Journal of University of Babylon for Engineering Sciences, Vol. (26), No. (7): 2018.

Calculation of Wear Rate by Weight and Volume for Aluminum Samples

Fadhel Abbas Abdulla

Mechanical Engineering Department, College Of Engineering Al Mustansiriyah University, Baghdad, Iraq

fadhel975@yahoo.com

Nader Majed Moustafa

Mechanical Engineering Department, College Of Engineering Al Mustansiriyah University, Baghdad,Iraq

nader_majed2000@yahoo.com

Ehsan Sabah Al-Ameen

Mechanical Engineering Department, College Of Engineering Al Mustansiriyah University, Baghdad, Iraq

Ehsan1970@yahoo.com

Submission date:- 10/6/2018	Acceptance date:- 2/7/2018	Publication date:- 5/8/2018

Abstract

Two ways of calculating the wear rate was investigated experimentally by weight and volume using aluminum samples with different load (500g, 1000g, and 1500g) and different time of test (300 s, 600 s, and 900 s). The results show that, When the load increasing from 500 g to 1500 g the wear rate by weight increase by (83%, 80%, and 37%) for test time (300s, 600s, and 900s) respectively. Also, the increasing test time from 300s to 900 s causes increasing in wear rate by weight by (216%, 155%, and 136%) for load (500g, 1000g, and 1500g) respectively. Also, when the load increasing from 500 g to 1500 g the wear rate by volume increase by (740%, 612%, and 662%) for test time (300s, 600s, and 900s) respectively. Also, the increasing test time from 300s to 900 s causes increasing in wear rate by volume by (152%, 110%, and 128%) for load (500 g, 1000g, and 1500g) respectively.

Key words: Wear rate, Aluminum, Volume, Weight.

1. Introduction

The friction between materials is very important and it is work interesting a lot of researchers because the process is found in brake system of cars and a great number of machines. For example, the vibration and noise in brake systems of cars have done by researchers like [1]. A process of interaction in the surfaces or a face of bonded solid which is working to loss parts from dimensions solid during working in its environment can be defined as a wear without or with losing of material. In the results in the wear standard tests, the removing of part from volume of the test sample can be used to expression the wear formals of the wear test. This way can be give result of wear more accurate than the result comes from weight technique [2],[3]. When a rough hard surface moving across a soft surface, the abrasive wear will be occurring. American Society for Testing and Materials (ASTM) define wear as losing in the material as a result applied load on a solid surface as due to hard nprotuberances or hard particles that are moving along and forced against. According to the contact environment and type of contact the Abrasive wear is classified. The mode of abrasive wear is determined the type of contact. According to ASTM D 1044 or ISO 9352 the Taber Abrasion Test can be used to measure Abrasive wear as losing of mass. The wear rate by volume is expressed by the following relation [4],[5]. Wear rate and friction coefficient of SS 202 (stainless steel202) with slid of mild steel on it are studied experimentally by [6]. The pin on disc was fabricated designed apparatus. In experimental work, the rough or smooth pin (SS 304) was sliding on disc (SS 202). Normal load is conducted experimentally at 20, 15 and 10 N, velocity of sliding 2, 1.5 and 1 m/s and humidity (relative) 70%. Different variations were investigated of the duration of rubbing with a friction coefficient at different velocities of sliding and normal loads. The coefficient of friction shows in the results as influenced by normal load, velocity of sliding, and rubbing duration.

The friction and wear properties of AA4015 reinforced with nanoparticles (Titania) were investigated by [7]. Volume fraction varied the test matrix of Titania, applied load and sliding distance to investigate the effects of coupled on the nanocomposites (AA4015/Titania) tribological properties. In a steel counter face against dry sliding, the samples of nanocomposite were tested. The ranged of specific wear rate are (6.24×10^{-6} to 1.17×10^{-5} $mm^3/N\text{-}m$) and the ranged of coefficient of friction are (0.16 to 0.72). Specific wear rate increased with increasing applied load and sliding distance at any volume fraction of Titania nanoparticles in the range tested.

