OPTIMIZATION OF PROCESS PARAMETER FOR STIR CASTED ALUMINIUM METAL MATRIX COMPOSITE USING TAGUCHI METHOD

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Abstract

From the past few years, materials research and development has shifted from monolithic to composite materials, adjusting to the need for reduced weight, low cost, quality, and high performance of the composites. Aluminium metal matrix composite used in areas of aerospace and automotive industries include high performance, economic and environmental benefits. The aim involved in designing the metal matrix composite is to combine the desirable attributes of metals and ceramics. The present investigation has been done to study the effect of different input process parameters namely particle size of alumina, wt. % of alumina and stirring time on the hardness, impact strength and tensile strength. Three parameter i.e. particle sizes of alumina (75, 105 and 150 micron), wt. % of reinforcement (3%, 6% and 9%), stirring time (15, 20 and 25 minute) was used to fabricate different sample of AMMCs by using stir casting technique. Each parameter has three different levels. L9 orthogonal array table used to made different specimen. The effect of these input process parameter on the output response have been analyzed using analysis of variance (ANOVA). The contribution of each process parameters on the hardness, impact strength and tensile strength was analyzed by using ANOVA. The results have shown that the wt. % of alumina, stirring time and the particle size of alumina have a significant effect on the hardness, impact strength and tensile strength.

***Keywords**: MMC's, pure aluminium, Al_2O_3 particulates, Stir-Casting, Taguchi method.*

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1. INTRODUCTION

Materials design has shifted from monolithic to composite materials because of reduced weight, low cost, quality, and high performance in structural materials. Metal-matrix composites (MMCs) have been attracting growing interest in these days [1-3]. These MMC have superior properties as compared to monolithic material. Among these composites, aluminum matrix composites attract much attention because of their lightness, high strength, moderate casting temperature and other properties [1, 4]. Many kinds of Ceramic materials, e.g. Al_2O_3, Sic, Tic, WC, TiB_2, MgO, TiO_2, B_4C, BN and graphite are mostly Used to reinforcement in aluminum matrices. Various properties of this material like high refractoriness, high hardness, high compressive strength, wear resistance etc make it use as reinforcement in MMCs [5-7].

Behind the developing of the metal matrix composite (MMCs) is to combines the properties of the matrix metal and ceramic reinforcement materials. There are various advantages of the aluminium metal matrix composite (AMMCs) high strength, improved stiffness, reduced weight, improved high temperature properties, more wear resistance, improved damping capabilities as compared to unreinforced material [8-10]. The AMMCs are now used in a variety of applications, such as connecting rods, automotive drive shafts, cylinder liners and brake rotors. Due to the high strength to weight ratio of AMMC enables it to be applied extensively in the aerospace industry [11].

According to the literature survey it is evident that though the application scope for AMCs is expanding, but the major hindrance is in the production of these AMCs. The AMCs can be produced by either solid state processing or liquid state processing. Mostly the liquid state processing especially, stir casting is used for the synthesis of AMCs because of their simplicity and scalability [12]. Most of the researchers have focused on effect of single parameter either weight percentage of reinforcement or particle size of reinforcement on mechanical properties and not much research has been done using three process parameters particle size of reinforcement, wt. % of reinforcement, and the stirring time simultaneously. Bharath et al. [5] fabricated the aluminium metal matrix composite with Al_2O_3 particles by stir casting technology. The particle size of Al_2O_3, 25 μm used and results showed that with 6, 9 and 12 wt. % of particles, the homogenous distribution takes place by stir casting technology. With the increase in wt. % of Al_2O_3 particles, the hardness of the composite also increased. But the ductility of pure aluminium was higher than composite. So both the tensile and yield strength were higher incase of composites as compared to as cast 6061Al. so with increasing wt. % of Alumina, the tensile strength shows an increasing trend. Aluminium alloy based casting composite material manufactured by Jokhio et al. [13] via using stir casting technique. The 7xxx series Aluminium matrix usually contains Cu- Zn-Mg. the research was conducted to investigate the effect of Cu- Zn-Mg in aluminium matrix on mechanical properties of the aluminium composite prepared by stir casting and reinforced with Alumina particles. Age hardening treatment was also applied to study the aging response on strength, ductility and the hardness. The results indicated that Alumina reinforcement up to 10 % increase the tensile strength to 297MPa and elongation 17% in aluminium alloy matrix contained Cu- Zn-Mg.

