



Full Length Article

Surface properties enhancements by optimizing synthesizing parameters of AA8026 + Zr₂O₃/TiO₂ hybrid composite

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ABSTRACT

Aluminium alloy is one of the widely used lightweight materials and is utilized in the production of a wide variety of components. The AA8026 properties enhancements through optimizing the synthesizing parameters through the Taguchi route is the aim of this investigation. Thereby establishing control over the stir casting process to alter the wear and microhardness of AA8026 aluminium alloy by hybrid reinforcement. There were 16 samples of AA8026 + Zr₂O₃/TiO₂ composite prepared as per Taguchi L16 orthogonal array. The process parameters varied four levels such as stirring time from 15 min to 30 min, quantity of reinforcement from 3 wt% to 12 wt%, molten temperature from 750 °C to 900 °C, and stirring speed from 450 rpm to 600 rpm. The fabricated samples are investigated for microhardness and wear properties. From the analysis, it is inferred that stirring speed is highly influenced by wear and microhardness properties. The results exemplify that 0.086 mm³/m was minimum wear and 180.2 HV was maximum microhardness achieved.

1. Introduction

Composite materials are made from various components and are strong and good for product production (Han et al., 2022). Composite materials' low weight and excellent strength have made them prominent in the automobile sector (Xiang et al., 2024). Alloy objects are widely used due to advances in material science and modern technology's high-performance demands (He et al., 2024). Aluminum composite bars may replace steel bars in NSM-reinforced concrete members. These materials are now consumed more. Aluminum-Metal Matrix Composites (AMMCs) are used in many automobile parts, including cylinder liners, pistons, and brakes (Bandhu et al., 2018; Behera et al., 2019; Bhowmik et al.,

2021). Aluminum alloys are utilized to make most domestic products, electrical conductors, and food packaging. Some cars employ aluminum alloys (Bose and Nandi, 2020). AMMCs may be made via stir casting or powder metallurgy. Both procedures are discussed here. Liquid metal-lurgy includes stir casting. This technique involves melting the material at high temperatures and mixing it with hard ceramic particles (Faisal and Kumar, 2018; Fatile et al., 2017). Testing different stir-casting settings helps enhance the process. It is one of the cheapest and most frequently accepted procedures for creating a uniform mixture of component materials (Hima Gireesh et al., 2018; Idrisi and Mourad, 2019; Inegbenebor et al., 2018). Stir casting's simplicity, adaptability, and high-volume manufacturing capability are among its many

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advantages. Stir casting is a cost-effective method for making large AMMC components (Kandpal et al., 2022; Kaushik and Sandeep, 2018). Stir casting reduces chemical interactions between the base material and the reinforced particles, resulting in cast AMMCs with low porosity (Khatkar et al., 2018). Stir-casting mixes base material with reinforced particles and homogenises them by varying stirring speed. When stir-casting AMMC, the difficulty of even reinforcement material distribution, wettability of composite materials, porosity of cast AMMC, and chemical reactions between reinforcement material and matrix alloy must be considered (Shabani et al., 2020). In stir-casting, reinforcing particles must be dispersed in the molten base matrix during casting. Issues might arise during this phase because of the density difference between the base material melt, alloying components, and reinforcing materials (Shakir and Alsaheb, 2023). Stir casting avoids this via vortexing. After melting the matrix material and stirring it aggressively to generate a vortex, the reinforcing material is applied to the exterior of the vortex. A time is spent stirring the slurry before casting. For quality cast samples of metal matrix composites, matrix alloy and reinforcement particles must be wetted (Shakir and Alliwe, 2021). Wettability defines a liquid's penetration and spread over solids. Melt must wet solid ceramic phase to incorporate solid ceramic particles in casting. Stir-cast metal matrix composite samples have porosity issues. Effective mechanical stirring reduces it (Shakir and Abdlsaheb, 2022). Additionally, it reduces casting corrosion resistance. Hydrogen evolution, shrinkage during solidification, and gas trapping during mixing cause porosity. Porosity formation depends on holding times, stirring speeds, and impeller design, size, and location (Sharma et al., 2022). Stir casting process factors include stirring speed, duration, holding time, pouring temperature, and impeller size and position that impact sample quality. Adjusting these variables improves cast MMC porosity and wettability (Shayan et al., 2019). Many statistical methods may be used to analyze experiment results. Genichi Taguchi developed Taguchi statistics to improve manufacturing quality. Taguchi is a strong design approach (Kn, 2022; Kumar Bhoi et al., 2020; Kumar et al., 2020). Due to industrial advances, the Taguchi technique is applied in all technological applications, biotechnology, marketing, and advertising. The Taguchi optimization method is preferred for quality-based testing (Kumar et al., 2022). Two smooth surfaces in contact and loaded undergo "sliding wear" relative motion. Pin-on-disc apparatus, sliding distance, sliding velocity, and applied stress are needed for wear study (Kumar et al., 2017; Mozammil et al., 2019; Muduli et al., 2022). When stress is raised, material is lost faster and surfaces acquire delaminated changes and craters (Pazhouhanfar and Eghbali, 2018). Various hardness tests may be performed to evaluate a material's microhardness, which is assessed by an indentation (Qasim, 2022). The microhardness test measures material hardness quickly and accurately. The issue is how reinforcing changes aluminum alloy AA8026 surface attributes like wear and microhardness. Does reinforcing affect stir-casting parameters? This experimental research sought to answer these problems. The reinforcing type and range used to change AA8026's surface characteristics are unique in this work. This study adjusted reinforcing and stir-casting synthesis parameters to reduce wear.