The wear and friction properties of composite polymer matrix are investigated experimentally by [8] such as unidirectional Glass –Epoxy (G-E) laminates are experimentally examined using three different fiber orientations, namely cross ply, symmetric ply, unidirectional ply, at different temperature conditions. These laminates are made by hand layup followed by compression molding. The wear behavior of these composite will be investigated by pin on disc apparatus which is a wear friction monitor machine. Against one standard EN31 steel disc under various sliding speed and loading, different temperature conditions and design of experiments approach using orthogonal arrays of Taguchi.

An investigation on the wear rate and coefficient of friction of carbon steel samples with 0.41%C, 0.346%C, 0.20%C, 0.14%C, and 0.05%C, with contact of Nitride Titanium and coated a steel substrate by PVD was studied by [9] under pin-on-disc technique without lubricated on a tribometer conditions. The specimens were conducted experiments by the form of a sliding pin with against a disc TiN. The operating variables in experimental work represent sliding speeds 10,7,5, and 2 N and normal loads of 7.67 and 15.33 cm/s. The wear rate, time steady state to reach friction, and friction coefficient variations were investigated at variables normal loads and sliding speeds. The results obtained from experimental work show that, the wear rate and coefficient of friction were varied with rubbing duration sliding speed and normal load. Also, when the rubbing duration of coefficient of friction increasing and the sliding of speed decreasing, the coefficient of friction will be decreased, while increasing the duration of rubbing will be causes increased of wear rate. In general, the coefficient of friction will be increased for a certain duration of rubbing, after that the coefficient of friction will be remained constant until the time of experimental work ending. Also, in the results, it is clear that, the samples which have content higher carbon gives a better behavior of tribological.

In this study, the effect of load and time using weight and volume methods of calculation the wear rate for aluminum samples was investigated.

2. **Theoretical Work**

Different samples of aluminum were used in this work, two methods of wear calculation were used in this work which are: -

Wear rate by weight:

Wear rate by weight (W.R.W.) = (W1-W2)*t/ W1 (1)

Where:

W1= weight of aluminum sample before friction action.

W2= weight of aluminum sample after friction action.

t= test time (300s, 600s, and 900s)

Wear rate by volume:

Wear rate by volume (W.R.V.) = p*(V1-V2)/ V1 (2)

Where:

V1= weight of aluminum sample before friction action.

V2= weight of aluminum sample after friction action.

P=load (500 g, 1000 g, and 1500 g)

The dimension of aluminum sample is 35 mm length (l) and 8mm diameter (d) and the volume calculated as

$$V=\frac{\pi}{4}d^2l \quad (3)$$

The sliding speed as 500 r.p.m. and the variables in this work are list in table 1

Table 1. Variables of Present Work

variable	Load (gram)	Time (second)
	500	300
	1000	600
	1500	900

3. Experimental Work

The following steps were to be taken into consideration for each experiment.

1. Values of applied loads on the samples for each case.

2. Radius of disc and its speed.

3. Period of time for each experiment.

4. Weights of each aluminum sample before and after each experiment (loss of weight and volume).

5. Distance slid: the distance was moved by aluminum sample at fractioned part of the metal disc.

4. Results and Discussion

Figure (1) shows the relation between wear rate by weight (W.R.W) for aluminum sample and load at different time of test (300s, 600s, and 900s). From the figure, it can be seen that, the increasing of load causes increasing in W.R.W. Also, the increasing of test time causes increasing W.R.W. That in because, the increasing time of test causes removing particle of aluminum sample. When the load increasing from 500 g to 1500 g the W.R.W. increase by (83%, 80%, and 37%) for test time (300s, 600s, and 900s) respectively. Also, the increasing test time from 300 s to 900 s causes increasing in W.R.W. by (216%, 155%, and 136%) for load (500g, 1000g, and 1500g) respectively.

