Evaluation of wear response under reciprocating sliding of A390 alloy when squeeze casting pressure and stroke length vary

TRACK OR CATEGORY
Non-Ferrous Metals III: Tribology

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1. INTRODUCTION
Components of cast aluminium alloys is the most important category of light metals. A390 alloy one of the aluminium alloys that has better wear resistance, high strength and low thermal expansion. Together with excellent castability and reduced density A390 is mostly utilized for heavy wear applications. The superior wear resistance is due to the hard silicon particles which precipitates throughout the aluminium matrix [1, 2, 3]. Reciprocating sliding contact results in a higher wear rate than a continuous wear system. Hence material system has to be tested separately under this type of contact [4, 5, 6, 7, 8]. Squeeze Cast (SC) fabricated engineering components are reported to have fine grained structure, excellent surface finish, reduced porosity and improved mechanical properties compared to stir cast composites [9, 10].

In this paper, an examination of wear loss and the combined effect of SC pressure and stroke length is examined. Al-18%Si alloy was cast by gravity and SC at 50 MPa. Pin on plate type reciprocating tribometer was employed with varying stroke lengths of 50 mm, 100 mm and 150 mm at loads from 15-75N. The results of this study is discussed in this paper.

2. ALLOY PREPARATION
The Al-18%Si alloy was prepared from master alloys. The chemical composition of this alloy is given in Table 1.
Table 1 – Composition of the Al-18%Si alloy prepared

<table>
<thead>
<tr>
<th>Element</th>
<th>Al</th>
<th>Cu</th>
<th>Mg</th>
<th>Si</th>
<th>Zn</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt%</td>
<td>77.40</td>
<td>5.00</td>
<td>0.90</td>
<td>18.00</td>
<td>0.50</td>
<td>remaining</td>
</tr>
</tbody>
</table>

Pins were made from castings and were heat treated under T6 condition. Squeeze casting were done in SwamyEquip supplied furnace with 100 T press. A390 prepared alloy was remelted in the furnace to 730°C and allowed to flow to the preheated die cavity at 200°C. Then the press ram was moved and the preset load (50 MPa) was applied on the poured metal. Holding time was 40 seconds. After that the casting was ejected. Pins where made from these castings, heat treated to T6 condition and wear tests where conducted.

3. WEAR TEST

Wear tests were carried out on a pin-on-plate tribometer (in house fabricated; reciprocating wear test rig) under dry sliding condition [11]. Wear tests where conducted on the in house made reciprocating tribometer and results are presented. The dimensions of the pins were 30 mm length and 5.9 mm diameter. Initially specimens were thoroughly cleaned by using acetone and waited few seconds to dry. Then the wear specimens were accurately weighed three times in a Shimadzu Micro-analytical Balance with a least count of 0.01 mg and averages were taken. Specimens were then loaded on to the wear test rig, load is applied through the lever mechanism. The reciprocating motion was provided by a rotating crank which has a provision to change the radius. Thus radius of crank used were 25 mm, 50 mm and 75 mm resulting a reciprocating sliding stroke lengths of 50 mm, 100 mm and 150 mm. The average reciprocating speed where 0.4 m/s and sliding distance is 400 m. The wear loss was noted for loads of 15 N, 30 N, 45 N, 60 N and 75 N. The wear was measured by weight loss method using a micro balance. Weight of pins were taken before and after the tests. For estimating the coefficient of friction, the lateral forces had to be measured. For this two force sensors (load cells) where used. Data was recorded using a Keithley make DAQ of Model Integra Series 2700 Multimeter. The load cells where calibrated before tests. The voltage corresponding to the frictional force recorded and converted to corresponding weight using the calibration equation. The data were then analysed to obtain the wear loss in mg and coefficient of friction. These are presented in the Figures 3, 4,5 and 6.
4. RESULTS AND DISCUSSION

The wear loss was more at 50 mm. This is because for same average speed of 0.4 m/s, speed of rotation of the crank varied. For 50 mm stroke length speed was 240 RPM, at 100 mm it was 120 RPM and for 150 mm it was 80 RPM. Due to high RPM more energy was dissipated in unit time. The heat soften the material thereby increased the wear. As the stroke length increases the amount of frictional energy dissipated per cycle increases. This increased energy per cycle increases wear loss. Kennedy [12] proposed that almost 95% of the frictional energy dissipated as heat energy. The most important factors governing surface temperature magnitudes as quoted were, the rate of heat generation, sliding velocity, thermal properties of the contacting materials and the true nature of the real area of contact. Hence for the same sliding pairs, with same load and speed, wear loss increases with stroke length. But the temperature effect is more predominant in the present study. Hence the wear loss can increase with stroke length only if the RPM is constant. The wear resistance of the Al-18% Silicon alloy was better for the squeeze cast alloy as expected [13] If the average velocity is constant, then wear will be more at shorter stroke length.

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REFERENCES


**KEYWORDS**

Materials:Aluminum, Applied Tribology:Aluminum Industry, Friction:Unlubricated Friction, varying stroke length