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Solution Concentration Influence on the Performance of a Diffusion Absorption Refrigeration System Using Different Refrigerant Blend

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Abstract

Diffusion absorption refrigeration technology is highly intriguing field of research in current times owing to its low or no power requirement. The diffusion absorption refrigeration system is operated by waste heat or renewable energy sources. Numerous studies worldwide have investigated various refrigerant blends to identify the best performing option, which exhibits the lower global warming potential and emits the fewest greenhouse gases. Generally, a diffusion absorption refrigeration (DAR) system operates with three fluids, namely water, helium and ammonia. The objective of this study is to investigate the performance of DAR systems using five alternative refrigerant combinations, aiming to replace conventional refrigerant blend, and to examine the influence of rich solution concentration. The refrigeration performance metrices, including cooling capacity, performance coefficient, heat supplied to the generator and exergy are estimated for various refrigerant blends. The results of this study reveals that the diffusion absorption refrigeration systems utilizing isobutane, dimethyl formamide, and helium mixtures achieve optimal performance at lower rich solution concentration compared to other refrigerant combinations.

Keywords: Diffusion absorption refrigeration; Solution concentration; Isobutane; Dimethyl formamide; Cooling capacity; Coefficient of performance.

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1. Introduction

Refrigeration has become essential for many chemical and processing industries to improve the standard, quality, precision, and efficiency of many manufacturing processes. Normally, the conventional type refrigeration system is a cost expensive, and certain harmful gases are emitted when using organic fluids. Thus, it is necessary to achieve a cost-friendly refrigeration system. In the last few decades, enormous advancements have been done in the refrigeration system for enhancing the energy efficiency rate and cooling performance of the refrigerator. The cooling effect is generated by exchanging heat from a region of low-temperature to a high-temperature level with the aid of mechanical work [1]. There are

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many methods of refrigeration, mechanical compression and vapor absorption technology are the globally adopted in the field of air conditioning and refrigeration, former requires large amount of power and the latter operated by heat. Mechanical parts present in the compression refrigeration system needs additional maintenance to augment the cost. Nowadays, absorption refrigeration run by waste heat or renewable energies is widely used in air conditioning and refrigeration purposes. Platen Munters developed the concept of diffusion absorption refrigeration (DAR) system in 1920 and patented in 1928 [2]. Recent times Diffusion absorption refrigeration (DAR) system is the most relevant research interest in the world. DAR system has no moving parts, hence quieter operation, not as much of maintenance and reliable and performed by ecofriendly refrigerants. DAR systems operated by triple fluids like water as absorbent, refrigerant is ammonia and hydrogen or helium as inert gas. The exceptional characteristic of this system is the addition of inert gas decreases the refrigerants partial pressure in the evaporator facilitating evaporation and enable cooling [3]. DAR system is completely operated by heat and not necessary for mechanical or electrical energy.

The major components in the DAR system are a generator, condenser, bubble pump, absorber, and an evaporator. The Diffusion absorption cycle operates by the use of three working fluids namely, absorbent, refrigerant, and auxiliary gas for pressure equalization and the whole system operate at a single level of pressure. In the conventional DAR system, the working fluids such as ammonia used as refrigerant, water as an absorbent, and the gases namely, hydrogen or helium, are used as an inert gas [4,5]. However, for safe working conditions, the inert gas used is helium as a substitute of hydrogen in the evaporator to improve the performance. The DAR system is a reliable and it is widely used in the hotel rooms as domestic usage [6]. The DAR system can be operated by using different conventional energy sources such as waste heat, LPG, electricity, and these characteristics make the system as beneficial. The least mass flow rate of the cycle and delivers reduced coefficient of performance due to the introduction of inert gas in to the evaporator is the demerit of the DAR cycle [7,8]. DAR water/ammonia blend functions relatively lower temperatures at the range of –10 to –30 °C, at the temperature for running is higher than 150 °C, although ammonia shows superior thermo-physical properties, and the demerits are corrosive to copper and other nonferrous metals, explosive and toxic in nature [9]. Performance coefficient obtained is higher about 40 % by using helium in place of hydrogen, because of less heat conductivity and clear hotness of helium foremost refrigerant integration and decreased the losses of the inner sections [10]. Augment the refrigeration capacity more than the household by optimizing the heat removal from a condenser and absorber, an optimum nominal cooling capacity of 108 W and the performance coefficient of 0.26, at the same time bubble pump receives the heat input of 300 W [11]. DAR systems operated by five variety of refrigerants (R134a, R32, R125, R22, and R124), DMAC as organic absorbent and helium as auxiliary gas was studied numerically [12]. Result unveils that the temperature of evaporation was larger values and lower value of COP attained in comparison with ammonia for various five refrigerants. Though the smaller value of generator temperature and condensation temperature were noted.

