ABSTRACT

The machining industries are always looking for a process of machining which provides high quality, dimensional accuracy in the work piece, surface finish, high production rate, tool life and economy. The Computer Numerical Controlled (CNC) machines play a major role in modern machining industry to improve the product quality as well as productivity. Turning is the primary material removal process from the surface of a rotating cylindrical work piece.

Stainless steels are used in aerospace, automotive, marine applications and in the manufacture of surgical instruments, springs, valves, shafts, ball bearings, turbine equipments, petrochemical equipments etc, because of their resistant to corrosion, high temperature oxidation and maintenance of their mechanical properties over a wide range of temperature. Stainless steels are generally difficult to machine due to their high tensile strength, high ductility, superior work hardening rate, low thermal conductivity, and abrasive character. This combination of properties often results in high cutting forces, temperatures, and tool wear rates, as well as a susceptibility to notch wear, chip breaking difficulties, built up edge formation, and poor machined surface finish. A collection of papers related to this topic is there but little empirical studies have been conducted on the issue of responses. The most essential parameters which are affecting the quality of turning operation are cutting tool related parameters (tool geometry and tool material), work piece based parameters (composition, structure, strength and
hardness) and machining parameters (cutting speed, feed, depth of cut, wet cutting and dry cutting). Moreover, it is necessary to optimize the machining parameters to obtain an extended tool life and better productivity.

Most of the researchers concentrated on the effect of the tool geometry, performance of the different cutting fluids, the coating methods of the cutting tool, performance of the cubic boron nitride tool (CBN) and polycrystalline cubic boron nitride cutting tool (PCBN) on turning stainless steels. Moreover the researchers had conducted turning experiments with high cost tools like CBN and PCBN on stainless steels. Coating on cutting tool is important to achieve an essential improvement in tool performance with low cost. However the performance of the coated tools in CNC turning on stainless steels has received less attention. Limited researches were reported for turning stainless steels using different coated cutting tools.

This research work mainly focuses on optimization of machining parameters such as cutting speed, feed and depth of cut for turning in order to get better values of surface roughness (SR) and tool wear (TW) by different coated tools from the economical point of view. In the first stage of this research work, selection of the different coated tools for turning such as tools coated with TiCN/Al2O3, TiAlN, Ti(C, N, B), B-TiC, B-Al2O3 was made. Experiments were conducted on AISI316 and AISI410 in CNC turning under dry conditions with varying conditions. The work piece materials for all the trials were of diameter of 32 mm and machined length of 60 mm at different cutting conditions. Three factors and three levels were taken for this research work.
The second stage of this research work deals with the single response optimization of machining parameters for turning AISI316 and AISI410 with different coated tools using Taguchi Technique. Taguchi concept is that the product must be produced at optimal levels and with minimal variation in its functional characteristics. Hence, experiments were conducted as per the Taguchi’s L$_{27}$ orthogonal array. The confirmation experiment was conducted at the optimum settings for the entire coated tools to verify the response for turning AISI316 and AISI410. Confirmation test results proved that the determined optimum combinations of parameters satisfied the real requirements of CNC turning on with AISI316 and AISI410 different coated tools.

Taguchi method is a powerful tool for optimization and this method is limited to solve single response problems and the multi response problems received less attention. In this research work, one approach was proposed which transformed multi response optimization problems into a single response problem. This approach had the advantage of Taguchi method, grey relational analysis to form a robust and practical methodology in tackling multi response optimization problems. The grey relational analysis has been suitably modified for simultaneous optimization of mean and variance. After normalizing the signal to noise (S/N) ratio value, a grey relational grade is obtained to evaluate the multi responses. As a result, optimization of the multiple responses could be converted into optimization of a single relational grade.
In addition, a new approach namely Box Benken design (BBD) was used to build the model and predict the responses. This methodology not only reduced the cost and time, but also provided adequate information pertaining to the main and interaction effects with a limited attempt of experiments. The TiAIN coated cutting tool performed better than the other coated cutting tools during turning AISI316 and AISI410. The sliding wear occurred on the edge of the cutting tool during turning AISI316. The plastic deformations with abrasive wear on the cutting tool occurred during turning AISI410.