A Study on Mechanical and Tribological Properties of Al-3% SiC Alloy by using Stir Casting

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***Abstract**: Metal matrix composite (MMC) has dramatically increases properties including high mechanical strength; mechanical modulus, damping ability and strong wear resistance compared to unreinforced alloys. Composites containing low density and low cost replacements have become increasingly of interest. Among the numerous discontinuous dispersoids used, SiC is one of the largest available in expensive low density reinforcement which is cost efficient. Therefore, composites with SiC as reinforcement in small engine applications are expected to resolved the cost barrier for wide spread use in automotive. In the present test, A7068 matrix alloy was strengthened with specific Wt percent of SiC (3%) mechanical & wear properties. MMCs and later were measured earlier and later extrusion with as-cast alloy. The composite's longevity, stiffness, and tear properties increased with SiC's weight percentage increasing. Extruded MMCs from Al7068 demonstrated superior performance, i.e. stiffness, strain and wear properties relative to MMCs previous to extrusion. The present research illustrates the prominent characteristics of SiC's casting methodology and classification enhanced Al7068 MMCs.*

Keywords: A7068 alloy, SiC, Hardness, Compression and Wear.

I.INTRODUCTION

Metal matrix composite is a composite material which contains at least two constituent metal components. Additionally, two of the other components can be another metal or some other material, such as a ceramic or natural com-pound. The composite generally has finest characteristics than any of the individual components. MMCs are made by dispersing a reinforcing material into a (usually ductile) metal matrix.. The matrix is the single-crystal monolithic or monocrystaline substance into which the reinforcement is embedded, and is fully continuous. Unlike two materials sandwiched together, this capacity that there is a path across the matrix to every stage in the substance. The reinforcing element is incorporated in the matrix. The reinforcing typically no longer performs a basic protective function that strengthens the substance but is utilized in addition to sharing physical residences such as wear and corrosion resistant to increases Weight small. The strengthening can be either continuous or discontinuous. They can be designed to improve wear resistance and better ambient temperature, increases thermal and mechanical fatigue and creep tolerance than those of monolithic alloys, such as high physical strength and stiffness. Discontinuous MMCs may be isotropic, but are severely impaired by the existence of weak and almost non-deformable reinforcements such as particulate whiskers or strong fibres, such as Al / Sic or Al_2O_3 composites, and can be employed with normal metal processing techniques such as extrusion. There are some increases properties for MMCs provided underneath. Owing to the highest basic electrical rigidity and wear resistance in addition to the manufacturer temperature, MMCs are commonly used in a variety of applications.

II. LITERATURE REVIEW

Rohatgi et al [1]. Analyzed that the usage of gasoline pressure penetration solution may be synthesized with A356-fly ash cenosphere composites over a wide variety of reinforcement scale fraction from 20 to 65 percent. The densities of Al356-fly ash cenosphere composites, developed under a variety of experimental conditions, are within the range of 1250-2180 kg / m3 corresponding to the cenosphere fraction in the range 20-65 per cent. The volume of composites grew with increases particle dimension, added stress and melt temperature for the same Cenosphere size fraction. This appears to be linked to a reduction in voids in a chemosphere mattress present near particles by way of and enhancement of the soft flow. The compressive force plateau tension and composite modulus increased with the density of the composites.

Venkat prasat et al [2]. Investigated the aluminum alloy tribological behaviour, filled with alumina and graphite, is materialized utilizing stir casting method. The wear and frictional properties of the composites of the hybrid steel matrix used to be tested through dry sliding wear tests using a pin-on- device placed on track. Experiments were carried out mainly on the basis of the graph of experiments produced by taguchi's technique. AL27 orthogonal array was chosen for data evaluation. Investigations to find they have an impact on the load sliding distance imposed by wear rate sliding velocity, as correctly as the friction coefficient. The results demonstrate that the ideal sliding gap has an influence on the load and sliding pace measured. Finally, an affirmation examination was carried out to validate the experimental findings and microscopic work on the placed on surfaces was accomplished on the scanning electrons.