Figure (2) show the relation between wear rate by volume (W.R.V) for aluminum sample and load at different time of test (300s, 600s, and 900s). From figure, it can be seen that, the increasing of load causes increasing in W.R.V. Also, the increasing of test time causes increasing W.R.V. when the load increasing from 500 g to 1500 g the W.R.V. increases by (740%, 612%, and 662%) for test time (300s, 600s, and 900s) respectively. Also, the increasing test time from 300s to 900 s causes increasing in W.R.V. by (152%, 110%, and 128%) for load (500 g, 1000g, and 1500g) respectively.

Figure (3) shows the relation between wear rate by weight (W.R.W) for aluminum sample and time at different load of test (500g, 1000g, and 1500g). From the figure, it can be seen that, the increasing of time causes increasing in W.R.W. Also, the increasing of test load causes increasing W.R.W.

Figure (4) show the relation between wear rate by volume (W.R.V) for aluminum sample and time at different load of test (500g, 1000g, and 1500g). From the figure, it can be seen that, the increasing of time causes increasing in W.R.V. Also, the increasing of test load causes increasing W.R.V.

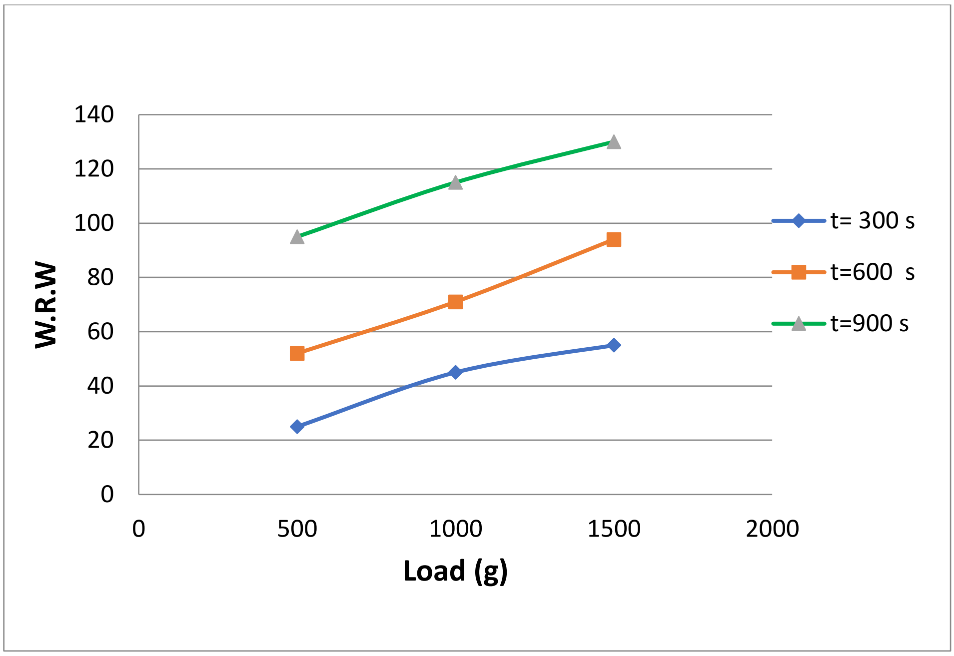

Figure 1. Relationship between Wear Rate by Volume (W.R.W) and load for Aluminum Sample at Different Test Time

