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COMPARATIVE STUDY OF ABSORPTION REFRIGERATION SYSTEM USING LIBR-H_2O AND AQUA-AMMONIA AS ABSORBENT-REFRIGERANT PAIR

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ABSTRACT

This article presents comparative study of absorption refrigeration system using aqua-ammonia and LiBr-H_2O as absorbent-refrigerant pair. Effect of generator temperature on COP of both the systems are studied at condenser and absorber temperature of 50°C looking towards the Indian weather condition, evaporator temperature of 10°C for the thermal comfort application, and effectiveness of solution heat exchanger of 0.7.

keywords: *Absorption Refrigeration System, Aqua-Ammonia, Cop, Libr-H_2o.*

INTRODUCTION

Vapour compression refrigeration system uses high grade energy such as electricity. Some of the refrigerants which currently uses in vapour compression refrigeration cycle causes environmental issues. Researchers are working on absorption refrigeration system which uses low grade energy like solar energy, waste heat etc. However, absorption refrigeration system have lower COP as compared to vapour absorption refrigeration system. Therefore, researchers and engineers are working to improve the performance of the absorption refrigeration system. This section, presents the work of some researchers who have worked on absorption refrigeration system.

Absorption refrigeration system based on second law analysis was presented by Aphornratana and Eames [1]. A new method of calculation of entropy of LiBr solution was presented. Results obtained by their model was compared with results of literature. In terms of performance prediction, first priority was given to evaporator and second to the absorber. Solution circulation ratio ng parameters [2-5]. It was concluded that aqua-ammonia system mainly used for the refrigeration system and LiBr-H_2O system used for the comfort thermal system. Several studies were carried out to evaluate the performance of the system using $NH_3/LiNO_3$, $NH_3/LiNO_3+H_2O$, $NH_3/NaSCN$ and $H_2O/LiCl$ [6-10]. Geothermal energy has also potential to use in a combined absorption/compression refrigeration system [11]. R134a was used as refrigerant in compression system, while aqua-ammonia as absorbent-refrigerant pair in absorption system. Their results showed that present temperatures and low value of generator and evaporator temperatures. Kilic and Ipek [15] analyzed absorption refrigeration system with the use of solar energy with LiBr-AL_2O_3/Water nanofluid. Nano fluid is used to improve heat transfer rate. Flat plate solar collector was used to provide heat in the generator in their study. Highest COP was found as 0.86 at 0.1% concentration of nanoparticles at 85°C generator temperature.

Based on the literature, it can be observed that researchers and engineers are working on absorption refrigeration system, its performance improvement and their energy and exergy analysis. Several researchers have also worked to find different absorbent-refrigerant pair. But most suitable pair is aqua-ammonia and LiBr-H_2O. Hence, present study is concern with comparative study of LiBr-H_2O and aqua-ammonia absorption refrigeration system.

THEORETICAL MODEL OF ABSORPTION REFRIGERATION SYSTEM

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System description

Figure 1 illustrate schematic diagram of absorption refrigeration system. Vapour compression refrigeration system consist of compressor, LiBr-H_2O system, hence present study is carried out for the air conditioning application. Aqua-ammonia absorption refrigeration system requires rectifier additionally, which is placed after generator. It is not shown in Figure 1. Rectifier is not required in LiBr-H_2O absorption refrigeration system.

