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An Experimental Investigation on Dry Sliding Wear Behavior of Aa 6082 Alloy

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Abstract: In the present study, an AA 6082 (Al-Mg-Si) alloy is to be investigated, over the wear analysis by dry sliding wear operation. The experiments has to be carried out using L9 orthogonal array with design of experiments on wear testing machine. At the time of experiments to optimize the wear behavior, three input parameters like load (N), time (s), and Speed (rpm) were taken as control factors. The wear rate and frictional force were taken as output responses and both are optimized individually. The experimental result shows that the time and load increases, the wear rate and friction force has been increased gradually.

Keywords: AA6082, Pin-on-disc, Taguchi Methods

1. INTRODUCTION:

Aluminum is the second most abundant metal available in the earth's crust and because of its strong affinity to oxygen, it is always found as oxides or silicates [Polmear (2006)]. Aluminum is a light weight metal, with a density of 2.70 g/cm3 or one-third the density of steel and is often used when weight is an important factor, as required for aircraft and automotive applications [Small man and Bishop (1995)]. Aluminum alloys are alloys in which Aluminum is the main metal and the typical alloying elements are copper, magnesium, manganese, silicon, tin and zinc. The attractive properties of aluminum and its alloys are lightweight, aesthetic appearance, excellent corrosion resistance, high strength-to-density ratio, good toughness and excellent formability including good weldability [George E. Totten and Scott MacKenzie (2003)]. The 6000 series aluminum alloys are age hardenable super high strength aluminum alloys belonging to the Al-Mg-Si group, widely used as aircraft structural materials, especially 6082 aluminum alloy extensively used in aircraft structures and other highly stressed structural applications because of its high strength to-density ratio, good ductility, high toughness, resistance to fatigue and very good machinability [Williams and Starke (2003), Hosseinifar and Malakhov (2008)]. Wear is the progressive loss of material or surface damage, due to relative motion such as sliding, rolling or impact motion between a two solid surface and contacting substance. The continuous unidirectional or reciprocating relative motion between two moving bodies in contact under load is known as sliding wear. The loss of material from a surface, transfer of material from one surface to another or movement of material within a single surface leads to wear. It is a serious problem in many engineering applications such as bearings, moving parts, engine parts, etc. Further wear is a surface phenomenon, it can destroy the functioning of the components by reducing fine tolerances and destroying surface finish which eventually lead to the early replacement of the components. In order to design and select materials for tribological system it is essential to understand the relationship between the material properties and its wear behavior [Yuvaraj (2018; Panagopoulo et al. (2009)].

2. EXPERIMENTAL PROCEDURES:

The dry sliding wear tests were conducted as per **ASTM: G99** to evaluate the wear behavior of all the materials in a DUCOM® pin on disc wear testing machine with data acquisition system. Wear sample pins of 6 mm diameter and 31 mm height prepared from the extruded heat treated materials (AA 6082 alloy) were allowed to slide over hardened D3 steel counterpart disc, having a hardness of 63 HRC. In order to study the wear behavior of the pin, keeping the counterpart without wear, the counterpart was chosen to have hardness higher than that of the pin. The standard disc used for testing was made up of hard steel. The wear test was carried out at room temperatures. The material chosen for the present study was AA6082 as listed in table 1. The experiments were conducted as L9 orthogonal array using Taguchi method [Sandhya Rani Rana et al. (2018)]. The experiments were considered as three factor and two level Taguchi method. The load, time and speed are taken as the input parameters, wear rate and frictional friction are taken as the output response.

