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Wear Analysis of Composite Material Al-Sic-Nickel Graphite by Pin on Disc Tribometer

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ABSTRACT: A piston is an very important part of an reciprocating engine, Pumps, Compressors and pneumatic cylinders which reciprocates at very high speed. Piston is reciprocating moving in the cylinder. Piston rings are used for gas tight joint. The piston converts expanding energy of gases in to mechanical energy via crank shaft and connecting rod. The most commonly used material for piston of internal combustion engine are Cast Iron, Aluminum alloy, Cast steel, forged steel. Piston is subjected to very high mechanical and thermal stresses due to cyclic gas pressure and the work force during engine operation. Also sliding motion of the piston causes wearing of piston. In this paper the wear analysis is done by pin on disc tribometer. This testing is done in the comparative manner between Al-Sic, Al & Al-Sic-Ni-Graphite. The casting of material has been done to prepare sample of this.

KEYWORDS: Analysis, internal Combustion Engine , Thermal Stress, Tribometer

I. INTRODUCTION

In automobile industry, the internal combustion engine is one which expands the gas inside the cylinder and converts chemical energy in to mechanical energy. Wear is the progressive loss of materials from contacting surfaces relative in motion. Different wear mechanisms occur during engine operation. According to the literature survey; especially, wear in the cylinder bore and on the piston ring is caused by abrasion, scuffing (adhesion), corrosion, bore polishing and delamination. One of the most critical tribological areas in an engine is the cylinder-ring interface. Cylinder-ring wear has been known to play a major role in internal combustion engine durability, performance, emissions and fuel economy. Wear in an engine cylinder liner reaches its maximum at the top ring reversal point. Wear at the top dead center (TDC) of the piston ring travel is heavy because of the high contact pressure. The internal combustion engine developed near about year of 1800. An internal combustion engine is classified as two stroke and four stroke engine. With decade by decade the huge revolution has been taken place in system and manufacturing process of components of internal combustion engine. Piston plays most vital role in engine. Since it is subjected to greatest stress i.e. fatigue stress, mechanical stress, and thermal stress failure. The worst working condition of piston will leads to piston sidewear, piston crown crack etc

II. METHODOLOGY

The sample will casted in casting foundary and the testing has been done on each sample After that results will discussed. Wear analysis will be performed to check wear analysis of ddiffrent matrix of aluminium and results were tabulated. Physical testing of composite material is done by various testing method. i.e. hardness testing, tribological testing on Pin on disc Trobometer.

III. MODELING AND ANALYSIS

Steps To Testing

- Casting of Composite material of aluminum
 - Al
 - Al-Sic
 - Al-Sic-Ni-Graphite

- Preparation of sample pins for pin on disc testing.
- Tasting of pin

Casting Of Aluminum based composite.

Aluminum alloy castings may be used in a number of heat-treated conditions. High-pressure die-castings are most usually used in the as-cast condition, not because of any special property of the alloys, but because the high-pressure die-casting process introduces artifacts into the casting that make any subsequent heat treatment redundant. The other processes all produce castings that can benefit from heat-treatment if deemed necessary.

Heat treatment can be used for a number of reasons: to increase hardness and mechanical properties, to stabilize the mechanical and physical properties, to ensure dimensional stability where the castings are used at temperature, and to relieve residual stresses.

The age-hardening aluminum casting alloys come in three types: those containing copper, those with zinc, copper, and magnesium, and those that utilize the Mg_2Si solid-state precipitation reaction. Generally those containing copper or the Mg_2Si hardening phases are age hardened by heat-treating, whereas the zinc-containing alloys can be aged at room or slightly elevated temperatures. A full heat-treatment cycle involves a solution treatment, quenching, and then precipitation heat treatment or aging. The temperatures and time cycles vary from alloy to alloy, and also depend on the casting geometry, specifically the maximum section thickness. In general, though, the solution heat treatment range is between 490°C and 540°C for anything up to 24 h. Quenching is often carried out in cold water. This gives a high quench rate, which can be disastrous for the casting, as it may induce residual stresses that are at a level close to the yield stress of the material. Better results are obtained in castings quenched in boiling water, where the quench rate is a little less severe. However, it is now becoming more common to specify a polymer quenchant, especially in critical casting applications, e.g., for aerospace use. It is also possible to quench directly from the mold, without a solution cycle, using air blasts. This is a much cheaper process and can give excellent properties, and it has a lower tendency to produce quench cracks or distortion.