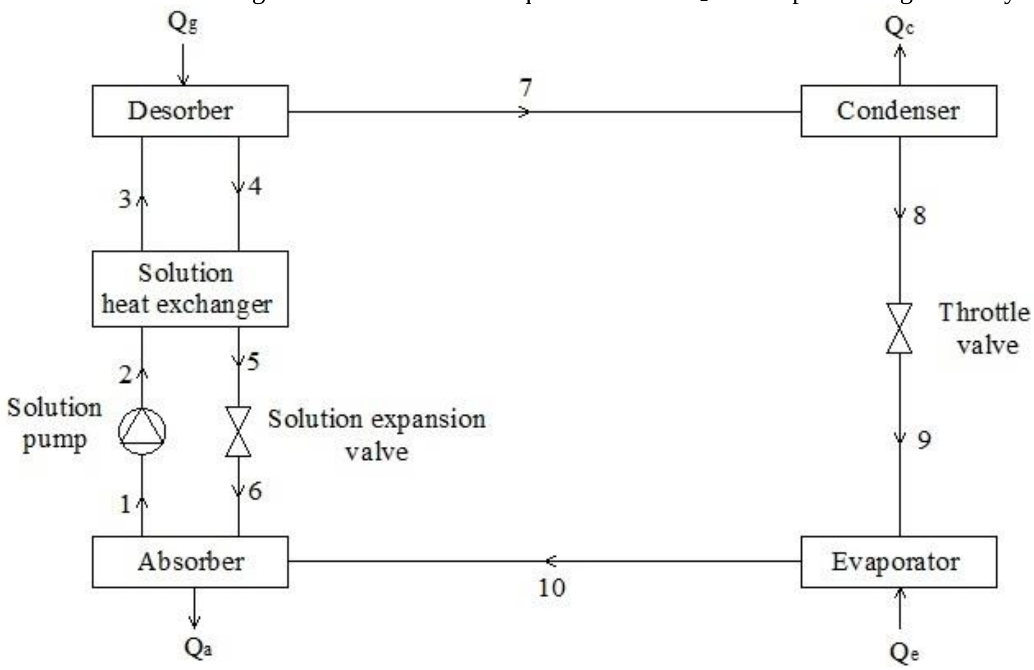

Figure 1 Schematic diagram of absorption refrigeration system

MODELING

This article presents study of 1 TR absorption refrigeration system using LiBr-H_2O as well as aqua-ammonia as working fluid pair. A complete mathematical model is prepared for the system. Present work is carried out to find COP of the system by considering following assumptions.

- The refrigerant leaving the condenser and evaporator is saturated at their respective temperatures.
- The rich and poor solution leaving the absorber and generator respectively at their respective temperatures.
- Pressure drop in the pipes and system components are neglected.
- Absorber temperature is same as that of condenser temperature.
- Refrigerant is pure vapour at outlet to rectifier in aqua-ammonia absorption refrigeration system.
- Solution pump efficiency is 100%.

A complete model is prepared using EES software [16] as per the state points mentioned in Figure 1. Following equation are used to find mass flow rates, energy balance and COP of the system.

Mass balance can be written as

$$\sum \dot{m} = 0$$

(1)

Refrigerant mass balance can be written as

$$\sum \dot{m}x = 0$$

(2)

Where, x is the ammonia mass fraction (kg/ kg solution)

Energy balance in condenser is given by

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$$q_c = \dot{m}_7 \left(h_7 - h_8\right)$$

(3)

Energy balance in throttle valve is given by

$$h_9 = h_8$$

(4)

Energy balance in evaporator is given by

$$q_e = \dot{m}_9 \left(h_{10} - h_9\right)$$

(5)

Energy balance in absorber is given by

$$q_a = \dot{m}_{10} h_{10} + \dot{m}_6 h_6 - \dot{m}_1 h_1$$

(6)

Energy balance in solution expansion valve is given by

$$h_6 = h_5$$

(7)

Energy balance in desorber/generator is given by

$$q_g = \dot{m}_4 h_4 + \dot{m}_7 h_7 - \dot{m}_3 h_3$$

(8)

Effectiveness of solution heat exchanger is given by

$$\varepsilon_{she} = \frac{T_4 - T_5}{T_4 - T_2}$$

(9)

Energy balance in solution heat exchanger is given by

$$\dot{m}_4 h_4 + \dot{m}_2 h_2 = \dot{m}_5 h_5 + \dot{m}_3 h_3$$

(10)

COP is calculated by using following equation

$$COP = \frac{q_e}{q_g + W_p}$$

(11)

RESULTS AND DISCUSSION

Present study deals with comparison of performance of LiBr-H_2O and aqua-ammonia absorption refrigeration system. Present study is carried out at condenser temperature of 50°C as per Indian weather condition and evaporator temperature of 10°C for the air conditioning application. Absorber temperature is considered same as that of condenser temperature. Effectiveness of solution heat exchanger is assumed as 0.7.

