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TRIBOLOGICAL BEHAVIOUR OF GREASE CONTAMINATED BY SAND

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ABSTRACT:

The friction and wear losses produced by abrasive contaminants pass through filter affect the operating internal combustion engines economics in cars, buses, trucks and other equipment. In this work, the influence of sand as contaminant to grease on the friction and wear of carbon steel is discussed. The experimental was carried out on cross pin wear tester. The grease contaminant by different percentage of sand 1, 2, 3, 4 and 5% under different values of normal loads. The sand with different particle size was 0-90 µm, 90-125 µm, 125-160 µm, 160-180 µm and 180-200 µm. The effects of the sand content and size of sand particles have been discussed.

Based on the investigations in the present study, It can be investigated that friction and wear increase with sand concentration in the lube. Solid proposals should to be considered, in order to instruct the general population on the importance of exchanging the oil filter of a car engine's regularly. Friction coefficient and wear increased with increasing sand contaminant grease. The lower particle size of sand tends to rolling between the contact surface more than embedment this action helps for reduce friction and wear The lower load shows the relatively lower friction and wear values. It can be recommended to use the filter screen for machining with lower particle size if possible. The abrasive dust particle size has a major effect on the wear and friction of the moving parts, which affects the performance of the engine. For good effect in controlling the dust filtration into the engine, air filtration can be used. The efficiency of the filter has an important effect on the wear rate and filters with the highest available efficiency are recommended to be used.

KEYWORDS: Sand, Grease, friction, wear, Particle size.

INTRODUCTION

The operational environment in Middle East is principally severe in terms of the high ambient dust concentrations experienced throughout the Eastern and Western Provinces. During severe dust storm conditions dust concentrations of the order of 100 to 500 times higher may be encountered, [1]. Contaminants in the lubricating oils and greases are considered as one of the major reasons for machine elements failure, [2]. Solid contaminants can be classified into three groups. The first is the external contaminants that enter the lubricating oils and greases through air, fuel and fresh oil as well as fresh grease. The second is the contaminants introduced by friction and wear of the rubbing surfaces while the third item covers the contaminants introduced during manufacturing and assembly of different elements of the machine. The abrasive particle dirtiness is the major cause of quick failure of the mechanical equipment's in cement factories due to the highly dusty ambience. The influence of rigid contaminants on the wear mode for a cement factory was experimentally quantified. various contaminants were composed from several areas in the cement industry comprehensive the air cooled refuse with low ferrous particles, greasy clay, sandy clay, water cooled refuse with medium ferrous particles, iron ore, lime stone and air cooled refuse with high ferrous particles.

It was establishing that lithium grease should be scattered by 30 wt. % oil to equilibrium the contaminants and bring the lowest friction coefficient and wear values. Friction coefficient increased and wear lightly decreased, when the oil content, added to the grease [3]. Besides, sand showed the highest friction coefficient and wear values followed by kaolin, while limestone displayed the lowest coefficient of friction and wear.

Coefficient of friction created from the behavior of the mixture showed comparatively higher values than limestone and lower values than sand and kaolin. Coefficient of friction and wear lightly decreased with increasing tin concentration. The surface roughness of engineering surfaces shows as a spectrum of peaks and valleys. The mission of lubrication is to disconnect these peaks and valleys so that approach is avoided in metal to metal to minimize or rest the wear. Solid lubricants guaranty boron nitride, graphite, glass, molybdenum disulfide, polytetrafluoroethene, tungsten disulfide, tin, lime. Tin is a naturally revolving watery magnesium silicate. Structurally, tin is involving of a sheet of brucite or Mg (OH)2 sandwiched amidst SiO2 sheets, [4 – 6]. The primary sheets are little bonded to each other. As a results the layers slither apart with minimal force presenting tin its ingrained softness and lubricity. Tin is naturally hydrophobic which contributes to its functional cajolery as well.

