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Review on Effect of Various Types of Reinforcement Particles on Dry Sliding Wear Behaviour of Aluminium Alloy Matrix Composites

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ABSTRACT: The aluminum matrix composites, especially with hybrid reinforcement are the complex materials that have been generally utilized as a substitute material in the transport sector, to produce lighter-weight and higher-efficient components. With the creation and advancement of these aluminum metal matrix composites different downsides faced by the engineering society have been conquer and most ideal solutions are given. As these components are frequently subjected to sliding wear under working conditions, subsequently a few of these applications require improved frictional and wear resistance. An endeavor has been made to present and review the different viewpoints significant to sliding wear behaviour of aluminum alloys and the hybrid composites, with various mixes of reinforcements. Further, it has been discovered that the expense and the weight of the aluminum matrix composites can be extensively controlled, by expansion of hybrid reinforcements, without compromising the tribological properties. This paper leads the scientists and engineers towards proper selection of materials by their properties in the significant field and diverse systems associated with manufacturing of metal matrix composites, especially on the fluid state metal handling method like stir casting process parameters and preparation of AMC utilizing aluminum alloy as matrix form and various ceramic materials as reinforcements by varying proportion. This paper presents impacts of dry sliding parameters (sliding distance, sliding speed and load) combined with process parameters on the dry sliding wear behaviour of aluminum composites prepared by stir casting method. Numerous analytical works have been done on the effect of sliding speed, load and sliding distance.

KEYWORDS: Aluminium Composites, Hybrid Reinforcements, Stir Casting, Wear Behaviour.

I. INTRODUCTION

Metal matrix composites (MMC) are designed non solid materials which comprise of a metal or a alloy as the continous matrix and a reinforcement that can be molecule, short fiber or continous fibers. The evolvement of MMCs has started feasible combination of various material properties (mechanical, physical and tribological) coming about into accessibility of extensive pool of materials utilized in applications, for example, aerospace, automotive, building construction, industrial, and sports (Sallahauddin et al., 2015). Metals, for example, aluminum, titanium and magnesium have been utilized as matrix after some time due to their high strength to weight ratio, high resistant to corrosion, astounding thermal properties among others. Notwithstanding, aluminum composite has kept on getting a charge out of an increasingly noticeable use as a result of its properties, performance, financial and environmental advantages (Saravanan et al., 2015). The vast majority of the aluminum compounds picked as matrix are A356, 2000 and 6000 alloys (Dasgupta et al., 2010).

The need to reinforce aluminum alloy with different materials to create aluminum matrix composites (AMC), which is valuable in applications where aluminum alloy can't be utilized is because of poor reaction of aluminum alloy to such conditions as wear resistant conditions. Nonetheless, AMCs have ended up being a reliable and efficient wear resistant material particularly to slide wear applications (Dasgupta, 2012). The reasonableness of materials for wear applications requires great comprehension of the idea of wear. Wear has been depicted as the consequence of full

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interaction between surfaces in relative movement or the consistent loss of matter from surfaces as an impact of relative movement (Sergio, 2004; Yust, 1985). Wear is knowledgeable about various modes in different building applications. It is comprehended that total information of wear mechanism eventually results in better particular of materials including composition and properties (Rabinowitcz, 1965).

II. STIR CASTING

Stir casting is a simple and cost effective fluid metallurgical system that is sent in the production of MMCs particularly when the reinforcements are discontinuous fibres or particulates (Rahdika et al., 2011). While there are varieties of processing systems methods for particulate or discontinuous reinforced MMCs, stir cast strategy has delighted in support for the production of large amount of components in business practice (Mathur and Barnawal, 2013). Its appeal is because of simplicity, adaptability and it is for the most part economical for huge measured components production (Hashim et al., 1999).

III. IMPACT OF DRY SLIDING WEAR PARAMETERS

This depicts the dry sliding wear behaviour of materials therefore by expansion it determines the appropriateness of materials for wear resistant operations particularly in engineering applications that were dry sliding contacts being normal. Dry sliding wear parameters usually researched are sliding speed, sliding distance and load.

