A Review on Thermodynamic Analysis ofSingle Stage Water Absorption System

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ABSTRACT: Absorption refrigeration systems are the cooling systems that use heat as input for operation instead of electricity. This type of refrigeration system reduces the fossil fuel consumption, indirectly restricts the CO_2 emission to the atmosphere, and restricting at the same time the usage of toxic refrigerants. In this study,asystematic review on energetic analysis of single stage LiBr-H_20 absorption system has been done. First law of thermodynamics has been used by many researchers for performing analysis. The effect of exit temperature of generator, absorber, condenser and evaporator on COP, heat load, circulation ratio have been discussed. This paper presents the review of the past researches done in the similar fields.

KEYWORDS: Absorption refrigeration systems, LiBr-H_20 absorption system, EES code, generator temperature, absorber temperature, condenser temperature , evaporator temperature

I. INTRODUCTION

Absorption refrigerator is a chemically driven refrigeration system which uses an absorbent- refrigerant combination as the main working pair. In case of LiBr+water combo, LiBr solution works as absorbent whereas water works as refrigerant.

As working absorbent is an electrolyte solid in a solution form, higher concentration can lead to crystal formation which can block the pipes, hence it is needed to have a high pressure in the condenser and generator so that crystallization won't happen at the working temperatures.

A single effect vapour absorption system consists of a generator, an absorber, a condenser, an evaporator, a solution heat exchanger (SHE), a refrigerant heat exchanger (RHE), a solution expansion valve, a refrigerant expansion valve and a pump. Water enters the evaporator at low temperature and pressure. Here water is in vapour – liquid state. This water refrigerant absorbs heat from the substance to be chilled and gets fully evaporated. Then this water vapour enters the absorber section at constant pressure. Concentrated LiBr solution is present in absorber. Since water is highly soluble in LiBr solution, water vapour is absorbed through this concentrated solution making it dilute. In generator, heat is supplied to the solution. This heat is generally the waste heat. Water vaporises from the solution and moves to the condenser and the dilute LiBr+water solution becomes concentrated again and moves to the absorber. Condenser block is used as a device to condense the water vapour to liquid water. This can be done by passing normal cooling water or air flow. After condenser, a valve is places to decrease the pressure. Normally a heat exchanger is used between generator and absorber so that heat can be exchanged between dilute solution and concentrated solutions. Pump is used to move the dilute solution from absorber to the heat exchanger so that the required flow rate can be maintained.

II. LITERATURE REVIEW

Azhar et al. (2019) presented exergy analyses of lithium bromide-water based single to triple effect direct and indirect fired vapour absorption systems. The analysis carried out by various investigators on exergy of the absorption cycles have been discussed. To fill the gap in the knowledge on exergy destruction rate in the absorption system, optimization of the single to triple effect direct and indirect fired absorption cycles have been conducted for a wide range of operating conditions. **Mussati et al. (2019)** presented the effectiveness factor of each proposed heat exchanger considered as a model optimization variable which allows (if beneficial, according to the objective function to be minimized) its deletion from the optimal solution, therefore, helping us to determine the optimal configuration. **Singh et al. (2019)** presented computational intelligence is used to calculate the energy and exergy analysis of lithium bromide–water (LiBr-H_2O)-operated vapour absorption refrigeration system. An artificial neural network (ANN) is trained for predicting the thermodynamic properties of the solutions. **Cui et al. (2019)** presented an innovative cascade absorption refrigeration (CAR) system for recovering low-grade waste heat. Based on the simulation results, t energy, exergy and economic (3E) analyses of the cascade refrigeration system have been conducted. The analysis results show that there is a contradiction between economic performance and thermodynamic performance. **Konwar et al. (2019)** presented multi-objective optimization of the series and parallel flow type double effect absorption refrigeration systems. Genetic algorithm is used to find the optimal solutions and the Pareto-optimal fronts. First, a thermodynamic model is developed to simulate the double effect series and parallel flow configurations with water–lithium chloride and water–lithium bromide solution pairs. **Arshadet al. (2019)** presented analyzation and maximization of the performance of ARS using exergy efficiency instead of conventional coefficient of performance (COP) approach. Both the series and parallel flow configurations have been considered for the analysis and optimization. **Raghuwanshiet al. (2019)** presented observational relations for finding the attributes and execution of a solitary stage Lithium bromide - water (LiBr-H2O) vapor absorption refrigeration system. The fundamental heat and mass exchange conditions and suitable conditions depicting the thermodynamic properties of the working fluid at all thermodynamic states are assessed. **Dzino et al. (2019)** presented the influence of the heating source temperature on the energy efficiency of real single-stage cycles of a lithium bromide-water absorption refrigeration machine (LBWARM), lithium bromide absorption lowering thermal transformer (LBALTT) and lithium bromide absorption raising thermal transformer (LBARTT) depending on the magnitude of the degree of internal heat regeneration.**Setia et al. (2019)** presented the feasibility of implementing the Li-Br Absorption Chiller System to produce chilled water for cooling the ambient air before entering the gas turbine compressor utilizing chiller/precooler. **Yılmaz et al. (2019)** presented investigation on the effects of critical operational constraints on the operational domain of a double-effect lithium bromide/water absorption refrigeration system and its performance. These constraints were determined as the equivalence state of concentrations, the thermal unbalance between the system components of high-pressure condenser and low-pressure generator, freezing and crystallization risk of lithium bromide/water solution. **Mussati et al. (2018)** presented an optimal process configuration for double-effect water-lithium bromide absorption refrigeration systems with series flow – where the solution is first passed through the high-temperature generator – is obtained by minimization of the total annual cost for a required cooling capacity. **Assad et al. (2018)** presented a lithium bromide absorption chiller operated with a geothermal heat source that is thermodynamically analyzed. The focus ison the solution heat exchanger performance, in particular, the effect of geothermal heat source fluid temperature as well as mass flow rate on the absorption chiller coefficient of performance (COP). **Malinina et al. (2018)** presented the influence of changes in the average daily temperature and humidity on the efficiency of solar lithium bromide-water absorption cooling system working on solar energy for the purposes of conditioning and condensing moisture from the air. **Sabbagh et al. (2018)** presented an optimal control strategy to operate these systems. For the implementation of the optimum control a dynamic model to evaluate the system is developed and discretized and solved using the interior point optimization (IPOPT) solver. The cases studied where a step and a sinusoidal perturbation on the hot water inlet temperature. **Li et al. (2018)** presented a novel combined cooling and power system comprising a supercritical CO_2 (sCO_2) power cycle and a vapor absorption refrigeration cycle with lithium bromide as the working fluid. A comparative study is conducted between this system and the combined sCO_2/ammonia-water system to show its advantages and potential on the basis of the self-built thermodynamic simulation platform.