The paper discussed the various methods to uplift the performance and upcoming trends of diffusion absorption refrigeration system. The cooling performance was increased by the geometrical modification of the components in the diffusion absorption refrigeration system. Hybrid fluids and blends are utilized to augment the performance coefficient. In addition, the refrigeration capacity was enhanced in a diffusion absorption refrigeration system with addition of nano particles in a working fluid and using ionic working fluids. Meanwhile the researchers are concentrated to analyze the cooling performances including exergy analysis, performance coefficient, cooling effect etc. rather than lowering the consumption of energy and reduction in cost [13]. Parametric study of DAR system run by dimethyl formamide (DMF) as absorbent, binary refrigerant comprising R134a and R23 and the auxiliary gas is helium to analyze the optimum COP conditions, then COP obtained was smaller values in comparison with ammonia- water mixture [14]. Numerical analysis of DAR system operated by tetra ethylene glycol dimethyl ether (TEGDME) as absorbent and 2-2-2 trifluoroethanol (TFE) is refrigerant and the outcome obtained was 0.45 performance coefficient at the temperature of generator 170 °C [15]. Experimental study of DAR system with less GWP refrigerants comprising R1234ze with the absorbent DMAC and iso-octane as absorbent with the natural refrigerant R600a and the outcome reveals that 0.134 optimum COP attained in R1234ze/DMAC and in R600a/iso-octane Performance coefficient reported was 0.157 [16]. Chloro fluro and hydro fluro carbon refrigerants are largely used in DAR systems in the current years because of their superior physical, thermodynamic properties and non-corrosive properties [17]. Recent study reveals that the utilization of these fluids damage to the environment. Munshi *et al.* [18] numerically studied the influence of hydromagnetic mixed convection two-dimensional flow run by double lid square cavity with elliptic heated block inside. The paper demonstrated the buoyancy ratios, Renolds number, and Grashof number on the local values. The outcome unveils that lid direction and various elliptic heated block are highly effective on mass and heat transfer on fluid flow with uplifting magnetic field for all parameters observed.

The irregular load causes harmonic deformation at the AC input side and not ecofriendly and climate are the hurts of conventional air conditioning system. To simplify these inadequacies conventional air conditioning system is powered by solar energy instead of single-phase ac supply. The primary need for an air conditioning system are dc-dc convertor and battery during night hours due to the unavailability of solar energy. In addition, there is no battery is needed during daytime, the air conditioning system is run by ac supply. The air conditioning system of 1.5 tons capacity run by solar energy was designed by Simulink and analyzes the different constraints speed and torque. The outcome unveil that the air conditioner performs better in spite of difference in solar irradiations [19]. The effect of Dufour number and heat generation parameter of magneto hydrodynamic (MHD) was studied and analyzed the natural convection flow of an incompressible electrically conducting viscous fluid on the inclined plate implanted in a porous medium. The effect of the parameters mass diffusion on varying temperature are estimated by mass and energy balance and obtained the concentration, temperature and velocity [20]. Ahmad *et al.* [21] analyzes the energy of vapor absorption refrigeration system performed by two fluid combinations lithium chloride-water and lithium bromide-water under various running climate conditions. The performance constraints like solution concentration, heat load and performance coefficient at various parts and maximum temperature of the generator was estimated for the two systems. The outcome unveil that the lithium chloride-water mixture shows optimum COP in the range of 0.809-0.906 and lithium bromide- water exhibited in the range of 0.741-0.902. The least heat load at the generator was 370.787 kW for lithium chloride-water and 382.0573kW for lithium bromide-water blend. The paper outcome is that the Lithium chloride-water system shows least heat load of generator and greater COP in comparison with Lithium bromide-water system. The novel combined absorption-adsorption cooling system (ABC-ADC) has studied and estimate the performances in a different working condition. The results shows that the cooling capacity of the ABC-ADC system (25.5 kW) was higher than that of ADC and ABC by 177 and 16.8 % at the temperature of heat source of 75 °C and the performance coefficient reported was 0.644, 0.36, and 0.69. The effect of mass flow rate was significant influence in the performance. The ABC-ADC system works efficiently with low-grade heat and made better performance compared to the previous literatures [22].

