CHAPTER 7

CONCLUSIONS

After an exhaustive study of SiC reinforced Al composites through upper bound, finite element methods and experimental method for the six various die profiles, the following conclusions have been arrived.

- It is observed that it is possible to obtain a dead metal zone size reduction by means of suitable design of the die geometry shape. This determines the reduction in friction encountered during the plastic deformation and extrusion load as well.

- It is concluded that during the extrusion of SiC /Al composite, the reinforced SiC particles moves in two ways. They flow either with the matrix material or move with an abrading action over the die surface.

- The SiC particles found in the outermost layer of the composite material may adhere to the die profile entrance and scratch the die surfaces thereby causing a higher frictional effect.

- Development of dead metal zone found to be in two sections as primary and secondary dead zone. Higher development of dead metal zone accompanying with greater frictional force causes the outer most layer of the billet into more severe deformation than the central part.
• Higher dead metal zone, adhering and agglomeration of SiC particles, development of scratches are concluded as potential constraint, when the SiC particle reinforced billet is forced into extrude.

• Uniform curvature effect right from starting to end of the cosine profile facilitates the homogeneous flow of MMC material with negligible effect of adhering and agglomeration of SiC particles and also minimizes the effect of scratching the die entrance and die profile surfaces. This uniform profile of the cosine die also nullifies the effect of dead metal zone.

• Benefit of cosine profile die over the rest of five different profiles is learnt from the metal flow analysis through the upper bound technique, finite element technique and the experimental study.

• It is realised that the cosine profile die is the most optimized die profile for the extrusion of SiC/Al 6061 composite with aforementioned volume fraction and particle size, because the results obtained for the six various die profiles from UBT, FEM and experimental methods have not incurred any significance deviations to each other.

Study of optimization conducted following Taguchi’s design of experiment technique to optimize the extrusion parameters of hot extrusion process draws the conclusions as follows

• L9 orthogonal array was selected using Taguchi’s method of experimental design for three process parameters like ram speed, initial billet temperature and friction between the die billet region with three levels as low, medium and high.
Experimental response values were analyzed with average response method. Average response graph revealed that the optimum level of extrusion process parameters were ram speed of 3 mm/min, initial billet temperature of 450°C and friction factor of 0.1 designated as A₁ B₃ C₁.

Predicted average response value for the recommended optimum level of process parameters to extrude SiC/Al composite was observed as 11.63 tons.

Analysis of variance (ANOVA) was also executed to determine the degree of significance of each parameter. ANOVA table revealed that the friction between the die billet regions has the highest significance followed by the billet temperature which has got second significance ranking. The effect of third parameter ram speed was felt as lesser impact than the rest of other parameters.

Result of confirmation test conducted to extrude the hot SiC/Al composite billet under the recommended optimum level of process parameters assures that the predicted response is very closer to the experimental one.

As an additional measure of analytical validation, recommended level of process parameters were substituted in the UBT mathematical model to determine the response value.

It has been concluded that the optimum response predicted from the average response method does not deviate much with the either the results of confirmation test or the response value calculated from the UBT model.