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Thermodynamic Analysis of Single-effect LiBr-H_2O Absorption Refrigeration System

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Abstract—*Thermodynamic analysis of single-effect LiBr-H_2O refrigeration system has been performed to investigate the effect of temperature variation in the major components of the cycle. The effect of governing parameters such as generator temperature, absorber temperature, condenser temperature and evaporator temperature on COP, ECOP and circulation ratio has been observed and accordingly suitable application for the system has been found in the real world scenario.*

Keywords: *Energy, single-effect, absorption, circulation ratio.*

1. INTRODUCTION

The real world application of absorption refrigeration through single-effect lithium bromide-water absorption refrigeration technique has been an area of interest for researchers since last sixty years. Analysis of this system shows that performance of the system is limited to only low-temperature applications. For efficient utilization of the low-temperature heat sources, absorption refrigeration cycle has been analyzed to determine the change in performance of the system by changing some parameters such as temperature. He and Chen (2007) showed that the absorption refrigeration system, driven by low-potential thermal power such as solar energy gives potential of energy saving. It also have the benefits of using ecofriendly working pair, H_2O/LiBr and NH3/H_2O. Vereda et al. (2012) said that the potential of the absorption cycle for low-temperature waste heat recovery has been of good extent. It has application to solar cooling which enables this for the benefit due to the appreciative combination between solar energy and air-conditioning demand. Single-effect absorption cycle can operate with low driving temperatures, which supports the use of flat plate collectors. But it should not be lower than about 70˚C for air-conditioning. Stitou et al. (2000) observed that increase in the driving temperature for the process provides a comparatively better exploitation of the thermal power of heat source. The amount of heat at the top temperature can be degraded many times before being rejected to the sink, shows the way for possibility of cooling or heating from the machine. Tozer and James (1998) have said that two single stage cycles with one operating at a higher driving temperature can be considered equivalent to double stage cycle. They also showed that heat rejected from condenser must be equal to the heat absorbed by the low temperature generator.

2. SYSTEM DESCRIPTION

Fig.1 shows the single-effect LiBr-H_2O absorption refrigeration cycle. It consists of an absorber (A) and generator (G) which form the part of solution circuit. Condenser (C) and evaporator (E) are the parts of refrigeration circuit which produces cooling. Strong solution of refrigerant from heat exchanger (HE) enters into the generator and refrigerant water vapour sent to the condenser. The remaining part of the solution strong in LiBr reaches to the absorber. The absorber and evaporator are at low pressure levels while generators and condenser are at higher pressure level.

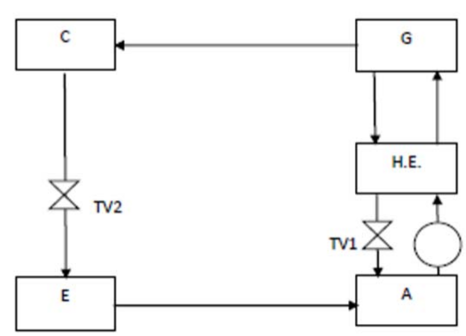

Fig. 1: Single-effect absorption cycle

Table 1: Main parameters considered for the analysis

Environment Temperature (K)	298
Environment pressure (MPa)	0.10135
AbsorberTemperature (K)	311
Heat exchanger effectiveness	0.60
Condenser temperature (K)	313
Evaporator temperature (K)	283
Generator temperature(K)	363
Mass flow rate of refrigerant vapour(kg/s)	1

3. THERMODYNAMIC ANALYSIS

The thermodynamic behavior of the absorption refrigeration system and its components have been studied. Part of the exergy supplied to an actual thermal system is destroyed due to irreversibility within the system. The exergy destruction is equal to the product of entropy generation within the system and the temperature of the reference environment.

The coefficient of performance of the cycle is given as:

$$COP = Q_e/Q_g\# \quad (1)$$

The exergetic coefficient of performance is given as:

$$\mathrm{ECOP} = \mathrm{Q_e\{1\text{-}(To/T_e)\}/[Q_g\{1\text{-}(T_o/T_g)]} \quad (2)$$

The circulation ratio of EARS is given as:

$$f = m_r / m_s\# \quad (3)$$

To find the steady-state performance of the system from these equations, the operating temperatures, weak and strong solution concentrations, effectiveness of heat exchanger and the refrigeration capacity. It is assumed that the solution at the exit of absorber and generator is at equilibrium so that P-T-ξ and h-T-ξ charts can be used for evaluating solution property data.

4. RESULTS AND DISCUSSION

A thermodynamic analysis has been done to observe the effect of temperature variation of various components of single-effect absorption system.

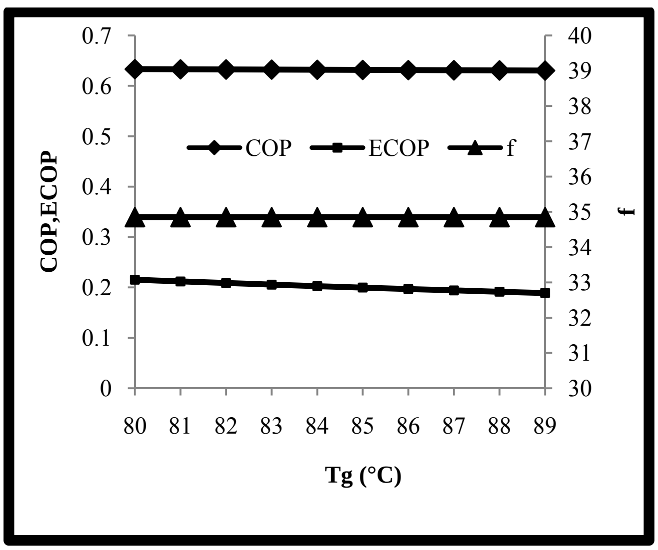

Fig. 2: Effect of generator temperature variation

Fig. 2, 3, 4 and 5 shows the effect on COP, ECOP and circulation ratio with temperature variation in generator, absorber, condenser and evaporator. The circulation ratio (f) remains the same as the temperature increases in case of condenser, evaporator and generator. It varies non-linearly in case of absorber. The COP increases in case of evaporator temperature but it decreases in other components like absorber, condenser and generator.