Sajjadi et al. [14] produced Nano and micro metal matrix composites with 1, 3, 5 and 7.5 wt. % micro-Al_2O_3 and 1, 2, 3 and 4 wt. % Nano-alumina by stir-casting and compo-casting technique. Hardness of composite was increased with weight percent of Nano and micro-particles. Strength and hardness was noted significant when 3 wt. % of nano-Al_2O_3 and 5 wt. % micro-Al_2O_3 particles embedded in compo-casting and 2 wt. % nano-Al_2O_3 and 5 wt. % micro-Al_2O_3 particles added in stir casting. Also Ductility increased with decreasing particle size and wt. % of reinforcement. Also, ductility of compo-casting was greater than stir casting samples. Nano-sized ceramic particle reinforced aluminum matrix composites were fabricated using conventional stir casting technique by Su et al. [15]. The nano-Al_2O_3/2024 composite were prepared by solid–liquid mixed casting combined with ultrasonic treatment. Ultrasonic vibration on the composite slurry during the solidification was beneficial to refine the grain microstructure, and improve the resulting distribution of Al_2O_3 nanoparticle in the matrix. The ultimate tensile strength and yield strength of 1 wt. % Nano-Al_2O_3/2024 composite were increased by 37% and 81%, respectively as compared to the alloy matrix. A novel three step mixing method for the preparation of MMC was studied by Sazzadi et al. [16]. Results showed that poor incorporation of micro particles in aluminium melt prepared by common condition and wettability of particles within molten matrix had been decreased by increasing Al_2O_3 percent and decreasing particle size. Three steps mixing had only ability to fabricate sample up to 5 wt. % of micron sized and 3 wt. % of Nano sized Al_2O_3 at 300 rpm speed. Composite strength of Nano composite is greater than micro composite. Singh et al. [17] studied to develop the Al alloy LM6 based Sic and Al_2O_3 particulate MMC with stir casting technique. The particles were embedded with 2.5, 5, 7.5, and 10% by weight in the melt. Results show that elongations tend to decrease with increasing particle wt. % and the behavior of material changes from ductile to brittle. The UTS and yield strength starts increases with increase in weight percentage of Sic and Al_2O_3particles in the matrix. Also the hardness and impact strength was increased by adding SiC and Al_2O_3 particles in the composite. Muhammed et al. [18] manufactured the Al-Si/Al_2O_3 composite by vortex technique. The different parameters stirring time, stirring speed and wt. % of the reinforcement were used for the preparation of composite. Taguchi method was used improve the performance of the product, process design and system. Tensile and hardness test were performed for the resulted casting. The optimum level of process parameters to obtain good mechanical properties are 15wt. % of particles, 3 min stirring time, and 50 rpm stirring speed for tensile strength and 150 rpm for hardness. The experimental and analytical results showed that wt. % was the most influential parameter that gives the highest tensile and hardness properties to the composite.

From the previous work done by the different investigators it was clear that different process parameters were not used at the same time, it is quite promising to pursue research in the area of production of MMCs with three parameters. In this investigation has been done by using three process parameters simultaneously. The objective of the present research is to find out and effect and contribution of these parameters on the hardness, impact strength and tensile strength using tagauchi method.

2. EXPERIMENTATION

2.1 Composite Preparation:

In this study pure aluminium was used as matrix material and alumina (Al_2O_3) up to 9 wt. % used for the preparation of composite. The chemical composition of the pure aluminium is shown in the table 1.

Table 1 Composition of pure aluminium

Element	%
Aluminium	99
Copper	0.01
Silicon	0.30
Iron	0.580
Manganese	0.024
Lead	0.038
Tin	0.015
Titanium	0.012
Chromium	0.002

Three different particle size 75,105 and 150 micron was used in different wt. % 3, 6 and 9 with different stirring time i.e. 15, 20, and 25 minutes used in manufacturing of the composite.