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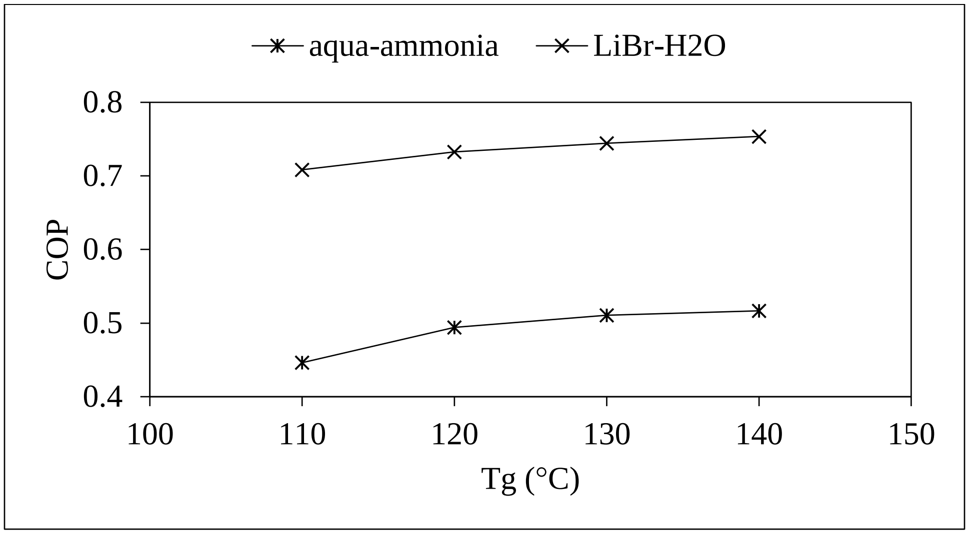

Figure 2 Variation of COP with generator temperature

Figure 2 shows the effect of generator temperature on COP of absorption refrigeration system with the use of LiBr-H_2O and aqua-ammonia as working fluid pair. It is observed that COP increases with the increase of generator temperature. For the same condenser and to aqua-ammonia absorption refrigeration system for all values of generator temperature at same all other operating parameters. It is also observed that with the increase of generator temperature, pump work reduces at same all other operating parameters.

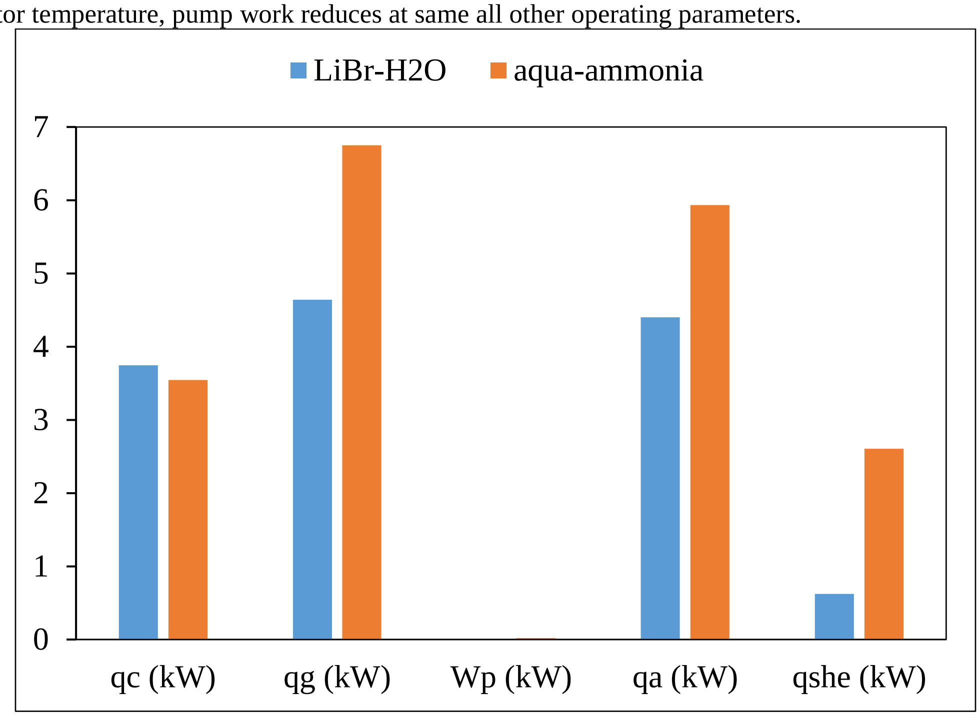

Figure 3 Comparison of LiBr-H_2O and aqua-ammonia absorption refrigeration system

Figure 3 shows comparison of different energy in LiBr-H_2O and aqua-ammonia absorption refrigeration system. Energy input to the LiBr-H_2O absorption refrigeration system is 2.109 kW lower as compared to aqua-ammonia absorption refrigeration system for the same all other operating parameters at 140°C generator temperature. It can

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be also seen that required pump work is very less for both the system, but for the LiBr-H_2O system it is very less compared to aqua-ammonia system.

CONCLUSIONS

Present study deals with comparative study of absorption refrigeration system using aqua-ammonia and LiBr-H_2O as absorbent-refrigerant also observed that LiBr-H_2O absorption system is better as compared to aqua-ammonia system in terms of COP. As well as energy input requirement in LiBr-H_2O system is lower as compared to aqua-ammonia system.

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