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To analyse the Behaviour of AISI 4340 steel under lubricated condition using Pin on Disc Apparatus

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***Abstract*— In the sliding pairs, friction and wear are the core reasons for energy losses that reduce the efficiency of the mechanical systems. This thesis presents an experimental study to predict the frictional and wear behaviour of AISI 4340 steel under lubricated conditions.**

The experiment was conducted on a pin on disc machine during which EN-31 steel disc was used as a counter surface. The tribological characteristics of AISI 4340 material were observed under different loads varied as 30N and 90N at a fixed sliding distance of 1500m at a continuing speed of 1.0,1.5,2.0,2.5 m/s. it had been found that variation of load and sliding distance play a crucial role in frictional force and wear behaviour of the gear material. The wear and tear of AISI 4340 steel found to be increased with the rise of sliding distance. Load is that the most significant factor which liable for wear loss. The result showed that irrespective of the loads the COF minimum at 2.0 m/s sliding speed and then it increases with the increase in sliding speed.

Index Terms: **Pin on disc, Sliding Speed, COF, Wear loss.**

I.INTRODUCTION

One of the key reliability indices for alloy steel gears can be considered among the standards for wear resistance. In addition to direct material loss, which results in functional failure. Sur face wear causes the equipment to vibrate and make noise, which is essential since the excitation of the gear mesh is highly responsive to its surface geometry [1]. The properties of any substance are determined by the conditions under which it is utilised to conduct operations. Vibration and unwanted foreign/pollution particles are frequently linked to minor excess loads on the contact profile or even during machining operations in points of contact for high-speed and heavy-duty equipment [2–4]. When the surfaces of two or more components of a machine interact, various types of wear occur. Under severe pressures, abrasion, sliding, and contact fatigue can cause more frequent and complex surface and subsurface damage to wear behaviour. Scuffing occurs when the load and sliding speed cause an impulsive impact on the material's surface during operation. Better gear wear has been normal practise for resisting surface modification methods for several years [5–7]. Friction is the resistance to motion that occurs when a solid slides across another body. Due to the vagaries of the process, many sorts of friction arose. Movement is a force of resistance that runs parallel to the direction of the 'friction force. 'Everyone is familiar with the term "wear," and we all assume we know what it implies. Wear, on the other hand, is a difficult concept to define clearly and completely [8]. There's also no way to totally eliminate friction from movements. When performing procedures, it is quite difficult to avoid the effect of produced friction. Oiling is the most effective way to reduce friction between moving parts. An oil film is placed between the contact surfaces of moving parts to reduce wear [9]. Wear and friction can be easily decreased by using lubricants. It's a really effective way to lessen the effects of wear and tear. When executing an operation, friction occurs. We must use extreme caution while selecting the type of lubricant to be utilised in the operation. If we make a mistake when selecting lubricants, it may influence the material's properties as well as increase wear and friction [10]. Wearing behaviour using tribometers required to minimize friction and wear of materials. The wear rate of the material can be assessed by utilizing digital balances to calculate weight loss.

A tribometer is a device that allows pin-on-disk or ball-on-disk tests to be performed with precision. The best application of the tribometer device was used to conduct dry or lubrication type wear tests. A frictional and wear force The tribometer equipment was connected to a frictional force arrangement. We can simply determine the weight loss and COF with the help of this setup.

The tribometer allows researchers to investigate tribological behaviour while altering contact pressure, sliding speed, time, and lubricants [11,12]. AISI 4340 is used in a variety of industries, including aircraft, cars, and manufacturing. In terms of We are employing this material in our experiment since it is also used in the food processing unit's gear box. Because of its great strength and ductility, this material can be used in the gear box of a variety of manufacturing machine setups. The purpose of a pin on disc wear test is to determine the weight loss and coefficient of friction. The ASTM standard governs material pin-on-disk tests Various parameters are well described with the help of Analysis of value for sliding distance is adjudged as the most variance. Result of favourable parameter. The effect of sliding speed, sliding distance and different loads on wear rate and C.O.F were also determined by this pin on disk test [13].