The aluminum metal matrix composite was prepared by stir casting route. Aluminium was melt in a graphite crucible by heating it in the muffle furnace at 800ºC temperature. The reinforcement aluminium Oxide (Al_2O_3) was preheated at 300ºC [5] temperature for 1 hr. to remove the moisture from the powder and make their surface oxidized. As the melting temperature of aluminium near about 650ºC but the furnace temperature raised above the liquidus temperature of aluminum so that complete melt takes place. After an interval of time the temperature cooled down just below the liquidus temperature near about 700ºC to form the slurry in the semi solid state by controlling the temperature with the help of control unit of furnace. The stirrer also placed in the furnace for preheating purpose. Now the molten aluminium was stirred for 10 minutes for the homogenous melt form at stirring rate of 300 RPM. Preheated alumina particles were embedded in the molten by three steps mixing of melt [5]. At every stage before and after introduction of reinforcement, mechanical stirring is carried out for a period of 5 min. Similarly remained reinforcement particles were added. In the final mixing process the furnace temperature were controlled within 700±10ºC. The stirrer position was such that 35% of material should be below the stirrer and 65% of material should be above the stirrer [20]. After the complete addition of particles, the melt was stirred for a defined time. The melt was poured in the preheated mould (300ºC) to get a desired shape of composite. The mixture was allowed to solidify for a desired time. The next specimen was manufactured with same process but size, wt. % of reinforcement and stirring time were different.

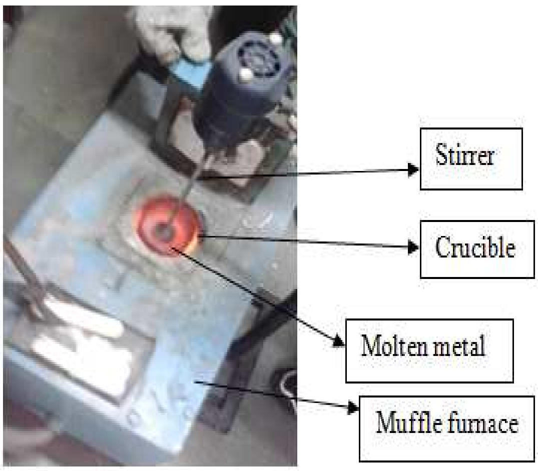

Fig. 1 Stir casting setup

The hardness of composites were measured with Rockwell hardness tester using a 1/8´´ diameter steel ball indenter with a 100 N minor load & 600 N major load used for the pure aluminium. For aluminium alloy 1/16´´ diameter steel ball used with a load total load 1000 N. For each sample, three hardness readings were taken and the average considered for analysis.

Similarly the impact strength of these specimens were measured using the Charpy Impact test machine with a dimensions of specimen were 55mm×10mm×10mm. The tensile tests were carried out on a Universal Testing Machine (UTM). The composite were machined to prepare tensile specimens according to ASTM standards.

2.2 Taguchi technique for DOE:

In the design of experiment Taguchi method used because it is a problem ‐ solving tool which can improve the performance of the product, process design and system. This method combines the experimental and analytical concepts to determine the most influential parameter on the result response for the significant improvement in the overall performance. Design of experiment is a technique of defining and investigating all possible conditions involving multiple factors, parameters and variables in an experiment. It establishes the method for drawing inference from observation, when these observations are not exact, but subject to variations and also used to collect data. A three level L9 3^3 orthogonal array with nine experimental runs was selected [18]. To observe the most influential process parameters in the preparation of composite namely (1) particle size (2) wt. % of reinforcement (3) stirring time each at three levels were considered and are shown in table 2

Table 2 process parameter and level

S. No.	Factors (Units)	Parameter Designation	Level 1	Level 2	Level 3
1	Particle size	A	75	105	150
2	wt. %	B	3	6	9
3	Stirring time	C	15	20	25

In this research nine different composite were manufactured with different parameters and at different levels. The effect of these parameters on the response i.e. the hardness, impact and tensile strength of the composite were studied using Analysis of variance (ANOVA).