Table 1: Chemical Composition of AA 6082									
Alloying Element	Mg	Si	Mn	Cu	Cr	Zn	Ti	Fe	Al
Wt. (%)	0.63	1.02	0.54	0.030	0.013	0.008	0.015	0.18	97.56

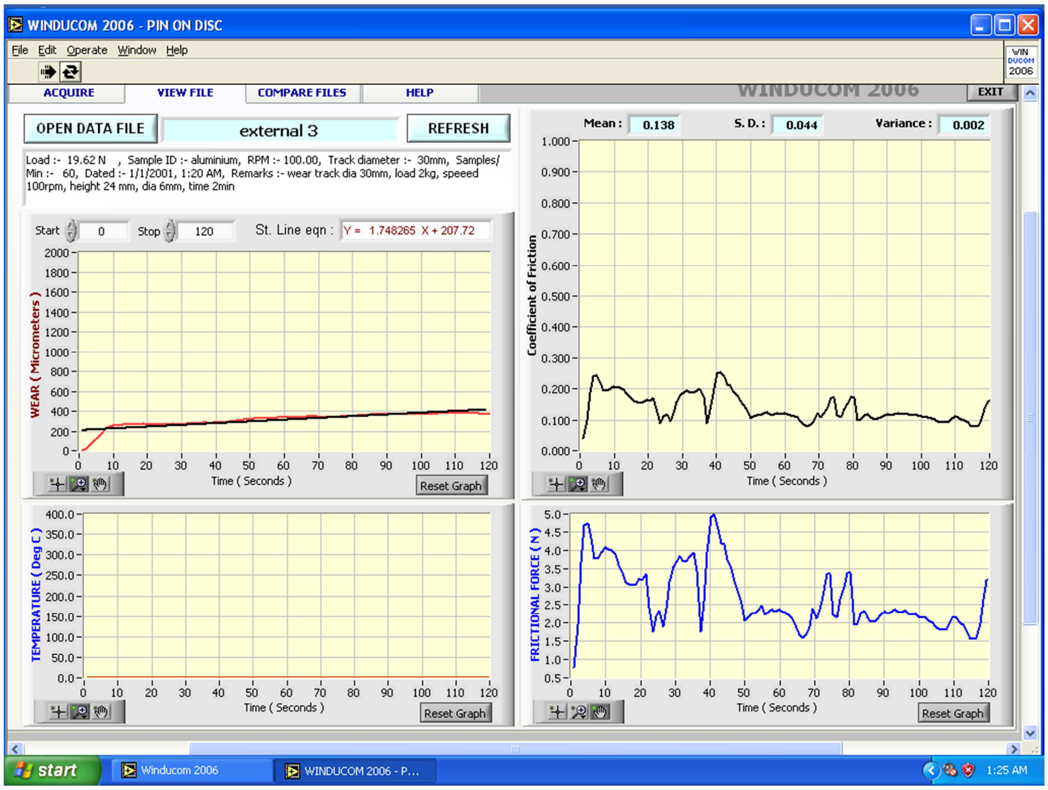
3. RESULTS AND DISCUSSIONS

The experimentally were carried out using pin on disc equipment and are listed in the table 2. In this wear analysis, increasing speed and time, the wear rate is more. Load and time plays important key role in the wear rate and frictional force. From the output graph shows clearly, time increase, wear rate is increased gradually. Simultaneously frictional force and coefficient of friction is increased gradually. The wear testing machine with data acquisition system is shown in Fig.1. The wear rate of the tested materials was noted directly from the wear testing machine. The coefficient of friction was noted directly from the data acquisition system coupled with wear testing machine for each and every experimental run. The experimental density values are used for calculating wear rate of the materials from the mass loss measurement.

