Optimization Process Parameters in Testing of Wear properties of Aluminium Alloy 6082

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Abstract. When the two materials are in contact in motion, wear rate of the materials taken an important role. Aluminium alloys used in many applications like automobile components, aerospace components, home appliances, machine tool components. Advanced aluminium alloys are used in aerospace components. In this project wear studies of advanced aluminium alloys are carried using pin-on-disc machine three processing parameters considered are Load, Time and Speed. Twenty seven samples ae been tested to find wear rate of aluminium alloys. A Taguchi method is applied to find optimization process parameters which are having minimum wear rate. Aluminium alloy 6082 has a medium strength and good corrosion resistance. It is the strongest alloy

Keywords: Taguchi, Wear rate, Load, Time and Speed;

1. Introduction

The optimization process parameters in measuring wear qualities of aluminum alloy 6082 is a critical aspect in determining the material's performance and durability. Wear characteristics are important in a wide range of applications, including automotive components, aircraft components, and medical implants. The optimization process parameters used to identify the best combination of parameters for a certain application's wear attributes. This document will go through the procedure factors for optimizing wear properties testing. This paper represents an optimization process for testing the wear properties of aluminum alloy 6082. The optimization process involves the selection of parameters like test speed, Time and load. The wear properties of aluminum alloy 6082 were tested using a pin-on-disc tribometer.

2. Literature review

Aluminium and its compositions are next-generation sophisticated materials with superior mechanical qualities such as high specific strength, hardness, and wear and corrosion resistance. All of these characteristics make aluminium a viable material for the production of vehicles and aeroplanes. Because of the abrasive nature of the reinforced particles and the hardness of MMCs, machining of these materials remains challenging [1,14].

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The industrial sectors were always in need of innovative engineering materials for a variety of purposes. As a result, metal matrix composites improve. The development of novel materials, such as MMCs, is a hotly debated topic these days. Many literatures on the development, characterisation, and use of MMCs are available in the open literature [2]. Metal matrix composites were developed in response to the ongoing demand for new class materials to satisfy specific requirements (MMCs). The addition of more than one type of reinforcement with varied qualities results in hybrid MMCs with higher quality that overcome the disadvantages of MMCs [3,12]. High tool wear rate and high cycle time in traditional machining have supplied a horrific response for tougher materials and it is also very difficult to manufacture the complicated forms using such machines. Wire Electric Discharge Machining (WEDM) is a popular non-conventional machining technique for hard materials and complicated forms. In this study, an attempt is made to evaluate the surface integrity of the machine surface as well as the performance of the hybrid MMC A359/Al2O3/B4C during the wire-EDM process under various operating circumstances [4]. Friction stir additive manufacturing (FSAM) is an emerging additive manufacturing technology that uses the notion of solid friction stir processing to produce multilayer components by layer by layer joining [5]. Friction stir processing is a cutting-edge approach for creating novel surface composites or altering material characteristics by severe, solid-state localised material plastic deformation. This property change is caused by introducing a non-consumable spinning tool into the workpiece and travels laterally through the workpiece [6,8]. The traditional machining of engineering hard materials like composites is a demanding operation owing to quick tool wear and high machining cost. Because of its superior machining results, non-conventional machining techniques such as abrasive waterjet cutting are commonly used for the cutting of such hard materials [13,15]. The key requirements in the realm of defence, such as aircraft constructions and aerospace applications, are lightweight and high strength materials. Because of their increased properties, aluminum-based composites are one of the best options in this context. The current study attempts to generate aluminium (A359)-based surface composites by integrating Si3N4 particles by friction stir processing (FSP) [8]. The main purpose of the machining operation—getting the workpiece to the specified surface quality and geometry—is to use the cutting tool to its maximum capability throughout its lifetime. Many characteristics can influence the surface processes utilised in machining procedures [9,7]. Because of improved micro structural and mechanical properties, aluminium have emerged into technical industries, military, aerospace, and automotive. Friction stir processing is employed in this work to make Al2024/SiC composites with one, two, and three passes of the cylindrical tool [10,11,16].

3. Material Properties of Aluminium Alloy 6082

In this experimentation Aluminium Alloy 6082 is considered. The Mechanical properties are shown in table 1, Chemical properties have shown in table 2, Physical properties are shown in table 3.

Table 1. Mechanical properties of AA6082.

Strength	**value**
Tensile strength	275 Min MPa
Hardness	84 HB
Elongation A100mm	6 Min %
Elongation A50mm	9 Min %

Table 2. Chemical Properties.

Element	content (%)
Iron, Fe	0.5
Chromium, Cr	0.25
Manganese, Mn	0.6-1.2
Zinc, Zn	0.2
Silicon, Si	0.7-1.3
Copper, Cu	0.1
Titanium,	0.1
residuals	0.15

Table 3. Physical Properties.