Degree Of Freedom (DOF) = number of levels -1 …… (1)
For each factor, DOF equal to:
For (A); DOF = 3-1=2
For (B); DOF = 3-1= 2
For (C); DOF = 3-1=2
The total degree of freedom is calculated as:
Total DOF=No. of experiments -1 ……. (2)
The total DOF for the experiment is DOF= 9-1 = 8

In the tagauchi method the response variation were studied using signal-to-noise ratio and minimization the variations due to untrolable parameter. The larger the better S/N ratio used for these responses:

$$\text{S/N (dB)} = -10\log\left(\frac{1}{r}\sum_{i=1}^{r}\left(\frac{1}{y_i}\right)^2\right) \quad \ldots\ldots (3)$$

Here db means decibel, y = observation, r = total number of observation and y_i = i^{th}response [19]

The S/N ratio was calculated for hardness, impact strength and tensile strength in each of the nine trial conditions to see the effect of each parameter on the response.

3. RESULT AND DISCUSSION

The hardness value for the pure aluminium was 29 HRB. An average hardness value from 37 HRB to 58 HRB were obtained for the Al2O3 particle reinforced composites. The presence of stiffer and harder Al2O3 reinforcement leads to the increase in constraint to plastic deformation of the matrix during the hardness test. A significant increase in hardness of the pure Al matrix can be seen with addition of Al2O3 particles. Higher value of hardness is clear indication of the fact that the presences of particulates in the matrix have improved the overall hardness of the composites. Similarly the impact strength increased from 12 Nm to 30.59 Nm. With increases in wt. % of alumina these values showed an increasing trend. The tensile strength of composite reinforced with 9 wt. % Al2O3 particles is a modest superior than that of the pure aluminium. The Al2O3 particle reinforced composite exhibited tensile strength up to 147 N/mm² while the pure aluminium had a tensile strength 96 N/mm².

The hardness, impact strength and tensile strength of the composites were measured in three trails. The mean of these values are shown in table 3.

Table 3 Mean of hardness, impact and tensile strength

Trail No.	(A)	(B)	(C)	Mean hardness (HRB)	Mean impact strength (Nm)	Mean tensile strength (N/mm²)
1	75	3	15	37	15.07	107
2	75	6	20	46	22.06	129
3	75	9	25	58	30.59	147
4	105	3	20	39	16.59	110
5	105	6	25	52	25.13	137
6	105	9	15	46	18.89	124
7	150	3	25	38	15.42	106
8	150	6	15	41	18.56	118
9	150	9	20	49	22.86	137

Table 4 shows the S/N ratio for the response of the composites. From S/N ratio it is cleared that each parameter has different effect on hardness, impact strength and tensile strength of composites.

Table 4 S/N for hardness, impact and tensile strength

Trail No.	(A)	(B)	(C)	S/N Ratio Hardnes	S/N Ratio Impact strength	S/N Ratio Tensile strength
1	75	3	15	40.90	33.10	50.13
2	75	6	20	42.79	36.41	51.75
3	75	9	25	44.81	39.25	52.88
4	105	3	20	41.36	33.93	50.37
5	105	6	25	43.86	37.54	52.27
6	105	9	15	42.79	35.06	51.41
7	150	3	25	41.13	33.30	50.04
8	150	6	15	41.79	34.71	50.98
9	150	9	20	43.34	36.72	52.27

3.1 Effect of Various Parameters on Hardness of Composite

The mean S/N ratio for level 1, 2 and 3 can be calculated by taking the averaging of the S/N ratio for the experiment 1-3, 3-6 and 6-9. To draw the graph that shows the effect of each parameter at each level on the response, the mean S/N is used for hardness of composite as shown in table 5

Table 5 Mean S/N ratio for hardness

Parameter	Level 1	Level 2	Level 3
A	42.83	42.67	42.09
B	41.13	42.81	43.65
C	41.83	42.50	43.27

1. Effect of wt. % of alumina: - It is clear from the fig. that with increase in the wt. % of Al_2O_3 reinforcement, the hardness of composite increases. wt. % of alumina was found to be most influent parameter for the hardness of composite. Fig. shows that up to 6% alumina the hardness increases suddenly and after that with increase in wt. % of alumina hardness increases slowly as comparison to last addition of reinforcement. As the wt. % fraction of alumina increases the mean S/N ratio also increased from 41.13 to 43.65 as shown in the fig. 2. . In S/N ratio highest hardness 43.6 HRB is achieved at 9wt. So this variation follows the hardness results by Bharath, V. et al. 2012 whose result shows the increase in hardness from 90 VHN to 190 VHN with the increase in wt. % of alumina from 0-12%.