It was establishing that to equilibrium the contaminants and bring the lowest friction coefficient and wear values lithium grease must be scattered by 30 wt. % oil, [7]. As the oil, added to the grease, increased coefficient of friction and wear lightly decreased. Besides, sand showed the highest friction and wear values followed by kaolin, while limestone showed the lowest coefficient of friction and wear. Coefficient of friction created from the act of the blend displayed comparatively higher values than limestone and lower values than kaolin and sand. Coefficient of friction and wear lightly decreased with increasing tin content.

In dusty ambience, abrasive particles entering between the machines moving parts cause earnest wear of the gliding parts, [8, 9]. Abrasive wear of composite materials is a convoluted surface damage process, influenced by a number of factors, such as microstructure, mechanical properties of the purpose material and the abrasive, loading situation, environmental effect, etc. Microstructure is one of the main factors; however, its influence on the wear mechanism is complicated to examine experimentally, [10, 11], due to the conceivable synergism with other influences. Lubrication is dangerous for reducing wear in mechanical systems, [12], that work for extensive time periods. growing lubricants that can be applied in engineering and mechanical systems without restoration especially those that are environmentally amiable is very remarkable for increasing the practical lifetime of mechanical parts. White Portland cement or white ordinary Portland cement (WOPC) is identical to average, gray Portland cement in all regard barring for its high degree of whites, [13]. The pure materials implicated in white cement are kaolin (8 %), Sand (80 %) and limestone (12 %). In the present work, the effect of the sand concentration and sand particles size contaminated grease on the friction and wear of carbon steel is discussed.

EXPERIMENTAL WORK

Tests were done using a cross pin wear tester, Fig. 1. It consists, fundamentally of rotating and fixed pins of 15 mm diameter and 160 mm long. The rotating pin was connected to a chuck mounted on the essential shaft of the test device. The fixed pin was settled to the loading part where the load is applied. The essential shaft of the test rig is driven by DC motor (250 watts, 230 volt) meanwhile reduction unit. Moreover, with change the input voltage the motor speed can be controlled by using an autotransformer. The test rig is attached by a load cell to measure the frictional force produced in the contact area between the rotating and fixed pins. Normal load was applied by means of weights joined to a loading part. A counter weight is used to equilibrium the weights of the loading arm, the loading part and the fixed specimen. A digital screen was connected to the load cell to discover the friction forces. Friction coefficient is specified by the ratio between the friction force and the normal load while, wear can be obtained by measuring the scar diameter with the optical microscope.

