CHAPTER 9

CONCLUSIONS

9.1 MICROSTRUCTURE, HARDNESS AND DENSITY OF COMPOSITES

- AMCs and hybrid AMCs were successfully fabricated using the low cost Stir casting technique.

- Optical micrograph of composites shows a uniform distribution of reinforcement particles in the matrix.

- 356+9%B₄C Composite material has the highest hardness value among the 356 AMCs.

- 413+9% Fly ash Composite material has the highest hardness value among the 413 AMCs.

- Density of the composites decreases with the increase of weight percentage of reinforcements. The densities of the Fly Ash and Boron Carbide are less than the densities of aluminium alloys 356 and 413.

- Fly ash, an inexpensive resource material, may be introduced into the aluminum alloy to make a cost competitive composite with a slightly decreased density and a marginally increased hardness.
9.2 WEDM OF COMPOSITES

- WEDM experiments on AMCs were conducted using Taguchi Design of Experiments method and analyzed using Taguchi S/N ratio analysis and Grey relational analysis. Optimal parameters were selected and confirmation experiments were conducted.

- Gap voltage is the most significant parameter for MRR followed by pulse on time and pulse off time.

- MRR increases with increase in pulse on time and decreases with increase in gap voltage and pulse off time.

- Reinforcement percentage is the most significant parameter for SR but MRR is not affected by the type and weight percentages of reinforcement. The reason is WEDM can machine difficult-to-cut materials.

- SR is affected by the parameters reinforcement, gap voltage and the interactions of parameters with gap voltage.

- For roughing operations of WEDM S/N ratio optimum parameters of MRR can be used to obtain higher MRR, for finishing operations of WEDM S/N ratio optimum parameters of SR can be used to obtain minimum SR. When there is no roughing and finishing operations, Grey Relational Analysis optimum parameter can be used to obtain Maximum MRR and minimum SR simultaneously in one operation.

- The experimental results confirm that the proposed method in this study effectively improves machining performance of WEDM process.
• The confirmation experiment verifies that the proposed GRA method has the ability to find out the optimal process parameters with multiple quality characteristics.

• The WEDM process due to its ability to effectively machine difficult-to-machine materials and complex contours or fragile geometries has its own application area unmatched by other manufacturing processes.

• Aluminium alloy 413 + 9% Fly ash composite has good machinability and surface finish properties.

9.3 WEAR BEHAVIOUR OF COMPOSITES

• Wear behaviour studies on AMCs were done using Taguchi Design of Experiments method and analyzed using Taguchi S/N ratio analysis and Grey relational analysis. Optimal parameters were selected and confirmation experiments were conducted.

• Load is the most significant parameter for both the parameters specific wear rate and coefficient of friction.

• The specific wear rate decreases with decrease in Sliding Distance and Reinforcement and decreases with increase in Sliding Speed and Load.

• Load is the most significant parameter for minimum specific wear rate followed by sliding distance, reinforcement and sliding distance.
While comparing the matrixes, specific wear rate is better for 413 AMCs than 356 AMCs the high silicon content gives more wear resistance.

Worn pin surfaces were analyzed for finding the wear mechanisms, wear is due to metal deformation predominantly. The harder reinforcement resists the wear.

Taguchi’s experimental design method is used to obtain optimum parameter combination for minimization of wear rate and coefficient of friction successfully.

The confirmation experiment verifies that the proposed GRA method has the ability to find out the optimal process parameters with multiple quality characteristics.

Aluminium alloy 413 + 9% Fly ash composite has good wear resistance property and Aluminium alloy 413 + 3% boron carbide composite has low COF.

9.4 CONTRIBUTION TO THE RESEARCH

- Research work in WEDM of composites is minimal and has been done using Alumina and SiC as reinforcements in aluminium matrix. WEDM of AMCs with aluminium alloys 356, 413 as matrix materials and Fly Ash, Boron Carbide and hybrid of Fly Ash with Boron Carbide as reinforcement materials are the new contributions to the research.

- Enormous studies have been conducted on Wear behaviour of AMCs with Boron Carbide, Alumina, SiC, Fly Ash etc., as reinforcements. The new approach in this research work is conducting wear tests using Taguchi design of experiments
and analyzing using S/N ratio analysis for single objective optimization and Grey Relational Analysis for multiobjective optimization of Boron Carbide and Fly Ash reinforced AMCs and hybrid AMCs.

9.5 SCOPE FOR FURTHER RESEARCH

- Mathematical models can be developed for MRR, SR, SWR and COF.
- The experimental results can be analyzed using other optimization techniques.
- The effects of wire electrical discharge machining parameters on recast layer thickness can be studied.
- The effects of wire electrical discharge machining parameters such as wire tension, flushing pressure and wire diameter may also be studied.
- Solid lubricants can be added in the composites for enhanced wear properties.
- Wear behaviour studies can be conducted at high temperatures.
- The techniques used in this research work can also be tried for other machining processes.
- The aluminium matrix composites plates fabricated by stir casting can be used for performing other machining operations, such as drilling, milling etc.