ABSTRACT

Grinding is one of the most important manufacturing process for high precision parts. Grinding force has a direct influence on grinding wheel wear, grinding temperature, the surface quality of the workpiece and the design of machine tool component. Also, the cutting force is proportional to the specific energy in grinding and this influences the performance and surface integrity of the workpiece. Hence the measurement of forces in grinding process is very important. In surface grinding, forces are measured using the dynamometer placed on the grinding table. But in cylindrical grinding the force measurement is a difficult process compared to other machining and surface grinding process, since the workpiece and the wheel are in motion. Also, the available force measurement methods are more suitable for research laboratory than for industrial application. In all these methods the modifications are done either in the workpiece or in the machine setup. Therefore, in this research work, a strain gauge based force measurement setup has been developed and it can be implemented in the industrial work without any major difficulty.

The detailed investigation was conducted in ANSYS to analyze and identify the region of strain in the stationery tailstock in cylindrical grinding due to grinding forces. It is observed from the ANSYS results that the elastic deformation is more in the area of conical portion of the dead center and it increases with an increase in the load. Using this result, the location to place
the strain gauge is identified and two wheatstone bridge circuits are constructed to measure the signals of the tangent and the normal component of grinding forces. The normal and tangential component of grinding forces are measured using the experimental setup. A hall effect sensor based current probe was used for measuring the grinding power of the spindle motor. The tangential component of grinding force is also derived from the measured grinding power. The tangential grinding force measured using the experimental setup is compared with the derived grinding power.

The grinding process being a quality defining finishing process, it is an important task to understand the effect of grinding parameters on the output variables (surface roughness, geometrical error and surface hardness) and the process variables (power, force and temperature). Therefore, in this research work, the experiments have been carried out to study the effect of selected process parameters (work speed, depth of cut and traverse feed) on the output variable (surface roughness) and the process variables (tangential and normal component of grinding forces). Grinding was performed using a full factorial design ($3^3$), each having a combination of different level of parameters. Based on the results it is found that the surface roughness and the grinding component forces are increasing with an increase in the depth of cut, the traverse feed and the work speed.

In a grinding process, it is an important task to select grinding parameters for achieving high grinding performance. The desired grinding parameters are selected by the use of the hand book or by experience. The selected grinding parameters may or may not give optimal performance. Now
a days, to select the appropriate grinding parameters, several mathematical
models based on statistical regression techniques or neural computing have
been used to establish the relationship between the grinding performance and
the grinding parameters. Then, objective functions with constraints are
formulated to solve the optimal grinding parameters using any one of the
optimization techniques. Furthermore, a large number of grinding
experiments have to be performed and analyzed in order to build the
mathematical models. In this research work, the desired grinding parameters
are achieved by employing the Taguchi method. The grinding parameters
namely work speed, depth of cut, traverse feed and the coolant flow rate are
varied to observe the effect on the surface roughness, variation of hardness,
tangential and normal component of grinding forces.

An orthogonal array (L_{27}), signal to noise ratio and the analysis of
variance (ANOVA) are employed to investigate the grinding characteristics of
En19 alloy steel using alumina wheel. Through this study, the optimal
combination of grinding parameters that affect the grinding performance are
determined. The main conclusion drawn from this study is that the depth of
cut is the most influencing and predominant factor on the surface roughness,
the surface harness and the grinding component forces followed by the
traverse feed and the work speed. The coolant flow rate considered for this
study is not significant to surface hardness and the grinding component forces
except the surface roughness.