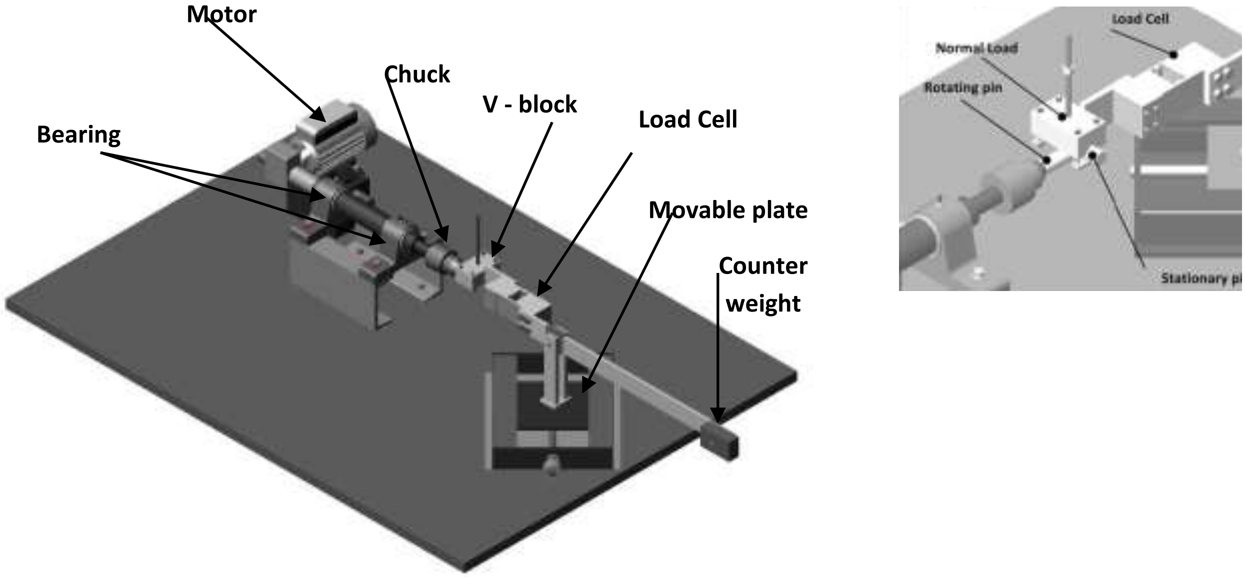


Fig. 1 Arrangement of the cross pin wear tester.

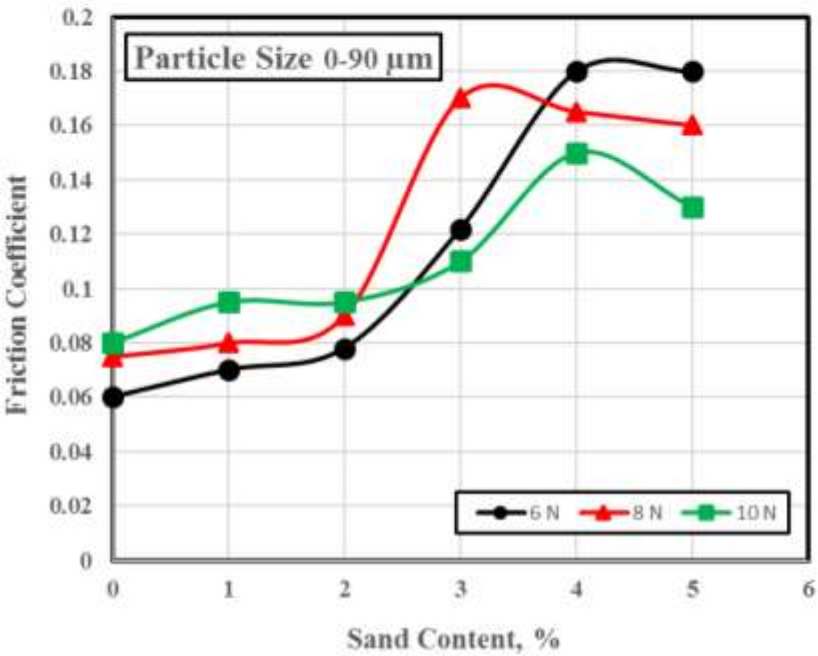
The Specimens were cylindrical with 20 mm diameter and 120mm Length. The specimens were prepared from carbon steel with, Ultimate Stress, 750 N/mm^2, Yield Stress, 550 N/mm^2, Modulus of Elasticity, 9.5*10^3 N/mm^2, Surface roughness 0.6 µm. The tests were carried out at sliding velocity of 0.4 m/s and 6, 8 and 10 N normal loads. The rotating pin was greased before the test and moreover adding grease every 40 second during the test. The test time was 6 minutes. The wear diameter was measured for the upper fixed pin using the optical microscope, Fig. 2. Within an accuracy of ±1 µm.

Experiments were carried out at 25 °C using grease contaminant by sand at concentration of 1, 2, 3, 4 and 5%. The sand with different particle size was 0-90 µm, 90-125 µm, 125-160 µm, 160-180 µm and 180-200 µm.

Fig. 2 The optical microscope

RESULTS AND DISCUSSION

Figure 3 shows the relation between coefficient of friction and sand content. It can be investigated that, the coefficient of friction increase as sand content increasing, for lower load, friction coefficient shows the lower values of coefficient of friction because of sand particles is rolling in between the sliding surfaces. The higher load, help for impediment the particles in contact zone then friction coefficient increase. At height percentage of sand, the lower load shows the higher friction coefficient.



coefficient

Figure four shows the relation between coefficient of friction and sand content different values of normal load. It can be noticed that, the coefficient of friction increasing as sand content increase. This observing related to the abrasion behaviour of sand particles which embedded in surface and abrasion the other surface. The particle size ranged from 90 to 120 µm shows the normal distribution of coefficient of friction with applied normal load. The lower load shows the lower values of coefficient of friction. This results related to the sand particles tends to rolling more than embedment. While at higher load the particles embedment in contact surface, then the coefficient of friction increase with increasing normal load.