Due to its performance, durability, and cost-effectiveness, aluminum alloy AA8026 is used in industries like aerospace, automobile, marine, and others that need lightweight, high-strength materials. Improving surface quality by changing synthesizing parameters would increase functional reliability in its applications (Kuang et al., 2018). Thus, this study has a worldwide impact.

This experiment tested hybrid aluminium metal matrix composites (AA8026 + Zr2O3/TiO2) for wear and microhardness. This work uses Taguchi analysis to determine stir-casting process parameter optimum values (Radhika et al., 2021). Cast AMMCs' microhardness and wear resistance increase with parameter adjustment.

2. Materials and methods

Purpose of this experimental work, the aluminium alloy AA8026 was chosen to serve as the basis material. Hard particles, such as zirconium oxide-based (Zr_2O_3) powder (Purity: >99.9 %, average particle size: 30–45 μm and titanium dioxide (TiO_2) powder (99.5+ % and Size: 1 μm), were added to the basic material to make it stronger. The base material and the reinforced particles were procured from Asian Chemical Corporation in Chennai. The AA8026 aluminum alloy was utilized as a matrix material. For this investigation, several key process factors of the stir-casting technique were considered to optimize and fine-tune the synthesizing process (Rao, 2018). The statistical model and optimization were designed and carried out by using the Minitab-18 software.

3. Experimental procedure

When using stir casting, the base material and reinforced particles are essentially melted down as the reinforcement is not melted before being added (Rajesh et al., 2019; Rana et al., 2022 Jan 5; Rangrej et al., 2021). Hybrid composites were manufactured at a rapid pace using this method; a simplified illustration of the stir-casting procedure (Rao, 2018). Both the powders of the reinforced particles Zr_2O_3 and TiO_2 are subjected to preheating in the crucible with varying amounts of their respective weights (3 wt%, 6 wt%, 9 wt% and 12 wt%). The preheating process eliminates humidity that may have been present in the reinforced particles and enhances wettability; a crucible at a temperature of 600 °C for five hours was maintained in this study (Reddy et al., 2018; Sakthivelu et al., 2021; Senthil Kumar et al., 2019). With the assistance of a bottom pouring furnace, aluminium alloy AA8026 is maintained at a temperature of 750 °C. After that, the molten matrix material was mechanically stirred to generate a fine vortex in the melt. At a steady feed rate, the molten base materials are combined with the molten reinforced particles; in this case, a mixture of warmed Zr_2O_3/TiO_2 particles and an equivalent weight of flux (10 wt% of Zr_2O_3/TiO_2) was fed into a vortex. During the procedure, argon gas was added to the melt to create an inert environment. The mixture is stirred to obtain the complete standardised mixture of reinforcement elements in the base materials. The molten mixture was stirred before being poured into the heated permanent mould. Three distinct pouring temperatures were maintained while the melt's temperature was kept at an average of 860 °C. Castings with different weight percentages of Zr_2O_3/TiO_2 particles (3 wt% and 12 wt %) were taken. The detailed procedure for the casting process was explained by (Srivivas and Charoo, 2008) and they were observed in this fabrication process.

It is possible to optimize the stir casting process by adjusting the weight percentage of reinforced particles added, the stirring speed, and the amount of time the mixture is stirred. By adjusting the values of these variables, the stir-casting process can be optimized. By pouring molten material into a die of the desired dimensions, the required number and size of samples can be produced.

3.1. Test for wear characteristic

ASTM G99 defined the wear test specimen preparation, and the DUCOM model equipment performs the dry sliding wear test. The wear test specimens are 12 mm in diameter and 40 mm long, as shown in Fig. 1. The wear test starts after cleaning and weighing each specimen. Acetone was used to clean the spinning disc, and the weight difference was utilized to measure wear and mass loss. A computerized balance weighs materials after the abrasion test. The wear test involves holding specimens upright and contacting the rotating disk. The next step is to compute wear characteristics using sample beginning and ending weights.

