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Effect of Copper Content on Wear Properties of Aluminium Alloy

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ABSTRACT

Aluminium alloys are extensively used in aircraft, automobile and other engineering structures. The reason for this large application is due to a wide range of excellent properties including low density, corrosion resistance and high strength to weight ratio excluding its strength. In this paper Al-Cu binary alloy is considered in different weight propositions with aluminium as main component and varying copper content from 2-6% in weight. Wear test were carried out using a pin on disc apparatus and found that there is more wear in Al-6Cu composition by 38%.

KEY WORDS: Sand casting, Wear, Aluminium alloy.

1. INTRODUCTION

Aluminium alloys are extensively used in aerospace, automobile, medical industries due to their light weight and high weight to strength ratio. However, aluminium by itself exhibits poor tribological properties. Hence, tibological behaviour of Aluminium is gaining more attention by Venkataraman and Sundararajan (2010). Jiang and Tan (1996), have studied the influence of alumina fibre reinforced in Al-Si alloy composites in dry sliding wear condition behaviour. It was found that reinforced alloy has underwent to severe wear at a high load as compared to the unreinforced alloy. Perrin and Rainforth (1995), studied the size of the subgrains below the worn surface of an Al-Cu alloy and found a minimum value at a certain depth below the worn surface due to saturation of flow stress but, reinforcing Al-Cu alloy with alumina fibres a uniform size of the subgrains can be attained below the worn surface as the fibres could distribute the load uniformly.

With a view to remove the gaps in the above literature at least partially in our current level of understanding, wear experiments with different test loads (10 N, 30 N) were conducted with Al-2Cu, Al-3Cu, Al-4Cu, Al-5Cu, Al-6Cu Aluminium alloy as the test material (in the form of pins) sliding against hardened steel discs. The results of the above experiments are discussed in this paper.

2. EXPERIMENTATION

Materials: The materials used in the present study were as follows: (a) Al- 2% Cu alloy (b) Al- 3% Cu alloy (c) Al- 4% Cu alloy (d) Al- 5% Cu alloy and (e) Al- 6% Cu alloy. The various Al-Cu composition alloys were fabricated using Sand Casting route.

Sliding Wear Tests: The wear tests were carried out using a Pin-on-Disc tribometer machine as shown in Fig.1. It consisted of a steel disc that was carried by a mandrel driven by a motor. The test specimens consisted of two cylindrical pins that were mounted on a hydraulic loading mechanism consisting of dead weights, spindle and hydraulic cylinder. The specimen to be tested is fixed to the collect and the collect along with the specimen is positioned at a 80mm track diameter. This track diameter is to be changed after each test i.e., a fresh track is to be selected for each specimen. During the experiment specimen remains fixed and disc rotates. Load is applied through a dead weight loading system to press the pin against the disc and frictional force raised at the contact can be read out from the controller. For each composition of Aluminium Copper alloy a 5 sets of specimens were tested and average was taken. Each set of test is carried out for a period of one hour. After each one hour run the test pieces were removed from the machine and weighted accurately to determine the loss in weight. The test was repeated for 10N and 30N load at 800rpm.

Figure.1. Pin on Disc Tribometer

Table.1. Specifications of equipment

Conforms to the specifications of	ASTM G99
Sliding Speed Range	0.26-10 m/sec
Disc Rotation Speed	100-2000 rpm
Maximum Normal Load	200 N
Frictional Force	0-200 N
Wear Measurement Range	4 mm
Pin Size	3-12 mm diagonal/diameter
Disc Size	160 mm diameter x 8 mm thick
Wear Track Diameter	10-140

3. RESULTS AND DISCUSSION

Wear Behaviour: Fig.2, shows the variation of the steady state value of the wear rate in the case of Al-2Cu, Al-3Cu, Al-4Cu, Al-5Cu, Al-6Cu specimens as a function of applied load. The wear rate of the alloy is found to be high at 6% copper for both 10N and 30N load and is minimum at 3%Cu for a 10N load and for 30N load it is at 5% copper. Wear rate is found to be fluctuating with different percentages of copper. This fluctuation is may be due to improper manufacturing of alloy during sand casting.

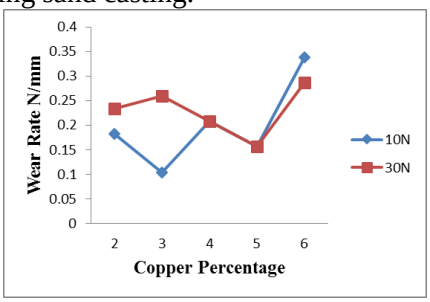

Figure.2. Wear Rate of Copper

Microstructures of worn surfaces: Fig.3(a), 4(a), 5(a), 6(a) and 7(a) shows the microscopic surfaces of Al-2Cu, Al-3Cu, Al-4Cu, Al-5Cu, Al-6Cu specimens before wear and Fig.3(b), 4(b), 5(b), 6(b) and 7(b) shows the microscopic surfaces of Al-2Cu, Al-3Cu, Al-4Cu, Al-5Cu, Al-6Cu specimens with more worn out surfaces at 6% composition of Al-Cu alloy.