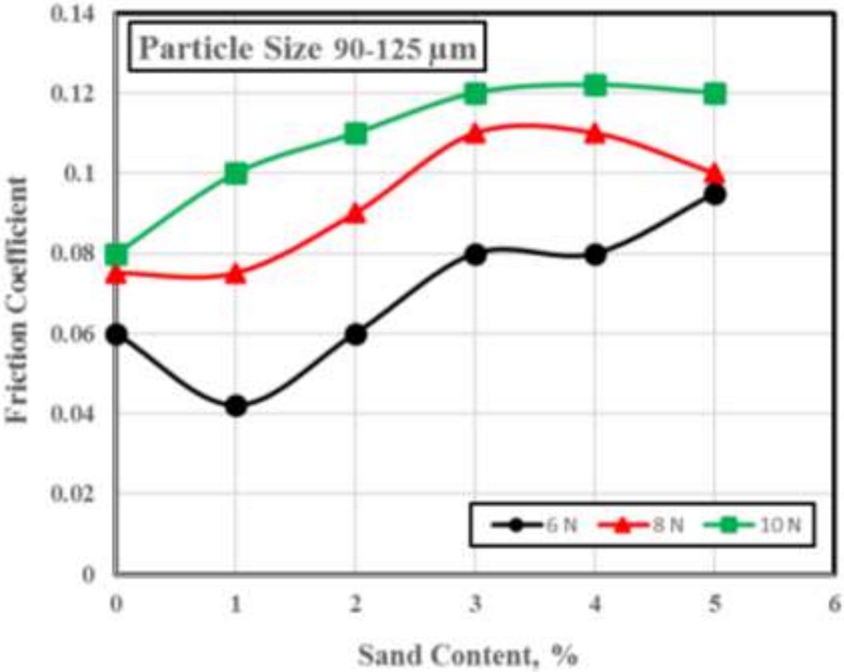


Fig. 4 Effect of sand contaminant grease on friction coefficient

Effect of sand content on coefficient of friction for grease, was shown in Fig. 5. It can be observed that, the coefficient of friction increase with increasing sand content. Increasing particle size of sand to 125-160 µm show increase in friction coefficient values at lower load. This behavior related to the shape of sand particles is not round and tends to embedment more than rolling. The higher load show lower friction coefficient values compared to lower load.