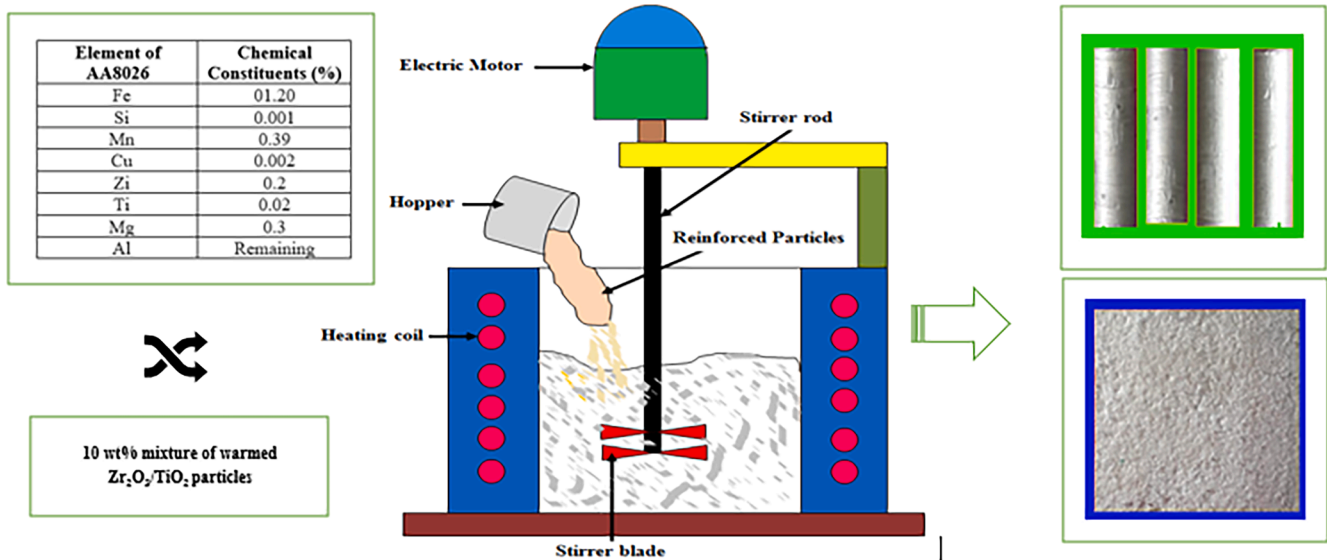


Fig. 1. An illustrative diagram of the stir casting process.

3.2. Microhardness test

In this experiment, the ASTM E384 requirements were properly followed to perform the microhardness test. This study uses a Vickers hardness machine for hardness analysis. All samples are cleaned before testing. After enough trial runs, each reading is averaged. Process parameters were varied at Four levels. Pouring temperatures (A) was 750 °C, 800 °C, 850 °C, and 900 °C; hybrid reinforcement amount (B) was 3 wt%, 6 wt%, 9 wt%, and 12 wt%; stirring duration (C) was 15 min, 20 min, 25 min, and 30 min; and stirrer speed (D) was 450 rpm, 500 rpm, 550 rpm, and 600 rpm. Table 1 shows the experimental design (L16 orthogonal array), microhardness, and wear rate.

4. Results and discussions

The observations were analysed in Taguchi analysis and the output of signal-to-noise ratios was presented for each run for the rate of Wear and microhardness. The minimal wear rate was calculated to be 0.086 mm³/m, and the associated values for each parameter are listed in Table 1. The lowest recorded wear rate was achieved at a 6 wt% reinforcement level, 450 rpm stirring speed, 20 min of stirring time, and 850 °C molten temperature.

As a result of performing an analysis on the microhardness, all of the parameters that were involved have been compiled into Table 1, where

it can be seen that the highest microhardness achieved was 180.2 HV. A higher microhardness value was accomplished by using a molten temperature of 750 °C, a stirring time of 25 min, a stirring speed of 500 rpm, and 12 wt% reinforcement.

Table 2 shows that stirring speed influenced the final product based on rank order and delta values. The temperature of the molten material has the most influence after reinforcing, followed by stirring time. According to Taguchi analysis, the best sample with a lowest wear rate of 0.086 mm³/m had 6 wt% reinforcement, 450 rpm stirring speed, 20 min of stirring, and 850°C molten temperature. When reinforcement was raised from 3 wt% to 6 wt%, the wear rate decreased, but when increased further, wear rate rose. After considering all aspects, 450 rpm and 20 min of stirring time had the lowest wear rates. Using molten temperature, 8500C has the lowest wear rate. This is 89.59 less than the sample generated at run number 12 parameters. (See Table 1).

In the microhardness investigation, stirring speed had the greatest influence, followed by reinforcing percentage, molten temperature, and stirring speed. Table 2 shows research outcomes. With 6 wt% reinforcement, 450 rpm stirring speed, 20 min stirring time, and 850 °C molten temperature, the wear rate was 0.086 mm³/m. See Fig. 2(b).

In the case of wear rate (WR), All of the contribution percentages were estimated using the F-value, and a higher F-value indicates that the parameter has the greatest possible contribution (Refer to Table 3).

Maximum microhardness values were recorded when the

Table 1
Wear rate and Microhardness observations of specimens as per Taguchi Design of Experiment L16 orthogonal array with S/N ratios results.

Index of Run	A	B	C	D	Rate of Wear (mm ³ /m)	Signal to Noise ratio	Microhardness (HV)	Signal to Noise ratio
1	3	450	15	750	0.231	12.72	90.3	39.10
2	3	500	20	800	0.382	8.357	124.9	41.92
3	3	550	25	850	0.298	10.51	145.3	43.24
4	3	600	30	900	0.599	4.45	136.8	42.72
5	6	450	20	850	0.086	21.31	73.8	37.36
6	6	500	15	900	0.392	8.13	133.7	42.52
7	6	550	30	750	0.689	3.23	168.4	44.52
8	6	600	25	800	0.623	4.11	175.6	44.89
9	9	450	25	900	0.394	8.09	85.5	38.63
10	9	500	30	850	0.612	4.26	158.3	43.99
11	9	550	15	800	0.734	2.68	136.9	42.73
12	9	600	20	750	0.826	1.66	174.3	44.82
13	12	450	30	800	0.651	3.72	165.8	44.39
14	12	500	25	750	0.765	2.32	180.2	45.11
15	12	550	20	900	0.474	6.48	142.1	43.05
16	12	600	15	850	0.396	8.04	156.3	43.87

Table 2
Taguchi Analysis Results of signal to noise ratio for Wear Observations.