Sheppard and Patterson et al [3] investigated the variants of stress with billet lengths of AA1100 and AA2014 alloys, with the aid of extrusion. They found that the peak stress and billet length relationship was once linear for each the alloys. The decided friction coefficient was once 0.88 for AA1100 and 0.8 for AA2014.

Mahendra boopathi.M et al [4]The mechanical saves such as length, elongation, stiffness, yield strength two, and tensile take a look have been tested by conducting carefully planned laboratory tests that reproduce the operation conditions as closely as feasible. In the form of fly ash and silicon carbide [sic (5%) + fly ash (10%) and fly ash (10%) + sic (10%)] In the case of aluminum, the outcome indicates that the density reduction with increases harness and tensile energy was additionally found while the elongation of the hybrid MMC in the unreinforced aluminum test was decreased. The composites of the hybrid metal matrix varied considerably in all the homes assessed. Two sic (10 percent)-fly ash (10 percent) aluminum was once the toughest replacement for aluminum sic and aluminum fly ash composites angles.

S.O Adeosun et al [5] Have made an investigation of die entry angles 15^0,30^0,45^0,60^0,75^0&90^0 had been simulated, improvement is located with 45^0,90^0& 75^0 die entry angles. It has been located that 45^0 die entry perspective the index of 2.1 for simple carbon steel die & 1.8 for metal die.

III. EXPERIMENTAL SETUP

In this work fabrication is carried out by stir casting Method

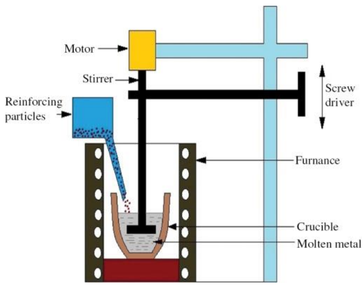

Figure 1: Stir Casting Setup

It is placed in a graphite crucible of an Induction furnace and heated to a temperature of 720^0c .Mean while a mixture of SiC of varying combinations & fixed amount of graphite is placed in a muffle furnace for a period of 2-3 hrs at a temperature of 150-200^0c. Since solid-phase production takes a longer period than the solid-phase materialization solution. Stir casting techniques have proved to be the simplest and most advanced technique in the manufacture of MMCs. Throughout this method, the crucial factor is to establish sufficient wetting between the particulate reinforcement and the molten metal, which from in homogeneity in the reinforcement distribution in such cast composites can also be a concern due to friction with the suspended ceramic components. This method has the primary advantage of very small development costs for MMCs. Many propose a two-step stir-casting procedure to boost the reinforcement homogeneity within the composite.

A known quantity of Al7068 with a composition of alloy (Weight Percent)

Designation of Silicon Carbide as reinforced alloy

S/No	Alloy/Composite	Designation Earlier Extrusion	Designation Later Extrusion
1	As-Cast (Al7068)	A7068	$A7068_E$
2	Al7068 + 3% SiC	3S	$2S_E$

Si	Fe	Cu	Mn	Mg	Cr	Zn	Zr	Others	Balance
0.12	0.15	1.5-2.4	0.1	2.2-3.0	0.05	7.3-8.3	0.05-0.15	0.05	Aluminium

Extrusion is a method of plastic deformation in which a block of metallic (billet) is forced to slip by strain by the flow into the die opening in a narrower cross-sectional area than the initial one. Forces are formed with the con-container with the job piece response (billet) and these forces die attain high values.

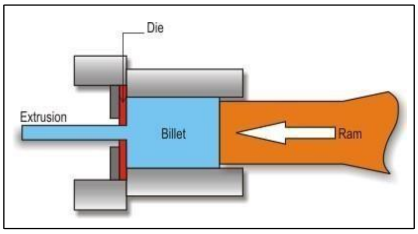

Figure 2: Extrusion Setup

The Vickers hardness test is used in the context of the micro hardness test load range to assess the hardness of a material. However, the hardness test is also used to test thin layers such as coatings or to solve the problems of fragile and cracking materials.