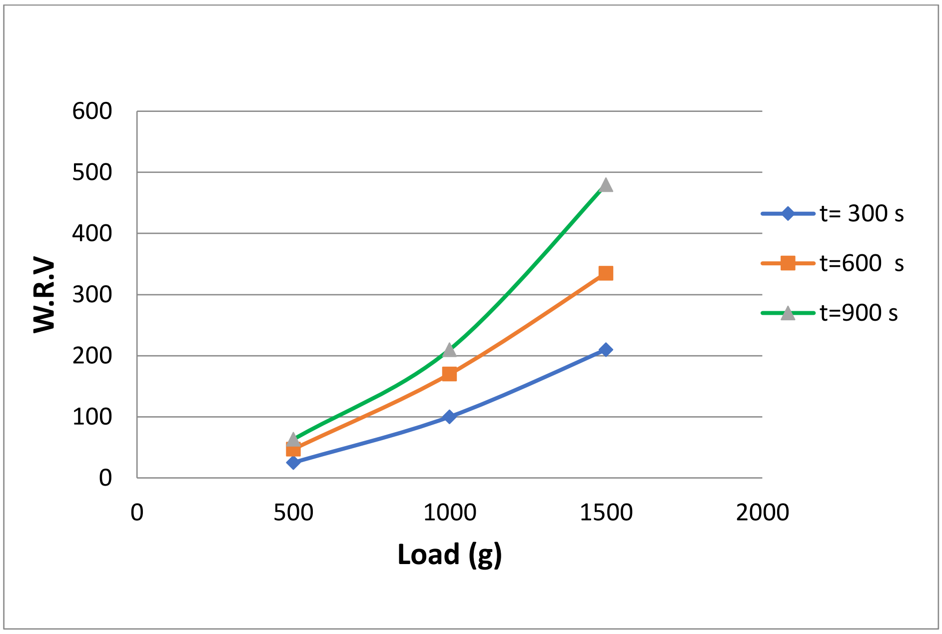

Figure 2. Relationship between Wear Rate by Volume (W.R.V) and load for Aluminum Sample at Different Test Time

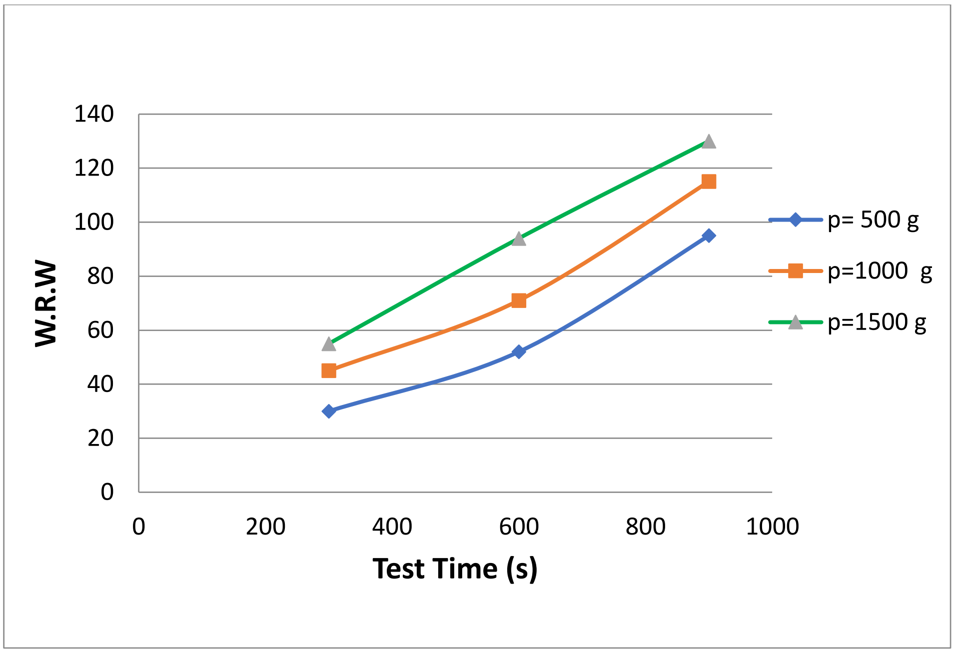

Figure 3. Relationship between Wear Rate by Volume (W.R.V) and Test time for Aluminum Sample at Different Test Time

