Design & Fabrication of 4-Stroke S.I Engine Connecting Rod of A Two Wheeler using A356 Alloy/Aluminum Oxide (Al_2O_3)

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Abstract

In the present investigation, A356 alloy is used as matrix and Al_2O_3 is used as reinforcement containing 5, 10 and 15wt% particulates of 40µm were successfully synthesized. The synthesis of these composites was carried out by stir casting technique. The connecting rod is fabricated using sand casting. Wear testing was done on samples by using pin on disc equipment, and found the lower wear rates, The experimental results showed significant grain refinement and remarkably improvement in mechanical properties of casting.
Keywords: Aluminum metal matrix composites, stir casting technique, Wear testing, microstructure analysis

I. INTRODUCTION

Now a day's more than 85% of products are produced by casting processes. The totality of metals and alloys begin to work by a very important operation, that of solidification. Solidification is the operation that gives shape and structure. Currently the solidification technique has experienced a rapid development. Because of progresses made as yet the castings are used in high security parts in the aero-spatial industry, the automotive, chemical and metallurgical equipment. In this paper we have discussed. The connecting rod is fabricated using sand casting process and research work going on in the field of stir casting process.

II. SELECTION OF MATERIAL

A356 alloy was procured from M/s HINDALCO as 20 kg ingots,

Table – 1
Chemical Composition

component	*Si*	*Cu*	*Mg*	*Ti*	*Fe*	*Al*	*Zn*
%Wt	*6.5*	*0.05*	*0.4*	*0.06*	*0.09*	*Balance*	*0.03*

In the present investigation, aluminum based hybrid metal matrix composites containing 5, and10 wt% Al2O3 particulates of 53µm were successfully synthesized by vortex method. The matrix materials used in this study was Al-Si alloy (A356) whose chemical composition was shown in table 1

III. METHODOLOGY

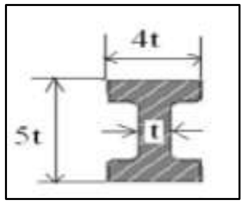
A. Designing of Connecting Rod

B. Introduction to Catiav5r16:

CATIA started as an in-house development by French aircraft manufacturer Avionics Marcel Dassault, at that time customer of the CADAM CAD software. The software name was initially CATI (Conception Assisted Tridimensional Interactive - French for Interactive Aided Three Dimensional Design), but was renamed to CATIA in 1981. CATIA, developed by dassault systems, is one of the worlds leading CAD/CAM/CAE packages. Being a solid modeling tool, it not only unites the 3d parametric features with 2d tools, but also addresses every design through manufacturing process. Besides providing an insight into the design content, the package promotes collaboration between companies and provides them with an edge over they competitors.

C. *Calculations of connecting rod:*

Thickness of flange & web of the section = t
Width of section B= 4t
The standard dimension of I - SECTION



Height of section H = 5t,

Area of section A= 2(4t×t) +3t×t , A = $11t^2$

M.O.I of section about x axis: I_{xx} = 1/ 12 [4{5} 3 −3{3} 3] = 419/12[t4]

MI of section about y axis: I_{yy} = 2×1/ 12× {4t}3 +1/ 12{3t}t3 = 131/ 12[t4]

$$I_{xx} / I_{yy} = 3.2$$

Length of connecting rod (L) = 2 times the stroke : L = 117.2 mm
Width of section B = 4t = 4×3.2 = 12.8mm
Height of section H = 5t = 5×3.2 = 16mm
Area A = 11t =11×3.2×3.2 = 112.64 mm^2
Height at the big end (crank end) = H2 = 1.1H to 1.25H = 1.1×16
H2 =17.6mm
Height at the small end (piston end) = 0.9H to 0.75H = 0.9×16
H1 =12mm

Table - 2
specifications of connecting

Crankshaft radius	*48.5mm*
Connecting rod length	*117.2mm*
Piston diameter	*86mm*
Mass of piston assembly	*0.434kg*
Mass of connecting rod	*0.439kg*
I about center of gravity	*0.00144kg*
Distance C.G. from crank end -center	*36.44mm*
Maximum gas pressure	*37.29 Bar*

Table - 3
Material Properties of Connecting Rod

Material Property	*unit*	*Scalar value*
Modulus of Elasticity	*Gpa*	*206.7*
Poisson's Ratio	*Unitless*	*0.30*
Mass Density	*Kg/m³*	*7820*

