Thermodynamic Analysis of R134a-DMAc based Solar Powered Vapor Absorption Refrigeration System for Rural Cold Storage

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Abstract

This paper explains the thermodynamic analysis of a lab scale prototype of cold storage for agri-products that work on solar power. The design is based on absorption refrigeration system which consists of a pair of working fluid i.e R134a (1,1,1,2 Tetrafluoroethane) as a refrigerant whereas DMAc (Dimethylacetamide) as an absorbent. Basically, the compressor of a regular cooling system is replaced by a combination of generator, absorber and a small pump in the vapor absorber refrigeration system. In this system, the vapor refrigerant from the evaporator is absorbed in the weak solution coming from the generator through an expansion valve. Formed strong solution in the absorber, is pumped to the higher pressure generator where the solution boils due to the heat from solar collector. Furthermore, the heated refrigerant vapor from generator is condensed in the condenser by the rejecting heat. Proposed system, it has been designed for 1/3 tons of refrigeration to cool 37kgs of fruit and vegetable in one hours. All the required thermodynamic properties of the system such as temperature, enthalpy, concentration, mass flow rate and the thermal load of each component including generator heat by solar collector have been evaluated by mathematic modeling of the absorption system. The generator temperature is selected to be 80^{o}C (low temperature heat source), absorber temperature as 30^{o}C, sink temperature as 40^{o}C and the evaporator temperature as 5^{o}C. The Coefficient of performance (COP) of the absorption system was found to be 0.8. The system has been analyzed this system for various generator temperature, absorber temperature and evaporator heat load and found that with the increase of generator temperature COP of the system increases to a maximum and then decreases. Compared to the regular cooling systems the operation cost of the designed system is found to be lower.