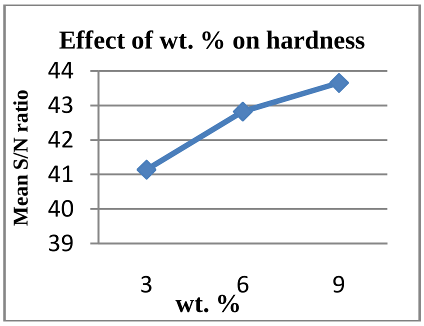

Fig.2 Effect of wt. % on hardness of the composite

2. Effect of Stirring time: - Results shows that with increase in the stirring time the hardness of composites increases continuously because of the distribution of reinforcement particles in the matrix metal. As the stirring time increase the mean S/N ratio for hardness increased from 41.83 to 43.27. The graph showed that at 25 Min. stirring time maximum hardness of composites obtained. In S/N ratio highest hardness 43.4 HRB is achieved at 25 minutes stirring time. These results followed the results by Muhammed, et al. 2009. In Muhammed, et al. 2009 experiment the hardness increased by increasing the stirring time from 1- 3 minutes. So our results are toward the direction of previous results. The effect of stirring time on the hardness of composite is shown in figure 3.

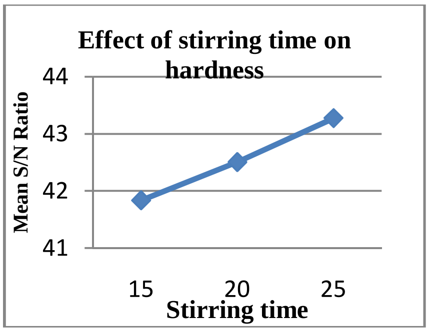

Fig. 3 Effect of stirring time on Hardness of composite

3. Effect of particle size: - Results shows that as the particle size increases the hardness of composite decreased. As the 75 µm sized particles used in composite, maximum hardness of the composite obtained. Graph shows that with increase in size from 75µm to 105µm hardness decreased from 42.83 to 42.01. Similarly as the particle size of reinforcement increased more from 105 µm to 150 µm, then hardness decreased suddenly because of gravity effect on particles in molten. In S/N ratio the highest hardness 42.8 is obtained at 75 µm. According to the Kumar et al. 2013 size of the reinforcement material have low influential on the mechanical properties of the composite. So our results followed the results of Kumar et al. 2013 that particle size have low effect on the harness of the composite. The effect of particle size on the hardness of composite is shown in figure 4.

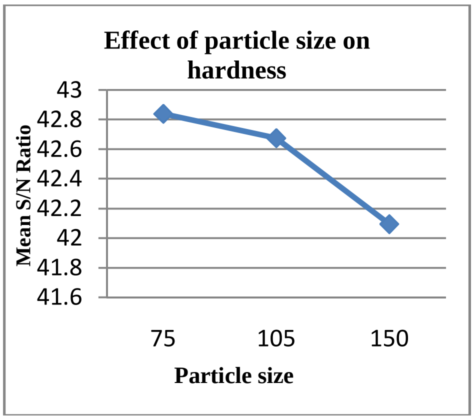

Fig. 4 Effect of particle size on Hardness of composite

3.1.1 Analysis of Variance (ANOVA) For Hardness of the Composites

The Analysis of variance (ANOVA) was applied to study the contribution of all parameters. Table 6 shows the ANOVA results for the S/N ratio for the hardness of the composite.

Table 6 ANOVA for S/N ratio for hardness of composites

Source	D.O.F	SS	MS	F-ratio	Contri-bution
(A)	2	0.91	0.45	2.38	6.43
(B)	2	9.85	4.92	25.58	69.11
(C)	2	3.10	1.55	8.04	21.74
error	2	0.38	0.19		
Total	8	14.2	1.7		

The highest rank 1 of wt. % signifying the highest contribution about 69.11 % in the hardness of composites. After that stirring time showed its contribution up to 21.74 %. At last particle size showed its too much least 6.43 % contribution in the hardness.