Current times large amount of waste heat expelled from power plants and industries results polluted environment. The protection of the energy and nature is promoted by the utilization of recovery of waste heat. Choi *et al.* [23] developed the commercial DAR systems run by heat energy and the refrigerant is ammonia. Generally commercial DAR systems are made by carbon steel in place of copper because ammonia reacts with copper. The study encourages copper absorber, low global warming potential refrigerant R 600a was used to modify the performance coefficient. Absorber and bubble pump are constructed by copper to augment the rate of heat transfer. Experimental study was conducted to concentrate on how the absorber performance and the effectiveness deviated in comparison with copper and carbon steel used to make the absorber. Absorber effectiveness was modified by 9.05 – 35.71 % by using copper as absorber material instead of carbon steel. Performance coefficient attained was 0.2, with least value of temperature of generator was 71.07 °C. Conventional refrigerant blends have some issues to nature such as toxicity, global warming and depletion of ozone layer. Valiyandi *et al.* [24], in their paper recommends ecofriendly DAR cycle from various six substitute refrigerant combinations. Mass flow rate, cooling effect, refrigeration capacity, heat supplied to generator, performance coefficient, and exergy analysis are estimated at various temperatures of the evaporator. The optimum refrigerant combination was obtained by Haris hawk Optimization (HHO). Validation was done by Elman recurrent neural network- based HHO methods. Isobutane – dimethylformamide – helium combination DAR systems perform optimum performance.

Mansouri *et al.* [25] conducted experimental and numerical work on commercial DAR systems of low capacity run by varying input temperatures in standing mode. Power of 46 W is utilized to run the system at a temperature of the generator was 167 °C, the system performs at best and the performance coefficient attained was 0.159. In addition, numerical simulation of the DAR system was done by a model made by the marketable Aspen-Plus flow sheeting program. Validation of the model was done by comparing the model predictions with experiment data obtained for three varying heat addition rates of generator are 46 W, 56 W, and 67 W. Zebbar *et al*. [26] conducted a work devoted to the analytical and thermodynamic investigation of DAR plants (diffusion, absorption, and refrigeration). Investigation of the mass and energy stabilities at the evaporator has made it possible to identify a novel and unique parameter that can be utilized to evaluate the performance of DAR systems at the evaporator inlets, it is the ratio of inert gas mass flow rate to refrigerant vapor mass flow rate. The quality and performance of the cycle, which are greatly affected by the rise in the inert gas flow energy needed to force the refrigerant through the evaporator, are shown by this coefficient, whose expression has been calculated theoretically for the first time. The investigation demonstrates that when the mass flow rate ratio increases, the coefficient of performance decreases. Semi- empirical model of solar operated DAR systems performed by ammonia- water-hydrogen was developed and implemented in village areas of India and to forecast the performance by considering dynamic and steady state attitude with a source of solar heat. The system attains highest performance coefficient of 0.25 at 14 bar pressure and least heat addition rate of 100 W for the system needs 2 h or more for the operation of bubble pump, before that no cooling was obtained [27]. Bourseau *et al.* [28] analyzed the coefficient of performance (COP) and the entropy balance in the DAR system by providing the rectifier or not incorporating the rectifier. Outcome reveals that Performance coefficient reaches maximum at temperature of the generator shows large for NH_3-NaSCN-H_2, system. In addition, the evaporator temperature highly effected the performance of the system. Ezzine *et al.* [29] shows that the refrigeration system run lower than 0 °C by the water ammonia absorbent refrigerant blend. Consequently, DAR system operates lower than water ammonia blend was R124- DMAC combination. Vapor pressure range of R124 -DMAC mixture exhibits least value and the performance coefficient shows greater value compared to water ammonia combination. Performance comparison of DAR system was done with lithium nitrate water and sodium thiocyanate as absorbent, the refrigerant was ammonia and inert gas introduced is helium [30]. NH3 – Lithium Nitrate- helium exhibits greater results and the performance coefficient attained was 0.48 at an evaporator of −15 °C, temperature of generator of 120 °C, and 40 °C condenser, and absorbers temperature.