Salhiet al. (2018) presented a model of operation of an absorption chiller uses heat energy of geothermal sources in Algeria. The effectiveness of this machine in the field of refrigeration and air conditioning has been studied. The simulation at various temperatures of geothermal sources of Algeria is used. The couples (refrigerant / absorbent) used are (R600a-DMF), (R32-DMAC) and (R134a-DMETEG). The curves of (H, X, T) and activity coefficient in the part of the generator and the absorber based on vapour-liquid equilibrium are plotted, and secondly COP of the system has been calculated.**Mohtaram et al. (2018)** presented an absorption refrigeration cycle with the working fluid of water-lithium bromide. The needful energy for generator is supplied by the steam at 100°C and in one atmospheric pressure. The exergy analysis is conducted on the whole cycle and it is calculated based on the first and the second laws of thermodynamics. **Shahbounet al. (2018)** presented the improvement of the system is achieved by utilizing the potential kinetic energy of the ejector to enhance refrigeration efficiency. However, the first and the second law of thermodynamics are used to analyze the performance of a single-stage water-lithium bromide absorption refrigeration system (ARS), whereas some working parameters are varied. **Patel et al. (2017)** presented a thermodynamic evaluation of a small cooling LiCl-H2O vaporizer carrier for the influence of 1 TR primarily based on the initial and 2d rules. Mathematical modeling is based on the concept of thermodynamics, which is employed in the engineering of equation solver to use mathematics.

Kumar et al. (2017) presented thermodynamic analysis and cooling efficiency of the aqua-ammonia system. The mathematical model is derived from the thermodynamic theory of integrating all the most useful computational circuits. The cut-off temperature to activate the gadget is available at many temperatures. **Ramesh et al. (2017)** introduced the Absorption- Compression Cascade Refidgeation, which combines a VCR tool at a low temperature stage with a VAR machine in the overheating phase. CO_2, NH_3 and R134a were taken as refrigerants in the pressure phase and H_2O-LiBr refrigeration in the input phase.

III. CONCLUSION

In the proposed work, a comparative thermodynamic performance evaluation of single stage LiBr -Water vapour refrigeration system will be performed. The first Law of Thermodynamics is connected to a single stage Lithium Bromide-Water Vapor Absorption Refrigeration framework, and the execution examination of every part is determined through thermodynamic modelling on EES.First law of thermodynamics is additionally used to ascertain to assessment of mass flow rate and heat rate in every part of the framework. Estimated the thermodynamic properties and Energy transfer rate in every part of Vapor absorption refrigeration system, with the assistance of empirical relation.

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