CHAPTER-4

Conclusions and Contributions

4.1 Conclusions

This chapter presents the major conclusions of the present research work aimed to assess the applicability of Barkhausen Noise analysis technique in surface integrity analysis of electro-discharge machined component. It also provides the future scope for carrying out further studies in the present area.

Following salient conclusions may be drawn may drawn from the present experimental study:

- Material removal rate and tool wear rate increase with increase in electro-discharge machining process parameters while machining with three different tool materials under both the polarity conditions. Pulse on time influences the MRR and TW more significantly in comparison to current and voltage. Tool wear rate was lowest in case of copper-tungsten tool followed by graphite then copper tool owing to better wear resistant property of tungsten.
- Surface finish of electro-discharge machined component is poor due to formation of cracks and crater. Surface roughness variation was found from 2 μm to 12 μm with variation in process parameters. Copper tool with negative polarity resulted in highest surface roughness, on the other hand lowest surface roughness value was observed in case of copper-tungsten tool having positive polarity.
- Melting and evaporation of work material as part of material removal mechanism causes alternation in micro-structure. White layer thickness and depth of dark band gets affected by amount of spark energy indicating their dependency on process parameters.
- Micro-hardness along the depth of machined surface increases with increase in pulse on time, voltage and current. The highest micro-hardness was observed

around 1500 HV in case of copper-tungsten electrode with positive polarity of tool.

- Electro-discharges machining resulted induction of high tensile residual stress in the surface of machined component throughout the entire experimental domain. Although effect of variation of process parameters on induction of tensile residual stress could not be observed owing to peculiar nature of EDM process.
- Barkhausen Noise signal parameters namely; root mean square value and peak value were observed to decrease with increase in process parameters with all three tool material as well in both polarity conditions. Any correlation between Barkhausen Noise parameters and residual stress could not be observed. Barkhausen Noise parameters get influenced by changes in micro-structure, microhardness alteration and state and magnitude of residual stress. Despite simultaneous occurrence of microhardness variation, severe changes in micro-structure, poor surface finish and induction of high tensile residual stress upon electro-discharge machining, a linear correlation could be established between micro-hardness and Barkhausen Noise parameters.
- Regression models were developed among process parameters and machinability indices and surface integrity characteristics using ANOVA and main effect plots which may be helpful to predict the surface integrity at shop floor of manufacturing industries.

4.2 Major Contribution

- EDM of die steel (HCHCr) provided tensile residual stress with significant to substantial change in microstructure, formation of white layer, change in microhardness, incorporation of plastic deformation. Despite their simultaneous occurrence, non linear regression models with good correlation coefficients were obtained between surface roughness and process parameters.
- EDM of die steel (HCHCr) employing three different electrode and two polarity yielded tensile residual stress, with change in microstructure and variation in microhardness etc. Even then non linear correlation between

Barkhausen Noise parameters and microhardness has been achieved for die steel.

4.3 Scope of the future work

This experimental investigation provided quite useful information from the analysis of experimental data. However, there is scope for the extension in the current research.

- Effect of flushing pressure and different die-electric fluid on machinability indices and surface integrity may be analysed.
- Tool may be rotated to study the effect of rotation of tool at various speed as well hollow tools having different diameters to pass the die-electric fluid may also be attempted.
- Hysteresis loop parameters such as coercivity, permeability and remanance (It is the magnetic property of material and defines the residual magnetism remained inside the ferro-magnetic material after removal of external magnetic field. It is the intersection point of hysteresis loop with Y-axis (i.e. magnetization) also characterizes the material properties. These may also be attempted in place of Barkhausen Noise parameters to judge their applicability for assessment of surface integrity upon electro-discharge machining.