighed by taking three rates for each particle size (1, 3 and 5%).

For immersion and absorption test, the tested samples have been weighted after oven drying for 6 hours at 50°C. The samples were then placed in deionized water for 24, 48, 72, and 96 hours after which they weighted again. Water absorption rates were recorded as the percentage increase in weight, according to the following equation.

$$Moisture\ content\ \% = \frac{M_f - M_\circ}{M_\circ} x\ \%$$

Where M_f the mass after immersion (final mass), and $M_\circ$ the mass before immersion (initial mass).

RESULT AND DISCUSSION

Figure 1. shows the images of the pure polymer and reinforced prepared samples at 1% rate and 75, 150 and 300 μm before and after fracture respectively.

Figure 2 (a, b, and c), explain the tensile - strain behavior of the prepared samples at (1%, 3%, and 5%) reinforcing rates for different particle sizes.

While Fig. 3 shows the tensile strength of prepared samples (pure and composite samples) opposite the reinforcing rates for different particle sizes.

The pure polymer samples behave as weak materials where its tensile strength is very low, while the reinforcing by the particles of the waste of the dates palm trunks increases the tensile strength from about $1 MPa$ to be about $2\ MPa$ when reinforcing by dates palm particles, this property will be improved greatly, where the particles will withstand the maximum part of loads and by consequence will raise the strength of composite material.

Figure 4 shows the relationship between the hardness opposite the reinforcing rate, for different particle sizes, where the reinforcing enhanced and improved the hardness of the specimens, where the hardness value raised from about 32 MPa to be about 39 MPa at particle size 75 μm.

Regarding moisture absorption values Fig. 5 (a, b, and c) of the composites samples the immersion of the samples vary from about 1.562 % to 6.666 % for 96 h at 5% reinforcing rate, while 1% reinforcing rate shows the minimum absorption rate which equal to 3.125%, 5.084%, and 3.571% at rates 1, 3, and 5% respectively, and this feature (moisture absorption) related and affects the mechanical properties of the prepared samples, where the sample who showed the least moisture absorption gives the best mechanical properties, in other words the moisture rates decreases with increasing of the (reinforcing particle size) particle size of dates palm waste, and that means the reinforcing particle of dates palm exhibit high resistant to moisture absorption.