Properties	value
Density	2.70 g/cm^3
Melting Point	555
Effusiveness	24*10^-6/k
Elastic modulus	70 GPa
Thermal Resistivity	180 W/m K
Electrical conductivity	0.038*10^6m

4. Pin-on-disc Wear Test

Pin-on-Disc a specific type of tribotester shown in figure 1 is used to find the wear properties of the materials. Disc material is harder than pin material. Pin is in contact on the rotating disc. In this wear test Aluminium 6082 Alloy material shown in figure 2 is used as pin material to fin its wear properties. The process parameters used are Speed(rpm), Time(min) and Load(N) in different levels. Optimum process parameters will be found based on minimum wear rate.

Fig. 1. Pin-on-Disc machine.

Fig. 2. Aluminium Alloy 6082.

5. Taguchi Analysis for Wear test

Taguchi anylasis performed using L9 orthogonal array. Three process parameters(factors) of Pin-on-disc taken are Speed(rpm), Time(min) and Load(N). The three levels of the speed are 500rpm, 800rpm and 1100rpm. The three levels of time taken for test 1 to 3 minutes. L9 factor is taken which gives the values of 3 to the power 2 factors to which the experiments are to be done with the values given by the minitab.

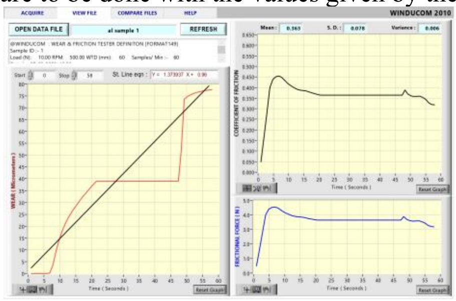

Fig. 3. Analysis of samples AA6082.

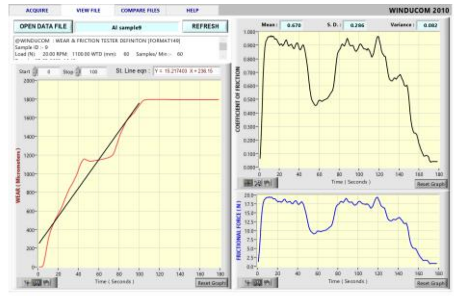

Fig. 4. Analysis of samples AA6082.

Figure 3 and 4 shows the results analysis of Aluminium 6082 Alloys experimentation has been done on pin-on-disc with varying parameters like speed, time, load.

Table 4 and Table 5 is about the Analysis of the experiment which is done on Pin-on-disc by considering the three factors Speed, time, Load which are ranging from 500-1100 Rpm, 1-3 minutes and 10-30 N respectively.

Table 4. L9 orthogonal array from Minitab.

Factor1	Factor2	Factor3
1	1	1
1	2	2
1	3	3
2	1	2
2	2	3
2	3	1
3	1	3
3	2	1
3	3	2

Table 5. Wear rate analysis of 9 samples and S-N ratio.

Speed (rpm)	Time (min)	Load(N)	Wear rate (m^3/Nm)	SN Ratio
500	1	10	48.98	-33.8004
500	2	20	98.32	-39.8528
500	3	30	146.3	-43.3049
800	1	20	85.23	-38.6118
800	2	30	190.05	-45.5774
800	3	10	195.81	-45.8367
1100	1	30	92.86	-39.3566
1100	2	10	110.94	-40.9018
1100	3	20	230.82	-47.2655

5.1 Results and Discussions

Table 6 shows the response of the signal-to-noise ratio, which is Wear rate versus S, T, and W, which stand for speed, time, and load, respectively. Higher values in each component are regarded for least wear, delta is the difference between the highest and lowest values, and lastly rank is evaluated as the highest of the three factors is first, second, and so on. Based on the data in table 5, it appears that sample1 has the lowest Wear rate and is the least wear material in the list. Due to the high rpm and load, it also has the greatest Wear rate at 1100 rpm for 3 minutes at 20 N load.

Table6. S-N ratio response.

Level	S	T	W
1	-38.99	-37.26	-40.18
2	-43.34	-42.11	-41.91
3	-42.51	-45.47	-42.75
Delta	4.36	8.21	2.57
Rank	2	1	3

Fig. 5. S-N ratio curves.

6. Conclusion

Optimisation of process parameters in testing wear characteristics of 6082 Aluminium Alloy was performed in this study. For testing on Pin-on-disc, three process parameters were chosen: speed, time, and load. Nine tests are carried out using the Taguchi L9 orthogonal array with these three process parameters varied. According to the results and comments (Taguchi analysis was performed using Minitab software), S-N ratio level 1 has the greatest values for all three process parameters. As a result, the wear rate is low for certain levels of process parameters. The test was performed at a speed of 500 rpm, a time of one minute, and a load of one pound, with a wear rate of 48.98 m3/min. As a result, Aluminium Alloy 6082 may be used for the above levels of process parameters to improve performance and longevity.

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