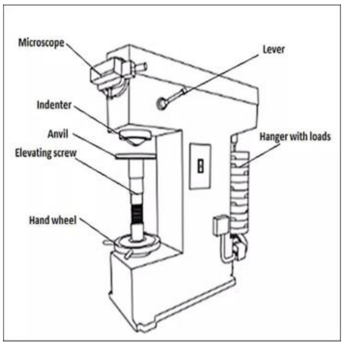

Figure 3: Vicker Hardness Tester

Wear test is carried out to predict the performance of wear and to examine the wear mechanisms. The two main reason as per material point of view test is performed to evaluate the property of a wear and to adequate for a specific wear application and to study the corrosion of a material.

Figure 4: Pin-on-Disc Wear Machine

V. RESULTS AND DISCUSSION

1. Hardness test results of A7068 alloy and its Composites earlier and later extrusion.

Table 1.1: Hardness test values of A7068 alloy and its composite later and after extrusion.

S/No	Alloy/Composite	Designation	Hardness VHN (Earlier Ex-trusion)	Hardness VHN (Later
1	As-Cast (Al7068 alloy)	A7068	73.5	75.7
2	Al7068 alloy + 3% SiC	3S	76.9	78.9

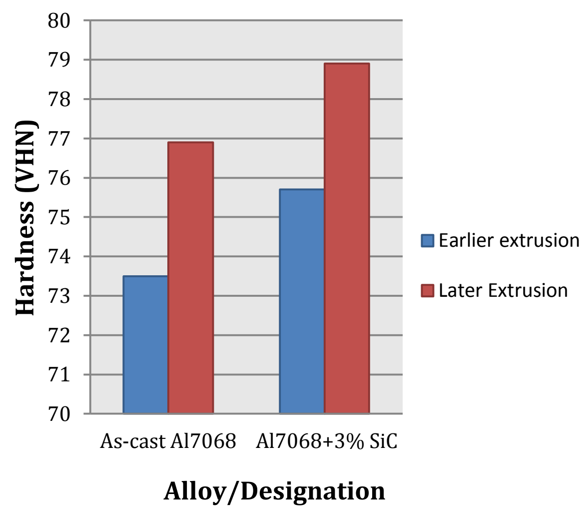

Figure 5: Hardness test values of A7068 alloy and its composites earlier and later extrusion.

From figure 5: we can see that there is a slight increase in hardness values later extrusion. The percentage increase in hardness values of A7068 alloy later extrusion was found to be 2.99 %. Similarly, the percentage increase in hardness values of Al7068 alloy reinforced with 3% SiC later extrusion. The increase in hardness values was due even dispersal of ceramic reinforcement and equated matrix grain structure leading to improvement in hardness in the matrix.

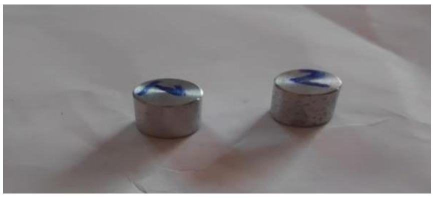

Figure 6: Hardness Tested Specimens

2. Compression test results of A7068 alloy anits composites earlier and later extrusion.

Table 2.1: Compression test values of A7068 alloy and its composites earlier and later extrusion.