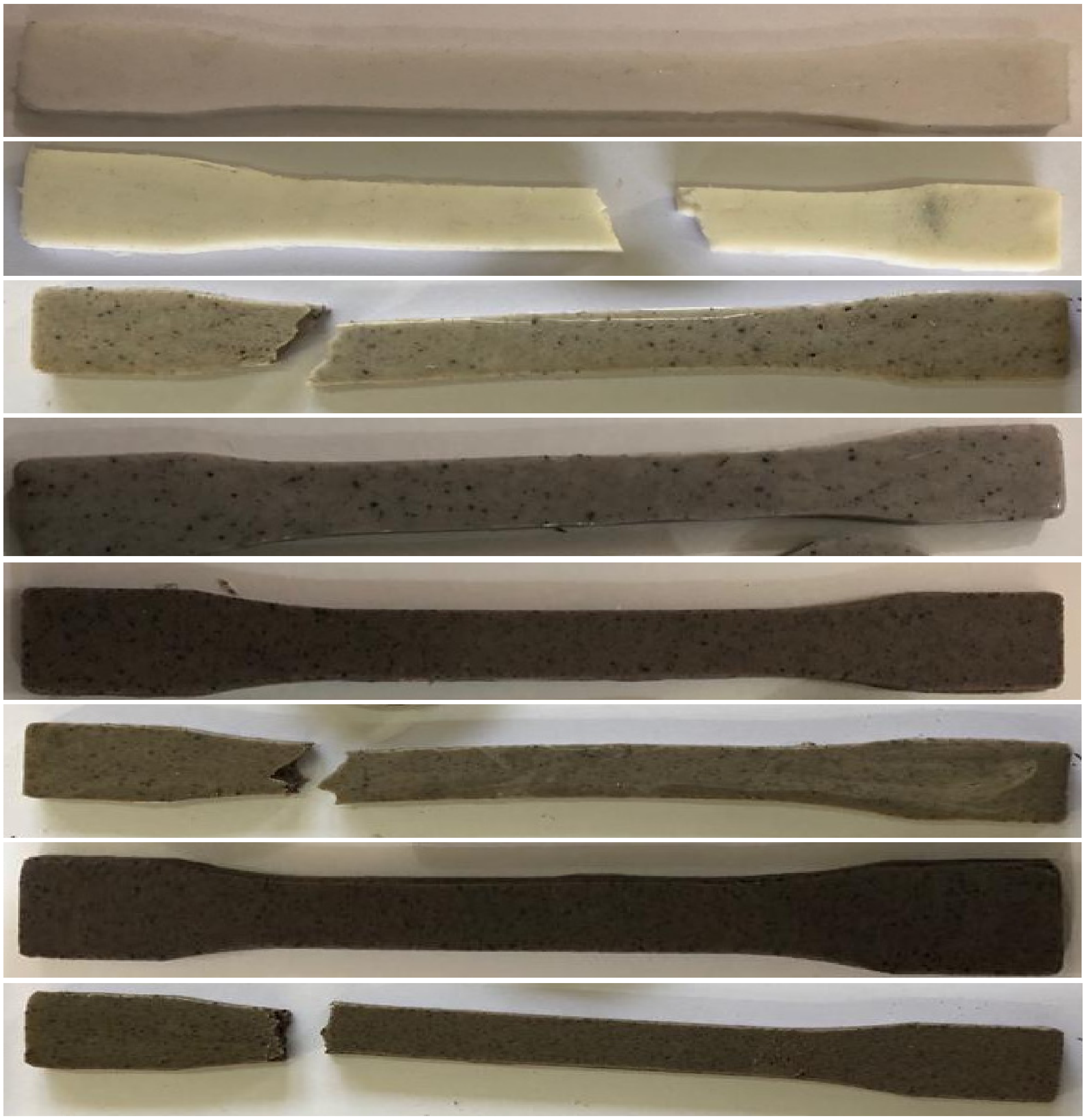


FIGURE1. Pure polymer, and reinforced prepared samples at 1% rate and 75, 150 and 300 μm before and after fracture for each sample (from top to down) respectively.