Several studies are to be done on DAR system for different fluids and to analyze the performances that effect generator temperature, evaporator temperature, and mass flow rate. In the past researches the performance coefficient can be improved by using alternative working fluid blends and choose the nature touch refrigerant mixture. The study of solution concentration that affect the performances of DAR systems using different refrigerant combinations is a new one in the recent world. Main aim of this paper is to select an ecofriendly refrigerant that contribute less global warming potential, least greenhouse gases and minimum ozone layer depletion. The study analyzes the parameter concentration of strong solution influence on the performance parameters of refrigeration capacity, exergy, heat supplied to generator and performance coefficient by using the five refrigerant blends.

2. Methodology

DAR systems operate on thermal energy, leveraging non-conventional energy sources, and have the potential to serve as futuristic solution for cooling and air conditioning purposes. The merits of DAR systems have been augmented, revealing that their performance can be significantly modified by the influence of design parameters. The performance of the DAR system is influenced by various constraints, including heat transfer rate, exergy, performance coefficient and cooling capacity. The study analyzes the impact of rich solution concentration on the performance of a diffusion absorption refrigeration (DAR) system operated with five alternative refrigerant combinations, deviating from the traditional water- ammonia-helium blend. Fig. 1 illustrates the DAR system layout. The study introduces five alternative refrigerant blends listed in Table 1, as substitutes for the conventional helium-water- ammonia working fluid combination. The refrigerant from the evaporator enter into the absorber and the weak solution in the absorber absorbs refrigerant and the solution becomes rich. The strong solution entered to the generator by the aid of the bubble pump which separates the refrigerant vapor and it entered into the condenser via rectifier, which separates water vapor merges in the refrigerant vapor. Rectifier purifies the refrigerant vapor free from the absorbent. Refrigerant vapor free from the absorbent condensed in the condenser and permitted to flow to the evaporator. At the entrance of the evaporator, refrigerant mixes with helium and due to partial pressure of these gases cooling effect is attained because of absorption of heat of the refrigerant. Refrigerant then flows to the absorber and the cycle continues

Table 1. Refrigerant blends.

NH_3-NASCN-He Ammonia + sodiumthiocyanate + helium
R134a-DMAC-He 1, 2-Tetrafluoro-ethane + dimethylacetamide + helium
R290-DMAC-He Propane + dimethylacetamide + helium
R600a-DMF-He Isobutane + dimethylformamide + helium
R1234yf- DMAC-He 2,3,3,3-Tetrafluoropropene + dimethylacetamide + helium

Table 2. Measurements of the system.

Quantity	Value
Ambient temperature (°C)	30
Rectifier volume (m^3)	1×10^{-4}
Condenser volume (m^3)	4.3×10^{-5}
Volume of evaporator (m^3)	1.5×10^{-4}
Absorber volume (m^3)	6.4×10^{-4}
Generator volume (m^3)	2.3×10^{-5}

The diffusion absorption refrigeration system shares operational similarities with traditional absorption refrigeration systems, yet it features primary distinction: the absence of mechanical pump for fluid circulation. The experiment is conducted on a commercial diffusion absorption refrigerator with 0.04 m^3 capacity. Heat exchangers are made by using tubes of copper. Differential pressure transducer is provided in the system used to measure the pressure difference obtained in the bubble pump and absolute pressure of the system. Pipe surface temperature is observed with the k type thermocouple coupled with the data logger. Bench link Datalogger-3 software is used on the personal computer Performs the controlling and data acquisition process. Test results are observed for a complete day for judging the ambient temperature differences. The measurements of the system at the starting condition exhibited in Table 2. The experiment was conducted on a conventional DAR system, without any modifications or alterations to the system.