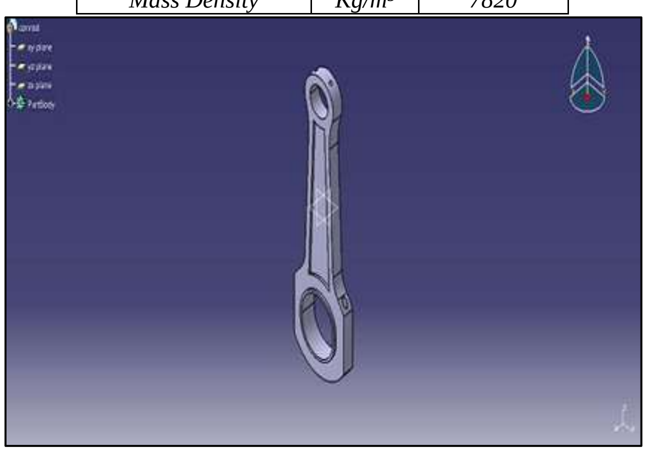


Fig. 1: modeling of connecting rod using Catia -software

D. Preparation of Specimen:

Discontinuous reinforcement is stirred into molten metal, which is allowed to solidify The synthesis of these composites was carried out by stir casting technique. A356 alloy were taken into a graphite crucible and melted in an electric furnace. After maintaining the temperature at 770 °C, a vortex was created using mechanical stirrer made of graphite. While stirring was in progress, the preheated particulates Al_2O_3 at 300^0C for 2 hrs were introduced into the melt. Care has been taken to ensure continuous and smooth flow of the particles addition in the vortex. The molten metal was stirred at 800 rpm under argon gas cover. The stirring was continued for about 2 minutes after addition of particles for uniform distribution in the melt. Still, the melt with reinforcement was in stirring condition the same was poured into sand casting mould. Stirring the composition of A356 alloy and al2O3 by using a motor rotating at a speed of 800rpm.

Fig. 2:stirrcasting

Fig. 3: pouring of molten composition in to die

Fig. 4: Finished component of connecting rod after machining

IV. EXPERIMENTAL WORK

In the present work studies have been carried out to assess the wear behavior of A356- Al_2O_3 particulate composites under controlled laboratory conditions. A comprehensive picture of wear under different working conditions has been presented by conducting laboratory tests in pure sliding mode using a pin-on-disc machine; and further characterization was carried out by using scanning electron microscopy to know the wear mechanism.

A. Dry Sliding Wear Tests:

Dry sliding wear tests have been carried out on a pin- on - disc apparatus (Model: Ducom TR- 20 LE) by sliding a cylindrical pin against the surface of hardened steel disc (with a hardness value of HRC 62) under ambient condition. The Pin-on-disc wear testing experimental set up was shown in figure 2.14. The same was in schematic view was shown in figure . The disc was ground to a smooth surface finish and renewed for each test. The wear test specimens were prepared from the alloy and composite castings in the dimensions of 10 mm ø and 30 mm length. Prior to testing, the test samples were polished with emery paper and cleaned in acetone, dried and then weighed using an electronic balance (Model: Sartorius Research R 200 D Germany) with a resolution of 0.1 mg. The samples were placed on the wear disc and the sliding wear tests were carried out at various loads, time and sliding distance. The test was conducted in a load range of 0.5 – 1.5 kgf (4.9 – 14.7 N) at a sliding velocity of 2.0 m/s and at sliding distance of 1.2 – 3.6 km. After each test, the specimens were removed, cleaned in acetone and weighed with an electronic balance within an accuracy of 0.1 mg. For each load, the volume loss from the surface of each specimen was determined as a function of sliding distance and applied load. The wear rate (K) was defined as the volume loss (V), divided by the sliding distance (L). Hence, the volumetric wear rate (K) was calculated from the weight loss measurement and expressed in terms of mm^3/km. The friction force (F) was continuously monitored during the wear test for determining the coefficient of friction (μ). The friction force was measured for each pass and then averaged over the total number of passes for each wear test. The average value of coefficient of fricition (μ) of composite was calculated from the following expression [53]: $\mu=F_f/F_n$ where: F_f is the average fricition force and F_n is applied load

Fig 5: Pins for wear test

Fig. 6: experimental set up of Pin-on-disc wear tester (Model: Ducom TR- 20 LE)

B. Heat Treatment Process

Casted product need to conducted Heat Treatment process there by controlled heating and cooling. In this process, we heated samples temperature to 155^0C and soaked the sample at temperature about 2hr.After that we quenched the sample in water at temperature of 15^0C.