II. MATERIALS AND METHODS

AISI 4340 alloy steel was utilised as specimens for the experimental study because it is used in the gearbox of food processing units. The major components of this alloy steel are Mn and Cr, which provide it with excellent strength and toughness. Specimen with a diameter of 10 mm and a length of 40 mm. Such pins are utilised with spherical heads for proper area of contact with rotating disc due to their simplicity of alignment. To achieve a hardness of 46 HRC, various heat treatment procedures are used on specific dimensions. The Rockwell hardness machine, which is available in-house, can be used to check it. The hardness of pins is tested using a diamond ball intender with a load of 150 kg. This ball intender is very important and best for use to check the hardness of the specimens with definite load present in it. Chemical composition of material AISI 4340 is display in the following Table 1.

The hardness of the disc utilized in this wear test is 62 HRC. The rotating disc and the specimen are perpendicular to one other, and the experiment was carried out this way. The disc is made of EN 31 material, and the lubricant for this wear test is SAE 80W-90 gear oil. It has an excellent viscosity since it is used as a non-circulating oil that can be changed every six months to improve output in food processing gear boxes. The process parameters used in this investigation were sliding distance and varied loads.

A total of eight experiments were conducted in order to determine the weight loss and COF values. The specimen is steady, and the disc rotates, while a natural force is applied via a lever mechanism. For experimental work, sliding speeds of 1, 1.5, 2.0 and 2.5 m/s were employed with two different normal loads of 30 N and 90 N and fixed sliding distances of 1500 m. On a Denver electronic machine, the specimens are weighed. It has the lowest tally of 0.01 mg. The specimens are washed in acetone before being cleaned. The difference between the original and final weight loss values, as well as friction, is calculated to determine wear.

A. *Figures and Tables*

Fig.1. Pin on Disc Apparatus

TABLE I

Table 3.1 Chemical composition (wt%) for pin and disc steel [39].

Material	C	Mn	P	S	Cr	Mo	Si	Al	Cu
AISI-4340	0.420	0.750	0.006	0.03	0.79	0.25	0.270	0.030	0.210
EN-31	1.03	0.4562	0.007	0.04	1.50	0.02	0.328	0.03	

I-COMBINITION OF PARAMETER AND

LOAD(N)	SPEED (m/s)	SLIDING DISTANCE (m)	C.O.F(μ).
30	1.5	1500	0.073214
30	2.0	1500	0.039138
30	2.5	1500	0.047303
30	2.5	1500	0.047303

LEVELS

2-COMBINITION OF PARAMETER AND LEVELS

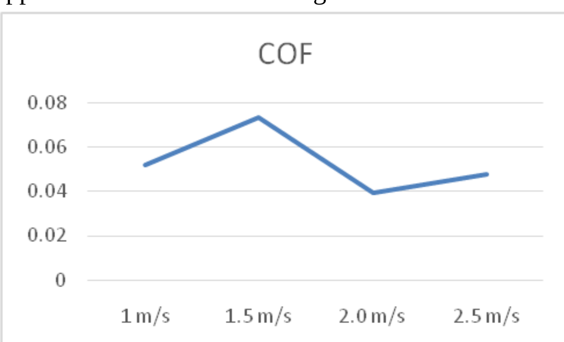
LOAD(N)	SPEED (m/s)	SLIDING DISTANCE (m)	C.O.F (μ).
90	0.5	1500	0.05476

90	1.0	1500	0.055876
90	1.5	1500	0.047651
90	2.0	1500	0.054423

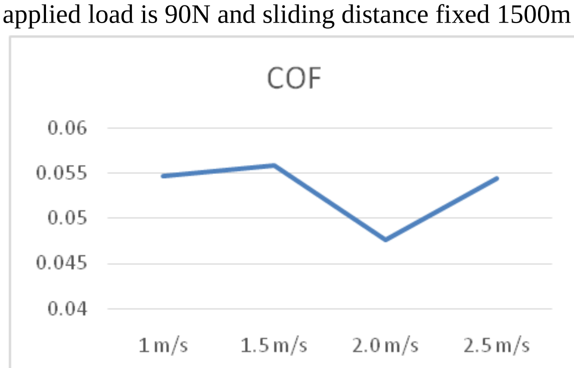
With input parameters sliding speed, sliding distance, and load, the observed data table describes the output of SWR and COF, as well as GRG. In this experiment, the pin is held vertically, or perpendicular to the surface. To conduct experiments, use a circular disc. In this experiment, a spherical head pin is employed. When using the drop-down method to locate material, it prevents or decreases material damage. Material lubrication is critical in preventing wear and friction. This experimental investigation uses SAE 80W-90 gear oil to see how it affects wear under various scenarios. Because SWR is a function of the load imposed, it's critical to examine what results emerge from this research. It's called a setup. Attached to a wear testing equipment, which provides us with values for frictional force and wear. As a result, we can calculate the weight loss and COF values for defining our results as out.