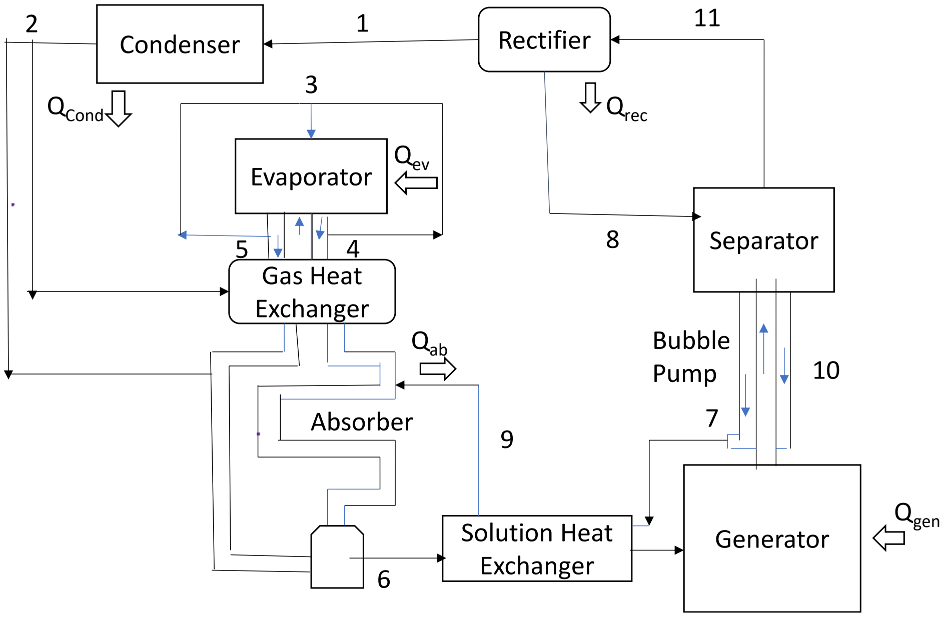

Fig. 1. Schematic layout of DAR system.

Develop a mathematical model of the diffusion absorption refrigeration system and analyze how the rich solution concentration influence on performance. The model for the system is obtained from fundamental equations of concentration, mass and energy. The system is divided into control volumes, indicating individual parts of the systems. The parts inlet and outlets are represented by the numbers from 1 to 11 exhibited in Fig. 1. Moreover, certain assumptions are necessary, followed by balance equations, and are as follows:

- ➢ The inlet of the condenser (1) receives pure, saturated refrigerant vapor.
- ➢ Condensed refrigerant from the condenser (2) is in a saturated state. Its temperature is the saturation temperature corresponding to the total pressure.
- ➢ The refrigerant vapor at evaporator outlet (5) is in a saturated state. The partial pressure of the refrigerant is the saturation pressure corresponding to the temperature at that point.
- ➢ The vapor and liquid mixtures at the generator outlet (10) and the rectified solution droplet at the rectifier outlet (11) are in a thermodynamic equilibrium state.

- The temperatures of the returning weak solution (8) and generator outlet (10) are assumed to be the same.
- The generator and solution heat exchanger are insulated.
- The pressure drops along the entire cycle is neglected.
- The gas mixtures are treated as ideal gas mixtures

The mass and energy balance equations of the condenser are shown in equations (1) - (2):

$$\dot{m}_1 = \dot{m}_2 = \dot{m}_r \tag{1}$$

$$Q_{cond} + \dot{m}_2 h_2 = \dot{m}_1 h_1 \tag{2}$$

The mass and energy balance equations of the combined evaporator are formulated as follows:

$$\dot{m}_2 + \dot{m}_{r,3} = \dot{m}_{r,5} \tag{3}$$

$$\dot{m}_{H,3} = \dot{m}_{H,5} \tag{4}$$

$$Q_{ev} + \dot{m}_2 h_2 + \dot{m}_{r,3} h_{r,3} + \dot{m}_{h,3} h_{h,3} = \dot{m}_{r,5} h_{r,5} + \dot{m}_{h,5} h_{h,5} \tag{5}$$

The mass and energy balance equations for the absorber are given as Equations (6)-(8).

$$\dot{m}_5 + \dot{m}_9 = \dot{m}_3 + \dot{m}_6 \tag{6}$$

$$\dot{m}_{r,5} + x_9 \dot{m}_9 = \dot{m}_{r,3} + x_6 \dot{m}_6 \tag{7}$$

$$Q_{ab} + \dot{m}_6 h_6 + \dot{m}_{r,3} h_{r,3} + \dot{m}_{h,3} h_{h,3} = \dot{m}_9 h_9 + \dot{m}_{r,5} h_{r,5} + \dot{m}_{h,5} h_{h,5} \tag{8}$$

The mass and energy balance equations applied to the generator are provided using Equations (9)-(11). Accordingly, based on the generator outlet (10) and the rectifier outlet (11) are assumed to be in a vapor-liquid equilibrium, their compositions are determined by the temperatures and pressures of the corresponding points.