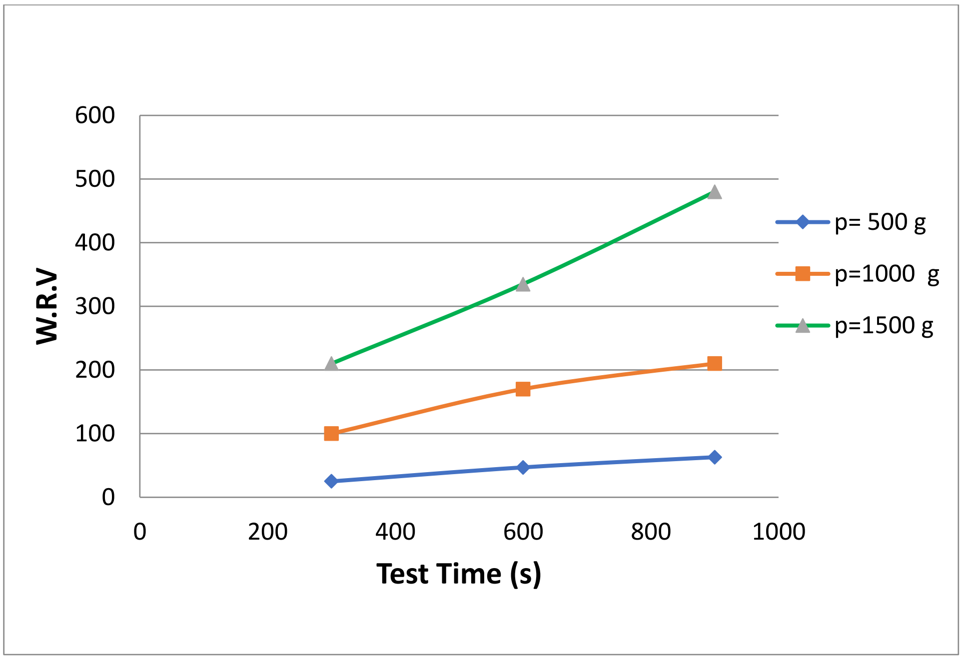

Figure 4. Relationship between Wear Rate by Volume (W.R.V) and Test Time for Aluminum Sample at Different Test Time

Table (2) gives all result of this work foe aluminum samples. Again, the increasing load (500g, 1000g, and 1500g) causes increasing in wear rate using wear rate by weight method and wear rate by volume method. And, increasing test time (300s, 600s, and 900s) causes increasing in wear rate using wear rate by weight method and wear rate by volume method.

Table 2. Result of Wear Rate

		Load (g)					
		500		1000		1500	
		W.R.W	W.R.V	W.R.W	W.R.V	W.R.W	W.R.V
Time (s)	300	30	25	45	100	55	210
	600	52	47	71	170	94	335
	900	95	63	115	210	130	480

5. Conclusions

The main conclusion of this work is:-

1- Two methods can be used to calculate the wear rate of materials.
2- The increasing time of test causes increasing in wear rate by weigh of aluminum, and the increasing time of test from 300s to 900s causes increasing in wear rate by weight by (216%, 155%, and 136%) for load (500g, 1000g, and 1500g) respectively
3- The increasing time of test causes increasing in wear rate by volume of aluminum, and the increasing time of test from 300s to 900s causes increasing in wear rate by volume by (152%, 110%, and 128%) for load (500g, 1000g, and 1500g) respectively
4- The increasing load of test causes increasing in wear rate by weigh of aluminum, and the increasing load of test from 500g to 1500g causes increasing in wear rate by weight by (83%, 80%, and 37%) for time (300s, 600s, and 900s) respectively.
5- The increasing load of test causes increasing in wear rate by volume of aluminum, and the increasing load of test from 500g to 1500g causes increasing in wear rate by volume by (740%, 612%, and 662%) for time (300s, 600s, and 900s) respectively.
6- The volume method of calculation wear rate gives increasing in wear percentage greater than the value comes from weight method.

6. Refrences

[1] V. P. Sergienko, S. N. Bukharov and A. V. Kupreev, " The Noise and Vibration in Brake Systems of Cars", Journal of Friction and Wear", Vol. 29, No3, 2008.

[2] B. K. Prasad, "Influence of Some Test Parameters on Dry Sliding Wear Characteristics of a Zinc-11.5 Aluminum Alloy", Journal of Materials Engineering and Performance, Vol. 11, N0.4, 2002.

[3] R. Rao, S. Das, D. Mondal, and G. Dixit, "Dry Sliding Wear Behavior of Cast High Strength Aluminum Alloy and Hard Particle Composites „Journal of Wear", Vol. 267, No.10,2009.

