ABSTRACT

Various types of stainless steel were classified on their crystalline structure with the addition of nickel content. Super duplex stainless steel, is one of the categorized metals with a high resistance to pitting corrosion and used in variety of industrial applications. Turning of this material was done in a medium machining process using CNMG uncoated cemented ceramic carbide inserts as cutting tool. This turning process was conducted in three different cutting conditions of dry, wet and gas cooled machining. The machining process parameters like feed rate, cutting speed and depth of cut were varied to determine the output response characteristics like surface roughness, tool flank wear, average cutting zone temperature and cutting force acted along x axis.

The present research work approaches to optimization of turning process parameters and the experiments were conducted according to Taguchi’s L18 orthogonal array. The process parameters level was chosen within the intervals recommended by the tool manufacturer and the investigation of the present study. Three process parameters at two and three levels led to total of 18 tests for turning operations. The measured output responses were analyzed using ANOVA (Analysis of Variance), optimized using RSM (Response Surface Methodology) and finally verified using NSGA-II (Non Dominated Sorting Genetic Algorithm). The percentage
contribution of various machining process parameters and their interactions on the output responses were presented. A regression analysis was carried out and RSM models were generated for dry, wet and gas cooled machining.

Gas cooled machining was found to be a best one while compared with the other methods. Using response surface methodology, the optimized values of machining process parameters for gas cooled machining are cutting speed = 100 m/min, feed rate = 0.06 mm/rev and depth of cut = 0.5303 mm. Also the predicted values of output responses are surface roughness = 1.0367 µm, tool flank wear = 0.0641 mm, average cutting zone temperature = 46.4795 °C and the force acting along x axis is 130.0426 N. The composite desirability is 0.98036.

The chips formed during all the experiments were collected separately and a detailed chip morphology study was carried out for all the three condition. It was found that, gas cooled machining gives the better machining performance when compared with the dry and wet conditions. Different machining surface microstructure was identified using SEM (Scanning Electron Microscope). Gas cooled machining changes the mode of chip formation and improves the chip tool interaction during machining. It reduces the chip reduction coefficient and the cutting strain and thereby reducing the operation time and energy loss which results in increased production rate.