ABSTRACT

Researchers have focused on introducing metal manufacturing applications to improve their characteristics up to several extents. In the row, this study focused on which such analysis of the impacts of thermal behaviour with the Aluminium alloy Al2024. Though there are a lot of materials that exist in material science, one of the most applied materials has been identified as Aluminium alloys. Aluminium alloys often provide several advantages for different fields of applications. Hence, this study considered aluminium alloys as one of the study's critical materials. Aluminum alloy's history is so long, and it is nearly five decades old that the practitioners are started to use with the particular reference of both the emergence and the development of the concurrent aluminum alloys ensuring the performance which has been the critical and non-critical measures within the concern of spectrum. Hence, improving the performance of aluminum alloys becomes a never-ending story; several studies started to explore different perspectives within the concern of aluminum alloys.

The review of existing studies can make several conclusions in terms of the literature gap and inferences. This subsection highlights such an existing literature gap and its corresponding hypotheses. The existing literature mainly focused on the aluminium alloys characteristic analysis, including both mechanical and tribological, but primarily limited to temperature-based studies. Though several studies argued the significance of considering temperature treatment of Al alloys, those failed to analyze the established case of concern with the radiant-based structure. Hence, considering thermal treatment with compression testing under the optimization focus provides a new theory for science and literature. Further, it will strengthen the current findings of the earlier studies with the concern of temperature treatment on Al alloys.

With a solid background and review of existing studies, the major research objectives were included as, i) To identify the temperature impact in the

Al alloys, more specifically on Al2024, under different temperature settings. ii) To explore the relationships between the temperature treatment parameters and other properties of the Al2024, including mechanical and compression testing. iii) The optimization technique will deploy the Taguchi method with temperature, length, and cross-sectional area as the input process parameters and compressive strength with their corresponding SN ratios as output parameters to enhance the existing parameter.

To achieve the above considered objectives, this study used different material treatments to explore its impact on the machining performance of Al 2024 alloys. Three other temperature material treatment treatments were considered for this study, namely, Room temperature, Elevated temperature, and Cryogenic temperature. Four different sample specimens were used for investigation in this study. The length and diameter have been changed for every sample to understand the influence of dimension were on the performance of output parameters. Based on the input parameters, totally 9 different alternatives were considered for this study with different thickness, cross sectional area and compressive load.

The morphological behaviour analysis was conducted Under the microstructural characterization, Energy-dispersive X-ray spectroscopy (EDS), Scanning Electron Microscope (SEM), and X-ray Powder Diffraction (XRD). The proposed specimen has been employed under the different regarded as ratios of the Al2024 powder. The SEM images of the considered representative highlight the quantitative results of temperature-induced Al2024 powders, which shows the presence of the toughened mixes with appropriate ratios. The significant clusters can be evident from the SEM images of all considered mixed proportions. It is mainly due to the narrative nature of the crystalline components present in the subject. The temperature induction can be evident from the XRD analysis's peaks, indicating the significance of considering thermal impacts, especially with cryogenic temperature. The optical micrograph highlights the strengths of Al2024. However, there are no such reinforcements,

still the effect of Al2024, and the temperature can be evident all over the upper surface of the considered specimen. It is mainly due to the grain boundaries presented in different shapes, including dendrite and non-dendrite. Such conditions can be seen differently under different thermal conditions. This also highlights the temperature distribution and penetration pattern, which viciously impacts the Al2024 and alters its nature through homogenous distribution, in addition to analyzing the existing designs, which also examined the structural bonding with the impact of temperature induced Al2024, which clearly shows that the temperature impacted Al2024 has given solid structural bonding. For shedding some highlights, the examples of SEM images of temperature-induced Al2024 have been displayed in the thesis.

The mechanical behaviour of the considered samples provides various insights for different experimental methods. Considering the Charpy impact analysis, $A_1B_2C_2$ (12 mm thickness, 25.48 mm^2 cross sectional area and 18.60 kN compressive load) possesses a high percentage of yield stress as 98.25%, and the maximum pressure observed as 5.21 ksi is higher than all other considered mix ratios. Among the considered specimen tensile strength properties, $A_1B_2C_2$possesses a high yield strength of 352 Mpa with the ultimate power of453.6 Mpa. The hardness measurement among different considered specimens is observed through various trails in which the average concludes as 129.32, which is high in $A_1B_2C_2$. The plain fracture toughness for all the considered specimens can be concluded as high as 421 Mpa compared to all available specimen samples. The abrasive wear rate on temperature-induced Al2024, especially with $A_1B_2C_2$, has been observed as 0.2 gm/min, lower among all the considered variants.

From compression analysis, it was identified that among the considered nine process parameters combination, trial no 2, i.e., $A_1B_2C_2$, has been produced a high SN ratio; however, as discussed in the earlier sections, the more excellent SN ratio, the better-optimized results. Hence, with the temperature of -197ºC, length of 12 mm, and cross-sectional area of

25.48 mm^{2}resulted in an SN ratio of 25.1632 as considered as the optimized process parameters of the considered alternatives. On the other hand, A3B1C3 has recorded very more minor SN ratios as 23.1974; with this, it has been concluded that 400ºC of temperature, 18 mm of length, and 12.34 mm^2 cross-sectional area is the most minor considered process parameters for Al2024 applications.

Finally, this study provides several contributions: i) The scientific contributions of this study include bringing a new age solution with the impact of compressive test loading and the other essential properties of Al alloys with the specific focus of Al2024. In addition, it contributes to the science with the findings on different perspectives of temperature assessments. ii) In terms of theoretical contributions, this study provides and combines different approaches, including compression testing with the concern of temperature in addition to the optimization of the parameters with the assistance of the Taguchi method. It also contributes to the theory with a detailed literature review and various statistical reports of earlier published studies.