IV. RESULTS

1-Graph between COF and sliding speed when applied load is 30N and sliding distance fixed 1500m



2-Graph between COF and sliding speed when applied load is 90N and sliding distance fixed 1500m



V. CONCLUSION

1. At lower loads such as 30N the value of COF increases with the increase in the sliding speed from 1.0m/s to 1.5m/s and COF is minimum at the 2.0 m/s and then COF gradually rises with increase in the sliding speed.
2. At the higher load such as 90 N the value of the COF firstly slightly rises from when speed changes from 1m/s to 1.5 m/s and then COF value fall down at 2.0 m/s but after that COF abruptly increases.
   The result show that irrespective of the loads the COF is minimum at the 2.0 m/s sliding speed and then COF increases at the 30 N and 90 N loads.
3. The weight loss increased with the increase in normal load as well as sliding distance. The amount of wear loss is high when load increases gradually as compared to sliding distance. Thus the load is the most significant parameter in this study.

REFERENCE

[1] A. Kahraman, H. Ding, Wear in gears, in: Q.J. Wang, Y.-W. Chung (Eds.), Encycl.Tribol., Springer US, Boston, MA, 2013, pp. 3993–4001.

[2] S.J. Bull, J.T. Evans, B.A. Shaw, D.A. Hofmann, The effect of the white layer on micro-pitting and surface contact fatigue failure of nitrided gears, Proc. Inst. Mech. Eng. 213 (1999) 305–313.

[3] M. Boniardi, F.D. Errico, C. Tagliabue, Influence of carburizing and nitriding onfailure of gears–a case study, Eng. Fail. Anal. 13 (2006) 312–339.

[4] C. Prakash, M.S. Uddin, Surface modification of b-phase Ti implant byhydroaxyapatite mixed electric discharge machining to enhance thecorrosion resistance and in-vitro bioactivity, Surf. Coat. Technol. 326 (2017)134–145.

[5] C. Santus, M. Beghini, I. Bartilotta, M. Facchini, Surface and subsurface rollingcontact fatigue characteristic depths and proposal of stress indexes, Int. J.Fatigue 45 (2012) 71–81.

[6] C. Prakash, S. Singh, B.S. Pabla, M.S. Uddin, Synthesis, characterization,corrosion and bioactivity investigation of nano-HA coating

deposited onbiodegradable Mg-Zn-Mn alloy, Surf. Coat. Technol. 346 (2018) 9–18.
[7] T. Bell, Source Book on Nitriding, ASM, Met. Park. OH, pp. 266–278, 1977.
[8] E.J. Mittemeijer, M.A.J. Somers (Eds.), Thermochemical Surface Engineering ofSteels: Improving Materials Performance, Elsevier, 2014, pp. 3–5.
[9] M.A.J. Somers, E.J. Mittemeijer, Layer-growth kinetics on gaseous nitriding ofpure iron: evaluation of diffusion coefficients for nitrogen in iron nitrides, Metall. Mater. Trans. A 26 (1995) 57–74.
[10] J. Halling, Principles of Tribology, The Contributors (1978).
[11] C. Prakash, S. Singh, On the characterization of functionally graded biomaterialprimed through a novel plaster mold casting process, Mater. Sci. Eng., C 110(2020) 110654.
[12] C. Prakash, H.K. Kansal, B.S. Pabla, S. Puri, Potential of powder mixed electricdischarge machining to enhance the wear and tribological performance of b-Tiimplant for orthopedic applications, J. NanoengNanomanuf. 5 (4) (2015) 261–269.
[13] H. Singh, A.K. Singh, Y. Singla, K. Chattopadhyay, Tribological study of nano flyash as lubrication oil additive for AISI 4140 steel for automotive engine applications, Int. J. Mech. Prod. Eng. Res. Develop. (2020)