Level of the Parameter	Wear rate				Microhardness			
	A	B	C	D	A	B	C	D
1	9.013	11.46	7.899	4.988	41.75	39.88	42.06	43.39
2	9.198	5.771	9.453	4.721	42.33	43.39	41.79	43.49
3	4.175	5.73	6.261	11.03	42.55	43.39	42.97	42.12
4	5.146	4.567	3.92	6.79	44.11	44.08	43.91	41.73
Delta	5.022	6.897	5.533	6.313	2.36	4.2	2.12	1.75
Rank	4	1	3	2	2	1	3	4
	Smaller is better				Larger is better			

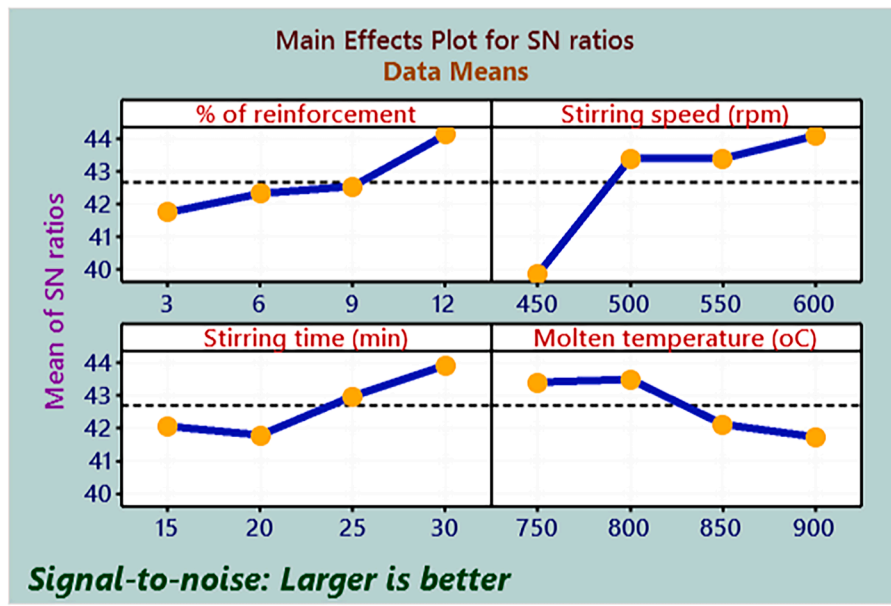
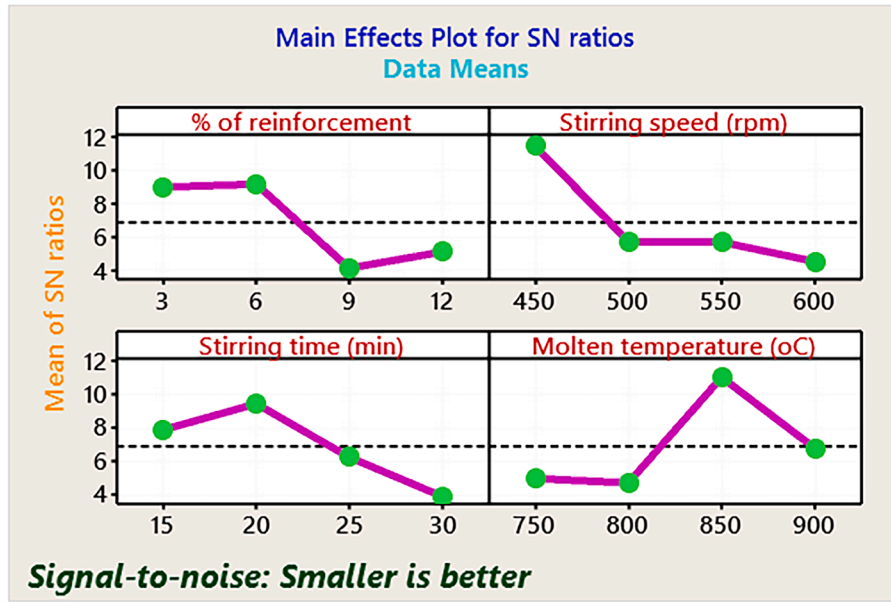


Fig. 2. Taguchi Output –Main effects plot for S/N ratio for the observations of a) wear analysis and b) Microhardness.

reinforcement level was increased to 12 wt%, the speed of the stirrer was increased to 600 rpm, and the period of stirring was increased to 30 min. When the molten temperature was increased from 750 °C to 800 °C, the result saw an increase in the microhardness values (Refer to Fig. 2b).

The prediction models were developed and presented in equation (1)

for wear rate and in equation (2) for microhardness.

Mathematical model to predict Wear rate.

$$\text{Wear rate (mm}^3\text{/m)} = 0.366 + (0.0259 \times A) + (0.001645 \times B) + (0.01353 \times C) - (0.001477 \times D) \tag{1}$$

Table 3
Result of ANOVA for wear observations.