3.2 Effect of Various Parameters On Impact Strength Of Composite

In Table 7 the rank importance of the various factors in terms of their relative significance has been shown. The table 7 shows the effect of each parameter on the impact strength of the composites

Table.7 Mean S/N ratio for impact strength

Parameter	Level 1	Level 2	Level 3
A	36.25	35.51	34.91
B	33.44	36.22	37.01
C	34.29	35.69	36.70

1. Effect of wt. %:- The experimental results shows that wt. % of alumina is most influent parameter that affect the impact strength very strongly as compared to stirring time and particle size of alumina. As the wt. % of alumina increases in the matrix metal, the impact strength of the composite increases. The graph shows that with addition of alumina (Al_2O_3) from 3 to 9 % impact strength shows an increasing trend mean S/N ratio from 33.44 to 37.01.

Results shows that as wt. % of alumina increased from 3 to 9 % the impact strength increased. Up to 6 % alumina the impact strength increases suddenly but from 6-9% the impact strength increases slowly. According to the Singh, D. et al. 2012 the impact strength increased from 5.86 Nm to 7.22 Nm with the addition of alumina. So our result is also towards in the direction of previous results.

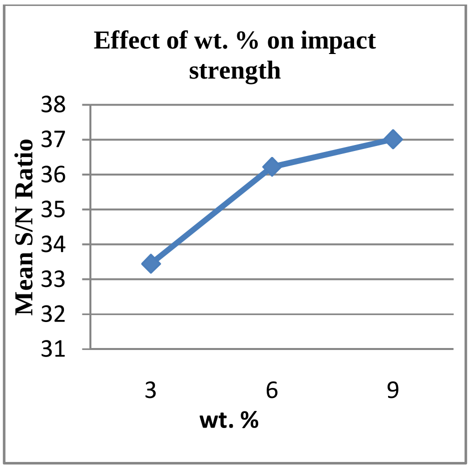

Fig. 5 Effect of wt. % on impact strength of composite

2. Effect of stirring time: - The impact strength of the composite increased by embedding of alumina powder in the matrix metal. Results shows that with increase in the stirring time the S/N ratio for impact strength of composites was increases continuously from 33.29 to 36.70 because of the distribution of reinforcement particles in the matrix metal. This may be attributed that as the stirring time increases the impact strength of the composite increases continuously. With increase in the stirring time the alumina distribute in matrix metal and give high impact strength. The effect of stirring time on the impact strength of composite is shown in figure 5

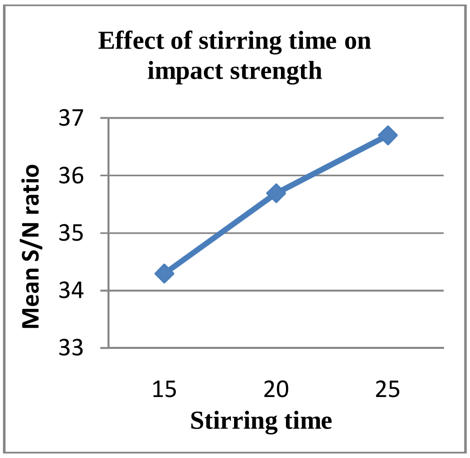

Fig. 6 Effect of stirring time on impact strength of composite

3. Effect of Particle size: - The effect of particle size on the impact strength of the composite is shown in fig.7. The size of alumina contributes its lowest value in impact strength of composite. Results shows that as the particle size increases the S/N ratio for impact strength of composite decreased from 36.25 to 34.91. As the 75 µm sized particles used in composite, maximum Impact strength of the composite obtained. Graph shows that with increase in size from 75µm to 105µm Impact strength decreased. Similarly as the particle size of reinforcement increased more from 105 µm to 150 µm, then impact strength decreased suddenly because of gravity effect on particles in molten. . It shows its too much least contribution in impact strength of composite near about 3 %. So these results followed the results of Kumar et al. 2013 and goes in similar trend. The effect of particle size on the impact strength of composite is shown in figure 7