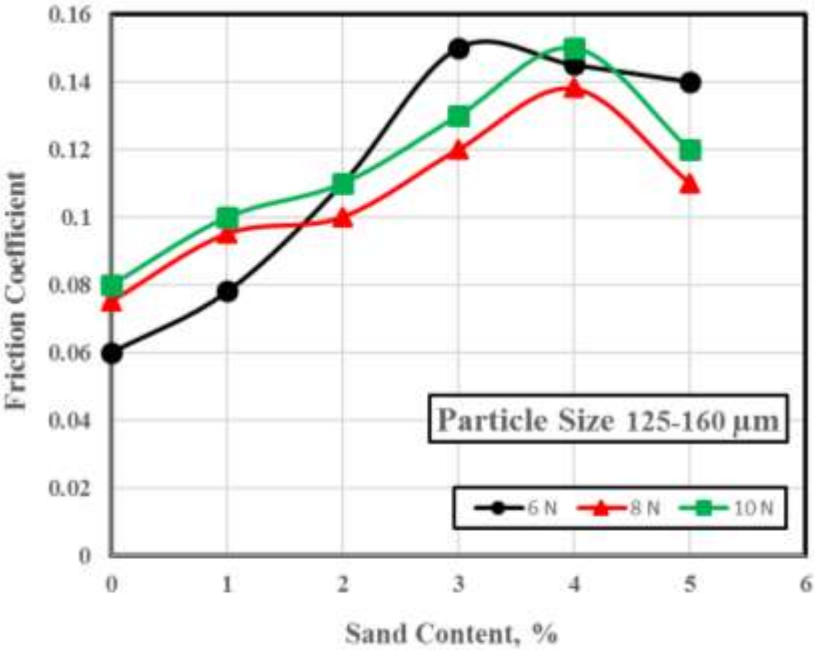


Fig. 5 Effect of sand contaminant grease on friction coefficient.

Figure 6 show the relation between coefficient of friction and sand content; for particle size 160-180 µm. It can be investigated that the coefficient friction increase with increasing sand content. Increasing particle size shows lightly increase in coefficient of friction values compared to -125-160 µm. Friction coefficient increases to maximum values at 6 N normal load, this action related to interaction between steel surface and sand particles.

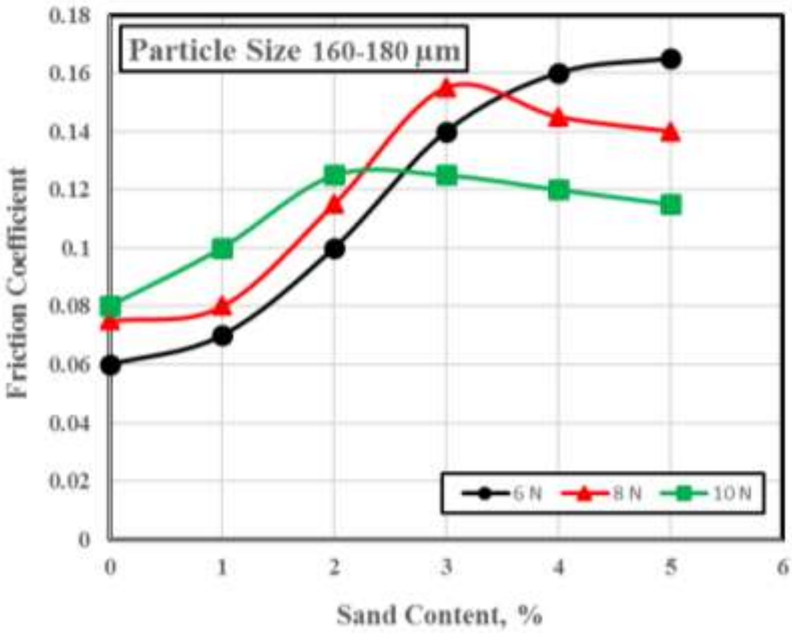


Fig. 6 Effect of sand contaminant grease on friction coefficient

The relation between coefficient of friction and sand content, shows in Fig. 7. It can be noticed that, coefficient of friction increase with increase sand content. The maximum coefficient of friction value observed at 6 and 8 N normal load, while the values of coefficient of friction decrease for 10 N applied normal load. Increasing in coefficient of friction values related to the embedment sand particles in steel surface.

