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Effect on the Mechanical Properties of Za-27/Graphite Reinforced Composites when Routed Through a Squeeze Casting Process

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Abstract**:** ***Zinc Aluminium Alloy with a presence of the alloy number of 27 is widely being used in the production as well as in the manufacturing of roller bearing and bushes mostly in the auto industry by replacing the bronze made bearings due to its low cost value along with the utmost best performance. And as an add-on, Zinc Aluminium Alloy 27 is a highly strengthened alloy with best metallurgical characters which is somewhat on the high side in the graph when relating it with other types of commonly utilized cast aluminium alloys. The current research work deals purely with increasing the mechanical characteristics of ZA 27 alloy and also to identify the characteristics of the similar alloy when it combines with a metal matrix composites that has been reinforced with the graphite which is purely produced by squeeze casting technique. With respect to this, the reinforced graphite and the Za 27 mixture increases the heat expansion and expands the autonomous lubrication property. The result of this research reveals about the input process parameter increase and then there will be a relevant improvement in its ductile character but with response to the rise in mass of the graphite particles, which will lead to the decrease in the mechanical property such as hardness.***

Keywords **:** ***Squeeze casting process; Zinc Aluminium-27 alloy; graphite particulate reinforcement; Mechanical characters.***

I. INTRODUCTION

Metal matrix composites have been evolved as the appropriate and the most important metal which could not be avoided in the classification of the most advanced materials mixtures. The respective materials will differ from the conventional type by comparing it with the property of homogeneity. Di-carbon composite is a typical example where the reinforcements are truly a dissimilar character in the matrix material. But in metal matrix composites, the path of mixing is distinct during when compared [2,3].The sole concern of the research is to incorporate the reinforced graphite particles with the Za alloy. It can be easily defined as the production methods involved which are on rising value for lower value density materials along with the increased. MMC's in addition to the particulate reinforcement might result by maximizing the strength in a minimal cost when comparing with the type of continuous reinforcements [2, 3]. When comparing with the real world applications,when there is requirement of isotropic properties, the respective type of composites might result in continuous fibre reinforced composites as well as they expand the minimal heat expansion and also it can withstand high thermal conductivity [4]. Recent trends of research community suggests that the commercially available Zinc aluminium alloys have become as a replacement for the aluminum casted alloys as well as for bronze bearings related to its overall better cast quality and for its unique mixture of properties [6].

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II. EXPERIMENTAL SET UP

Fig. 1. Squeeze casting machine setup

The molten melt is carried through the mould through the groove. The Hydraulic power press pressurizes the cast and molds it by setting the pressure and monitoring it in the power pack. The hydraulic pressure is a variable factor in the power pack where for this particular condition the value of variance is set from 60 to 100 Tonnes per Hour. A heat resistant pressure tube is connected with the furnace. The outlet from the furnace is led to the inlet of the squeeze casting component. As the temperature rises in the inlet tube , there will a drop in the temperature of the molten melt.

Temperature is regulated by the regulator monitored and altered respectively. All the temperature control is actuated by means of a thermocouple by placing two types of junctions, hot and cold in the source.

III. EXPERIMENTATION PROCEDURE

3.1 Composite Preparation

The zinc aluminium and graphite composites are produced directly with the help of vortex method a fixing a constant particle size, say 90µm of size. The graphite particle utilized in preparing the composites differs from a value from 0, 3, 5% [Table 1]. of the respective mass. This is just so when the graphite particulate increases by 7 percentages of mass or above that, it will obviously lead to rejection of the respective materials in the stir casting component. The component comprises of a cylindrical type electrical furnace with an efficient test temperature of 1000 ˚C working under in both open and closed conditions. A stainless steel retort is fixed with the furnace and it is a resistant to heat and corrosion and incorporated with a non return disc to arrest leak. A stirrer on the top end with a vertical linear movement is utilized to constantly mix up the molten melt with a variable speed of 110 to 1450 rpm. A long cylindrical tube connected with the component is utilized to transfer the argon gas, during the heating and melting process with the required assembly conditions to rigidly control as well as to act as a barrier for the atmospheric air. Maximum temperature as well as the non sticky coat is applied on top of the stainless steel grade blade and the retort to eradicate stickiness of the melt as well as to minimize the wear, tear and corrosiveness. During the early stages of the process the graphite particulate is annealed in the pre-heater to a temperature value of 2000 degrees and mixed with 100 grams/min of molten zinc alloy with the melting temperature value of 8020 degree celcius. The preparation of vortex is produced in the molten melt by making a horizontal movement in the SS stirrer coated with the aluminate to avoid mixing up of ferrous ions with the Za alloy. At a speed of 350 rpm the particulate is made to rotate by varying the speed gradually. Further the de-gas chemical agent is spread across the molten melt to release O2 gas [8].The die is then heated to a temperature of about 400 degree celcius in order to reach the equal and a uniform distribution all over the die to get the progressive solidification as a result. The moltened melt is then discharged through the cavity to get it in the absolute shape into the mould for casting to convert it into the required shape by squeezing it to a range of 60 mega pascals to 140 mega pascals[Table 2].