$$\dot{m}_7 + \dot{m}_{11} = \dot{m}_8 + \dot{m}_{10} \tag{9}$$

$$x_7 \dot{m}_7 + x_{11} \dot{m}_{11} = x_8 \dot{m}_8 + y_{10} \dot{m}_{10} \tag{10}$$

$$Q_{gen} = \dot{m}_{10} h_{10} - \dot{m}_{11} h_{11} + \dot{m}_8 h_8 - \dot{m}_7 h_7 \tag{11}$$

The mass and energy balance equations applied to the rectifier are formulated as follows:

$$\dot{m}_1 + \dot{m}_{11} = \dot{m}_{10} \tag{12}$$

$$\dot{m}_1 + x_{11} \dot{m}_{11} = y_{10} \dot{m}_{10} \tag{13}$$

$$Q_{rec} + \dot{m}_1 h_1 + \dot{m}_{11} h_{11} = \dot{m}_{10} h_{10} \tag{14}$$

3. Result and Discussion

Performances are analyzed by various strong solution concentrations of diffusion absorption refrigeration system run by five alternative refrigerant combination and the outcomes attained is elaborated in the subsequent pages.

3.1. *Coefficient of performance*

The performance coefficient, also known as the coefficient of performance (COP), is a key metric for evaluating the cooling efficiency of air conditioning and refrigeration systems. Coefficient of performance of diffusion absorption refrigeration system is the ratio of evaporator heat to the generator heat. Diffusion absorption refrigeration system using five different refrigerant blend is analyzed by varying the concentration of rich solution with the performance coefficient is demonstrated in Fig. 2. In the DAR system, the rich solution concentration has a profound impact on system performance. The performance coefficient improves at certain concentration ranges. The DAR systems operated by isobutane shows the increased value of coefficient of performance at lower concentrations than other refrigerant combinations. Optimum value of performance coefficient of 0.46 is attained at least concentration value of 0.22 with isobutane refrigerant blend. Maximum performance coefficient of 0.33 at higher concentration of rich solution of 0.28 is depicted by using ammonia blend. Coefficient of performance is augmented at minimum concentration of rich solution by introducing isobutane blend and the higher performance coefficient attained at higher value of rich solution concentration exhibited in NH_3 mixture and the remaining shows in between these blends. The performance coefficient of DAR system with isobutane refrigerant blend reaches its maximum value at lower concentration for enhanced system performance.

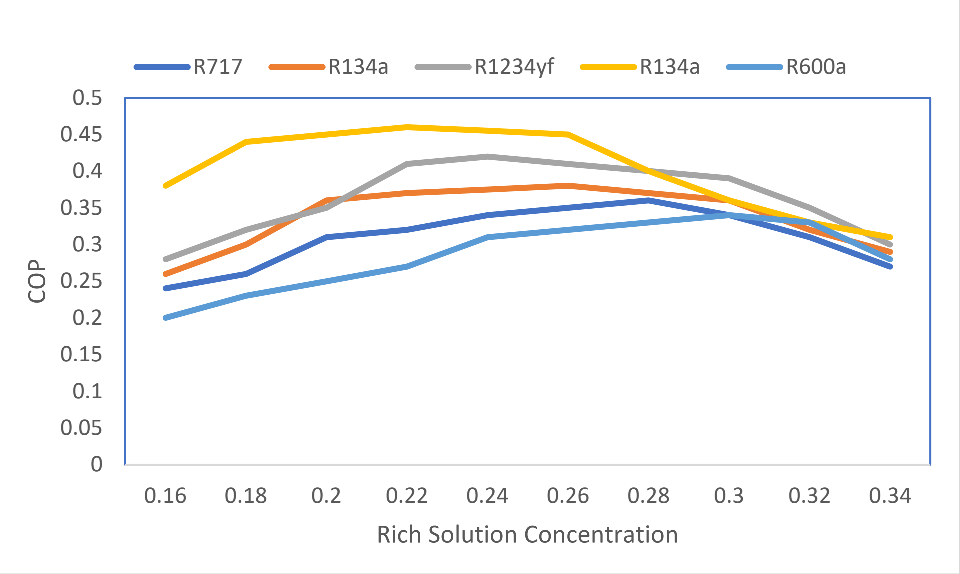

Fig. 2. Variation of concentration on Performance coefficient.

