

This study focuses on improving the energy efficiency of energy conversion systems by developing and applying sophisticated optimization algorithms in their design and by improving the accuracy of component modelling. The system under investigation is vapour cooling system with high speed centrifugal compressor. The life-cycle energy costs of the system will also be studied and used as optimization criterion. The optimization methods will be adopted from computer science with modifications to this particular problem. The research work is divided into four phases: making the system model, developing the optimization algorithm, experimental validation of the model, and optimization itself.

With the means described in this research plan the optimization of energy conversion systems can be significantly improved. The optimization methods regularly applied involve one-factor-at-a-time studies usually at the design point. Clearly most energy conversion systems operate most of the time in off-design conditions. Thus the optimization should be done considering the probable distribution of loads and not just the design conditions. Another major problem is capturing the real behaviour of the objective function. It is most likely that the objective functions of such complex systems have multiple minima, and global minimum is very likely not found with the current methods.

There are also unsolved challenges in the component modelling, especially with the two-phase heat exchange in the condenser and evaporator. The problems involved in multistage centrifugal compressor performance prediction in vapour cooling system were satisfyingly solved in the applicant's doctoral thesis. The heat exchanger models development will be based on literature and previous experience. The models will be experimentally validated. The results of the experiments will be used to develop more reliable models.

The main goal of this study is to improve the optimization procedures of energy conversion systems, in particular refrigeration systems. The energy efficiency of refrigeration is of major importance in reducing the CO₂-emissions worldwide. The secondary goal is to demonstrate the superiority of centrifugal compressor with variable speed control over constant pressure ratio compressors in vapour cooling systems and to quantify the associated energy saving potential in order to justify the higher initial investment.