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An Investigation of Wear Behavior of Metal Matrix Composite Al7075 With Boron Carbide.

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Abstract : The wear characteristics of Metal Matrix Composite (MMC) Al7075 with Boron Carbide (B4C) are examined in this review paper. Aluminum alloys are being used more frequently in the automotive and aerospace industries as a result of the rising need for lightweight materials with improved mechanical qualities. It has been demonstrated that MMCs, particularly those reinforced with Boron Carbide, have the potential to satisfy these demands. In order to form the composite, the research papers considered for this review investigate the effects of stirring different amounts of tungsten and boron carbides together. The research examines the Al7075-B4C composites' mechanical characteristics, tribological behavior, and microstructural analysis. The results show that increasing the Boron Carbide causes a significant increase in Vickers hardness and a reduction in wear rate. These MMCs are suited for lightweight applications, such as aircraft wings and engines, due to their increased strength-to-weight ratio.

Keywords – Stir Casting, Optimization, RSM method.

1 INTRODUCTION

Because there is an increasing need for novel materials to meet client needs, the use of composite materials is growing daily. The materials and technology that reflect human capabilities and understanding are frequently used to emphasize historical events. After centuries of advancements in smelting, refining, and research made all of these feasible, we discovered steel, iron, aluminum, and alloys during the Stone Age, opening the door to the discovery of more advanced materials. The issue of weight reduction then arises in order to save money on material. This advancement in the technology of reinforcements, matrices, and composite manufacturing is the result of the ability to reduce weight utilizing advanced composites, which also results in lower cost and improved efficiency. Improvements in manufacturing techniques, systematic property research, and fracture mechanics peaked in the 1960s throughout the first two decades. Since then, there has been an increase in demand for newer, stronger, stiffer, and lightweight materials with a low rate of wear in industries including construction, transportation, and automotive.

There is a lot of interest in creating and improving new metal matrix composite (MMC) materials in many industrialized nations. There were some improvements as a result in the industrial sector, but the commercial applications that followed were modest. MMC technology is still in the early stages of research, thus more significant systems will surely appear. Due to the fast-progressing demands in the aerospace, aero plane, and automotive industries, composite materials are primarily evolving in response to rising technological demands. Deeper investigations into the fundamental properties of materials and a better knowledge of the relationship between their structure and qualities have made it possible to create novel composite materials with enhanced mechanical and physical capabilities. These days, a lot of brand-new, high-tech Metal Matrix Composites (MMCs) are created by continuously improving standard metals and alloys. New Metal Matrix Composites are created to meet the continual demand for weight and cost reduction. With the right processing, adding different particle or fiber reinforcements to a metal matrix can produce MMC with enhanced characteristics.
(For instance, a greater specific yield strength, a lower density, and a higher specific modulus) perfect for many industrial applications, such as automotive and punch and die.

1.1 Composite Materials

Which on a microscopic level are in close contact with one another. The fact that they only include two materials—one of which is a matrix or binder and the other of which is reinforcement in the form of fibers or particulates—allows them to also be taken into consideration. A composite material is typically made of a matrix (polymers, metals, or ceramics) and reinforcement (fibers, particles, flakes, and/or fillers). While the reinforcement helps the matrix's overall mechanical qualities, it also holds the reinforcement in place to create the required shape. When appropriately created, the new composite material outperforms the constituent materials in terms of strength. Component materials must have a volume fraction more than 5% of the overall volume and possess unique characteristics.

The term "matrix" refers to a substance whose volume fraction is typically much higher than that of the other materials. A matrix may be made of metal, ceramic, or polymer. The individual components of the composites retain their distinct properties while being integrated into the composite in such a way as to only benefit from their positive qualities and not from their negative ones, making them compound materials that differ from alloys. Composites are multipurpose material systems that offer properties that are not possible with single materials. They are cohesive constructions created by physically fusing two or more materials that are compatible but differ in composition, traits, and occasionally form. On a microscopic level, composite materials are homogeneous materials since any part of them will have the same physical properties. They are heterogeneous materials because they contain two or more solid phases.

