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Exergy Analysis of a Vapor Absorption Refrigeration System Using Carbon Dioxide as Refrigerant

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Abstract : Vapor absorption refrigeration systems can replace vapor compression systems in many applications as they can operate on a low-grade heat source and are environment-friendly. Widely used refrigerants such as CFCs and HFCs cause significant global warming. Natural refrigerants can be an alternative to them, among which carbon dioxide is promising for use in automotive air conditioning systems. Its inherent safety, ability to withstand high pressure and high heat transfer coefficient coupled with easy availability make it a likely choice for refrigerant. Various properties of the ionic liquid [bmim][PF_6], such as non-toxicity, stability over a wide temperature range and ability to dissolve gases like carbon dioxide, make it a suitable absorbent for a vapor absorption refrigeration system. In this paper, an absorption chiller consisting of a generator, condenser, evaporator and absorber was studied at an operating temperature of 70^oC. A thermodynamic model was set up using the Peng-Robinson equations of state to predict the behavior of the refrigerant and absorbent pair at different points in the system. A MATLAB code was used to obtain the values of enthalpy and entropy at selected points in the system. The exergy destruction in each component and exergetic coefficient of performance (ECOP) of the system were calculated by performing an exergy analysis based on the second law of thermodynamics. Graphs were plotted between varying operating conditions and the ECOP obtained in each case. The effect of every component on the ECOP was examined. The exergetic coefficient of performance was found to be lesser than the coefficient of performance based on the first law of thermodynamics.

Keywords : [bmim][PF_6] as absorbent, carbon dioxide as refrigerant, exergy analysis, Peng-Robinson equations of state, vapor absorption refrigeration
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