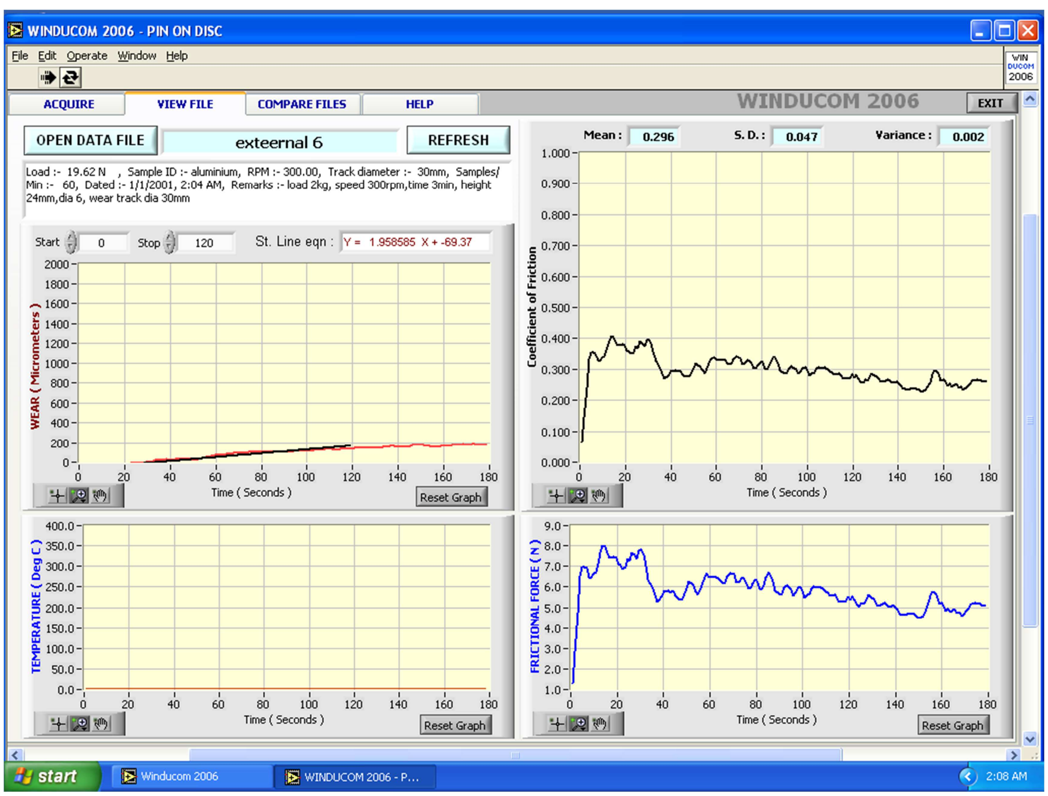
Fig 1: Wear testing machine with data acquisition system

Table 2: Pin on Disc Response Values					
Exp. no.	**Load (kg)**	**Time (min)**	**Speed (rpm)**	**Wear rate (mm^3/m)**	**Frictional Force (N)**
1	2	1	100	193	2
2	2	2	200	183	2
3	2	3	300	204	2.5
4	5	1	200	240	2.9
5	5	2	300	362	3.5
6	5	3	100	418	6.3
7	8	1	300	326	6.9

8	8	2	100	364	7.2
9	8	3	200	367	9.9




WINDUCOM 2006 - PIN ON DISC
File Edit Operate Window Help
ACQUIRE
VIEW FILE
COMPARE FILES
HELP
WINDUCOM 2006
EXIT
OPEN DATA FILE
external 5
REFRESH
Load :- 19.62 N , Sample ID :- aluminium, RPM :- 300.00, Track diameter :- 30mm, Samples/ Min :- 60, Dated :- 1/1/2001, 1:53 AM, Remarks :- load 2kg, speed 300rpm,time 2min, height 24mm,dia 6, wear track dia 30mm
Start 0 Stop 120
St. Line eqn : Y = 0.954166 X + -39.05
Mean : 0.267
S. D. : 0.064
Variance : 0.004
WEAR (Micrometers)
Coefficient of Friction
TEMPERATURE (Deg C)
FRICTIONAL FORCE (N)
Time (Seconds)
Reset Graph
start
Winducom 2006
WINDUCOM 2006 - P...
1:57 AM


WINDUCOM 2006 - PIN ON DISC
File Edit Operate Window Help
ACQUIRE
VIEW FILE
COMPARE FILES
HELP
WINDUCOM 2006
EXIT
OPEN DATA FILE
external 6
REFRESH
Load :- 19.62 N , Sample ID :- aluminium, RPM :- 300.00, Track diameter :- 30mm, Samples/ Min :- 60, Dated :- 1/1/2001, 2:04 AM, Remarks :- load 2kg, speed 300rpm,time 3min, height 24mm,dia 6, wear track dia 30mm
Start 0 Stop 120
St. Line eqn : Y = 1.958585 X + -69.37
Mean : 0.296
S. D. : 0.047
Variance : 0.002
WEAR (Micrometers)
Coefficient of Friction
TEMPERATURE (Deg C)
FRICTIONAL FORCE (N)
Time (Seconds)
Reset Graph
start
Winducom 2006
WINDUCOM 2006 - P...
2:08 AM