2 LITERATURE SURVEY

According to Sachin Prabha, Dr. Raghvendra.S, (2019): Because of their inherent qualities, aluminum alloys have seen a tremendous increase in application recently, particularly in the automotive and aerospace industries. MMCs are a new generation improvement in composites. In this project, the matrix metal is an Al7075 alloy, and the reinforcement particles are tungsten and boron carbides. The mass fraction of boron carbide (2–6wt%) was varied while the mass fraction of tungsten carbide (4wt%) remained constant during the stir casting method used to create the composite. In order to assess the performance of the composite, this study looks at its mechanical properties, tribological behavior, and microstructural analyses. When the amount of boron carbide is increased in a composite, the Vickers hardness test shows that the hardness value dramatically rises and the wear rate decreases. With the tiniest variations, the density of the composites is comparable to that of the Al7075 alloy.

In The Work of Babu. S, Arun prasad, Paul Gregory F, (2020): Any industry now has the right to pursue lightweight materials that offer promising strength for all of its key applications. Every organization makes significant efforts to attain this goal, from major Space Research organizations to vehicle manufacturers who try to use lightweight materials and minimize their useful weight. Aluminum 7075 and boron carbide composites are discovered to be promising in such a situation. This article provides a brief summary of an experimental finding employing these stir-cast aluminum-boron carbide composites with various particle weight fractions (3%, 6%, and 9%). The composites are useful for lightweight applications since they conveniently have a higher strength to weight ratio. This study suggests using this material in aircraft wings and engines.

In The Paper of Zeeshan Ali, M D Umar, (2019): The examination of the microstructure and mechanical behavior of Al7075 and Al7075-4% B4C produced this publication. When the microstructure of the composites was analyzed, it indicated a consistent distribution of reinforcement particles throughout the matrix, which improved parameters such as hardness, ultimate tensile strength, and yield strength. The investigation showed that the inclusion of reinforcements increased the hardness, ultimate tensile strength, and yield strength of composites.

The Research of Harish Kumar. S, Dr. Sanjay kumar S.M. (2018): Due to their superior mechanical and tribological qualities, which help reduce component weight, the automotive and aerospace industries are eager to introduce hybrid aluminum metal matrix composites. Based on a survey of the literature, the current work discusses the manufacturing of hybrid aluminums metal matrix composites (AL/B4C/WC). Stir casting technology, a liquid state metallurgy method, can be used to fabricate these hybrid aluminum metal matrix composites. The choice of materials for the production of hybrid Al/B4C/WC metal matrix composites is discussed. The weight proportion of reinforcing particles such as tungsten carbide (WC) and boron carbide (B4C) is chosen. The possible experimentation tests for the mechanical and tribological evolution of hybrid aluminum metal matrix composite (Al/B4C/WC) are described. Microstructures tests of the worn surface of an aluminum (LM25) composite reinforced with boron and tungsten carbide were described. Carbide hybrid aluminum metal matrix composites aid in our understanding of current automotive technology.

In The Paper of Rohit Sharma, Saurabh Jha Pardeep Sharma, (2017): Aluminum metal matrix composites are becoming more and more popular for usage in a variety of industrial applications, including those in the automotive, aerospace, agricultural, and farm machinery industries. These composites are preferred because of their important qualities, such as superior wear resistance compared to other metals and high strength. In the current investigation, reinforcements such graphite, fly ash, silicon carbide, red mud, organic material, etc. are added to the aluminum matrix in a variety of ratios. Each reinforced material has a distinct quality that, when combined, enhances the underlying alloy's capabilities. A review of the various composite combinations and how they affect the characteristics of the various aluminum alloys has been made. In order to investigate composites holistically and use the best findings to advance the development of aluminum reinforced composites, a thorough understanding of the characteristics is offered. The analysis demonstrates that other ordinary metals can be used in place of Al metal matrix composites to improve performance and extend life.