Source		DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Regression	WR	4	0.45634	69.28 %	0.45634	0.11409	6.2	0.007
	μH	4	12,466	76.56 %	12,466	3116.5	8.98	0.002
A	WR	1	0.12044	18.28 %	0.12044	0.12044	6.55	0.027
	μH	1	2475	15.20 %	2475	2475.2	7.13	0.022
B	WR	1	0.1353	20.54 %	0.1353	0.1353	7.36	0.02
	μH	1	5755	35.34 %	5755	5754.7	16.59	0.002
C	WR	1	0.09153	13.90 %	0.09153	0.09153	4.98	0.047
	μH	1	2085	12.81 %	2085	2085	6.01	0.032
D	WR	1	0.10908	16.56 %	0.10908	0.10908	5.93	0.033
	μH	1	2151	13.21 %	2151	2151	6.2	0.03
Error	WR	11	0.20234	30.72 %	0.20234	0.01839		
	μH	11	3817	23.44 %	3817	347		
Total	WR	15	0.65869	100.00 %				
	μH	15	16,282	100.00 %				

Mathematical model to predict Microhardness.

$$\text{Microhardness (HV)} = 59.8 + (3.71 \times A) + (0.3393 \times B) + (2.042 \times C) - (0.2074 \times D) \quad (2)$$

From the ANOVA analysis, the stirring speed was highly contributed up to 20.54 %, followed by % of reinforcement (18.28 %), molten temperature (16.56 %) and stirring time (13.90 %).

Table 3 helps to identify the factors which significantly influence in alternation of wear rate property. If the p must be less than 0.05. such factors influence altering the wear rate property of the composite. Among the influencing factors, rapid tuning (if the F-value is high) and

fine-tuning (if the F-value is low) can be done depending on the F-value. For the microhardness observations, According to the findings of the ANOVA, the stirring speed was recorded as the highly influencing factor that had the greatest impact, accounting for 35.34 % of the total, followed by the % of reinforcement (15.20 %), molten temperature (13.21 %), and stirring time (12.81 %). The F-value was utilised in order to analyse on percentage of contribution of every factor (parameter); a higher F-value indicates a greater contribution from the parameter. The inputs for the optimization process minimum and maximum microhardness observed as per Taguchi’s experimental design of L16 were 73.81HV and 180.23 HV respectively. The inputs of minimum and

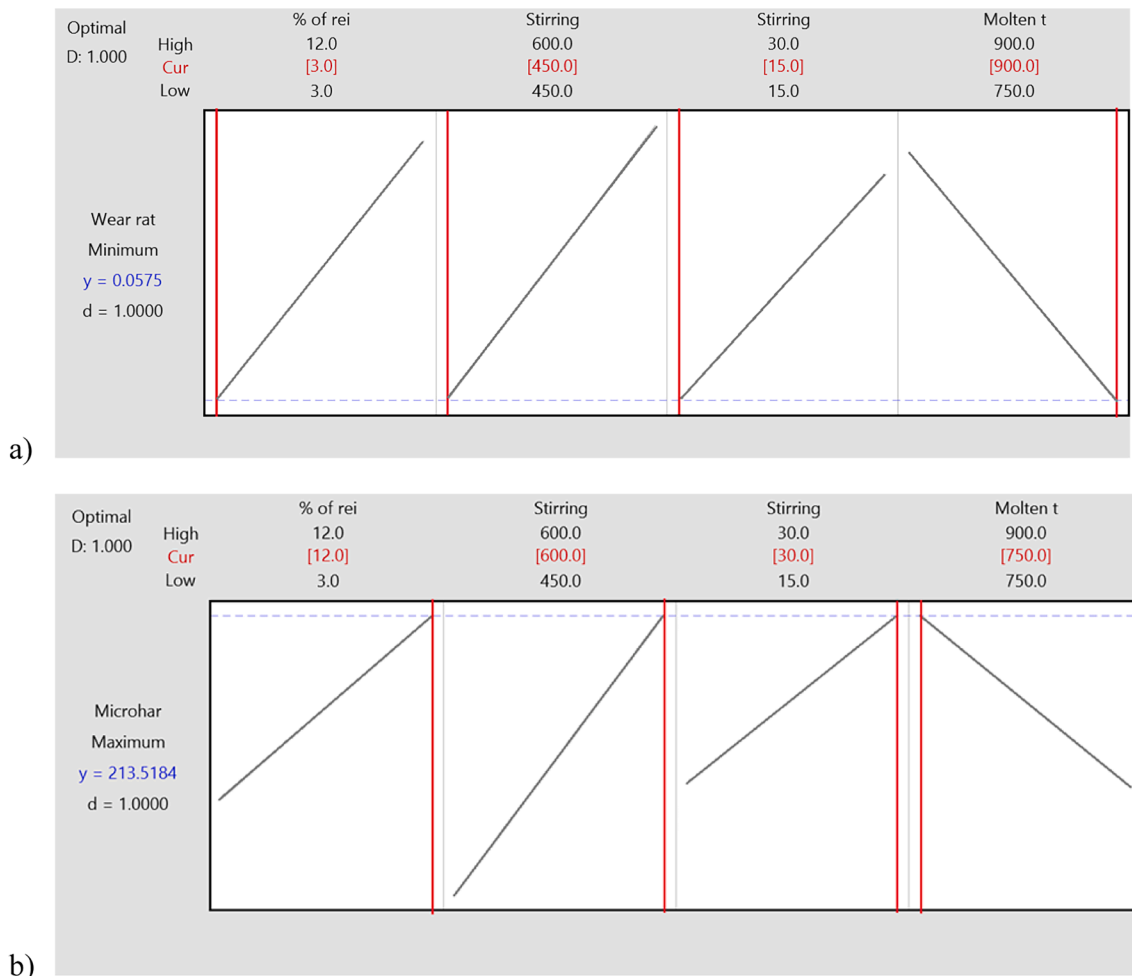


Fig. 3. Optimization plot for a) wear rate b) microhardness.

maximum Wear rates are 0.086 mm³/m and 0.086 mm³/m (Refer to Table 1). The optimized parameters for minimized wear rate 0.057475 mm³/m at the parameters settings of 3 wt% reinforcement quantity addition, speed of the Stirrer of 450 rpm, Stirring period of 15 min and temperature of Molten metal of 900 °C.