Table 1: Level of experiments conducted in L9 Array

Material Description	Levels	Wt percentage of graphite reinforcement	Squeeze Pressure in Mpa	Stirrer speed in rpm
ZA27 alloy / C	L 1	0 %	60	200
	L 2	3 %	90	400
	L 3	5 %	120	600

Table 2. Set of Experimental Result for ZA-27/graphite particulate composites

S.No	Wt % of graphite	Pressure (Mpa)	Stirrer rev (rpm)	Ultimate tensile strength (Mpa)	Yield strength (Mpa)	Hardness (BHN)
1.	0	60	200	327	278	133
2.	0	90	400	345	296	135
3.	0	120	600	352	303	138
4.	3	60	400	378	329	117
5.	3	90	600	385	336	119
6.	3	120	200	390	341	122
7.	5	60	600	407	358	110
8.	5	90	200	410	361	113
9.	5	120	400	415	366	115

3.2 Examination of mechanical properties

ZA27 graphite composites which are made by squeeze casting compares with all kind of mechanical characteristics [9,10]. The graph visualizes the influence of optimum process parameters that will enhance good mechanical properties [Fig.1].The output parameter responses like responses such as ultimate tensile strength and yield strength increases by decreasing [Fig.2]. Even though we get good responses due to the experimentation, the sole reason for the addition of graphite is to find betterment in the properties such as self lubrication, high thermal conductivity and low coefficient of thermal expansion. ZA-27 alloy has the highest value of hardness, highest ultimate tensile strength and yield strength when relating it with other type of graphite reinforced composites.

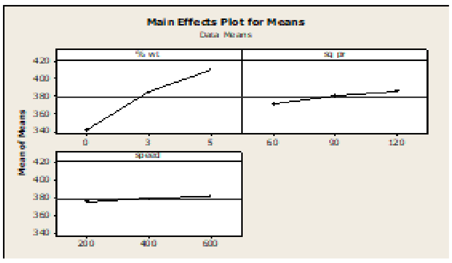

Fig. 2. Mechanical properties of Za27 with graphite reinforced composites (a) Ultimate tensile strength

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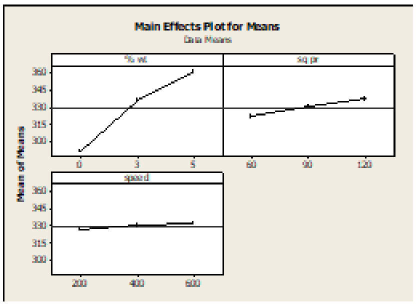

Fig. 3. Mechanical properties of Za 27 with graphite reinforced composites (b) Yield strength

IV. DISCUSSION

Best mechanical properties are resulted by a continuous and a more constant solidification process. Optimum stirring speed is also defined by the pressure of squeezed casting and also a most accurate and a defect free casting is resulted. The involvement of zinc addition improves the characteristics of materials like strength, toughness, ductility and hardness. By increasing the percentage of weight in the reinforced graphite particulate the hardness property is observed to be still soft by the classification solely responsible by autonomous lubrication along with the following characters such as minimized heat expansion, maximized thermal conductivity and best in the field thermal stability. The material can be widely applicable where there are two moving frictional parts or rotational components particularly in the field of automotive assembly sector and process industry where centrifugal rotary motion takes place.

V. CONCLUSION

The following conclusions have been arrived based upon the clarity that has been defined by the results delivered by means of the experimentation by following the standard operating procedures:

1. The characteristics of the tensile stress maximizes on a large scale by the increased addition of graphite particulate. Since this being an annealed material the graphite reinforcement particulate will pave way for the advancement of quality of lubrication inside the component [11].And in turn this will minimize the thermal expansion and it will increase the thermal conductivity as well as it improves the thermal stability.

2. Due to the effect of the pressurized components delivered by means of squeeze casting methodology the hardness in the mother material , that is Za 27 which has the add-on of graphite particulate composites increased moderately.

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