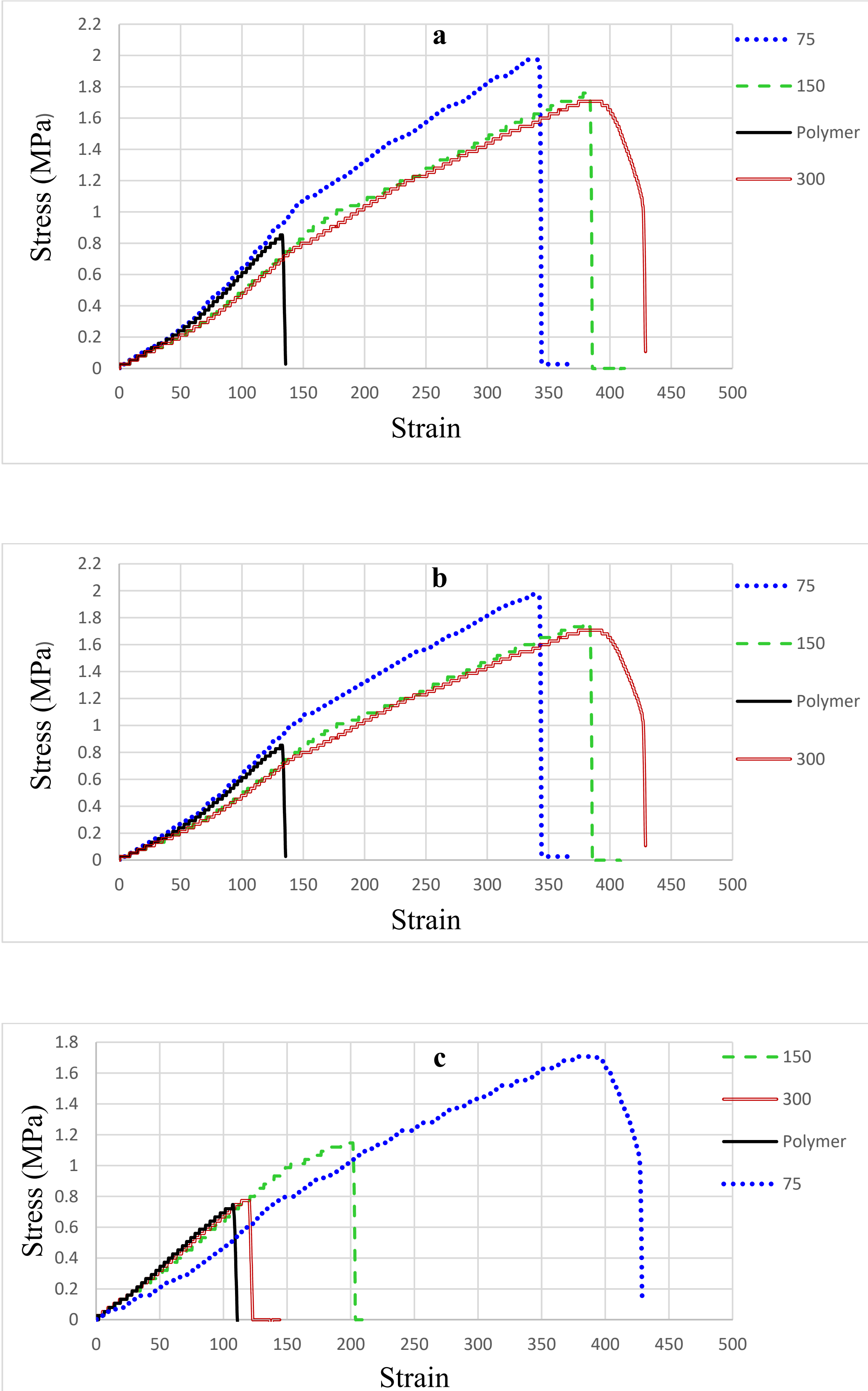


FIGURE 2. (a, b, and c), tensile - strain behavior at different reinforcing rates and different particle size, where a- 1%, b- 3%, and c- 5% respectively.

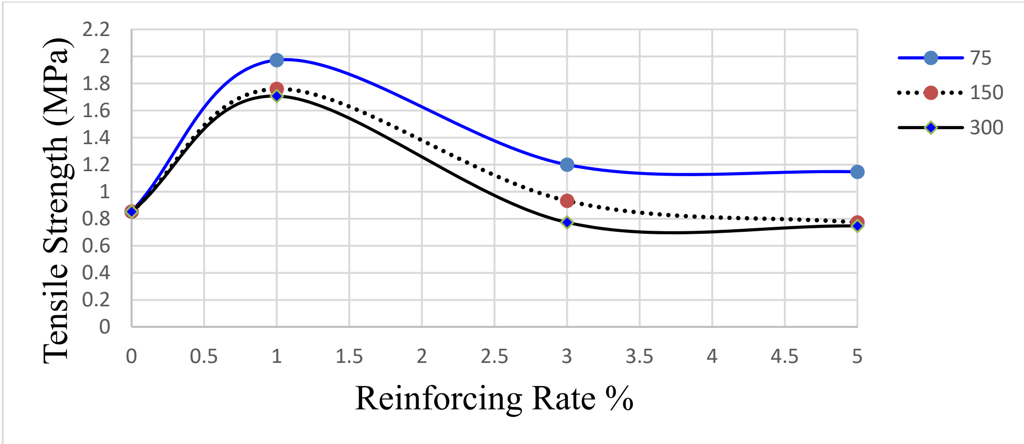


FIGURE 3. Tensile strength pure and composite samples opposite the reinforcing rates for different particle sizes.