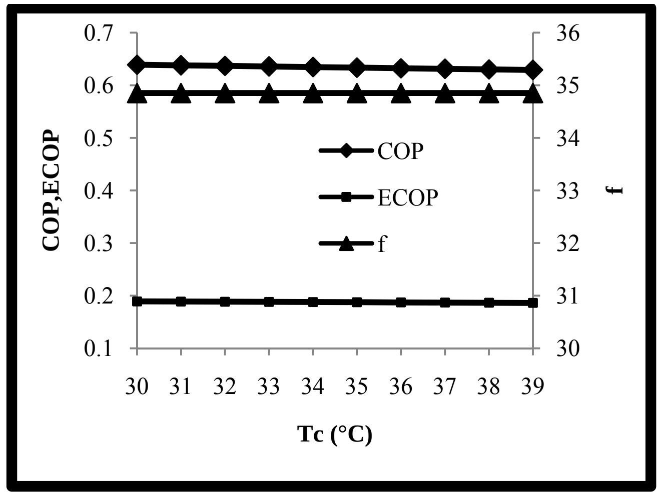

Fig. 3: Effect of condenser temperature variation

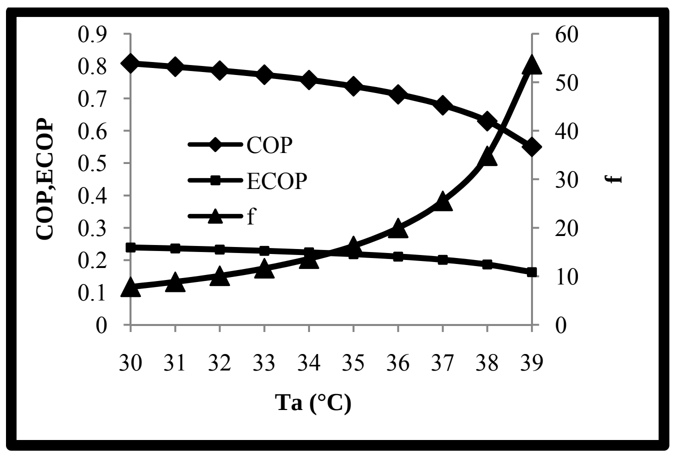

Fig. 4: Effect of absorber temperature variation

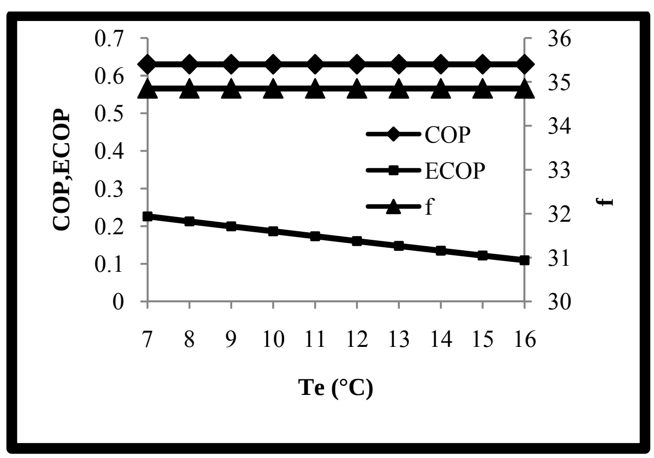

Fig. 5: Effect of evaporator temperature variation

The ECOP decreases with increase in the temperature of all these components. The results of this analysis also indicate that the designing of the absorption refrigeration system should be on the basis of thermodynamic point of view. In the residential and industrial locations, installation of the system is of major concern. The components of absorption refrigeration cycle like absorber, condenser, evaporator and generator are significant in the real world applications.

For commercial applications the above study can be considered a better tool and also for the cooling load and other parameters. From this discussion we see the essential and avoidable parameters of the cycle.

5. CONCLUSION

This study deals with the LiBr-H_2O absorption refrigeration system for cooling and air-conditioning. The effect of temperature variation has been observed on the performance with the help of first law and second law equations of the cycle.

From this useful discussion, it can be concluded that

- As the temperature varies in absorber, the circulation ratio increases while COP and ECOP decrease.
- As the temperature varies in evaporator, the circulation ratio remains same and ECOP decrease while COP increases.
- As the temperature varies in condenser, the circulation ratio remains the same, COP and ECOP decease.
- As the temperature varies in the generator, the circulation ratio remains, COP and ECOP decrease.

REFERENCES

[1] He Yijian, ChenGuangming, “Experimental study on an absorption refrigeration system at low temperatures”, International Journal of Thermal Sciences,46, 2007, pp. 294–299.

[2] Vereda C., Ventas R., Lecuona A., Venegas M., “Study of an ejector-absorption refrigeration cycle with an adaptable ejector nozzle for different working conditions”, Applied Energy, 97, 2012, pp. 305–312.

[3] Stitou D., Spinnera B., Satzger P., Ziegler F., “Development and comparison of advanced cascading cycles coupling a solid/gas thermochemical process and aliquid/gas absorption process”, Applied Thermal Engineering, 20, 2000,pp.1237-1269.

[4] Tozer Robert, James Ron W, “Heat powered refrigeration cycles”, Applied Thermal Engineering, 18, 1998, pp. 731-743.