S/No	Alloy/Composite	Designation	UCS (Mpa) (Earlier Extrusion)	UCS (Mpa) (Later Extrusion)
1	As-Cast (Al7068 alloy)	A7068	106	119
2	Al7068 alloy + 3% SiC	3S	118	129

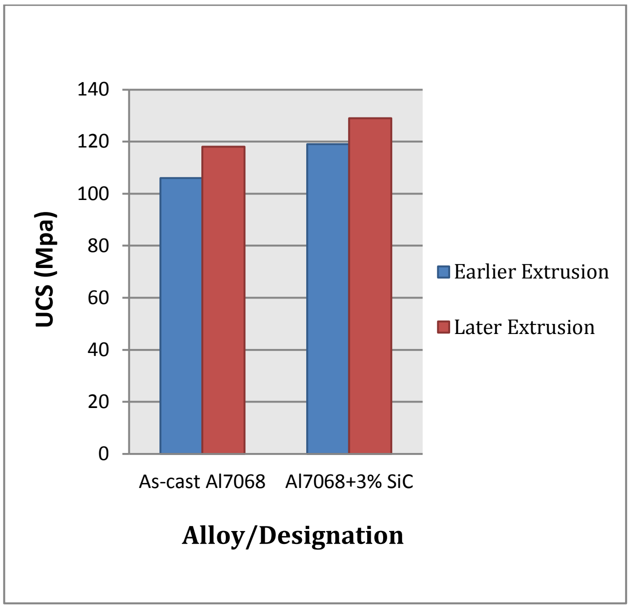

Figure 7: Compression test values of A7068 alloy and its composites earlier and later extrusion.

Figure 7: shows the compression test values of A7068 alloy and its composites earlier and later extrusion. From the figure we can see that there is a slight increase in UCS values later extrusion. The percentage increase in UCS values of A7068 alloy later extrusion was found to be 12.26 %. Similarly, the percentage increase in hardness values of Al7068 alloy reinforced with 3% SiC later extrusion. The increase in UCS values was due to the addition of hard ceramic reinforcement in the matrix and grain refinement caused by the addition of reinforcement and extrusion process.

Figure 8: Compression Tested Specimens

3. Wear test results of A7068 alloy and its Composites earlier and later extrusion.

Table 3.1: Wear rate test values of A7068 alloy and its composites earlier Extrusion.

Wear rate of A7068 & its MMCs earlier Extrusion				
S/No	Load(N)	10	20	30
1	As-Cast (Al7068 alloy)	1.6682	1.6715	1.6758
2	Al7068 alloy + 3 % SiC	1.6515	1.6548	1.6554

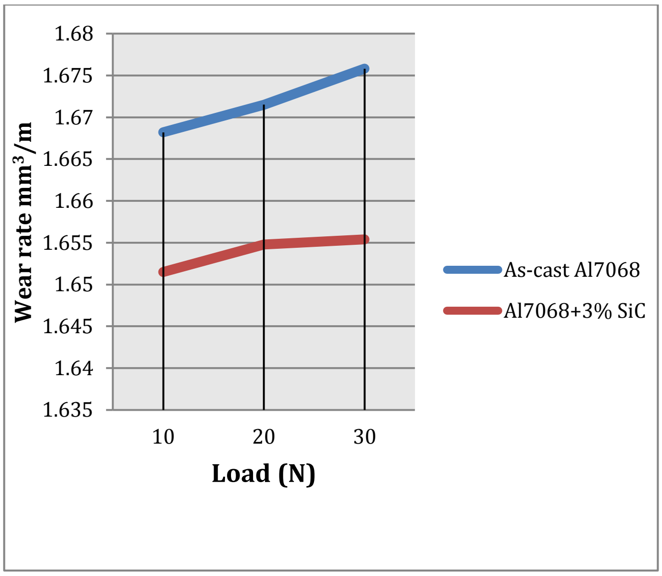

Figure 9: Wear rate test values of A7068 alloy and its composites earlier extrusion.

From Figure 9: we can see that as the load increases the wear rate increases .Highest wear rate is for AL7068 alloy i.e.1.6682 x 10^{-3} mm^3/m for 10N and 1.6758 x 10^{-3} mm^3/m for 30N respectively .Least wear rate is found for Al7068 alloy + 3 % SiC i.e.1.6515x 10^{-3} mm^3/m for 10N and 1.6554 x 10^{-3} mm^3/m for 30N respectively. SiC particles act as load bearing and protect matrix from wearing out.