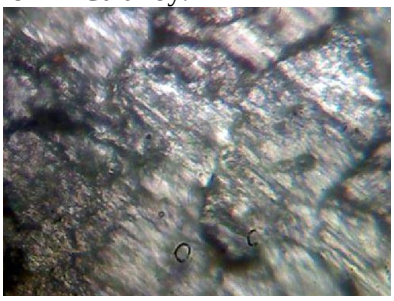

Figure.3(a). 2% Copper before wear

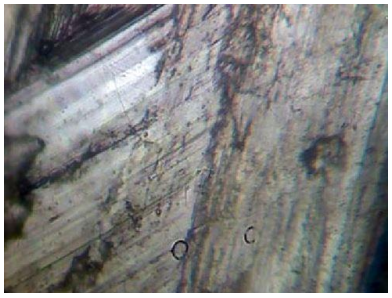

Figure.3(b). 2% Copper after wear

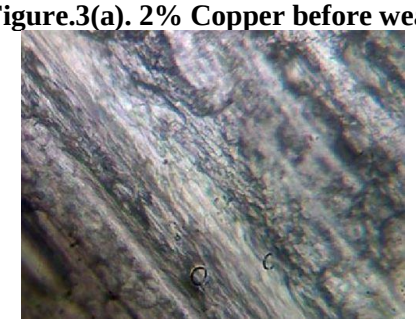

Figure.4(a). 3% Copper before wear

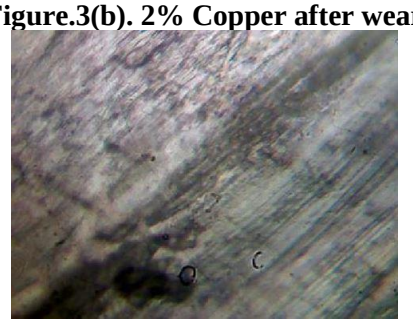

Figure.4(b). 3% Copper after wear

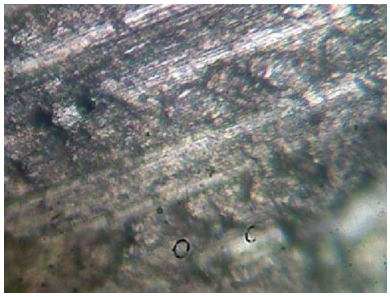

Figure.5(a) 4% Copper before wear

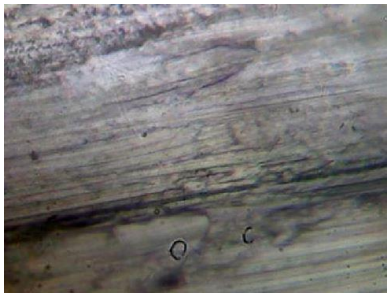

Figure.5(b) 4% Copper after wear

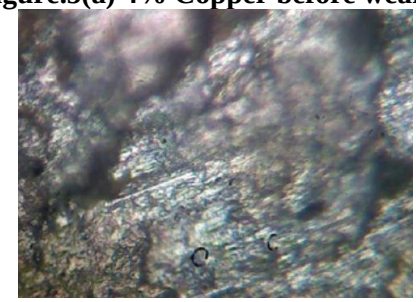

Figure.6(a) 5% Copper before wear

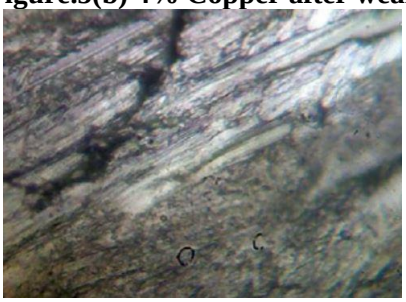

Figure.6(b) 5% Copper after wear

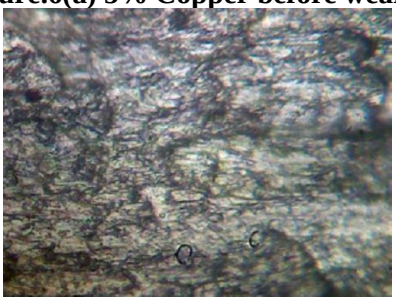

Figure.7(a) 6% Copper before wear

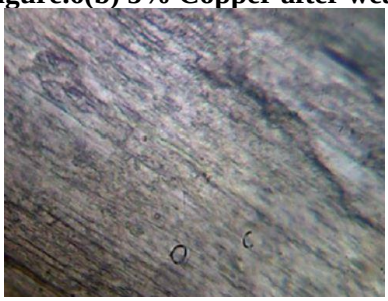

Figure.7(b) 6% Copper after wear

4. CONCLUSION

- The Al-Cu alloy was prepared by sand casting using pure form of Aluminium and fine powder of copper.
- The amount of copper was increased from 2-6% of copper.
- Wear rate of Al-Cu alloy is increasing with the increase in percentage of copper.

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