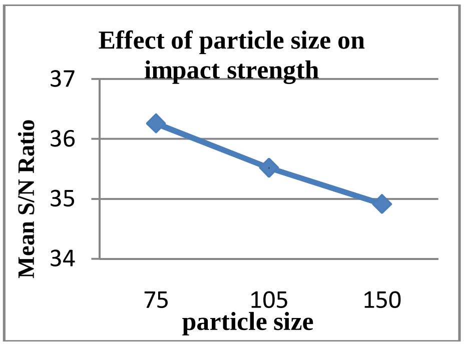

Fig. 7 Effect of particle size on impact strength of composite

3.2.1 Analysis of Variance for Impact Strength of the Composites

Table shows the ANOVA results for the S/N ratio for the impact strength of composites. All the three parameters i.e. particle size of alumina, wt. % of reinforcement (Al_2O_3) and stirring time were found to be significant factor that affect the impact strength of composites

Table 8 ANOVA for impact strength of composites

Source	D.O.F	SS	MS	F-ratio	Contri-bution
Particle size (A)	2	2.72	1.36	1.46	7.91
wt. % (B)	2	21.0	10.51	11.33	61.18
Stirring time (C)	2	8.76	4.38	4.72	25.50
Residual error	2	1.85	0.92		
Total	8	34.3	4.29		

The highest contribution is of wt. % of alumina 61.18 % in the impact strength of the composite. The stirring also contribute in impact strength of the composite near about 25.50 %. But the contribution of particle size in the composite is 7.91 % which is very low.

3.3 Effect of Various Parameters on Tensile Strength of Composite

Table 9 shows the S/N ratio of impact strength of the composites. From S/N ratio it is cleared that each parameter has different effect on tensile strength of composites.

Table 9 Mean S/N ratio for tensile strength

Parameter	Level 1	Level 2	Level 3
A	**51.59**	51.35	51.10
B	50.18	51.19	**52.19**
C	50.84	51.46	**51.73**

1. Effect of wt. %: - Wt. % is the main parameter that affects the tensile strength of the composite. Fig. 8 shows that as the wt. % of alumina increased, the S/N ratio for tensile strength showed an increasing trend from 50.18 to 52.19. From 3 to 6 % of alumina in composite showed continuously increase in tensile strength of composite. It is a most influent parameter that affects the tensile strength very strongly as compared to stirring time and particle size of alumina. Bharath V et al. 2012 results showed that tensile strength increased form 150 to 195 MPa as the wt. % of Alumina increases from 0- 12%. The effect wt. % of alumina shown below: -

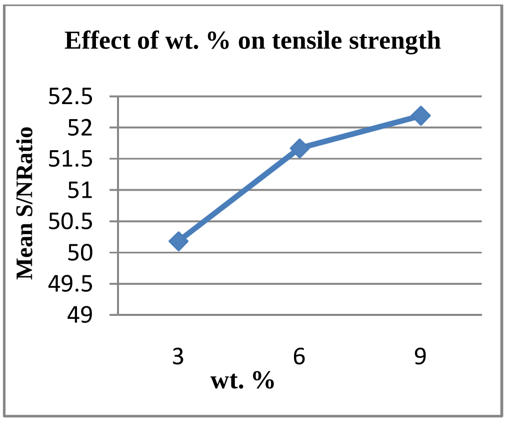

Fig. 8 Effect of wt. % on tensile strength of composite

2. Effect of Stirring time: - The tensile strength of composite increased as the stirring time increased for 15 to 25 minutes from 50.84 to 51.73. Figure 9 show that most of the part of alumina powder distributes in molten up to 20 minutes stirring time. But further with increase in time tensile strength increased. The graph showed that at 25 Min. stirring time maximum hardness of composites obtained. In Muhammed. et al. 2009 experiment the tensile strength of the composite increased from 171 MPa to MPa as the stirring time increases from 1 to 3 minutes. So our result goes in similar direction as in the previous results. The effect of stirring time on the tensile strength of composite is shown in figure 9