A Sliding Speed

Sliding velocity is an imperative parameter in the estimation of wear. The wear behaviour of composites can likewise be controlled by the sliding speed (Jha et al., 2011). Dasgupta et al. (2010), reinforced a 7075 Al alloy with 10 vol.% Silicon carbide (SiC) and conducted a sliding wear test utilizing a vertical pin on-disc wear testing machine with loads of 9.8, 29.4 and 49 N and speeds of 400 and 640 rev/min. The test specimens incorporate as produced composite and expelled composites.

B Sliding Distance

Another basic measure of wear is the volume of material removed per unit sliding distance. The ratio of the wear in units of volume removed per unit sliding distance to the real interfacial area of contact is an important dimensionless amount helpful in wear contemplates and is known as the dimensionless wear coefficient, or essentially the wear coefficient, Kok and Ozdin (2007) explored the wear resistnce of aluminum alloy and its composites reinforced by Al2O3 particles. Sliding wear tests on 10, 20 and 30 wt.% Al2O3 particles reinforced 2024 aluminum alloy composites created by a vortex process (stir casting). These tests were done by utilizing a pin-on-disc abrasion test apparatus where the example slided against SiC abrasive papers of 20 µm (600 grit), 46 µm (320 grit) and 60 µm (240 grit) under the loads of 2 and 5 N at room conditions. The impacts of sliding distance with different parameters (Al2O3 particle content and size, SiC abrasive grit size and wear load) on the wear properties of the composites were efficiently explored. It was seen that wear resistance expanded as the sliding distance increases.

Kumar et al. (2015) examined the impact of sliding distance on tribological behaviour of Al6061-T6 alloy and its composite reinforced with hard ceramic constituent alumina (3 wt. %) and strong lubricant graphite (3 wt. %) manufactured through stir casting method. It is seen that wear results showed an increasing pattern of specific wear rate of Aluminum Hybrid Metal Matrix Composite (AlHMMC) for sliding distance which is completely lesser than Al6061 alloy.

C Load

As the applied load and the subsequent temperature increments during a sliding wear test, the aggregation of discrete particles on the counter face results in accumulation of bigger clusters on the outside of the disk. These clusters in this manner split far from the disk shaping loose wear debris and the subsequent wear rate winds up serious. It is believed in a few quarters that the commanding parameters adding to the sliding wear of a given system are the loading and the relative sliding of the contact (Priit and Soren, 1999). Additionally, applied load has been seen to be the main parameter which to a great extent affected the coefficient of friction (Ashok et al., 2012); consequently applied load is a vital parameter in determining the tribological behaviour of composites.

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IV. EFFECT OF PROCESS PARAMETERS

Streamlining the input procedure parameters is important in upgrading the wear behaviour of aluminum composites (Rhadika et al., 2015). The procedure parameters will be studied under stirring parameters and reinforcement parameters.

A Stirring Parameters

Stirring parameters, for example, stirring speed and time, pouring temperature,blade angle etc have been seen to influence the wear bahaviour of composites. These are parameters that are related with the stirring mechanisms in the stir cast method. Haque et al. (2014) examined the impact of process parameters (stirring speed and pouring temperature) on wear rate and microstructure of Al6061-Cu reinforced with SiC by stir casting. The needy variable was chosen to be the wear rate by pin-on-disc wear strategy while the indepndent parameters incorporate five levels of pouring temperature and stirring speed: 675, 700, 725, 750 and 775 °C, and 50, 200, 400, 600 and 800 rpm at a consistent pouring pace of 2.5 cm/s that were considered. The ideal estimations of wear rate are seen between ranges of 200 to 600 rpm stirring speed while at high speed (800 rpm) the wear rate increments definitely. The wear rates are steady in range of 700 to 750 °C of pouring temperature, aside from at stirring speed of 800 rpm.

B Reinforcement Parameters

Support parameters, for example, the volume fraction, nature and size of particles in reinforced composites influence the wear behaviour of composites (Mehtap and Mehtap, 2011). Wear volume of metals decreases with addition of particles into matrix on the prerequisite that those particles have higher hardness than the matrix material. Material expulsion in a ductile metal, for example, aluminum alloy matrix is because of the indentation and ploughing activity of the sliding indenters. Addition of hard particles as reinforcements in metal matrix limits such ploughing activity of sliding indenters and enhances the wear resistance expectedly. Notwithstanding, the impact of particle (reinforcement) measure on the wear resistance of composite was more important than that of its volume fraction (Kok and Ozdin, 2007).

