Retraction

Retraction: Investigate the Tribological Properties of AISI 4140 Alloy Steel Under Various Loads and Sliding Speed (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012038)

Published 23 February 2022

This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

Retraction published: 23 February 2022
Investigate the Tribological Properties of AISI 4140 Alloy Steel Under Various Loads and Sliding Speed

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Abstract. Friction and wear are the main reason for energy losses in the mechanical systems. AISI 4140 is commonly use as gear material and other important applications. In this study experiments were conducted to predict the effect of the sliding speed and load on the frictional and wear behavior of AISI 4140 steel under the HP ZFL 80W-90 using a pin on disc tribometer. The tests were carried out under different loads (40,60,80) N and (0.5,1,1.5) m/s sliding speeds for constant distance of 300m. The tribological characteristic of the material was observed at different sliding speed. Based on the results, the wear mechanism of the AISI 4140 under HP ZFL 80W-90 lubricant was predicted. Results depicted that at low sliding speed the COF coefficient of friction decreases with increase in load. At moderate sliding speed also same trend was observed, whereas at higher sliding speed the COF increases with the increase of load.

Keywords: SAE 80W-90, AISI 4140, SEM, Tribometer.

1. Introduction
Wear is the common problem that arises between different or same materials which interact at different conditions. Friction is the main reason for the loss of energy in practical application like gears, brakes, shafts and many more systems. AISI 4140 has wide applications in like automotive, aerospace and manufacturing industries. Adhesive and abrasive wear is a prominent problem in rolling rolls, pipe joints, turbines and drive systems [1,2]. And for testing wear pin on disc in mostly used apparatus. The pin in the disc tester tests the friction and sliding wear behavior of a number of bulk materials and coating under dry or lubricated surfaces [3]. Friction induces a cold welding of the asperities on each surface to the other. The material volume transferred for adhesive wear is proportional to the actual contact area and the sliding distance. Several probabilistic models for dry and lubricated interactions are available in the literature centered on the Archard Adhesive Wear Rule [4,5]. The pin-on-disc wear rig is one of the most trending alternatives in sliding wear experiments. A spherical head pin is used to interact with flat circular disk for performing experiment as it gives better results of wear [6, 7]. A spherical surface pin has the benefit that the pin and disc surfaces are conveniently aligned and reproducible. This is why the pin has a spherical end in most situations [8-10]. The aim of this study is to find out the wear behavior of AISI 4140 alloy steel under various sliding speeds and loads using lubrication condition.
2. Materials and Methods
The AISI 4140 specimens were prepared for this experimental study. The reason behind choosing this material was that it has high tensile strength and has the ability to withstand adverse conditions. Length of specimens was 50mm and diameter was 10mm with a spherical tip. With the use of heat treatment process hardness of specimens was attained up to 42HRC. Table 1 shows the chemical composition of AISI 4140 alloy steel.

| Element | C   | Si  | Mn  | Cr  | S   | P   | Mo  | Fe   |
|---------|-----|-----|-----|-----|-----|-----|-----|------|
| %       | 0.380 | 0.231 | 0.932 | 0.901 | 0.005 | 0.004 | 0.216 | Rest |

Circular rotating disk was used in this wear test. It was made up of EN 31 material which is generally hard and of high strength. Disc was hardness up to 62 HRC. Table 2 represents the chemical composition of EN 31.

| Element | SiO | Cr  | C   | S   | P   | Ni  | Mn  | Fe   |
|---------|-----|-----|-----|-----|-----|-----|-----|------|
| %       | 24  | 1.45 | 1.07 | 0.017 | 0.027 | 0.34 | 0.51 | 72.25 |

In this paper while conducting the experiments, we use HP ZFL 80W-90 was used. It was chosen due to its application in gear box of food processing unit. HP Gear Oil ZFL 80W-90 was used in synchro manual transmission and transaxles, semi-automated mechanical drives, axles and so on is prescribed for the new-generation heavy-duty vehicles. It provides longer life to the components and excellent protection of these gear components from wear under various conditions. Wear testing pin on disk setup used was ASTM G-95 model TR-20LE-PHM-400. It has a power of 230V, 5A and 50Hz. In pin on disk setup where the pin is held perpendicular to the rotating circular disk to perform experiments. Various parameters such as loads, sliding distance and sliding speed were varied. Figure 1 is pin on disk tribometer setup machine.

