ID: 2016-ISFT- 443

Wear Testing of Aluminium Silicon Alloy Fabricated by Stir Casting

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Abstract: *This investigation describes about the wear characteristics of Al-Si (10%w%) on a pin-on-disc wear testing machine at room temperature. Test specimens were prepared by using stir casting technique. Dry testing condition and hydrodynamic film lubrication condition were used to perform the wear characteristic tests. It is found that addition of silicon improves the wear resistance of the aluminium. The wear rate is strongly dependent on impact pressure, velocity applied load and sliding speed.*

Keywords*: stir casting, wear, impact pressure*

1. INTRODUCTION

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders among other similar mechanisms. So the study of pistons is of utmost importance. Aluminium and silicon alloy are generally used as the casting material for pistons. P.V. Chandrashkhar [1] had studied the microstructure and dry sliding wear behaviour of hypereutectic Al-15Si-4Cu cast alloys with grain refinement, modification and refinement.Pin on disc test were conducted under dry sliding conditions.A.Kumar [2] had studied the dry sliding wear behaviour of cast aluminium 7% silicon alloys (A356) reinforced with SiC particles. Wear was measured by means of a block-on-ring type wear rig. R.L. Deuis[3] studied the effect of alloying elements on binary Al-17wt%Si alloy and multi-component (Al-17Si-0.8Ni-0.6Mg-1.2Cu-0.6Fe) cast alloy.

Anand Kumar [4] investigated the wear characteristics of insitu Al-12%Si/TiC composites and developed regression equations for predicting the weight loss and coefficient of friction. Belete [5] studied the wear behaviour of in-situ synthesized Al-4.5%Cu/TiC composites using a pin on disc method by describing the full factorial design of experiments. Dharmalingam [6] had attempted to optimize the dry sliding performances on the aluminium hybrid metal matrix composites using gray relational analysis in the Taguchi method. Different loads, sliding speeds and varying percentage of molybdenum disulfide were selected as control factors. The multiple responses to evaluate the dry sliding performances were specific wear rate and coefficient of friction. S. Basavarajappa [7] established a correlation between dry sliding wear of SiC reinforced Al–2219 alloy matrix composites and wear parameters like applied load, sliding speed, sliding distance and percentage of reinforcement.

2. EXPERIMENTATION

For the testing purpose a disc and pin of the aluminium Si alloys was fabricated by stir casting method. The aluminium material (99.5% Al, 0.25 % Cu, 0.30% Mn) was melted with elemental silicon and this mixture was stirred continuously for uniform mixing. The melted alloy was poured into the preformed moulds of the specific shape as required by the wear testing machine. After the solidification the final product was achieved by several machining processes.

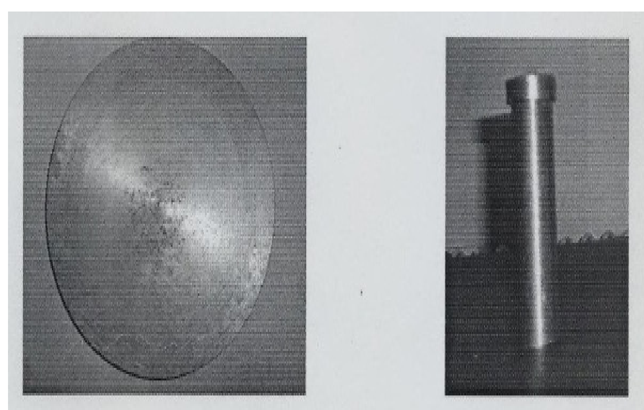

Fig. 1. Intial Tribometer disc and pin for wear test prepared by stir casting method

3. WEAR TESTING

For the calculation of wear a TR-20-LE pin on disc wear testing machine was used and wear tests were done in dry conditions and as well as wet conditions. The various observation recorded during the process as given in the following tables.

3.1 WEAR TEST UNDER DRY CONDITION

TABLE 1. Under dry test condition keeping speed constant (1000 rpm)

S. No.	Track Dia (mm)	Load (N)	Speed rpm	Time s	Gm wt. of test pin before wear1	Gm wt. of test pin before wear 2
1	130	20	1000	147	8.1540	8.1460
2	110	30	1000	174	8.1405	7.3996
3	90	10	1000	212	7.8031	7.7736

