CHAPTER 6

CONCLUSION

In recent years, CAP studies have gained enormous attention amongst researchers to improve the engine cooling system performance. To understand the current scenario about CAP design, its related issues, an extensive review related to cooling airflow management and thermal management in a automotive underhood zone had been carried out. In this research, an attempt has been made to design the CAP with minimal blockages and reduced heat exchanger interaction effect with a focus on improving radiator heat rejection performance. The airflow distribution over radiator face is investigated in a simplified CAP model and at vehicle level. A new guideline is proposed to determine the blockage area in the upstream direction of radiator based on airflow distribution and heat rejection rate analysis. Further, a new methodology is proposed for positioning the condenser in cooling airflow path which does not disturb much the radiator thermal performance. Experimental investigation was also carried out on specific case to validate the CFD results.

The following conclusions were arrived based on the outcome of the research work

- The airflow non-uniformity obtained on a radiator face in a simplified CAP model indicated that horizontal and vertical blockage type offers least non-uniformity compared to side to side and side to center blockages, for the same mass flow rate of air. The obtained non-uniformity ranges between 0.36 to 0.48 for horizontal and vertical blockages where as 0.63 to 0.92 for side to side and side to center blockages.
However, at vehicle level study the airflow non-uniformity on radiator surface ranges between 0.30 to 0.45 for the considered operating conditions.

The results indicated that non-uniformity decreases the thermal performances by 30%, compared to baseline. However, till the non-uniformity of 0.5, the deterioration in thermal performance is 10% only.

The relation between airflow non-uniformity and reducing rate of heat rejection could be considered as exponential.

Based on the relationship between blockage area, airflow distribution and heat rejection a new guideline is proposed to predict the blockage area in the upstream direction of radiator to improve the thermal performance. It was observed that blockage area could be around 40% of the radiator frontal area and beyond, 40% blockage area both heat rejection rate and airflow distribution worsens further, for the considered operating condition.

A control unit mechanism has been developed to position the condenser in CAP, to choose the configuration 'obo' and 'obelo'. It has been shown that airflow through condenser increased and Top Tank Temperature decreased in 'obelo' configuration. Placing the heat exchanger in 'one below other' configuration instead of 'one behind other' improves the thermal performance of radiator, beyond the vehicle speed of 30 kmph. This method could be used to reduce heat exchanger interaction effect and by positioning heat exchanger in such a way that it does not disturb the adjacent heat exchanger.

It is concluded that designing the CAP with minimal blockage and proper positioning of heat exchanger (condenser unit) will improve the radiator performance which in turn improves the engine cooling system performance.