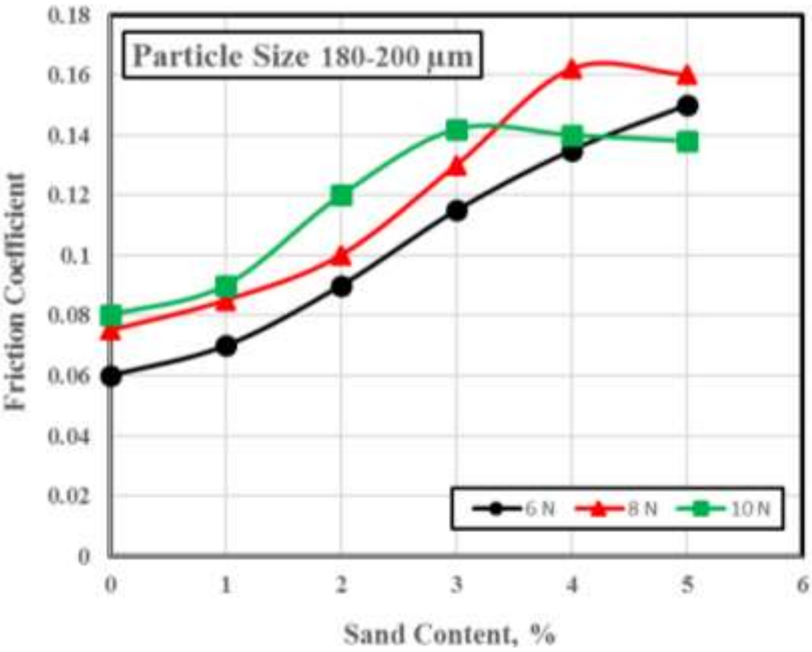


Fig. 7 Effect of sand contaminant grease on friction coefficient

Figure 8 show the rapport between wear scar diameter and sand content. It can be shown that, the wear scar diameter decreased as sand content increase. Wear diameter display the lowest value for 6 N normal load at 5% sand content, this action related to the rolling behavior of sand particles, this behavior prevents the contact between sliding surfaces. The maximum wear scar diameter was 4.0 mm observed at 1% sand particles, while the minimum value was 0.5 mm at pure grease.

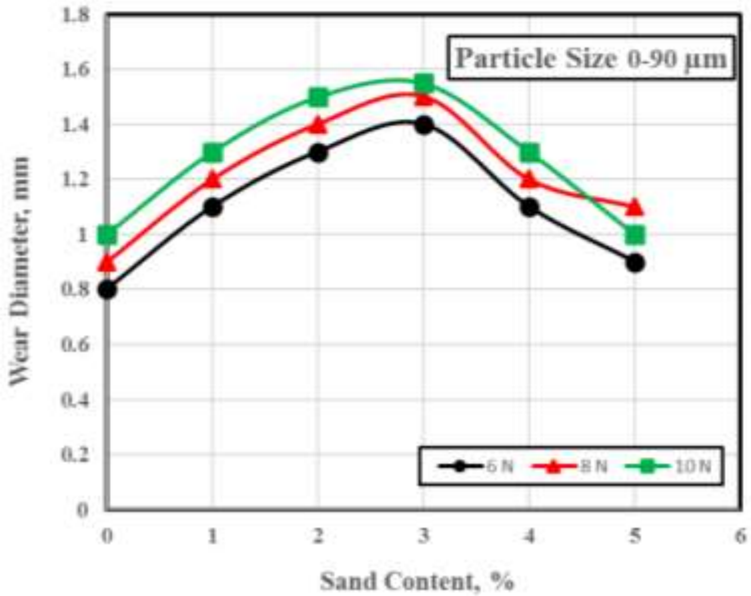


Fig. 8 Effect of sand contaminant grease on wear diameter.

Figure 9 show the rapport between wear scar diameter and sand content, at 90-125µm particle size. It can be observed that, the wear scar diameter increase with increasing sand content. Increasing sand particle size increase, the ability of sand to abrasion in contact surface which the sand shape is irregular. The lowest value of wear scar diameter was 0.5 mm noticed at pure grease.

