Circulation Ratio

$\lambda = \xi_{WS}/(\xi_{SS} - \xi_{WS})$

$\lambda = 0.48/(0.56-0.48)$

$= 6$

therefore, $m_{ss.} = \lambda \times m = 13.1652 \times 10^{-3}$kg/s

and

$m_{ws} = (1+\lambda)m = (1+6) \times 2.1942 \times 10^{-3} = 15.3594 \times 10^{-3}$ kg/s

Absorber: Applying the Energy balance

$Qa = mh_{10} + m_{ss}h_6 - m_{ws}h_1$

$= (2.19421\times10^{-3} \times 2509.96) + (13.1652\times10^{-3} \times -178) - (15.354\times10^{-3} \times -170)$

$= 577435W = 5.7743$ KW

Solution Heat Exchanger (H_X) Energy balance for Heat Exchanger,

$m_{ws} \times (h_3 \times - h_2) = m_{ss} \times (h_4 - h_5)$

$= 15.3594\times10^{-3} \times (h_3 + -170) = 13.16526\times10^{-3} \times (-108+178)$

$h_3 = 110.0041$ KJ/kg

Generator

$Q_G = mh_7 + m_{ss}h_4 - m_{ws}h_3$

$= (2.19421\times10^{-3} \times 2609.655) + (13.1652\times10^{-3} \times -108) - (15.3594\times10^{-3} \times -110.0041)$

$= 59938W = 5.993KW$

Condenser

$Q_c = m(h_7 - h_8)$

$= 2.19421\times10^{-3} \times (2609.655-117.30)$

$= 54687W = 5.4687kW$

Thus,

COP $= Q_E / Q_G$

$= 5250/5993$

$= 0.876$

COP = 0.876

9.6 Calculation of solar Collector

Useful energy (energy absorbed by the collector plate) is given by,

$Q_u = K \times S \times A$

Where,

K = efficiency of collector plate(assuming k=0.85)

S = average solar heat falling on earth's surface

= 6kW/hr/m²/day=250W/m²

A = area of collector plates

Now

Heat required in the generator,

$Q_g = 5993$Watt

Hence approximate area of the collector plates required for providing the above amount of energy

= 5993/ (250xK)

= 5993/(250x0.85)

= 28.20Sq.m

Total area of collector plates A = 28.20Sq.m

Therefore we can use 5 collector plates having dimension of 3x2 Sq.m.

Thus,

$Q_u = 0.85 \times 250 \times 28.20 = 5993W = 5993$ J/Sec

The energy absorbed by the collector helps in heating of the water flowing in the tubes of the collector plates.

$U = m \times C_p (T_o - T_i)$

Let the rate of water flowing through the tubes,

m= 1.2Kg/min

= 0.02kg/s, (example)

Specific heat of water, C_p= 4.187 KJ/KgK

T_o =outlet temperature of water in the collector

T_i = inlet temperature of water in the collector plates

= 21⁰C

Therefore,

$Q_u = 0.02 \times 4187 \times (T_o - 21) = 5993 = 92.^0C$

The temperature, T_o should be the inlet temperature of generator, but assuming water loses heat while flowing through the pipes. Also there is certain effectiveness of the generator as a heat exchanger, less than 100%. Hence net heating in the generator can be assumed to be taking place at 60⁰C.

Temperature at generator = 60⁰C

This is the net heat input to the system, which is running as a refrigeration unit of 5.25kW capacity.

COP of the system-

The COP of the unit can be calculated by the following equation:

COP = Refrigeration effect / heat input in generator

COP = Qe/ Qg

= 5250/59938

= 0.876

The COP of the system including Solar water heater

$$\frac{\text{Net refrigeration effect}}{\text{heat input at the solar collector}}$$

Heat input at the solar collector = Solar constant x Area

$= 250 W/m^2 \times 28.20 m^2$

$= 7050$ W

COP = 5250 W/7050 W

= 0.7446

COP = 0.7446

Hence the theoretical COP of the system comes to be 0.7446

10 Results –

The Evaporator is a chamber that has to be maintain at the low temperature but the main objective of the study is not to attain very low value of evaporator temperature but to provide the desired cooling effect. the Condenser and Absorber are maintained to be at a temperature of 28^0C and 21^0C respectively. Generator at maintain at the temperature of 60^0C.

Table.2. Components Wise heat capacity of Different systems

S.No.	COMPONENT	HEAT TRANSFER RATE	VALUES
1	Evaporator	Q_E	5.250
2	Absorber	Q_A	5.774
3	Generator	Q_G	5.933
4	Condenser	Q_C	5.468

11. Conclusion-

A small capacity (1.5ton) intermittent vapor absorption refrigeration system using LiBr-H_2O solution was designed based on some thermodynamic correlations. By analytical calculation the COP was 0.876.it was ascertained that the solar collector efficiency, clearness of sky play a big role for overall efficiency. The study suggests that, with a accurate theoretical design and thermodynamics analysis there is a scope for improving the performance of vapor absorption refrigeration system applying low grade thermal energy source. COP of the system is greatly acted upon the system temperature. The heat input can be provided by solar collector. It brings into light that solar collector can not only be used for heating, it can also be used for cooling purpose.

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