The Research of T. Prasad, P. Chinna Sreenivas Rao, B. vijay kiran, (2018): In comparison to alloys or other metals, metal matrix composites have much better qualities such as high tensile strength, hardness, low density, and good wear resistance. In this study, the aluminum alloy Al7075 is reinforced with magnesium oxide nano powder to create composite materials. The stir casting machine is used to create the composites. The weight fractions of the reinforced particles, which range from 5% to 10%, and the remaining aluminum alloy are used to create the MMC specimens. Tensile strength, impact test, and hardness are suggested mechanical properties to research.

According to Abhijeet Bhowmik, Dipanjan Chakraborty, (2020): This study assesses the wear resistances of stir-cast composites reinforced with silicon carbide particles and made from an aluminum matrix. With an average grain size of 20 um, silicon carbides in varying concentrations (0,3,6,9%) are uniformly distributed throughout the aluminum matrix. The X-disc wear test was performed at two distinct sliding speeds (123 and 4 m/s), with constant loads and sliding distances of 30 N and 2000 M for all casted samples, respectively.

The Research of A. Jayaraj & S. Jaikumar, (2020): This paper aims to investigate the mechanical, corrosion, and thermal properties of multiwalled carbon nanotube-reinforced aluminum metal matrix composites. In the current study, stir casting is used to strengthen the aluminum base alloy (LM 9) with multi-walled carbon nanotubes (MWCNTs) in concentrations of 1%, 2 and 3%. To determine the impact of MWCNTs as reinforcements, tests are carried out to measure hardness, thermal behavior under varied temperatures, and thermal conductivity. The findings show that composites made of aluminum and MWCNTs have better mechanical qualities. According to DSC thermographs, the thermal behavior of the composites does not change as a result of the changing temperature. Due to an increase in microstructure density and resulting enhanced hardness, thermal conductivity as evaluated using a hot disc thermal analyzer indicated a little drop.

According to Sumit Sharma & Ajay Sharma, (2020): Many mechanical systems require the sliding of metal parts when they are unlubricated over a wide range of velocities, but the sliding velocity of the unlubricated metals that exhibit tribological behavior. A tribometer is a device that gauges tribological characteristics like wear volume and co-efficient of friction between two surfaces in contact2, 8. There are several forms of tribometers, including the twin disc and the four-ball, pin-on-disc, block-on-ring, and bouncing ball. This work focuses on or uses an aluminum (Al) disc with a high-speed steel (H.S.S.) pin that makes point contact, which is a highly typical pairing.

In The Paper of Sudhakar, Madhusudhan Reddy. G & Srinivasa Rao. K, (2014): Aluminum alloys are frequently used in applications that call for great strength and low weight. However, all aluminum alloys have poor tribological characteristics, which limits their use in sectors of the automotive industry that require wear resistance, such as cylinder head liners, pistons, brake rotors, and sliding components. In order to increase service life, metallic substrates like aluminum alloys can be coated with ceramic or ceramic metal matrix composite (MMC) layers. It has been suggested that the fusion process used to create surface metal matrix composites (SMMCs) may cause the characteristics of the composite to degrade.

3. CONCLUSION

Insightful information about the wear behavior of Metal Matrix Composite Al7075 with Boron Carbide is given by the examined research papers as a whole. The experiments consistently demonstrate that the Al7075 alloy matrix's mechanical properties, including as hardness, ultimate tensile strength, and yield strength, are significantly improved by the addition of Boron Carbide reinforcement. Additionally, as the amount of boron carbide increases, the wear rate lowers. These results imply that Al7075-B4C composites have a bright future in a variety of industrial applications, especially in the automotive and aerospace industries, which have a high demand for lightweight materials with exceptional mechanical properties. These composites are suitable for usage in crucial components such as cylinder head liners, pistons, and brake rotors due to the observed increase in hardness and wear resistance. As a result, Al7075-B4C MMC development and application offer enormous potential for the advancement of contemporary engineering technologies.

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