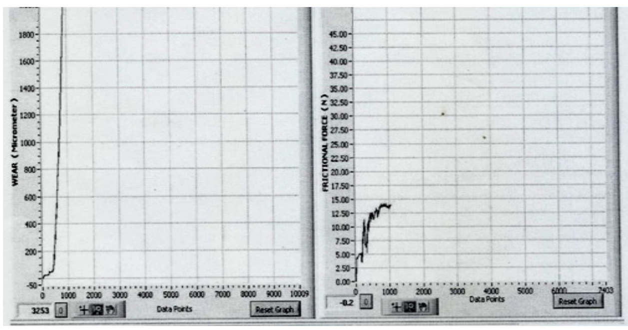

Fig. 2. Wear and Frictional force v/s sliding distance at 20 N load, 1000 rpm

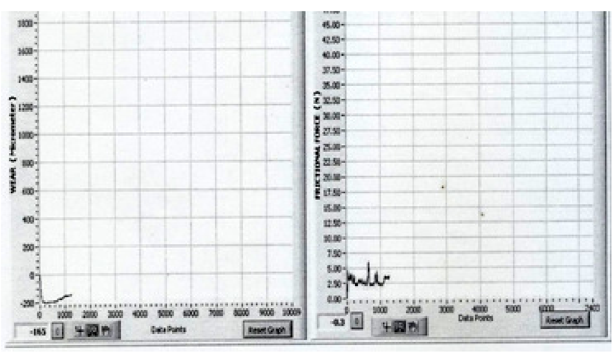

Fig. 3. Wear and Frictional force v/s slidingdistance at 30 N load, 1000 rpm

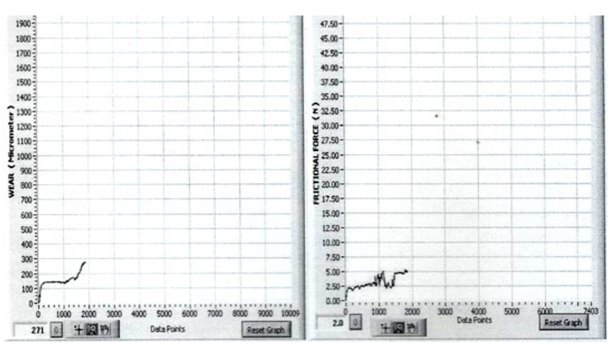

Fig. 4. Wear and Frictional force v/s sliding distance at 10N load, 1000 rpm

TABLE 2: Under dry test condition keeping load constant (10 N)

S. No.	Track Dia (mm)	Load (N)	Speed rpm	Time s	Gm wt. of test pin before wear1	Gm wt. of test pin before wear 2
1	70	10	1000	273	10.3819	10.3498
2	50	10	1500	255	10.3498	10.2873
3	30	10	2000	318	10.2873	10.2371