Fig. 3 is the optimal output obtained in the Taguchi analysis based on the regression equations (1) and equation (2). The optimization plot is presented in Fig. 3(a). Based on this plot, the 0.0575 mm³/m was recorded as a minimum wear rate. This was accomplished by using 3 wt % reinforcement, 450 rpm of stirring speed, 15 min of stirring time, and 900 °C of molten temperature. the maximum microhardness value, which was 213.52 HV. Maximum value of microhardness obtained by optimising parameters such as reinforcement percentage (12 wt%), stirring speed (600 rpm), stirring time (30 min), and molten temperature (750 °C).

Fig. 3 (b) depicts the optimization plot, and from this plot, we were able to determine the maximum microhardness value, which was 213.52 HV. Maximum value of microhardness obtained by optimising parameters such as reinforcement percentage (12 wt%), stirring speed (600 rpm), stirring time (30 min), and molten temperature (750 °C).

The minimal wear rate estimation parallel plot is shown in Fig. 4. The relationship between the percentage of reinforcement and the stirring speed is seen in Fig. 4(a). The correlation suggests that a combination of 9 % reinforcement and 500 rpm stirring speed yields the lowest wear rate. As can be seen in Fig. 4(b), the optimal combination of stirring speed (500 rpm) and stirring time (30 min) yielded the lowest wear rate.

Fig. 4(c) illustrates the relationships between stirring time and molten temperature by showing that the lowest wear rate occurred at 30 min of stirring time and an 850 °C molten temperature. Using a stirring temperature of 850 °C and the reinforcement percentage of 12 wt%, Fig. 4 (d) depicts the relationship between the molten metal temperature and the percentage of reinforcement.

Optimal conditions were identified from the experimented results (Table 2) based on the highest signal-to noise ratio (experimental run 5 in Table 1) is 6 % (high S/N ratio is 9.198) of reinforcement, 450 rpm (high S/N ratio is 11.464) of stirring speed, 20 min of stirring of time (high S/N ratio is 9.453), and 850 °C of molten temperature (high S/N ratio is 11.034) and achieved was 0.086 mm³/m (Table 1).

Fig. 3 furnishes the statistical optimization. The results of unexperimented trials within the research domain. The optimal conditions were further tuned to 3 % reinforcement, 450 rpm of stirring speed, 15 min of stirring time, and 900 °C of molten temperature to achieve further minimum wear of 0.0575 mm³/m. As the model R² value 96.88 % (>95 %) the predicted results are in good agreement with the experimented results and no need to conduct the confirmation run. Hence the recommended optimal conditions to obtain minimum wear is: 3 wt% reinforcement, 450 rpm of stirring speed, 15 min of stirring time, and 900 °C of molten temperature.

The correlation between the two factors yielded the highest hardness values shown in Fig. 5 as a heat map plot. Based on the relationship depicted in Fig. 5 (a), the optimal combination of reinforcement percentage and the stirring speed was 12 % reinforcement with 500 rpm.