![Figure 1. Pin on disc tribometer](Retracted)
3. Experimental work
The process parameters taken in this study was sliding speed (0.5, 1, 1.5) m/s, load (40, 60, 80) N and constant sliding distance of 500 m. The observed results of wear and coefficient of friction are displayed in the Table 3. With the start of the experiments all the arrangements were check before so as the error arising while performing the experiments would be neglected easily. A setup was attached to the pin on disk wear machine through which we could get the values of frictional force and wear simultaneously. The total nine experiments were performed in this study. It includes different sliding speed and loads with constant distance. The wear loss by weight was calculated by measuring the difference between initial and final weight of the specimen by using Denver electronic weight machine. After performing the experiments, the specimens were well washed with acetone before taking their final weight. The obtained values of coefficient of friction are shown below Table 3 as well.

| S.No | Sliding Distance (m) | Sliding Speed (m/s) | Load (N) | Wear (mg) | COF       |
|------|----------------------|---------------------|----------|-----------|-----------|
| 1    | 500                  | 0.5                 | 40       | 23        | 0.046105  |
| 2    | 500                  | 0.5                 | 60       | 20        | 0.040106  |
| 3    | 500                  | 0.5                 | 80       | 21        | 0.041286  |
| 4    | 500                  | 1                   | 40       | 26        | 0.19276   |
| 5    | 500                  | 1                   | 60       | 17        | 0.000996  |
| 6    | 500                  | 1                   | 80       | 20        | 0.040308  |
| 7    | 500                  | 1.5                 | 40       | 19        | 0.025547  |
| 8    | 500                  | 1.5                 | 60       | 22        | 0.04396   |
| 9    | 500                  | 1.5                 | 80       | 24        | 0.0515789 |

4. Results and Discussions
According to the process parameters that were used in this experimental study, fluctuations in wear and coefficient of friction values were noticed. Figure 2 represents the typical trend of coefficient of friction values during pin on disk test. Unidirectional sliding with the pin sliding across the same wear track was involved in the pin-on-disk testing conditions. As seen in the Figure 2, the maximum value of coefficient of friction was attained in 4th sample having value of coefficient of friction 0.19276. This value is attained with 40N load, 1m/s sliding speed and constant sliding distance of 500m. It can be seen that the value of coefficient of friction is increased with the increase of sliding speed. At next sample 5th where the load was slightly increased to 60N and at same sliding speed we get a much lower value of coefficient of friction 0.000996. It can be noticed that at load 80N and 1.5m/s sliding speed in 9th sample the coefficient of friction value 0.0515789 again starts increasing with increase in sliding speed.
The SEM micrographs are discussed in this section of sample 4th, 5th and 9th were taken because these three samples had higher, lower and medium coefficient of friction respectively. Figure 3 (a) describes the abrasive behavior of specimen at low load and medium speed to achieve high value of coefficient of friction. As we could see, this image taken at 50x some part of the surface resulted in scuffing of the specimen. At most places it is visible that worn surfaces appeared. It made an impulse impact on the value of coefficient of friction results in higher value of the same.

In Figure 3 (b) the wear behavior of sample 5th was taken at 50x. Here we took slightly higher load as per the process parameter which results in lowered coefficient of friction. This states that if we increase the load on specific medium speed the coefficient friction would decrease. The SEM image of specimen depicts slightly small amount of wear is occurred at fewer areas. That’s why the value of coefficient of friction got reduced.
At last, when the sliding speed was increased up to 1.5 m/s the wear was also increased resulting in higher coefficient of friction. In Figure 3 (c) SEM at 50x shows 9th sample where slightly more wear as compared to previous one was noticed. Here we took higher sliding speed as well load at the same constant distance. So, we could see that there are some places where small worn surfaces arose with higher sliding speed.

5. Conclusion
The pin on disk wear test was performed at different speeds and loads at constant distance. On performing the experiments, the obtained results describes that the adhesive wear occurred at various sliding speeds but there were some big fluctuations in 4th, 9th and 5th specimens. So, our objective of this study was achieved as of high, low and medium sliding speed and loads. Higher value of coefficient of friction was achieved at 4th samples i.e., 0.19276. Medium and lower values of coefficient of friction were 0.0515789 and 0.000996 as well. The SEM of these three samples tells us
about where the adhesive wear is occurring more or less as well where surface of material was worn out during pin on wear test.

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