Precipitation treatment (age hardening) can be carried out in the range from about 180°C to 250°C but, as stated previously, some of the zinc-containing alloys age harden at ambient temperatures over a period of 2–4 weeks.

In summary, heat treatment of aluminum alloy castings can, when used in ignorance, drastically reduce their load-bearing capabilities. Much care has to be taken with regard to quenching rates, support, orientation, and internal cavities, to ensure that the casting does not have worse properties after the process than when as-cast.

Commercial casting alloys include both heat treatable and non-heat treatable alloys. Therefore, the standard aluminium temper designation system is also applicable to aluminium castings. Die castings traditionally had a problem with blistering on heat treatment, but new alloys and processes now allow such castings to be heat treated to high tempers. Some developments in this area are presented elsewhere in this book.

Amongst the aluminium castings alloys, the Al-Si alloys are by far the most widely used, particularly for automotive applications. Silicon provides good castability, and a wide variety of properties can be obtained by alloys from this alloy system. Most are of the eutectic or hypoeutectic compositions (i.e. near eutectic), but hypereutectic alloys are also popular for certain applications which require elevated temperature strength, low thermal expansion and wear resistance.



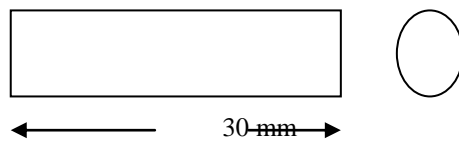
Fig .1.Casting Sample

Preparation of sample pins for pin on disc testing.

For the pin on disc testing purpose , sample is prepared by machining .The details of sample is as follows

Pin	Material	Al, Al-Sic, Al-Sic-Ni-Graphite
	Typ of Sample	Pin
	Length	30 mm
	Diameter	10 mm

Table No.01



What is a Pin on Disk Test?

Pin on disc Tasting of pin

Friction and wear (typically wear rates and wear resistance) characterization of materials is typically performed using various types of **tribometers**, while pin on disk test being probably one of the most common. The popularity of the method is due to its relative simplicity and abundance of the tribological contacts that can be well described by the a simple pin on disk motion: from dry contacts of bolt screws [to rail wheels to rail contact [2] and to lubricated contact of biological implants. The test typically allows to test several motion modes, such as unidirectional, fretting modes and recently any other complex motion patterns. Typically, the tests are performed under the following testing standards: ASTM G99, ASTM G133 and ASTM F732. Further information on the tribology testing standards can be found [here](#).