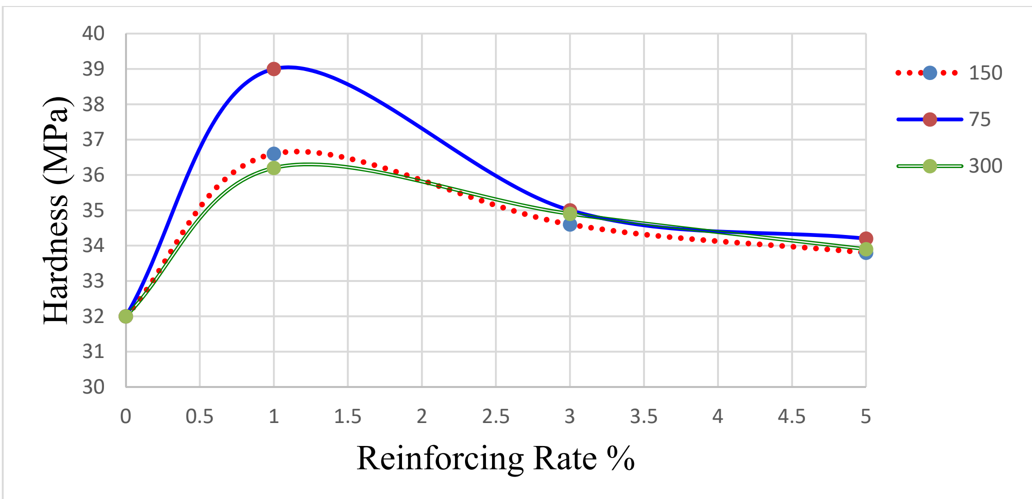
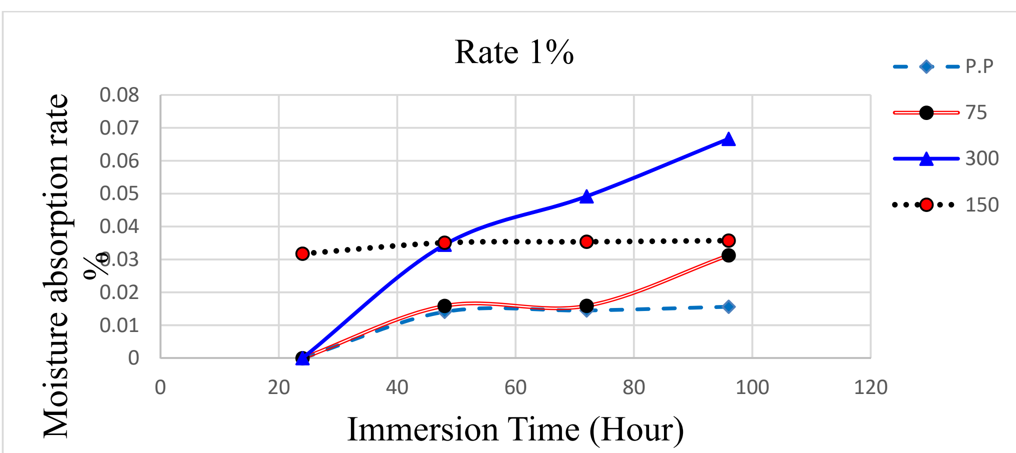
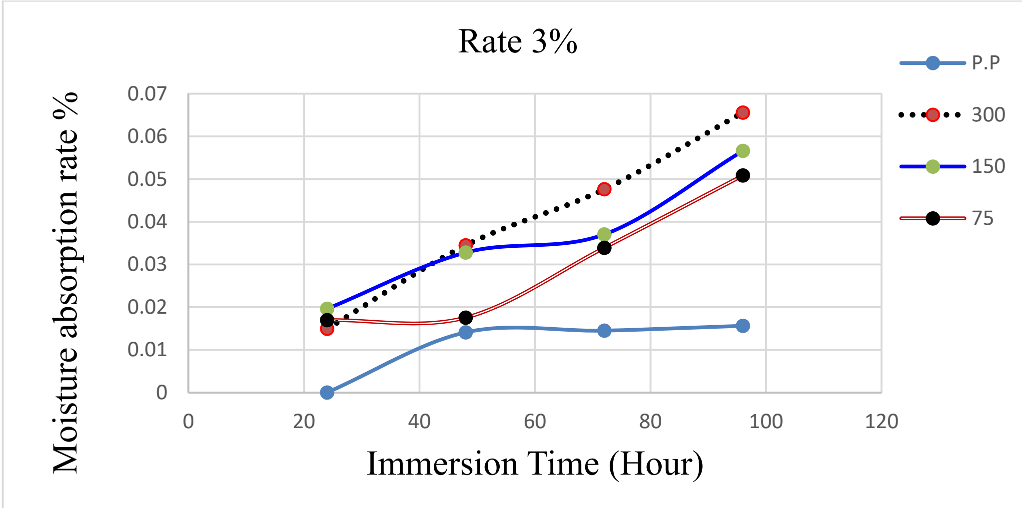