C. Wear Testing

Initially the castings were made with the dimension of 15*15*60, after that the specimen machined and converted to the standard dimensions ø10 lenth30mm. The wear test is conducted with pin and disc wear test apparatuses. Specimen tested at constant time and variable loading. The results are shown in table 6. And graph 3.

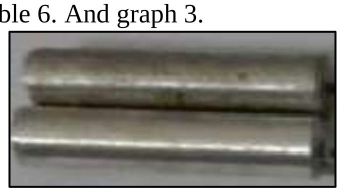


Fig. 7: Specimen for Wear Test

D. Microstructure

Microstructure test is conducted on computerized microscope. The total casted specimen is cut into 2 equal parts. Specimen is processed all metallographic stages, make it ready for microstructure test.

Fig. 8: Specimen for Microstructure analysis

V. RESULTS AND DISCUSSIONS

Table – 4
Values obtained from graph

S.no	*Weight (kg)*	*Time (min)*	*Wear rate (micrometer)*	*Coefficient of friction (N)*
1	*0.5*	*15*	*169*	*0.5*
2	*1.0*	*15*	*174*	*1.8*
3	*1.5*	*15*	*199*	*2.9*

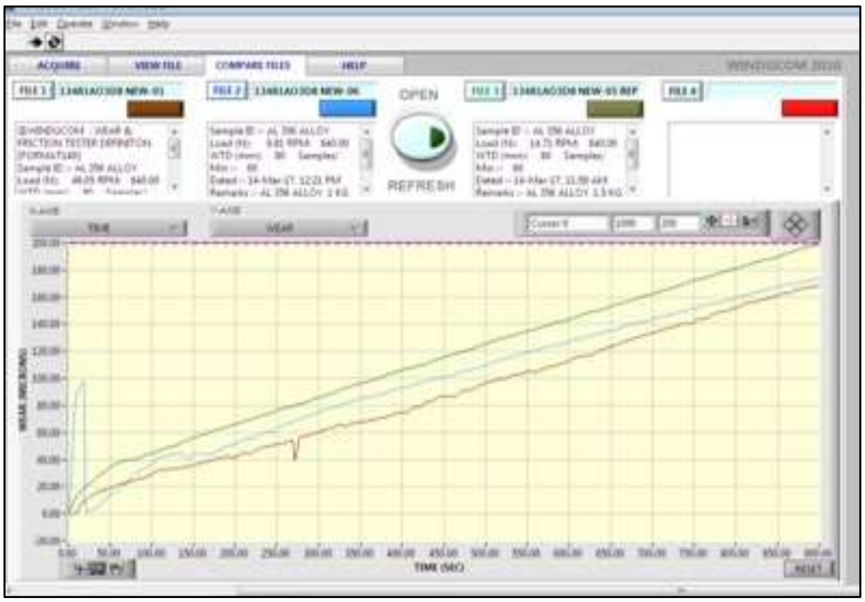
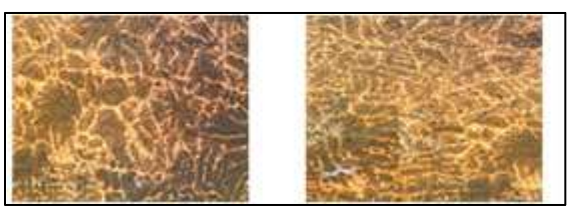


Fig. 9: comparision graph for 0.5,1 and 1.5 kg load

The graphs were taken at interval of against wear rate obtained at interval lads 0.5kg, 1.0kg, and1.5kg at constant time (15min). As loads increases the wear rate is increases because of hardness is increases

E. Microstructure Results

By increasing the frequency of vibrations the grain are refined, this can be seen in following figures 14.The microstructure test results (image)



Top part of the cast Bottom part of the cast
Fig 10: Microstructure

VI. CONCLUSION

Based on the results obtained from graphs drawn between the time period and wear rate of the material we can say that

- By changing the material of connecting rod with A356 alloy and Al_2O_3 the wear rate and hardness of material is improved of so much extent.

- The component is having a very light weight when compared to existing material and so advantageous for vehicles for having good efficiency of performance.
- Finally concluded that by changing the existing material of pure aluminium with A356 alloy we can improve its all properties like wear rate, hardness and a great light weight also of connecting rod.
- the casting procedure gives refinement of grains.
- Still we can improve many other properties for efficient working of automobile engines

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