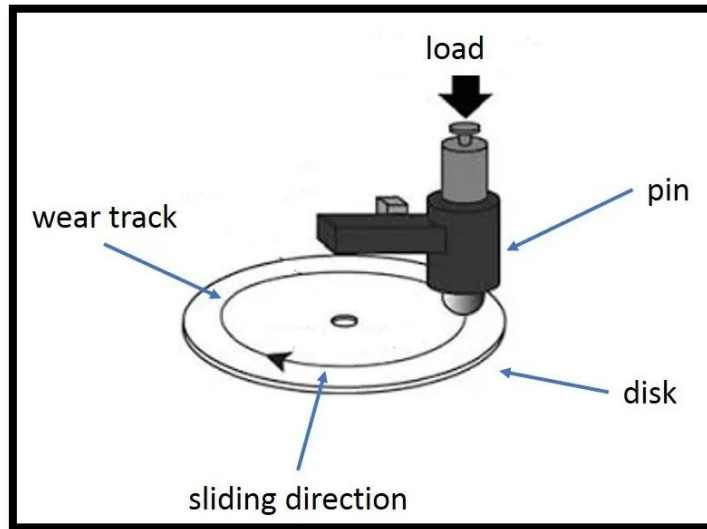


Fig.2 Schematic Of Pin on Disc Tribometer

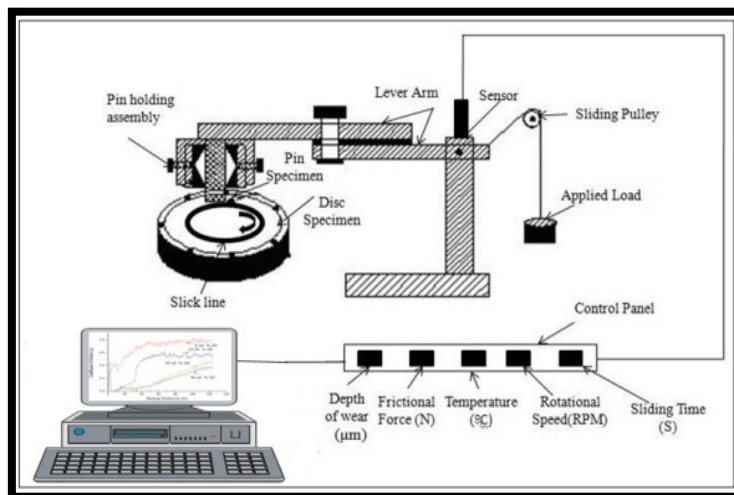


Fig.3 Schematic of Pin on Disc Tribometer

Tribological Analysis

Tribological analysis is the group of technique in which wearing of piston material has to test.

Pin-on-disc Wear and Friction Tribometer Test

Description: To establish wear and friction characteristics of cylinder liner-piston ring combination of Compression Ignition engine under different lubricated conditions, a wear and friction tribometer test rig was used. The wear and friction tribometer is a pin-on-disc type machine; model TR -201C with facilities to monitor wear and friction in sliding contacts under dry and lubricated conditions. The elements of the tribometer are a “pin” sliding on the flat face of a “disc” rotating in a vertical plane, with provisions for controlling load, speed and oil temperature and for measuring friction. The test oil is contained in a cup in which the disk rotates. Oil is swept up into the contact area by the rotating disk. The oil is heated by flat Chromolox heaters contacting the bottom of the aluminium oil cup. The oil temperature is measured and controlled by a double shielded thermocouple. A known load is applied along the axis of the pin and friction force is measured by the force transducer restraining pin motion. Load of the pin against the disk is applied by weights on a pan hanging on a thin steel cable over a pulley and hooked to the arm. Thus the weights pull the pin towards the disk. Tangential frictional force and wear were monitored with electronic sensors and are recorded. These parameters are available as function of load, speed or lubrication condition for continuous monitoring. The average

value of friction coefficient between the stationary pin and rotating disc with running time (sec) and sliding distance (m) was obtained using wear and friction tribometer test rig described earlier. All the experiments were carried out as per ASTM G-99. Sliding occurs between a stationary pin and a rotating disc. The principle of sliding was a cantilever loaded pin in the form of piston ring segment against a horizontal rotating cylinder liner disc, superimposed and bolted in oil bath. Normal load, rotational speed and wear track diameter can be varied to suit the test conditions. Fig. 4 shows the schematic diagram of the experimental setup .



Fig.4 Photographic view of experimental setup

Testing Conditions

Parameter	Value
normal load, N	50
speed, rpm	75
test duration for each run, hr	01
pin diameter,	10
sliding velocity, m/s	0.314
track length, mm	80

