CHAPTER 9

CONCLUSIONS

Thermodynamic investigations on three stage ARC system using Eco-friendly refrigerants aims at finding an alternative refrigerant mixture for CFC and HCFC refrigerants which is Zeotropic in nature and fulfils the requirements of error free working of the system in the range of 173K (-100 °C) taking care of environmental friendly, exergic and energy efficiency aspects during its life cycle.

The performance and exergy analysis was done on three stage ARC system using four combinations of three component Zeotropic mixtures. The best performance of the system was identified using the comparison of system parameters like COP, compressor work input, refrigerating effect, exergy efficiency, efficiency defect, exergy lost at each component, compressor suction and discharge pressure and temperature at all the state points of the system. Mind provoking findings that lead the recommendations are given below for the reviewers as an essence of this experimental study.

The COP and exergic efficiency of the four out of five tests conducted using Zeotropic Mixture of R290 / R170 / R14 (Combination 1) with mass fractions 0.197:0.193:0.61, 0.227:0.193:0.58, 0.287:0.193:0.52 and 0.317:0.193:0.49 were 0.363 & 56.5%, 0.318 & 62.4%, 0.302 & 56.6% and 0.291 & 51.2% respectively. The requirement is higher COP with higher exergic efficiencies at very low evaporating temperature. Since the emphasis has been laid on COP and evaporating temperature, exergic efficiency has not
been given primary importance and hence the study concludes that the Zeotropic mixture of R290 / R170 / R14 of mass fraction 0.257:0.193:0.55 offering the COP of 0.260 at 179K with exergic efficiency of 62.8% can be used as an alternative refrigerant for three stage ARC system working at the temperature range of -94 °C.

The COP and exergic efficiency of the four out of five tests conducted using Zeotropic mixture of R290 / R23 / R14 (Combination 2) with mass fractions 0.158:0.346:0.496, 0.188:0.346:0.466, 0.248:0.346:0.406 and 0.278:0.346:0.376 were 0.311 & 29%, 0.286 & 35.5%, 0.277 & 37.6% and 0.263 & 34.1% respectively. The requirement is higher COP with higher exergic efficiencies at very low evaporating temperature. Since the emphasis has been laid on COP and evaporating temperature, exergic efficiency has not been given primary importance and hence the study concludes that the Zeotropic mixture of R290 / R23 / R14 of mass fraction 0.218:0.346:0.436 offering the COP of 0.257 at 176K with exergic efficiency of 54.5% can be used as an alternative refrigerant for three stage ARC system working at the temperature range of -97 °C.

The COP and exergic efficiency of the four out of five tests conducted using Zeotropic mixture of R404A / R170 / R14 (Combination 3) with mass fractions 0.47:0.135:0.395, 0.5:0.135:0.365, 0.56:0.135:0.305 and 0.59:0.135:0.275 were 0.379 & 33.7%, 0.317 & 42.1%, 0.284 & 32.9% and 0.278 & 26.2% respectively. The requirement is higher COP with higher exergic efficiencies at very low evaporating temperature. Since the emphasis has been laid on COP and evaporating temperature, exergic efficiency has not been given primary importance and hence the study concludes that the Zeotropic mixture of R404A / R170 / R14 of mass fraction 0.532:0.135:0.333 offering the COP of 0.274 at 176K with exergic efficiency of 43.1% can be used as an alternative refrigerant for three stage ARC system working at the temperature range of -97 °C.
The COP and exergic efficiency of the four out of five tests conducted using Zeotropic mixture of R1270 / R170 / R14 (Combination 4) with mass fractions 0.205:0.18:0.615, 0.235:0.18:0.585, 0.295:0.18:0.525 and 0.325:0.18:0.495 are 0.376 & 56%, 0.324 & 61.3%, 0.309 & 55.5% and 0.298 & 50.1% respectively. The requirement is higher COP with higher exergic efficiencies at very low evaporating temperature. Since the emphasis has been laid on COP and evaporating temperature, exergic efficiency has not been given primary importance and hence the study concludes that the Zeotropic mixture of R1270 / R170 / R14 of mass fraction 0.265:0.18:0.555 offering the COP of 0.263 at 183K with exergic efficiency of 60.4% can be used as an alternative refrigerant for three stage ARC system working at the temperature range of -90 °C.

The COP, exergic efficiency and evaporating temperature of the three combinations out of four best Zeotropic mixtures each from four combinations studied (R290 / R170 / R14 of mass fraction 0.257:0.193:0.55, R290 / R23 / R14 of mass fraction 0.218:0.346:0.436 and R1270 / R170 / R14 of mass fraction 0.265:0.18:0.555) are 0.260, 62.8% & 179K (-94 °C), 0.257, 54.5% & 176K (-97 °C) and 0.263, 60.4% & 183K (-90 °C) respectively. The requirement is higher COP with higher exergic efficiencies at very low evaporating temperature. Since the emphasis has been laid on COP and evaporating temperature, exergic efficiency has not been given primary importance and hence the study concludes that the Zeotropic mixture of R404A / R170 / R14 of mass fraction 0.532:0.135:0.333 offering the COP of 0.274 at 176K with exergic efficiency of 43.1% can be used as an alternative refrigerant for three stage ARC system working at the temperature range of -97 °C.