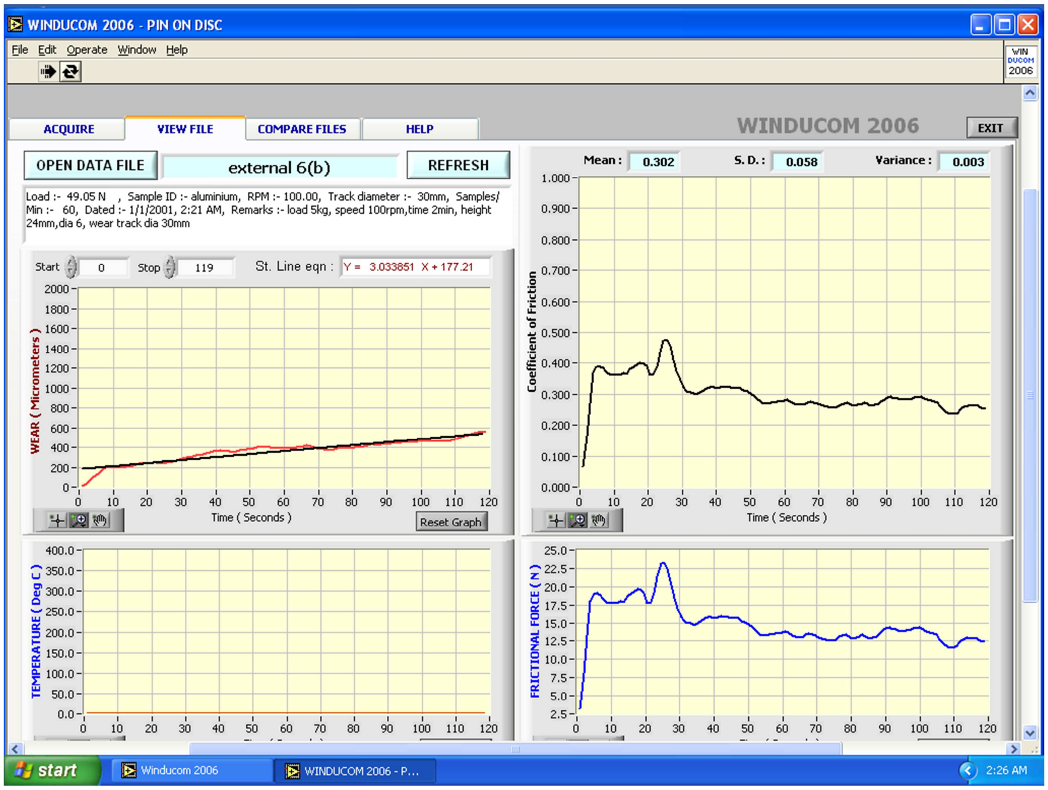


Fig. 2: Pin on disc Response Plot

The pin on disc response plot is shown in Fig 2. In this response plot clearly shows that, wear rate is increased gradually depends on the time. Frictional force and coefficient of friction is more in initial condition after that it slightly decreased due to extension of time.

4. CONCLUSIONS

Dry sliding wear behavior of 6082 aluminum alloy was successfully analyzed by Taguchi technique. From the wear rate and COF, the optimum parameter combinations to obtain minimum wear rate and minimum COF for all the tested conditions were identified. The most influencing wear parameters on wear rate and COF was identified by ANOVA analysis. Based on ANOVA, load and time are found to be majorly affecting wear rate in all the tested conditions. Aluminum 6082 alloy having high wear rate and better mechanical properties. From the observed results shows that, the load and time influencing the wear rate, coefficient of friction and frictional force. Due to speed, wear rate does not shows any significant variation.

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