[4] R. Magaziner, V. Jain, and S. Mall, " Investigation into Wear of Ti-6Al-4V Under Reciprocating Sliding Conditions" Journal of Wear, Vol. 267, No.10, 2010.

[5] A. Anasyida, A. Daud, and M. Ghazali, " Dry Sliding Wear Behavior of Al-alloy with Cerium Addition", Journal of Materials and Design, Vol.31, No.1, 2010.

[6] A. Mohammad, M. Dewan, K. Bioploy, H. Asraful, and M. Rakibul, "Experimental Investigation of Friction Coefficient and Wear Rate of Stainless Steel 202 Sliding against Smooth and Rough Stainless Steel 304 Couter-faces", Friction and Wear Research, Vol. 1 Iss. 3, October. 2013

[7] R. Chennakesava, "Tribological Investigation of the Effects of Particle Volume Fraction, Applied Load and Sliding Distance on AA4015/Titania Nanocomposites" IPASJ International Journal of Mechanical Engineering, Volume 4, Issue 10, October. 2016

[8] B.Sandeep, R. Patil, "Investigation of Wear and Friction Characteristic of Laminated Polymer Matrix Composite at Different Temperature", IJSRD - International Journal for Scientific Research & Development, Vol. 4, Issue 05, 2016.

[9] O. Steven, and S. Amandi, " Experimental Investigation on Tribological Behaviour of Carbon Steels", The West Indian Journal of Engineering, Vol. 39, No. 2, pp. 36-39, January. 2017.

حساب معدل التآكل حسب الوزن والحجم لعينات الألومنيوم

فاضل عباس عبد الله

قسم الهندسة الميكانيكية، كلية الهندسة، الجامعة المستنصرية، بغداد، العراق

fadhel975@yahoo.com

نادر ماجد مصطفى

قسم الهندسة الميكانيكية، كلية الهندسة، الجامعة المستنصرية، بغداد، العراق

nader_majed2000@yahoo.com

احسان صباح الامين

قسم الهندسة الميكانيكية، كلية الهندسة، الجامعة المستنصرية، بغداد، العراق

Ehsan1970@yahoo.com

الخلاصة

تم التحقيق في طريقتين لحساب معدل التآكل بالوزن والحجم عمليا باستخدام عينات ألمنيوم مع حمل مختلف (٥٠٠ جم، ١٠٠٠ غرام، و١٥٠٠ جم) ووقت اختبار مختلف (٣٠٠ ثانية، ٦٠٠ ثانية، و٩٠٠ ثانية). تظهر النتيجة أنه عندما يزيد الحمل من ٥٠٠ جم إلى ١٥٠٠ جم فإن معدل التآكل بالوزن يزداد بنسبة (٨٣٪ و٨٠٪ و٣٧٪) لوقت الاختبار (s٣٠٠ وs٦٠٠ وs٩٠٠) على التوالي. كذلك، يزيد زمن الاختبار المتزايد من ٣٠٠ إلى ٩٠٠ ثانية من معدل التآكل حسب الوزن (٢١٦٪، ١٥٥٪، و١٣٦٪) للحمل (٥٠٠ جرام، ١٠٠٠ جرام، ١٥٠٠ جرام) على التوالي. أيضا، عندما يزداد الحمل من ٥٠٠ غم إلى ١٥٠٠ غم معدل التآكل من خلال زيادة الحجم بنسبة (٧٤٠ ٪، ٦١٢ ٪، و٦٦٢ ٪) لوقت الاختبار (s٣٠٠، s٦٠٠، و٩٠٠ s) على التوالي. كذلك، يزيد زمن الاختبار المتزايد من ٣٠٠ إلى ٩٠٠ ثانية من معدل التآكل بالحجم بنسبة (١٥٢٪، ١١٠٪، و١٢٨٪) للحمل (٥٠٠ جرام، ١٠٠٠ جرام، ١٥٠٠ جرام) على التوالي.

الكلمات المفتاحية: – معدل التآكل، الالمنيوم، حجم، وزن.