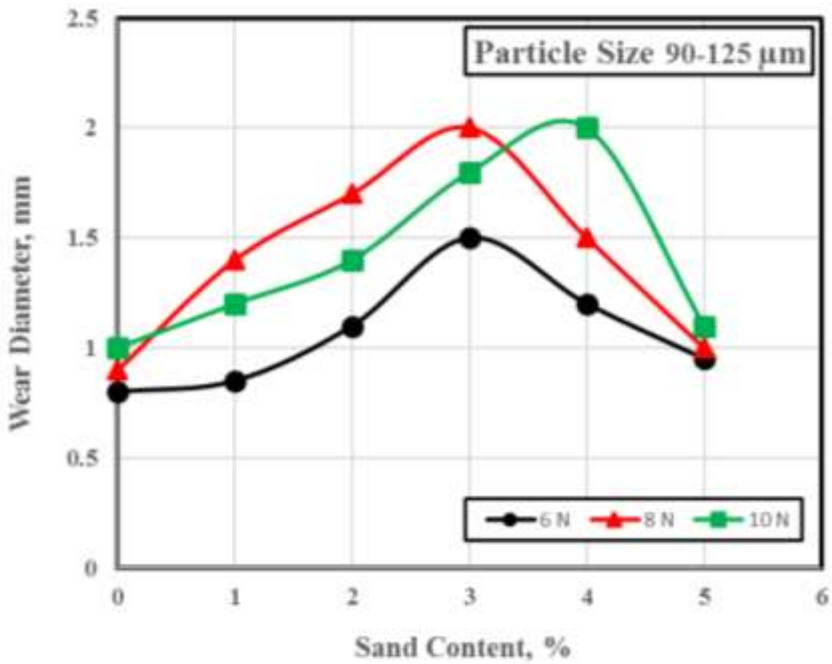


Fig. 9 Effect of sand contaminant grease on wear diameter.

The rapport between wear scar diameter and sand content was shown in Fig. 10. Generally, it can be investigated that, the wear diameter decreased with decreasing normal load. As the normal load increase the abrasion of sand particles in contact surface increase then the wear diameter increase. The lower load shows lowest wear values. It seems that the rolling behavior between the steel surface and sand particles.

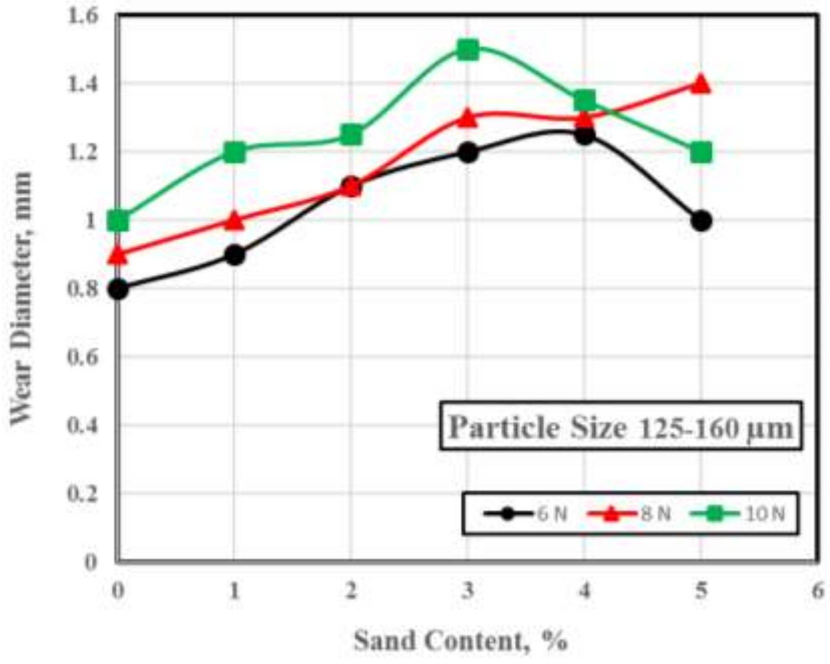


Fig. 10 Effect of sand contaminant grease on wear diameter.

Increasing sand particle size to 160-180 µm was shown in Fig. 11. It can be noticed that, the wear scar diameter increasing as sand content increase. This action related to more abrasion between two surfaces. The wear scar diameter decrease at grease contaminated by 5% sand, this results related to the rolling behavior between contact surfaces.