3.2. *Cooling capacity*

The cooling capacity is defined as the quantity of heat a system take away from a region or space at a specific temperature. Cooling capacity refers to the rate at which the system can remove heat and generate cooling. Fig. 3 exhibits the effect of strong solution concentration on the capacity of refrigeration of DAR cycle functioned by five refrigerant blends. Cooling capacity is the amount of heat removed from the space to be cooled in a DAR system. Cooling capacity is changed by varying rich solution concentrations Cooling Capacity is maximum at lower value of rich solution concentration shows DAR systems operated by isobutane blend. In addition, higher cooling capacity of 82 W attained at a concentration of rich solution is 0.22. Maximum capacity of cooling of 68 W reaches at the concentration of rich solution of 0.28 obtained by ammonia blend. The cooling capacity of other refrigerant combinations at varying rich solution concentrations is exhibited in between the isobutane and ammonia combinations. DAR systems work with isobutane mixture performs higher capacity of cooling at reduced value of strong solution concentration.

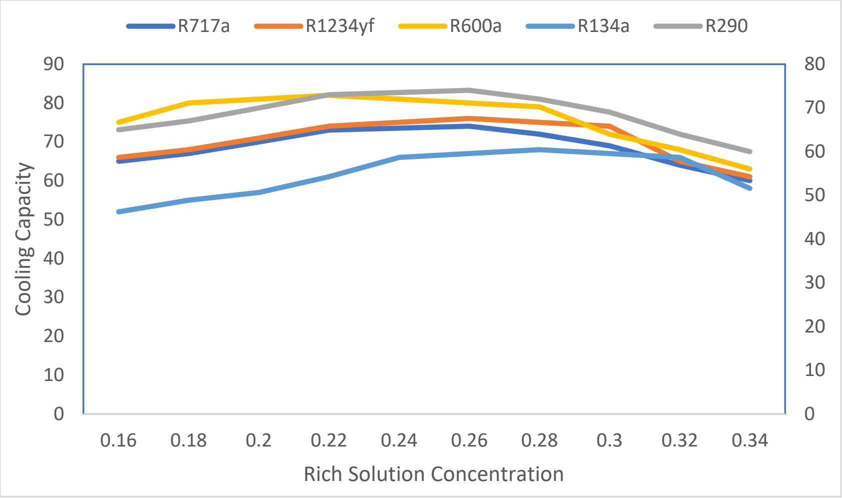

Fig. 3. Effect of cooling capacity on rich solution concentration.

4.3. *Heat supplied*

The performance coefficient of the system is improved by minimizing the heat addition to the generator. The effect of heat supplied to the generator on the strong solution concentration of diffusion absorption refrigeration systems operated with five different refrigerant combinations is depicted in Fig. 4. Heat at high temperature is supplied to the generator forms the refrigerant vapor attains more pressure, and make cooling in the evaporator. Concentration of strong solution greatly influences the heat supplied to the generator in a DAR system.

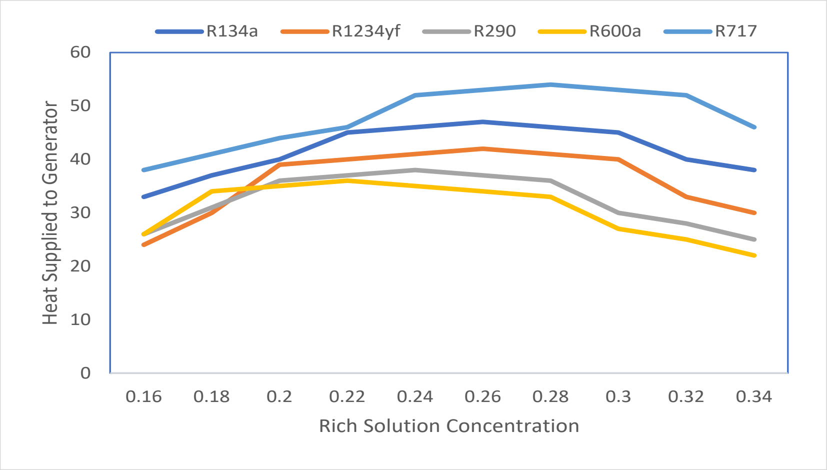

Fig. 4. Effect of Heat addition to the generator at the different rich solution concentrations.