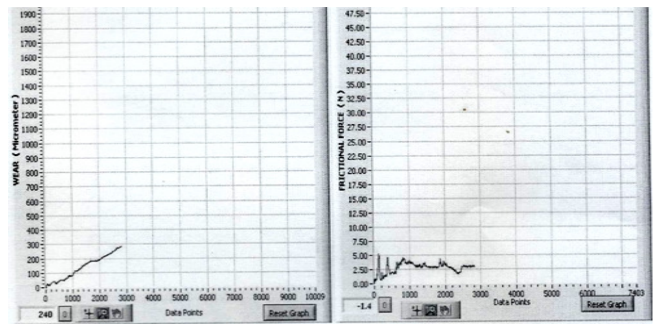

Fig. 5. Wear and Frictional force v/s sliding distance at 10N load, 1000 rpm

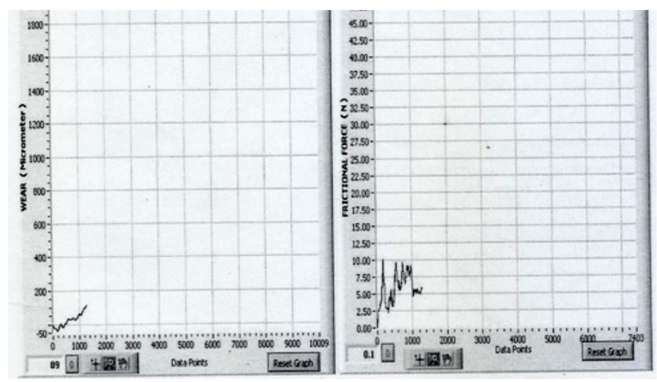

Fig. 6. Wear and Frictional force v/s sliding distance at 10N load, 1500 rpm

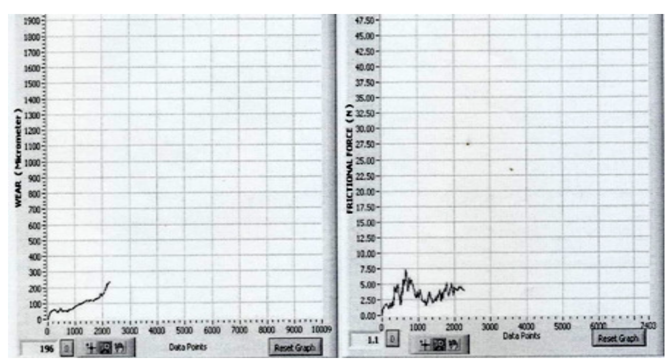

Fig. 7. Wear and Frictional force v/s sliding distance at 10N load , 2000 rpm

3.2 WEAR TEST UNDER HYDRODYNAMIC TEST CONDITION

TABLE 3: Under hydrodynamic test condition keeping speed constant (1000 rpm)

S.no.	Track Dia (mm)	Load (N)	Speed rpm	Time s	Gm wt. of test pin before wear1	Gm wt. of test pin before wear 2
1	110	40	1000	174	8.5526	8.5521
2	90	30	1000	212	8.5521	8.5467
3	70	50	1000	273	8.5467	8.5462

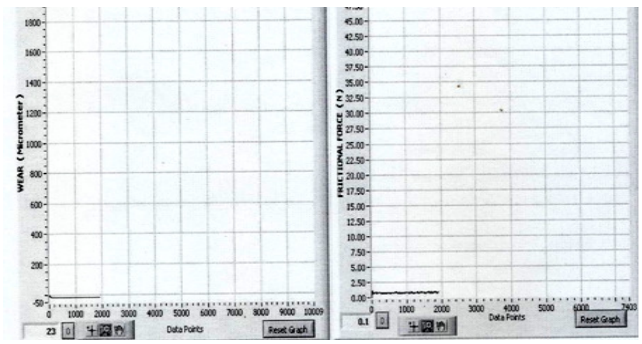

Fig. 8. Wear and Frictional force v/s sliding distance at 10 N load, 1000 rpm

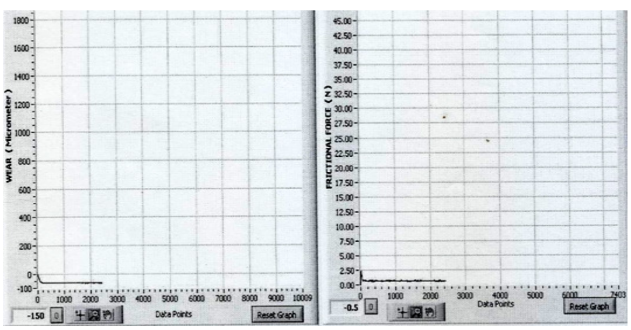

Fig. 9. Wear and Frictional force v/s slidingdistance at 30 N load, 1000 rpm

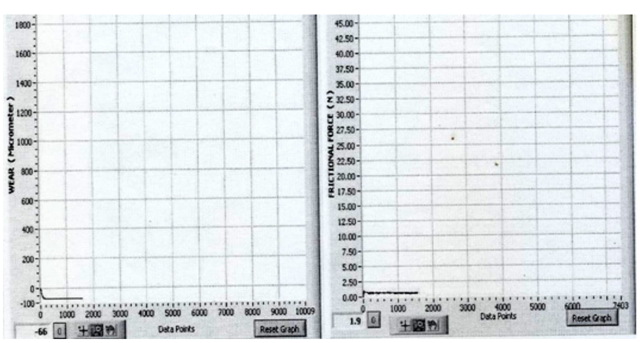

Fig. 10. Wear and Frictional force v/s sliding distance at 50N load, 1000 rpm

TABLE 4: Under hydrodynamic test condition keeping load constant (10N)

S. No.	Track Dia (mm)	Load (N)	Speed rpm	Time s	Gm wt. of test pin before wear1	Gm wt. of test pin before wear 2
1	70	50	1000	273	8.5462	8.5457
2	90	50	1500	141	8.5486	8.5476
3	110	50	2000	89	9.1780	9.1728