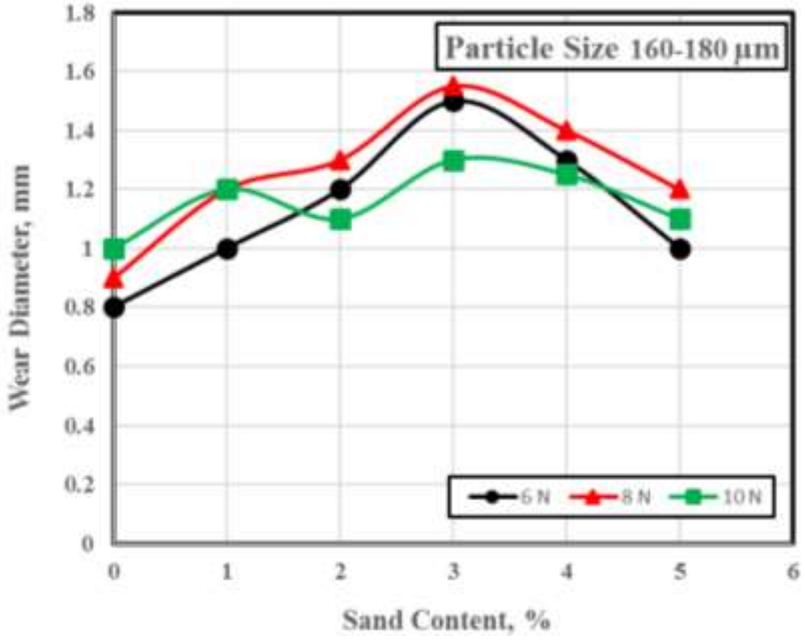


Fig. 11 Effect of sand contaminant grease on wear diameter.

Figure 12 show the rapport between wear scar diameter and sand content. It can be shown that, the wear diameter increased with increasing sand content. The sand particles were irregular shape which impediment in contact surface this observation closed on higher load help for embedment the sand particles in contact surface.

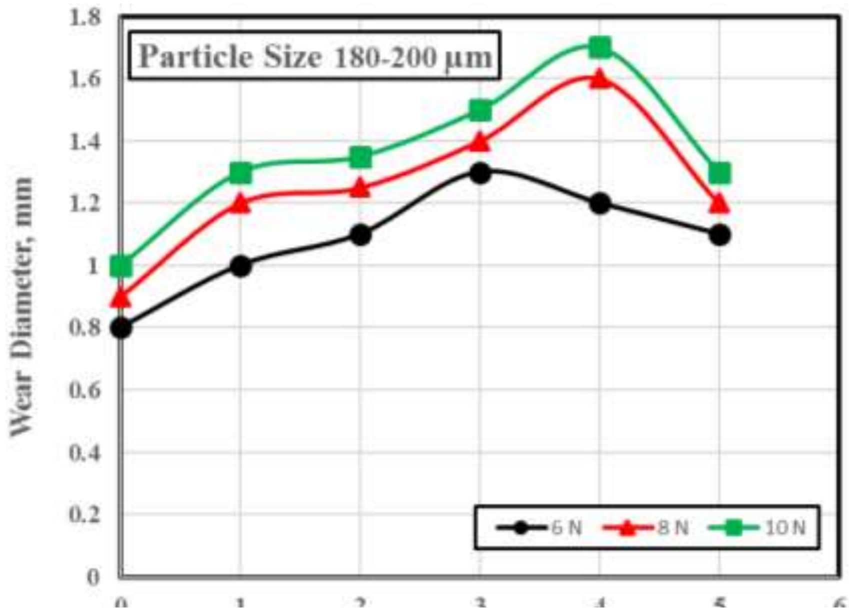


Fig. 12 Effect of sand contaminant grease on wear diameter.

CONCLUSIONS

1. Coefficient of friction and wear increased with increasing sand contaminant grease.
2. The lower particle size of sand tends to rolling between the contact surface more than embedment this action helps for reduce friction and wear
3. The lower loads show the relatively lower friction and wear values.
4. It is recommended to use the filter screen for machining with lower particle size if possible.
5. The abrasive dust particle size has a major effect on the wear and friction of the moving parts, which affects the performance of the engine.
6. For good effect in controlling the dust filtration into the engine, air filtration can be used. The efficiency of the filter has an important effect on the wear rate and filters with the highest available efficiency are recommended to be used.

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