Heat supplied to the generator attains minimum at the range of strong solution concentration from 0.18 to 0.26 by using R600a blend and the R717a blend maximizes heat addition to the generator from 0.24 to 0.32 concentration range. Minimum heat addition to the generator of 36 kJ/kg reaches at the concentration of strong solution in isobutane refrigerant exhibits at 0.22. However refrigerant combination R717 shows higher heat addition of 54 kJ/kg reached at a concentration of 0.28. The generator heat addition values on varying rich solution concentrations of the remaining refrigerant combinations are displayed in between the R600a blend and ammonia mixture. The results show that the isobutane based refrigerant blend in DAR system achieves the lowest heat input to the generator at a lower Concentration of rich solution, exhibiting superior performance compared to the other refrigerant blends.

3.4. *Exergy analysis*

The exergy analysis is grounded in the second law of thermodynamics, which provides the theoretical foundation for computing the optimum useful work potential of a system Exergy is stated as the optimum attainable work on/by a system to obtain the dead-state conditions Exergy study is used to analyze the system performance of the whole system. DAR cycle operating with five various refrigerant blend is studied by different values of rich solution concentration on the exergy displayed in Fig. 5. Exergy reaches maximum at the range of strong solution of 0.18 to 0.26 works with the R600a refrigerant blend and the least value of 0.24 to 0.32 concentration range exhibited by R717 refrigerant blend. Maximum exergy of 3.06 reaches at least concentration of rich solution of 0.22 shows the DAR cycle running with R600a refrigerant combination. Ammonia refrigerant blend shows the low value of exergy 2.23 at a higher concentration of 0.28. Exergy values of other refrigerant combinations at varying concentration exhibited between the isobutane, and ammonia blends. The diffusion absorption refrigeration systems operating with isobutane based refrigerant mixture exhibit superior exergy values at lower strong solution concentration.

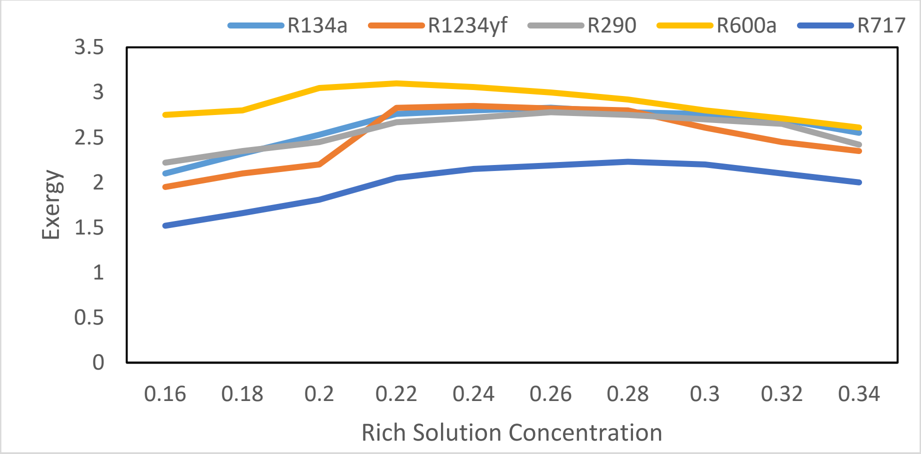

Fig. 5. Effect of Exergy at varying rich solution concentration.

5. Conclusion

The diffusion absorption refrigeration system has gained prominence in recent times due to its minimal or zero power consumption. The paper investigates the effects of varying rich solution concentration in diffusion absorption refrigeration (DAR) systems, using five alternative refrigerant blends instead of the traditional water- helium- ammonia blend, on various performance parameters, comprising exergy, performance coefficient, generator heat addition and cooling capacity. The results reveal that the performance of DAR systems is enhanced at minimum concentration, with isobutane (R600a) refrigerant blend, outperforming other refrigerant mixtures. DAR systems operating with R600a refrigerant mixture exhibit superior performance in terms of cooling capacity and performance coefficient at lower strong solution concentrations. In addition, the heat added to the generator is minimized at the lowest concentration when using the R600a refrigerant blend. Furthermore, the optimum exergy value is achieved at lower rich solution concentration with the R600a refrigerant blend, surpassing the performance of other combinations. In the future, further research will be conducted on DAR systems, exploring various fluid blends and additional parameters to identify the optimal ecofriendly refrigerant blend with enhanced performance.

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