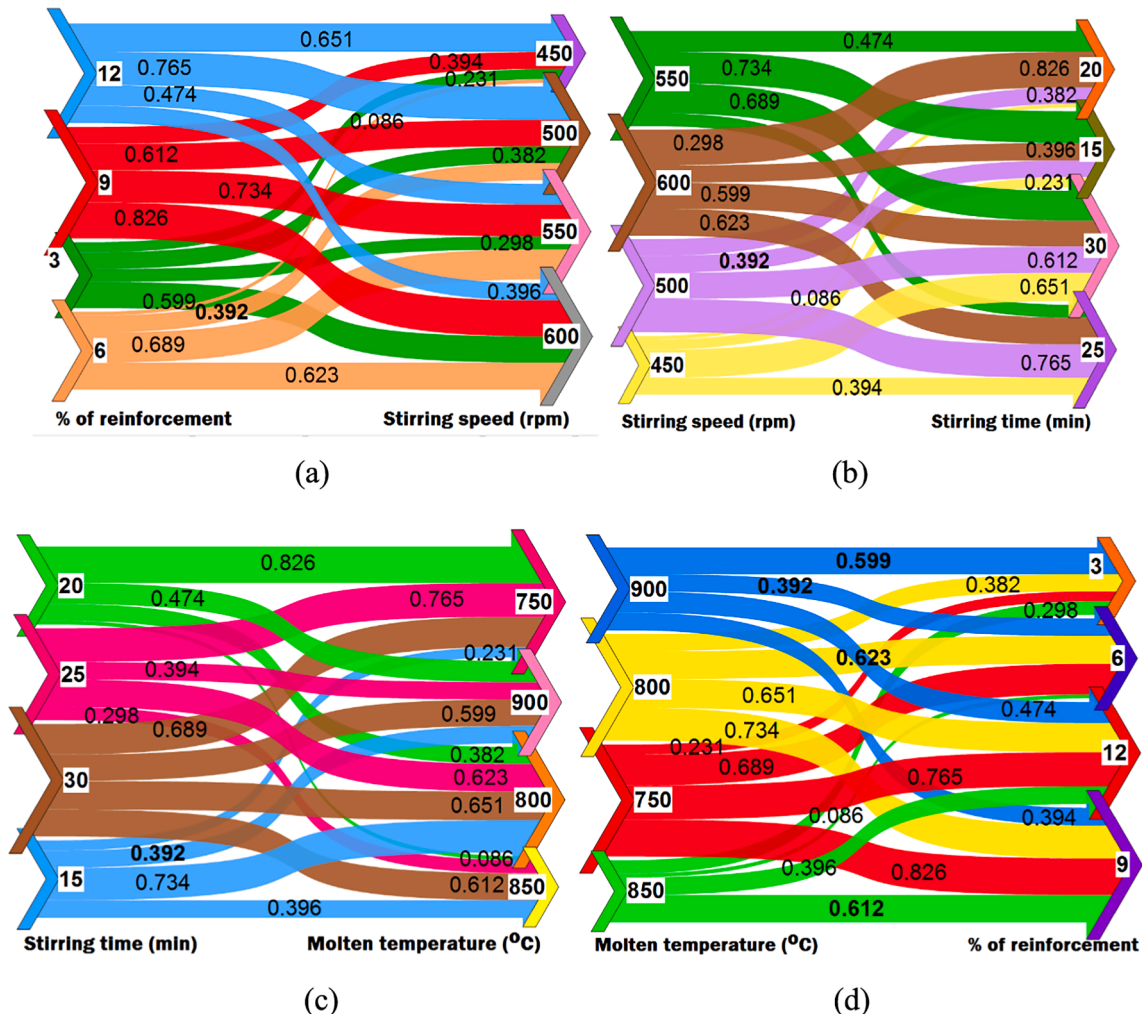


Fig. 4. Correlation between factors (a) A and B (b) C and D (c) B and D (d) A & D for altering the wear rate.

