ABSTRACT

Machine Tool industry is known as the mother industry of manufacturing industries. The metal cutting industry plays a vital part in machine working and fabrication that forms a significant industrial segment in India after the automotive industry. The increasing demand for Computer Numerical Control (CNC) machines has been aiding further growth of the machine tools market in India. Technavio's market research analyst has predicted the growth of the industry at a Compound Annual Growth Rate (CAGR) of 13 percent in India between the years 2016-20. According to 2014 World Machine Tool output and consumption survey by the Gardner Business Media, India ranks globally 13^{th} in the production of machine tools and it is the 10^{th} largest consumer. Aerospace, automotive and consumer durables are the industrial segments, where the demand for machine tools has grown rapidly in the last few years.

CNC machines are employed in many industries to enhance production with greater accuracy. CNC machine generally consists of computer-controlled servo-amplifiers, servomotors, spindle motor and various tooling. The electronic components within a CNC machine are particularly sensitive to the electrical supply to the machine. Absence of transients or noise in electrical supply is the critical need for CNC machine for its smooth and trouble-free operation. The accuracy of CNC machine depends upon the mechanical rigidity, servo drives, servomotors, CNC systems, feedback devices, power quality etc. The performance of electronic devices is directly related to the power quality level in a facility.

The machining processes considered in this research is turning. Keeping in view of the significance of the turning process, it is very

important to automate the process, find the optimum process parameters and to systematically investigate the process or product variables that influence product and power quality. In industries, the values of cutting parameters are randomly selected in limits of minimum and maximum values suggested by the machine tool manufactures.

This research work deals with experimental investigation and optimization of machining parameters for material removal rate, surface roughness and total harmonic current distortion in CNC Turning Centres. A mathematical model is developed to explain the variance in the dependent variable based on the values of the independent variable and it is analyzed using statistical simulation software MINITAB. Single objective optimization of machining process parameter was developed based on three popular statistical techniques using MINITAB statistical tool such as Taguchi Technique, Analysis of Variance (ANOVA) method and Response Surface Methodology. The results are analyzed for each combination of the cutting parameters which brings out the effects of cutting parameters on total harmonic distortion and machining performance. For optimization process, the cutting speed, feed and depth-of-cut were the parameters analyzed for eighteen different machining processes. Effect of these process parameters have been studied on two machining characteristics such as Material Removal Rate (MRR) and Surface Roughness (SR) and the power quality characteristics namely total harmonic distortion using Taguchi's design. The effect of machining/process parameters on material removal rate, surface roughness and total harmonic distortion was analyzed by S/N ratio and ANOVA analysis. The interaction study has been accomplished in experimentation using Response Surface Methodology (RSM). The optimal set of process parameters have been predicted and confirmed for each machining characteristics.

To overcome the problem in single response optimization of Taguchi method, the Grey-Taguchi method is proposed in this research for optimising the responses such as material removal rate, surface roughness and total harmonic distortion simultaneously in CNC Turning Centre.

Finally, this research work gives an optimal selection of cutting parameters of CNC Turning Centre in a distorted distribution system. The outcomes of this research work proved that there exists a substantial energy saving potential while adopting the optimization techniques in CNC machines. The use of optimization techniques can attain the consistent functioning of the machinery and confirm the process quality.