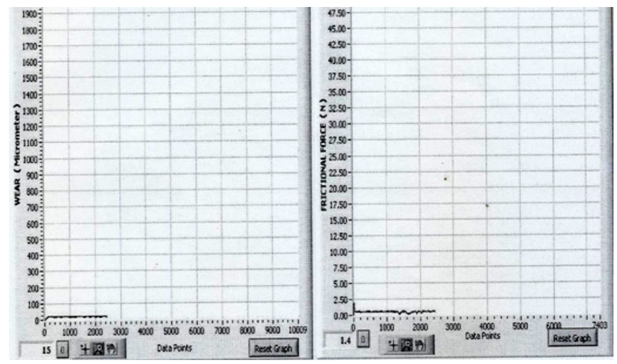

Fig. 11. Wear and Frictional force v/s sliding distance at 50N load, 1000 rpm

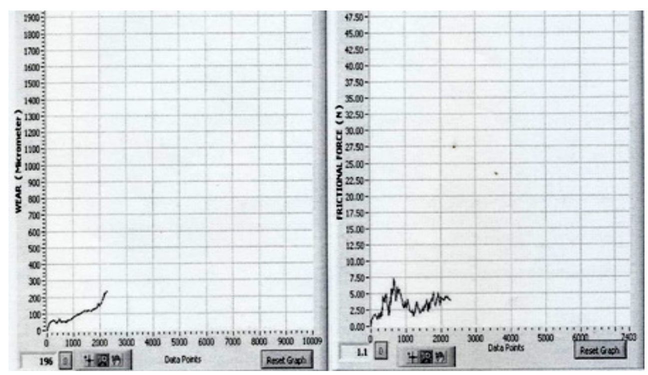

Fig. 12. Wear and Frictional force v/s slidingdistance at 50N load, 1500 rpm

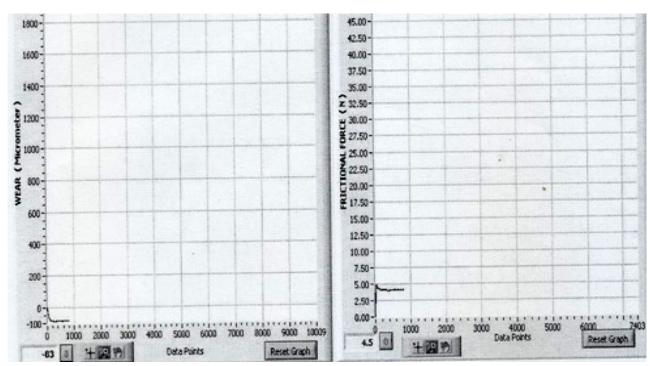

Fig. 13. Wear and Frictional force v/s sliding distance at 50N load, 2000 rpm

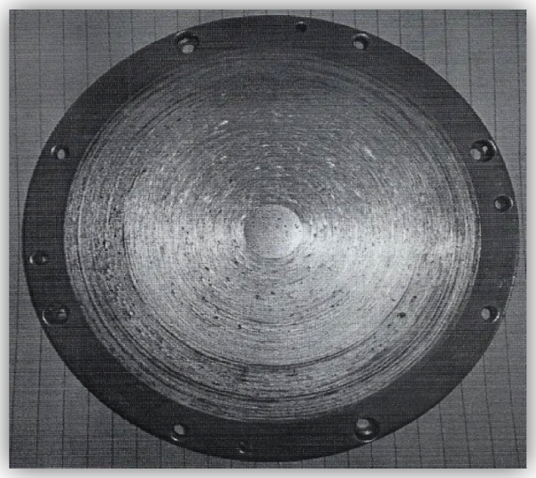

Fig. 14. Final Tribometer disc after testing

4. RESULTS AND DISCUSSION

The material Al-Si (10% w/w) used for manufacturing cast pistons undergoes heavy wear when used in dry conditions. The major amount of wear occurs due to sticking of the material due to the heat generated at the frictional contact. As the sliding distance increases the amount of heat increases and the wear of the test pin increases along with the frictional force, the frictional force increase due to the sticking of the metallic surfaces as it is a general tendency of aluminium alloys that it exhibit sticking when used under frictional environment without any lubrication.As the amount of silicon increases from hypoeutectic composition to hypereutectic composition wear resistance of the material increases.

5. CONCLUSIONS

Dry Sliding Wear Test

- The material undergoes heavy wear due to sticking of the surfaces due to heat generated from friction
- The amount of wear increases as the normal load increases
- The wear volume increases as the track diameter increases as centripetal force increases as the test pin moves away from the centre of the disc
- The test pin and the wear disc exhibits he amount of chatter due to sticking of surfaces.

Hydrodynamic Film Lubrication Wear Test

- The wear volume of the sliding surfaces attainsconstant values after primary wear setting of the surfaces.
- The operation of the test pin on the tribometer disc is quite as the lubricating oil does not allows the sliding surfaces to stick and also it carries away the heat generated due to sliding friction for this a continuous supply of oil is made by oil pump at the point of contact.
- The frictional force also attains a constant vale after the setting of the surfaces and the vales of frictional force along with wear increases as the load increases.

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