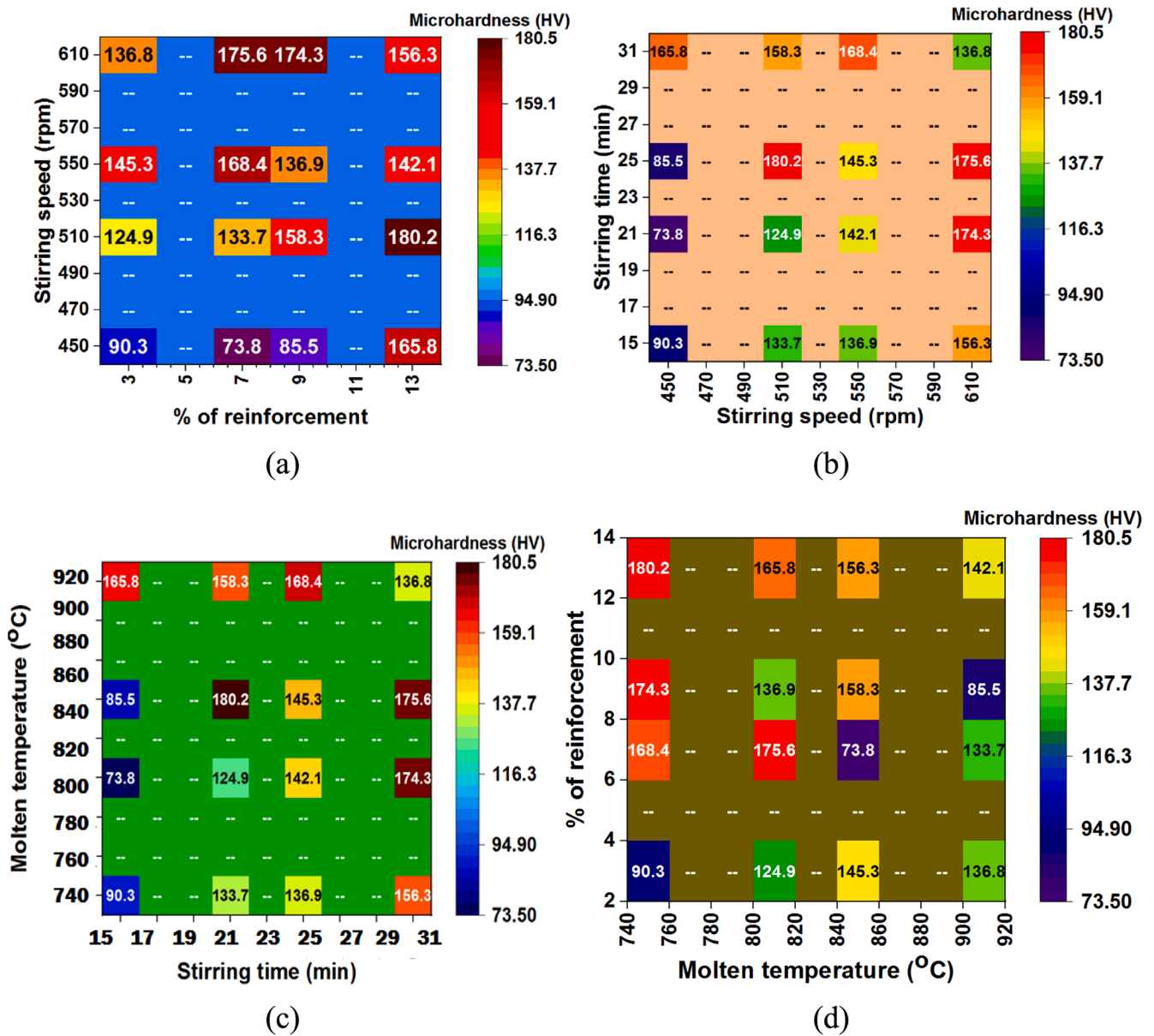


Fig. 5. Heat map plots:- Correlation between the Factors (a) A and B (b) C and D (c) B and D (d) A & D. for altering the microhardness.

Maximum microhardness was achieved at 500 rpm for 25 min of stirring (Fig. 5(b)), demonstrating the correlations between these two variables. Fig. 5(c) depicts the connections between stirring duration and molten temperature, revealing that 20 min of churning at 850 °C resulted in the highest microhardness. Using a stirring temperature of 750 °C and a reinforcement concentration of 12 wt%, Fig. 5(d) depicts the relationship between the molten metal temperature and the percentage of reinforcement.

Wear testing at a molten temperature of 850 °C for 20 min with a stirring speed of 450 rpm and a reinforcement density of 6 wt% yielded a minimal wear rate of 0.086 mm³/m (Table 1). Fig. 2 (b) shows the results of using 12 wt% reinforcement, 500 rpm of stirring speed, 25 min of stirring time, and 750 °C of molten temperature to obtain microhardness increases equal to 180.2 HV (Table 1). Based on the results of the experiments, the optimal casting conditions are as follows: 6 wt% reinforcement, 450 rpm stirring speed, 20 min of stirring time, and 850 °C molten temperature. For the microhardness test, the optimal stirring conditions were 12 wt% reinforcement, 600 rpm stirring speed, 30 min of stirring duration, and 800 °C molten temperatures. The wear rate was influenced by a combination of factors, including the minimum

stirring speed (contribution 20.54 % for microhardness), reinforcing (6 wt%), molten temperature (450 °C), and stirring time (20 min). Microhardness was determined by a combination of several variables, the largest of which was stirring speed (contribution 35.34 % for microhardness), followed by reinforcing, molten temperature, and stirring time. At 3 wt% reinforcement, 450 rpm stirring speed, 15 min of stirring time, and 900 °C molten temperature, the optimized wear rate was found to be 0.057 mm³/m (Fig. 5). With 12 wt% reinforcement, 600 rpm stir speed, 30 min of stir duration, and 750 °C molten temperature, the microhardness was raised to 213.52 HV (Fig. 3b).

5. Conclusion

Experimental confirmation that reinforcing AA8026 with varied percentages of Zirconium Oxide and Titanium dioxide and changing fabrication process parameters may affect its wear and micro-hardness was accomplished. Based on experimental data, Taguchi analysis optimized pouring temperature (molten temperature), stirring time, and other casting process parameters. These findings suggest the following.

With 6 wt% reinforcement, 450 rpm stirring speed, 20 min stirring

time, and 850 °C molten temperature, the wear rate was 0.086 mm³/m. Similar microhardness improvements of 180.2HV were achieved with 12 wt% reinforcement, 500 rpm stirring speed, 25 min stirring duration, and 750 °C molten temperature. The investigations demonstrate that 6 wt% reinforcement, 450 rpm stirring speed, 20 min stirring duration, and 850 °C molten temperature offer the optimum casting outcomes. Microhardness tests found that 12 wt% reinforcement, 600 rpm stirring speed, 30 min stirring duration, and 800 °C molten temperatures work well. After reinforcing, molten temperature, and stirring time, stirring speed caused 20.54 % of wear. Microhardness tests indicated that stirring speed (35.34 %) was most important, followed by reinforcement, molten temperature, and stirring duration. Optimization yielded a wear rate of 0.057 mm³/m at 3 wt% reinforcement, 450 rpm stirring speed, 15 min stirring time, and 900°C molten temperature. Microhardness increased to 213.52 HV with 12 wt% reinforcement, 600 rpm stir speed, 30 min stir, and 750 °C molten temperature.

The findings show that altering synthesis parameters may increase wear variability from 0.057 mm³/m to 0.826 mm³/m (1349 %) and surface microhardness from 73.8 HV to 213.52 HV (189 %). So surface quality may be modified within this range for many purposes.

CRedit authorship contribution statement

Ravi Kumar Saidala: Writing – original draft, Conceptualization. **Archana T:** Writing – original draft, Conceptualization. **Alias Paul:** Writing – review & editing, Investigation. **Naresh Kumar Reddy:** Writing – review & editing, Investigation. **T. Sathish:** Writing – review & editing, Supervision. **Abdullah A. Al-Kahtani:** Writing – review & editing, Funding acquisition. **Chander Prakash:** Writing – review & editing. **Mohd Shahzad:** Writing – review & editing, Data curation. **Satbir S. Sehgal:** Writing – review & editing. **Mohammad Yusuf:** Writing – review & editing, Validation, Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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