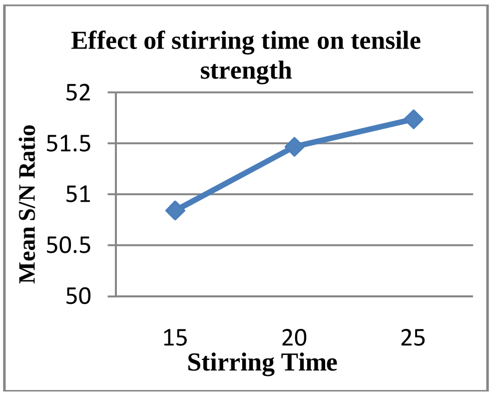

Fig. 9 Effect of stirring time on tensile strength of composite

3. Effect of Particle size: - As the particle size increases the S/N ratio for tensile strength of composite decreased from 51.59 to 51.10. Composites contain 75 µm particles have higher tensile strength than composite contains 105 and 150 µm alumina particles. Fig. 10 shows that with increase in particle size of alumina the tensile strength of the composite shows the decreasing order. So our results followed the results of Kumar et al. 2013 that particle size have low effect on the tensile strength of the composite.

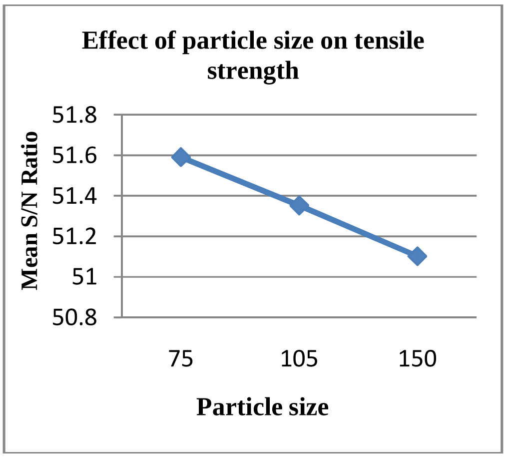

Fig. 10 Effect of Particle size on tensile strength of composite

3.3.1 Analysis Of Variance For Tensile Strength Of The Composites

Table 10 shows the ANOVA results for the S/N ratio for the tensile strength of composites. The parameters i.e. particle size of Alumina, wt. % of reinforcement (Alumina) and stirring time were found to be significant factor that affect the tensile strength of composites

Table 10 ANOVA for S/N ratio for Tensile strength of composites

Source	D.O.F	SS	MS	F-ratio	Contri.-bution
Particle size (A)	2	0.35	0.17	0.94	4.20
wt. % (B)	2	6.52	3.26	17.20	76.43
Stirring time (C)	2	1.27	0.63	3.35	14.91
Residual error	2	0.37	0.18		
Total	8	8.53	1.06		

The contribution of wt. % in the tensile strength of the composite is 76.4 %. After that the stirring time showed its less contribution i.e. 14.9 %. At last the contribution of the particle size of alumina had least contribution 4.2 % in the tensile strength of the composite.

CONCLUSIONS

The pure aluminum reinforced with Al_2O_3 at different level and parameter was successfully produced via stir casting method. The following conclusions can be made based on the studies carried out:

1. The composites containing Pure Al with 3, 6 and 9 wt. % of Al_2O_3 particulates were successfully synthesized by stir casting technique.
2. Hardness, tensile strength and impact strength increased from 29 HRB-58 HRB, 96 N/mm²-147 N/mm² and 12 Nm-30.59 Nm.
3. It was revealed that the hardness of composite increased with increasing the weight percentage of Al_2O_3 particles, stirring time but decrease with increase in particle size.
4. The tensile strength of the manufactured composite was higher in composite.
5. Impact strength was higher in case of composites as compared to the pure aluminium.
6. The Signal-to-noise ratio showed the effect of each parameter at each level on the hardness, impact strength and tensile strength of composite.
7. Analysis of variance determined the contribution of each parameter in the hardness, impact strength and tensile strength of the prepared composite.
8. All these mechanical properties shows increasing trend with increase in wt. %, stirring time and decrease in particle size of the reinforcement.

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