Table 3.2: Wear rate test values of A7068 alloy and its composites later Extrusion.

Wear rate of A7068 & its MMCs later Extrusion				
S/No	**Load(N)**	**10**	**20**	**30**
1	**As-Cast (Al7068 alloy)**	1.6441	1.6473	1.6481
2	**Al7068 alloy + 3 % SiC**	1.5531	1.5543	1.5558

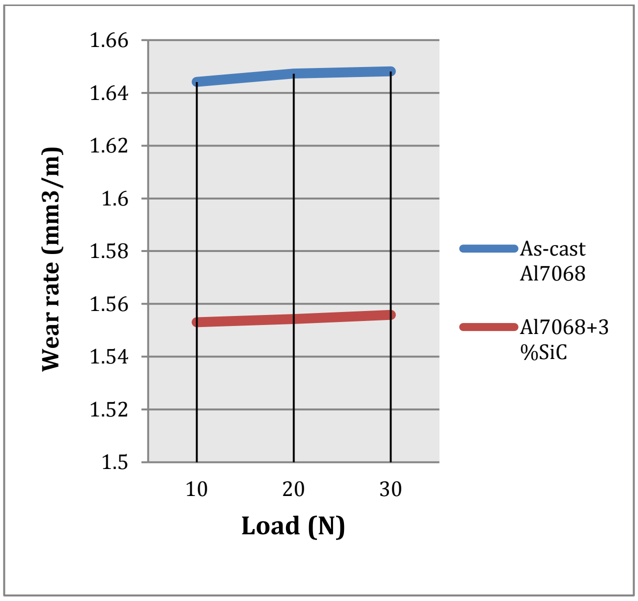

Figure 10: Wear rate test values of A7068 alloy and its composites later extrusion.

Figure 10: we can see that as the load increases the wear rate increases. Highest wear rate is for A7068 alloy i.e.1.6441 x 10^{-3} mm^3/m for 10N and 1.6481 x 10^{-3} mm^3/m for 30N respectively .Least wear rate is found for Al7068 alloy + 3 % SiC i.e.1.5531 x 10^{-3} mm^3/m for 10N and 1.5558 x 10^{-3} mm^3/m for 30N respectively. SiC particles act as load bearing and protect matrix from wearing out .Extrusion leads to formation of fine equated grains in the AL7068 matrix which further helps in reduction of wear rate.

Figure 11: Wear Tested Specimens

VI. CONCLUSION

From the tests conducted in order to determine the mechanical properties of SiC reinforced Al7068 composites of different weight fractions of the Reinforcement, it was found that:
(i)Silicon Carbide particles as a reinforcement helped in increasing the hardness (VHN) of A7068 from 73.5 (VHN) as per the following:

- 3% Silicon Carbide – 76.9 (VHN)
 (4.62 % increases).

(ii)Silicon Carbide particles as a reinforcement helped in increasing the hardness (VHN) of extruded Al7068 from 75.7 (VHN) as per the following:

- 3% Silicon Carbide – 78.9 (VHN)
 (4.22 % increases).

(iii)Silicon Carbide particles as a reinforcement helped in increasing the UCS (Mpa) of A7068 from 106 Mpa as per the following:

- 3% Silicon Carbide – 118 Mpa
 (11.32 % increases).

(iv)Silicon Carbide particles as a reinforcement helped in increasing the UCS (Mpa) of extruded Al7068 from 119 Mpa as per the following:

- 3% Silicon Carbide – 129 Mpa
 (8.40 % increases).

(v)Wear rate increases for As-Cast AL7068 alloy and AL7068+3% SiC is added for earlier extrusion.Wear rates decreases for As-Cast AL7068 Alloy AL7068+3% SiC is added for later extrusion.

VII. FUTURE WORK

1. Investigation can be carried out on A7068 alloy and its composites to have a study on machinability Characterization by varying various parameters.

2. Heat treatment studies can be carried out on A7068 alloy and its composites varying various Parameters.

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