Likewise, Ashok et al. (2012) examined the wear and frictional properties of Al6061 reinforced with SiC particles (10 and 15 wt. %) utilizing dry sliding wear test on a pin-on-disc wear analyzer. Tests were led dependent on the arrangement of analyses created through Taguchi's method. A L9 symmetrical cluster was chosen for investigation of the information. Impact of applied load, sliding speed and sliding distance on wear was considered. It was seen that for Al – 6061/10 wt. % SiC composites sliding distance has the most noteworthy (62.5%) effect on wear rate pursued by sliding rate (37.5%) and applied load (1.25%) individually. In any case, for the Al – 6061/15 wt. % SiC composites, applied load has the most noteworthy (57.2%) impact on wear rate pursued by sliding distance (7.1%) and sliding speed (7.1%).

Table.1 Dry sliding behaviour of aluminium composites produced from stir casting.

S.No	Alloy	Author	Reinforcement	Dry sliding wear behaviour
1.	Al(99.9%)	Sulardjaka et al. (2010)	10 and 30wt.% in situ aluminum diboride	Normal load and reinforcement ratio were the major parameters influencing the specific wear rate.
2.	4.5wt. %Cu–Al	Das et al. (2007)	Zircon	Smaller size reinforcements shows higher wear resistance when compared to the larger sizes.
3.	Al-Si	Sadi et al. (2015)	SiC	Optimum values of specific wear are SiC content of 15 wt.% SiC, melt temperature of 740 0C, rotation speed of 300 rpm and stirring duration of 10 minutes.

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4.	LM 24	Kumar et al., (2016)	fly ash and SiC	SiC showed higher wear resistance than fly ash.
5.	Al6061-Cu	Haque et al. (2014)	SiC	Optimal values of wear rate are observed between ranges of 200 to 600 rpm stirring speed.
6.	A332	Altinkok et al. (2013)	Al2O3/SiC	Wear reduces with presence of reinforcement.
7.	LM 24	Sivakumar et al. (2014)	Fly ash	Fly ash increases the composites wear resistance.
8.	Al/3.25Cu/8.5Si	Kumar et al. (2012)	fly ash particles	Coarse reinforcements show higher wear resistance when compared to fine reinforcements.
9.	Al6061	Ashok et al. (2012)	SiC	Wear behavior is a function of the wt.% of reinforcement.
10.	Al2219	Basavarajappa et al. (2006)	SiC	Wear of the composites and alloy increases as sliding distance increase.
11.	Al–Si alloy	Suresh et al. (2010)	fly ash	Wear increases with increase in distance.
12.	Al7025	Sallahauddin et al. (2015)	B4C	Volumetric wear loss and wear rate increases with increase in applied load.
13.	A356	Babić et al. (2013)	10SiC/1Gr	Wear rate decreases with increasing sliding speed.
14.	Al6061	Reddappa et al. (2011)	beryl	Specific wear rate decreased with sliding distance.
15.	Al 7075	Manikandan and Karthikeyan (2014)	B4C, Alumina and SiC	Wear rate decreases with increasing the sliding velocity.
16.	Al6061	Umanath et al. (2011)	SiC and Al2O3	Load had an intense effect on the wear rate.
17.	Al6061-T6 alloy	Kumar et al. (2015)	3 wt.% alumina and 3 wt.% graphite	Increasing trend of specific wear rate with sliding distance.
18.	Al2024	Kok and Ozdin (2006)	Al2O3	Increasing wear resistance as the sliding distance increases.
19.	7075 Al alloy	Dasguta et al. (2012)	10% vol SiC	Wear reduces at higher sliding speed.

V. CONCLUSION

1) Considerable works have been finished utilizing stir casting procedures to fabricate aluminum matrix composites because of its simplicity, flexibility and cost adequacy particularly for extensive volume production.

2) Prominent wear mechanical assemblies utilized in wear test are the pin-on-disc instruments and the parameters normally assessed are load, sliding velocity and sliding distance.

3) Load and sliding velocity plays a vital role in evaluating the dry sliding wear behaviour of composites.

4) Wear resistance of aluminum matrix composites delivered by stir casting process depends likewise on the type of reinforcement and volume fraction, and

5) The patterns watched for the impact of sliding distance and reinforcement size vary and could rely upon the type and nature of reinforcement utilized in composites' production.

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