THERMODYNAMIC OPTIMIZATION OF REFRIGERATION SYSTEM USING AN ENTROPY GENERATION MINIMIZATION METHOD

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ABSTRACT

In this thesis, the concept of entropy generation minimization / exergy analysis has been applied to cascaded vapor compression refrigeration system, single effect vapor absorption refrigeration system, double effect vapor absorption refrigeration system and trigeneration system. The main emphasis of the thesis is to use the concept of entropy generation / exergy destruction analysis to determine the exergy destruction in each component of the system. The effect of change in generator temperature, absorber temperature, evaporator temperature, condenser temperature etc. has been studied. This can guide researchers, practicing engineers and designers in the evaluation of existing real systems and design of future systems. **Chapter 1** presents a detailed literature survey and concepts related to the entropy generation /exergy destruction analysis of refrigeration systems.

The concept of entropy generation minimization has been applied for refrigeration system where cooling effect is obtained at the expense of work input. For low temperature refrigeration, single stage refrigeration cycles are inadequate and hence cascaded refrigeration cycles are needed. Based on entropy generation minimization method, the optimal temperature ratios for cascaded refrigeration systems have been evaluated. In this analysis, only superheating and throttling losses of the cycle are considered since they are inherent to the ideal vapor compression refrigeration cycle. **Chapter 2** of this thesis incorporates the entropy generation minimization analysis of cascaded vapor compression refrigeration system.

An absorption refrigeration system can be powered by relatively low-grade energy source such as waste heat form industrial processes, solar heat and geothermal heat [Wu (1992),

Chen and Anderson (1995), and Wu (1998)]. The solution is heated in the generator (by hot water / steam available from solar collector) thereby generating the refrigerant vapor. This is then condensed and expanded as in V-C systems while the remaining weak solution (poor in refrigerant) leaving in the generator is returned through the pressure reducing valve to the absorber to absorb the refrigerant vapors coming from the evaporator. In the present thesis, the second law analysis of a single effect absorption refrigeration system is described. It shows the exergy destruction in each component of the vapor absorption system that operates on LiBr-H_2O. The total exergy destruction for the system that operates on NH_3-H_2O is also presented. Results can guide the evaluation of existing real absorption refrigerators and influence the design of future absorption refrigeration systems. **Chapter 3** of this thesis incorporates the second law analysis of single effect VAR system.

A double effect vapor absorption refrigeration system includes two single effect vapor absorption system. The heat released at Condenser1 (C1) and Absorber1 (A1) is rejected to Generator2 (G2). In the present thesis, the second law analysis of double effect absorption refrigeration system is also described. It shows the exergy destruction in each component of the double effect VAR system that operates on LiBr-H_2O. **Chapter 4** of this thesis incorporates the second law analysis of double effect VAR system.

A conceptual trigeneration system is proposed based on the conventional gas turbine cycle for the high temperature heat addition process while adopting the heat recovery steam generator for process heat and vapor absorption refrigeration for the cold production. The mass, energy, and exergy balance in each component of trigeneration are strictly applied, and the expression for first law efficiency, electrical to thermal energy ratio, second law efficiency, and for the exergy destruction in each component are presented. The effects for pressure ratio, turbine inlet temperature, percentage pressure drop, process heat pressure, and the evaporator (refrigeration) temperature are examined**. Chapter 5** of this thesis incorporates the second law analysis of trigeneration system.

The overall conclusions of the present work and recommendations for future research are given in **chapter 6**. The above investigations have been carried out systematically for improvement and optimization of the refrigeration systems and the results have been presented in the form of following chapters.

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