ABSTRACT

Aluminum Hybrid Metal Matrix Composite (Al-HMMC) is one of the advanced materials with specific and specialized industrial applications. They are used widely in automobile industries such as bearing sleeves, piston, etc. One of the primary processes of manufacturing these components is conventional machining. Machining parametric table offered by the manufacturer is more essential and does not provide recently developed materials. Hence the parameters for newer materials need to be optimized. Reinforcement enhances the stiffness, strength as well as the capacity for temperature resistance. It also lessens the density of MMC. To attain these properties, the choice relies on the kind of reinforcement. Due to the addition of reinforcements like silicon carbide (SiC) and graphite which are harder as well as stiffer than the matrix material, machining turns out to be most challenging when compared to typical conventional materials. A more significant majority of studies related to the machining of Al-MMCs directed attention to turning off the materials. Recent researches indicate that particulate reinforced Aluminum Hybrid Metal Matrix Composites (Al-HMMC) stand as one of the difficult to machining of the materials. Hence in this work, experimental studies were carried out for the optimal setting of machining parameters on the turning of Al HMMC. Henceforth, investigations that various parameters of Al HMMC are remarkably required. So that in this research work, Al 7075 based hybrid metal matrix composite is fabricated and tested conclusively. Then it is analyzed through the Taguchi method to study the various machining parameters.
In the present study, Al7075 alloy-based metal matrixes composite reinforced through blends of silicon carbide (SiC)(17%) and graphite(3%) particles and were fabricated by the stir-casting method. The mechanical properties, for instance, hardness, Tensile and Compressive strength were studied and measured on developed samples according to ASTM standards at room temperature. The magnitude of hardness increases naturally as the function of the volume fraction of the particle. The influences of SiCp and graphite reinforcement on tensile strength have been evaluated. The microstructure was also evaluated using SEM images. The results of hardness and tensile strength testing show that the reinforcement has increased the mechanical properties of the composite.

The next stage of research work shows the optimization of machining parameter by ANOVA. In modern manufacturing industries, CNC machines have been used to manufacture complicated shapes on advanced materials with high accuracy and precision. An adequate choice of machining parameters for the CNC turning mostly leans on the experience of the operator and the manufacturer’s guidelines for parametric choice decision making. Unfortunately, the optimized results for AL-HMMCs are not captured in these references and near contributions are needed to bridge this gap. Thus the current research aims at finding the optimum machining parameters of CNC turning center on AL-HNAMC to attain minimal quantities of the surface as well as elevate material removal rate (MRR). The parameters of cutting contemplated in the current experimental research include the cutting speed depth-of-art feed rate. The orthogonal array, known as Taguchi’s L27 was selected to carry out the experiments. The signal-to-noise quotients (SIN), as well as the analysis of variance(ANOVA), were employed in the examination of the impact of cutting parameters on the surface roughness as well as MRR. The establishment of the contribution of each parameter for cutting to surface roughness as well as MRR was made.
The investigation discusses the derivation of an optimum setting of machining process parameters, namely, cutting speed, feed rate and depth of cut to obtain the optimal values of cutting force and power consumption while machining of Al-HMMC reinforcement. In the course of machining the AL-HMMC reinforcement, the impact of the chosen process parameters of the optimum setting of the parameters was attained through the employment of Taguchi’s design approach. The examination of the outcomes reveals that the most advantageous setting for the minimal value of cutting force and lesser power consumption are cutting speed, feed rate, and depth-of-cut and keeping them at a lower level in the selected parameter levels. The confirmation test outcomes concur appropriately with the experimented predicted outcomes.

The next stage of research involves optimizing the process parameter to gain insights into their impact on the production quality by using Response Surface Methodology (RSM) with the least experimental effort. This experiment was attained through the employment of the design of experiments (DOT) technique as well as regression analysis. The integrated employment of these methods has permitted the creation of both the first as well as second order models that allowed the explanation of the variability related to each of the know-how variables. In this experimental study, cutting force (Fc), power consumption (P), Material Removal Rate (MRR) and surface roughness (Rs) have been contemplated in evaluating the machining performance as well as our annual parameters on the response. The magnitudes of the parameters mentioned above have been evaluated by computing the values of varies constants using MINITAB and the relevant experimental data. It is interesting to note the fall of the residuals on a straight line. The implication is that there is a normal distribution of errors while the regression model exhibits an acceptable fitting compared with the observed values. Finally, this thesis provides concluding remarks and illuminates the directions of future work.