Table 2: Experimental Test Conditions

IV. RESULT AND DISCUSSION OF PIN ON DISC TESTING

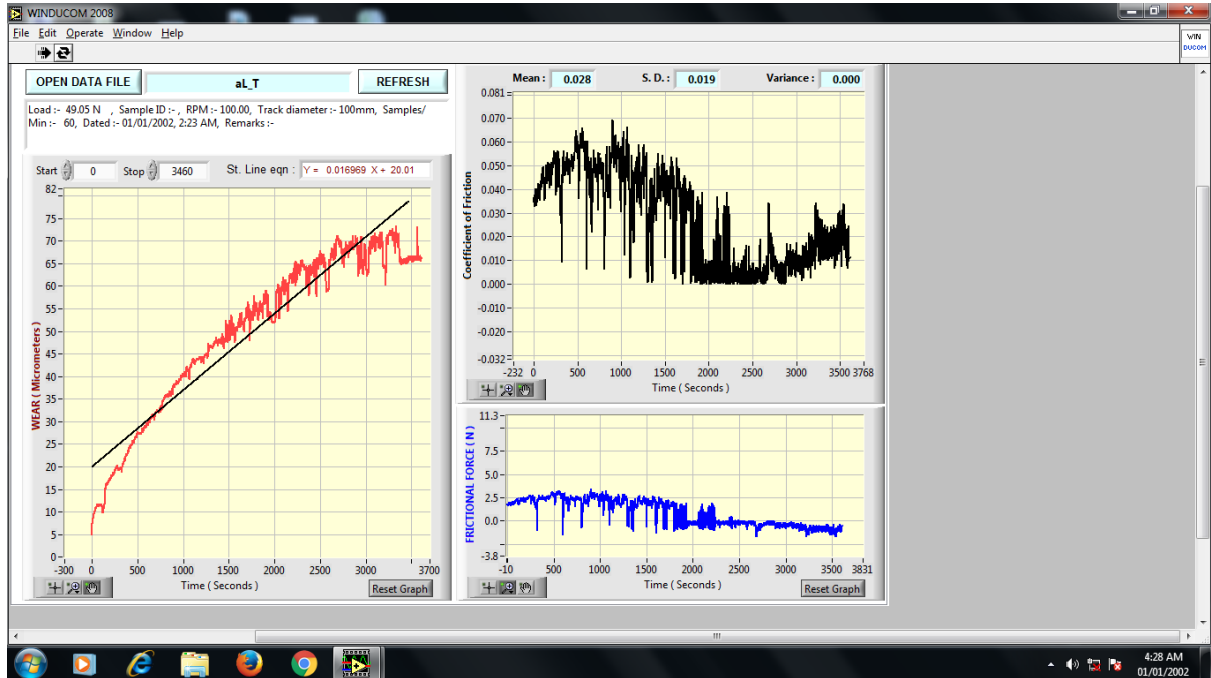


Fig.5 Wear, Frictional Force & Coefficient of friction characteristics For Al

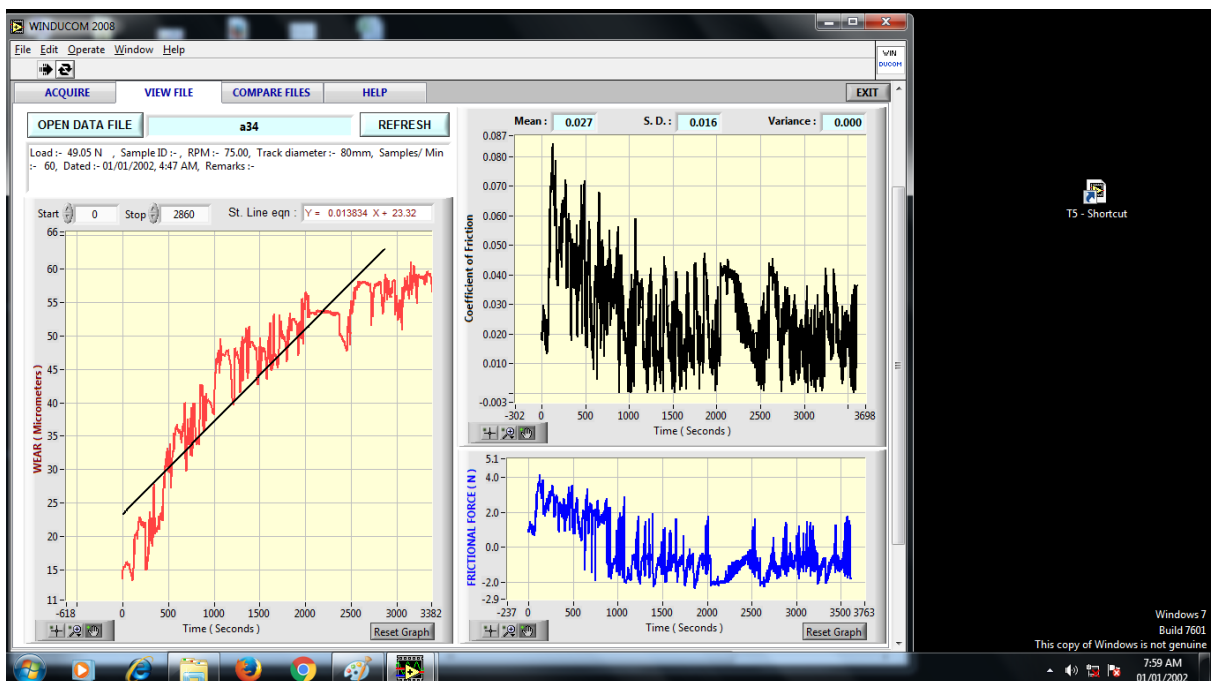


Fig.6 Wear, Frictional Force & Coefficient of friction characteristics For Al-Sic

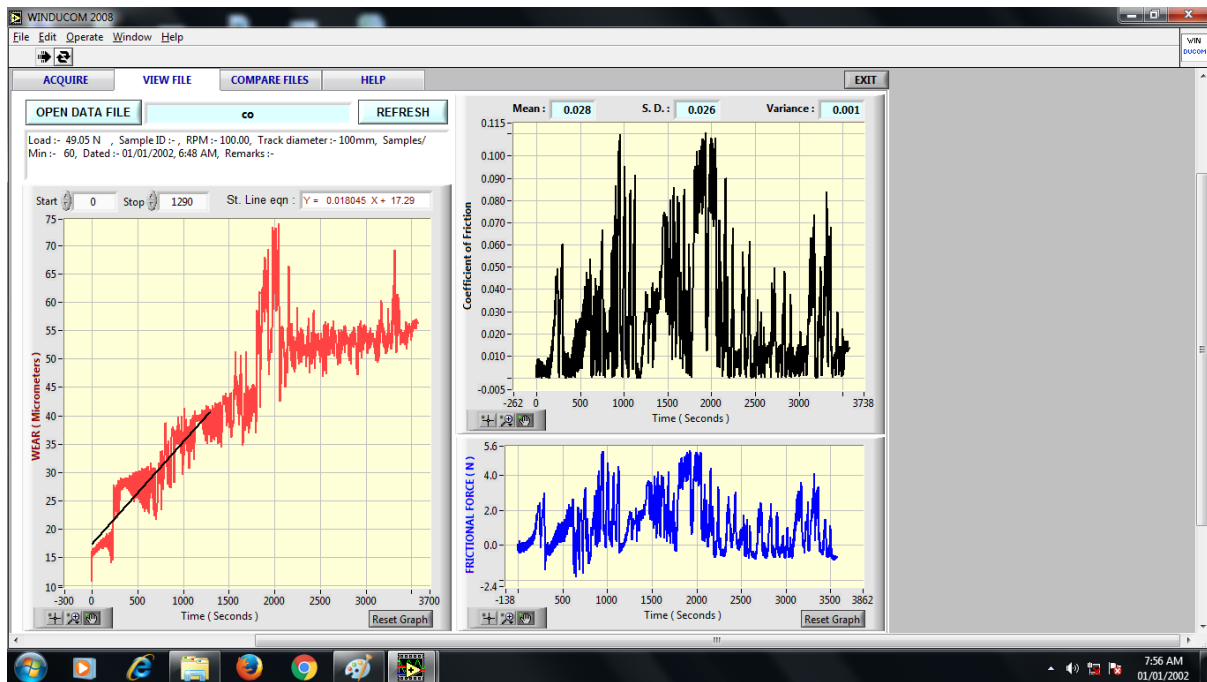


Fig.7 Wear, Frictional Force & Coefficient of friction characteristics For Al-Sic-Ni-Graphite

V. CONCLUSION

- The results from above sample testing, Al-Sic Ni-Graphite matrix which have the self-lubricating properties gives low wear rate and it can be used widely to develop self-lubricating composite after further study and analysis.

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