Two sets of silicon carbide particulate reinforced Aluminium Metal Matrix Composites (Al 7075/SiC\textsubscript{p} MMCs) were fabricated through liquid metallurgy stir casting method, based on Taguchi L\textsubscript{9} design of experiments. One set of the MMCs was heat treated to T6 condition and the other set was kept in the as-cast condition. Influence of heat treatment, weight percentage of SiC particulates and their mean particle size on different properties (i.e. microstructural, physical and mechanical) of the MMCs was investigated. Optical micrographs revealed homogeneous dispersion of reinforcements in the matrix alloy with some local agglomerations. T6 condition of heat treatment reduced the particle agglomeration up to a considerable extent. Energy-dispersive X-ray (EDX) spectra show presence of highest percentage of Al, along with other elements like Si, Zn, Mg, C and O in the MMC samples. X-ray diffraction (XRD) patterns show three phases i.e. solid solution of aluminium (Al\textsubscript{SS}), SiC and Al\textsubscript{2}CuMg. Density and percentage of porosity in the composites increased with increase in weight percentage of SiC\textsubscript{p} reinforcement. T6 condition of heat treatment increased the microhardness, yield strength, ultimate tensile strength, compressive strength, impact strength and flexural strength of all the test samples, but reduced their ductility and maximum deflection. Increase of reinforcement content and reduction of their mean particle size improved the microhardness, compressive strength and impact strength of the composites, but reduced their ductility, flexural strength and maximum deflection. Linear regression models were developed for the mechanical properties of the heat treated MMCs, using least square method of regression analysis. High coefficients of determination (R\textsuperscript{2}) for the models indicated very good prediction of the responses. During multiple performance optimization of fabrication process parameters for mechanical properties of heat treated Al 7075/SiC\textsubscript{p} MMCs using Taguchi based grey relational analysis, the highest value of the mean grey relational grade was achieved for the MMC with mean SiC particle size 6.18 \(\mu\text{m}\) and 25 weight percentage of SiC\textsubscript{p} content. Analysis of Variance (ANOVA) results for grey relational grade revealed the mean size of SiC\textsubscript{p} was the more influencing process parameter than its weight percentage in the MMCs.
Machinability of the optimized MMC sample, i.e. Al 7075/25 wt.% SiC\textsubscript{p} (6.18 µm) MMC was then studied in terms of cutting temperature (T), arithmetic average of surface roughness (Ra) and tool flank wear (VBc) both in dry and Spray Impingement Cooling (SIC) environments. Chip morphology was studied during turning both in dry and SIC environments. Effects of machining process parameters, i.e. spindle speed (N), feed (f) and depth of cut (d) on the responses (i.e. T, Ra and VBc) were investigated and response surface models were developed during turning the MMC in SIC environment. Significance of the models was verified through Analysis of Variance (ANOVA). Finally, Taguchi based grey relational analysis was applied for multiple response optimization of the machining process parameters during turning the MMC in SIC environment. SIC environment reduced the values of T, Ra and VBc during turning the heat treated Al 7075/25 wt.% SiC\textsubscript{p} (6.18 µm) MMC. Response surface quadratic models were developed for T, Ra and VBc during turning the MMC in SIC environment. The adequacy and fitness of the models were confirmed from the high values of determination coefficient, R\textsuperscript{2} (close to 100%). High significance of the regression equations were confirmed through ANOVA. Grey relational analysis revealed that during turning the heat treated Al 7075/25 wt.% SiC\textsubscript{p} (6.18 µm) MMC in SIC environment, a combination of spindle speed, feed and depth of cut of 250 rpm, 0.05 mm/rev and 0.2 mm respectively, was the optimal combination of machining process parameters for the multiple performance characteristics, i.e. cutting temperature, arithmetic average of surface roughness and tool flank wear. From the confirmation test the improvement in grey relational grade was 50.61%. ANOVA results for grey relational grade revealed feed was the most significant machining process parameter followed by spindle speed and depth of cut.