FIGURE 4. Hardness of composite samples opposite reinforcing rates for different particle sizes.





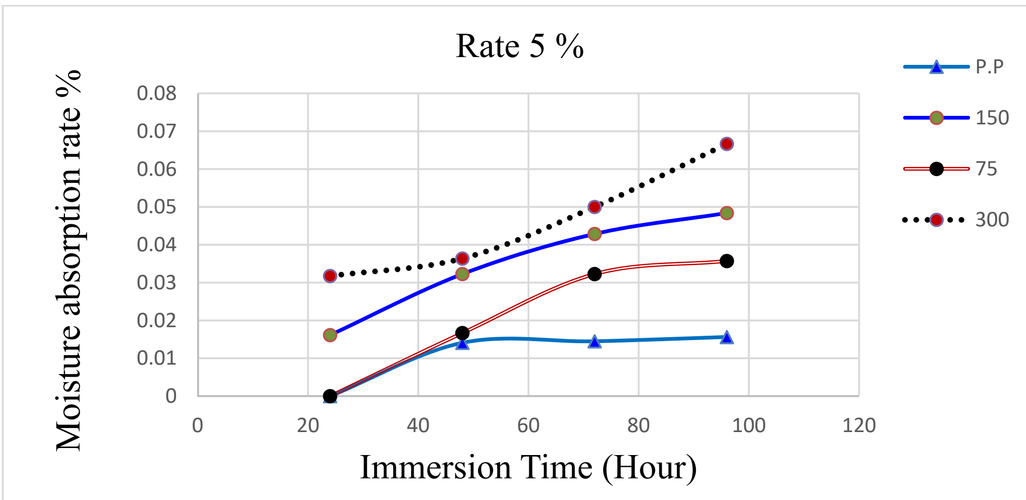


FIGURE 5. Moisture absorption rates for pure different reinforced particle size samples at reinforcing rates 1%, 3%, and 5% respectively.

CONCLUSION

Using of dates palm trunk waste particles of the palm trunks as a reinforcement for polymeric composites (silicone rubber) has many advantages at the same time. The first benefit is the getting rid of these wastes, the second is the reduction of environmental pollution, and the third is using of dates palm trunk waste particles as a reinforcement for silicone rubber matrix. Where the stress strain behavior, tensile and hardness tests of the samples reinforced by dates palm trunk waste particles improved the mechanical properties of silicone rubber, while at the same time the high resistant to moisture absorption, making it very useful in practical purpose or in several ways especially for using as coating layers and painting for surfaces and walls.

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