Abstract

Key words: Compression-absorption system, Working fluids, Absorber, Analysis, Experiments

Compression-absorption system, otherwise called as compression system with solution circuit, is an energy efficient system for high and medium temperature lift applications. Non-azeotropic mixtures are the working fluids used in this system. In this system capacity control can be achieved by varying the solution concentration only. However this system suffers from problems like liquid entry into compressor and the need for synchronization of the solution pump and the compressor. In this thesis the theoretical and experimental studies, carried out on single stage compression-absorption system, are presented.

Thermodynamic analyses have been carried out on single stage, two stage and double lift compression-absorption systems with R-22&E-181 working fluid pair. On the same basis comparative studies on the performance of the different working fluid pairs, R-22&E-181, R-22&NMP and R-134a&E-181 have also been carried out. These studies reveal that a single stage compression-absorption system with R-22&E-181 working fluid pair is suitable for the medium temperature lift application such as milk chilling and pasteurization. The second law analysis of this system is carried out, which shows that the major contribution to system irreversibility is due to the heat of mixing at absorber and the non-isentropic compression.

Studies show that the system performance depends very much upon the absorber performance and it is sensitive to any change in coolant temperature or coolant flow rate. Literature survey reveals that bubble type absorbers offer several advantages compared to falling film type absorbers. Hence analyses of vertical and horizontal bubble tube absorbers have been carried out. As expected, the horizontal absorber shows inferior performance compared to the vertical absorber. However, since horizontal absorber is easy to fabricate and it requires less space, it has been used in the experimental test-rig.

Each of the components of the single stage compression-absorption system has been designed, fabricated and assembled in the laboratory. The system has been charged with R-22&E-181 mixture. Experimental results have been obtained for different flow rates and inlet temperature of the coolant to the absorber, flow rates and inlet temperature of water to the

desorber and solution flow rate. The theoretical results have been validated with the experimental results.

The following conclusions have been drawn from theoretical and experimental studies of the single stage compression-absorption system.

- The compression absorption system yields better performance compared to the conventional vapour compression system when operated at higher pressures.
- Comparative thermodynamic analysis of single stage, two stage and double lift compression-absorptions shows that the single stage compression-absorption system is suitable for medium temperature lift applications.
- Comparative thermodynamic analysis of working fluid pairs like R-22&E-181, R-22&NMP and R-134a&E-181 show that R-22&E-181 fluid pair gives better performance than other two fluid pairs.
- Literature survey and our subsequent experimental studies show that proper care has to be taken to prevent entry of solution into compressor. This calls for proper design of the suction line and the use of separators between desorber and compressor.
- Since the operating conditions of the experimental test-rig are different from that of the standard compressor used in room air conditioners, overheating of the compressor is observed during the experimental studies. As a result, the system could not be run at higher absorber pressures (greater than 23bar). Though the problem of overheating is taken care by providing adequate compressor cooling, in actual system suitable compressors designed for the compression-absorption systems should be used to prevent overheating and to yield better efficiency..
- Cooling capacity of 1.3 kW and heating capacity of 2.075 kW with a combined COP of 2.12 have been obtained from the test-rig.
- Though the experimental results are found to match the theoretical results qualitatively, the performance of the experimental system is found to be lower than that of the theoretical predictions mainly due to the various heat losses from the system and non-ideal compression. System performance can be

improved significantly by using suitable compressors designed for higher pressure (around 30 bar) and with better insulation.