ABSTRACT

Today’s manufacturing environment is driven by competition which existed never before. Customers are demanding total solution to their needs and they want products of best quality at low prices. In turn, organizations are starting to improve the quality of their products. Quality and productivity improvement are more effective when they are integral part of the product and process development cycle. Throughout the world, companies are developing quality management systems like ISO 9001:2000 and invest money to improve the quality of their products. One of the critical requirements for the ISO 9001:2000 is to have adequate control over the process parameters and use of optimal conditions in machining operations.

During rolling operation, work rolls lose their initial shape and surface conditions. Work rolls used in hot rolling or cold rolling of steel show less wear but the roll surfaces lose their roughness and this influences the finished product as well. Work rolls periodically grind to the required surface finish while leaving the surface free of feed, chatter marks and surface irregularities.

Because of the increasing quality standards, special attention must be paid to the design of roll grinding processes. Besides the quality of the work rolls, the grinding process must be sufficient for economical requirements. The quality of the work rolls depends mainly on technological aspect, like the specification of the grinding wheel, dressing parameters,
material removal rate, cooling lubricants etc., which influence the surface roughness. In precision grinding operations, it is important to set the correct grinding machine parameters so as to produce parts of required quality. In order to reduce the cost and increase the production rate, the grinding machine must be set to operate within the shortest possible grinding cycle time.

Several efforts were made by various researchers to design a suitable model for grinding process such as, parameter optimization techniques, analytical and numerical approaches etc., Furthermore, intelligent approaches were also adopted by many researchers to optimize the grinding process conditions. In order to predict component behaviour during use or in control of the roll grinding process, it is necessary to quantify the surface roughness, which is one of the most critical quality constraints for the selection of grinding factors in process planning. From the literature survey, no work has been reported on optimization of roll grinding parameters considering the machining parameters with dressing mode. Further, it is also concluded that the multi-objective optimization on roll grinding by adopting the design of experiments methodology with artificial intelligence tools may increase the effectiveness of the approach. The aim of this research work is to study and design a roll grinding process to obtain required quality of the work rolls with higher productivity.

In this work, a statistical Taguchi approach and a back propagation neural network model were used to evaluate the effect of various parameters. These parameters are used to identify the optimal parameter setup values in grinding rough and finish work rolls to obtain a required surface roughness
consistently. A code is developed for this purpose, in which, the size of training and testing data is increased until desired prediction accuracy is obtained. The code also predicts the upper and lower estimates of surface roughness. Thus the prediction can be represented in the form of fuzzy number, which provides an idea about the error in a prediction and allows for fuzzy-based control of the process. The data filtration module incorporated in the code removes the spurious data.

In this approach, the optimization of complicated multiple performance characteristics such as surface roughness, grinding power required and material removal rate are transformed into the optimization of single Multi-Response Performance Index (MRPI). To optimize the multiple performance characteristics in the present study, the Taguchi method with fuzzy logic approach is used to determine the optimal machining parameters in work roll grinding.

Mathematical model has also been developed based on response surface methodology, which is an efficient statistical technique and also an attempt has been made to use the Genetic algorithm for the optimization of operating parameters for the roll grinding process. The proposed methodology of combined Taguchi approach and a back propagation neural network model overcome the problem on the collection of larger data for training the network by systematic procedure and require only minimum data collection for the selection of optimal cutting condition for obtaining a consistence surface roughness.
The multiple performance characteristics such as surface roughness, power required at wheel spindle and material removal rate also were improved through fuzzy logic with the Taguchi Method. Additionally, with the use of fuzzy model type, it is possible to take human knowledge into account that it is based on human experience.

From the application of response surface methodology, it is possible to predict the grinding power and the surface roughness before performing grinding operations. The grinding conditions satisfying constraints for industrial application can be selected very easily from the developed surface plots. The pareto-optimal conditions obtained may also give clear ideas to the decision maker for better operating conditions to achieve better results in work roll grinding process.