CHAPTER 8

CONCLUSION AND FURTHER IMPROVEMENT

The main objective of this research is to find out the optimized condition for machining the T90Mn2W50Cr45 cold tool steel with the EDM and the WEDM processes.

8.1 THE EDM PROCESS

The effect of process parameters (Pulse current, Pulse on Time and Pulse off Time) on response characteristics (Material Removal Rate, Surface Roughness, Electrode Wear and Rapidly Resolidified Layer Thickness) of the EDM are discussed in chapter 6 by the following methods:

- Effect of the process parameters on the responses and optimized condition of process parameters for individual responses are discussed by using the Response Surface methodology.

- From the experimental and predicted observations, optimized condition for the combination of process parameters is discussed.

- From the SEM analysis, optimized condition for the combination of process parameters is discussed.
The important conclusions in the EDM process are summarized as:

From the RSM technique, the minimum electrode wear is obtainable at the low value of Pulse on time (42 µs), low value of Pulse current (5A) and low Pulse off time (3 µs).

The Rapidly Resolidified Layer Thickness is minimized for the lower value of Pulse current and lower value of Pulse on time and the effect of Pulse off time is not significant. Hence it is observed that low Surface Roughness will improve the surface finish.

It is observed that for the higher value of Pulse current (15A), Material Removal Rate is 3.5mm³/min. But for the lower value of Pulse current and lower value of Pulse off time, the Material Removal Rate is moderately higher with a value of 2.78mm³/min which is more preferable, as this condition requires less input energy.

Surface Roughness value is low for the low values of Pulse current (5A) and low values of Pulse off time (3A).

From the analysis by the RSM technique, it is concluded that for the low value of Pulse current (5A), low value Pulse on time (42µs) and low value of Pulse off time (3µs), during the EDM process on T90Mn2W50Cr45 cold tool steel, the optimum condition of high material removal rate of 2.78mm³/min, low electrode wear rate of 1.96mg /min, low resolidified layer thickness of 14.05µm and hence low surface roughness of 3.39µm are obtained.

From Design Matrix, 20 experiments with different combination of Pulse current, Pulse on time and Pulse off time are conducted. Optimized condition for the EDM process is being found out in the experiment No.2 and
corresponding process parameters are Pulse current of 5A, Pulse on time of 42 μs and Pulse off time of 3 μs.

The experimental observations, predicted values and also from the SEM analysis, it is concluded that experiment No.2 and corresponding process parameters are the best combination (Pulse current of 5A, Pulse on time of 42 μs and Pulse off time of 3 μs) to minimize electrode wear and to achieve high material removal rate.

The application of desirability function based optimization approach has been proved to be effective and versatile in locating optimal machining condition subjecting to a defined responses (Material Removal Rate, Electrode Wear, Surface Roughness and Rapidly Resolidified Layer Thickness) value and machining input parameters. The obtained optimal settings shows 5.53, -1.8, 6.82 and 1.96 % as the percentage of relative error for Material Removal Rate, Electrode Wear, Rapidly Resolidified Layer Thickness and Surface Roughness, respectively.

8.2 THE WEDM PROCESS

For the same work material, T90Mn2W50Cr45 cold tool steel, the WEDM process is also performed. In the WEDM process, rod type of work piece material is cut using the wire electrode with the consideration of process parameters of Peak current, Pulse on time, Pulse off time and Wire tension. The resultant cutting surface is analysed for Material Removal Rate, Wire Wear Rate, Rapidly Resolidified Layer Thickness and Surface Roughness. Similar to the EDM process, the RSM technique is used to analyze the process parameters with selected number of experiments (31) as per the Design Matrix.
The important conclusions in the WEDM process are summarized as:

It is concluded that with the minimum value of Pulse off time (48µs) and for moderate Peak current value (170A), the Wire Wear Rate is minimum.

It is understood that the Rapidly Resolidified Layer Thickness will be moderate for the Peak current of moderate value and also for the moderate value of Pulse on time. Rapidly Resolidified Layer Thickness is 0.0740 µm for the Peak current of 170A and Pulse on time of 115µs.

Material Removal Rate tends to increase considerably with low value of Peak current, while at the maximum value of Pulse off time. It has an optimum value of 0.811mm³/min for the Pulse off time of 52µs and Peak current of 170A.

For the lower values of Peak current (170A) and for the lower values the Pulse off time (48µs), Surface Roughness is minimized as 1.17µm.

From design matrix, 31 experiments with different combination of Peak current, Pulse on time, Pulse off time and Wire tension are conducted. Optimized condition for the WEDM process is being found out in the experiment No.14 and corresponding process parameters are Peak current of 170A, Pulse on time of 120µs, Pulse off time of 48µs and Wire tension 6g. In the experiment No.14, Material Removal Rate is 0.811mm³/min which is maximum and Surface Roughness is 1.17µm which is minimum are the optimized responses.
From the experimental observations, predicted values and also the SEM analysis, it is concluded that experiment No.14 with the combination of parameters of Peak current of 170A, Pulse on time of 120μs, Pulse off time of 48μs and Wire tension 6g gives optimized response of maximum Material Removal Rate and minimum Surface Roughness.

Search-based optimization method making use of desirability functions has been used to find optimal input settings globally. The overall approach is first to convert each response into an individual desirability function that varies over the range. The desirability function based optimization approach has been proved to be effective and versatile in locating optimal machining conditions subjected to responses (Material Removal Rate, Wire Wear Rate and Rapidly Resolidified Layer Thickness) value and machining input process parameters. The obtained optimal settings show 6.53, -1.57, 10.9 and 3.93% as a percentage of relative errors for Material Removal Rate, Wire Wear Rate, Rapidly Resolidified Layer Thickness and Surface Roughness respectively.

8.3 SUGGESTIONS FOR FURTHER IMPROVEMENT

In this research work, with the new work piece material of T90Mn2W50Cr45 tool steel, experiments are conducted on both EDM and WEDM extensively with various process parameters and their effect on the responses like Material Removal Rate and Surface Roughness. For further improvement, use of T90Mn2W50Cr45 tool steel is further validated by considering more number of input process parameters like type dielectric fluid, flow rate and pressure of the dielectric fluid and their effect on the responses. Hence, alternative work piece material T90Mn2W50Cr45 tool steel for different industrial applications to replace the hot tool steel material can be investigated.