The Effects of Difference Temperatures on Various Cycle Parameters of NH_3-H_2O Absorption Chiller For improve The COP and Cooling Capacity When Energised From a Low Temperature Source

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ABSTRACT

A Simulation study, of several schematic model of water cooled and inlet temperatures effect in NH_3-H_2O absorption chillers energised by a high potential low temperature of (70 -180 ºC) solar source has been carried out using IPSEpro refrigeration software package. For water-cooled cycles, the rejected heat from the absorbers and the condensers was carried out by water, at an average fixed temperature of 25ºC, pumped out from ground water. The results obtained show impact and improve of coefficient of performance (COP), the refrigeration capacity, the main cycle components heat transfer, the hot water supply energy, the cooling water mass flow.

Keywords: Solar sources, NH_3-H_2O absorption chillers.

1. Introduction

This study is extended for Absorption chiller cycle (NH_3-H_2O) Driven by Solar Energy study [1] to improve the cycle and increase the COP and refrigeration capacity, the effects of coolant temperature on various cycle parameters of single effect libr-h_2o absorption chiller , it was successfully for improve the cycle and COP [2] . Many theoretical and experimental studies have been carried out on the NH_3-H_2O absorption chillers powered by low temperature solar energy, [3]. The high influence of cooling flow rates and temperatures on different cycle parameters such as solution circulation ration, coefficient of performance (COP) were given on the effect of weather parameters on the cycle cooling system. Can only achieve these chilled water temperatures from a low temperature chiller when the source flow rate is high and the chiller cooling air temperature low [4].

2. Model description and processes

An absorption cycle using ammonia-water mixture working fluid is perhaps the simplest manifestation of absorption technology using the IPSEpro refrigeration mode library [5]. The state points in the connecting lines are assigned state point numbers is provided in Figure 1. Point (10) is a low-pressure refrigerant vapour that enters the absorber. The solution leaving the absorber part comprises a high concentration level of refrigerant (1), that has a weak capability to absorb the refrigerant liquid, this is pumped with the necessary pressure from the generator (4). The low-temperature, high-pressure solution goes to the inlet of the generator, where heat is added. This increases the solution temperature and the quantity of refrigerant stored within the absorbent is reduced. The low concentrated refrigerant solution remaining in the generatoris described as a strong solution (ability to absorb the refrigerant. The strong solution at point (11) will return to the absorber. The high temperature and pressure refrigerant vapour (5) leaves the generator and goes to the rectifier, after which it will enter the condenser point (7). This results in a decrease in the temperature that condenses it into a liquid (8). The refrigerant will pass through an expansion valve, resulting in a decrease in the evaporator pressure (9). The refrigerant vapour in point (10) will leave the evaporator and return back to the absorber for complete the cycle. Figure 6.1 shows the liquid sub-cooler and solution heat exchange. A conclusion of the state point's explanation is shown in Table 6.1. As listed in the table, three points are saturated liquid (1, 8, and 13), three are sub-cooled liquid (2, 4, and 12) one is saturated vapour (10), one is superheated vapour (7), two are two-phase vapour-liquid states (9) and (11), providing a total of ten state points.

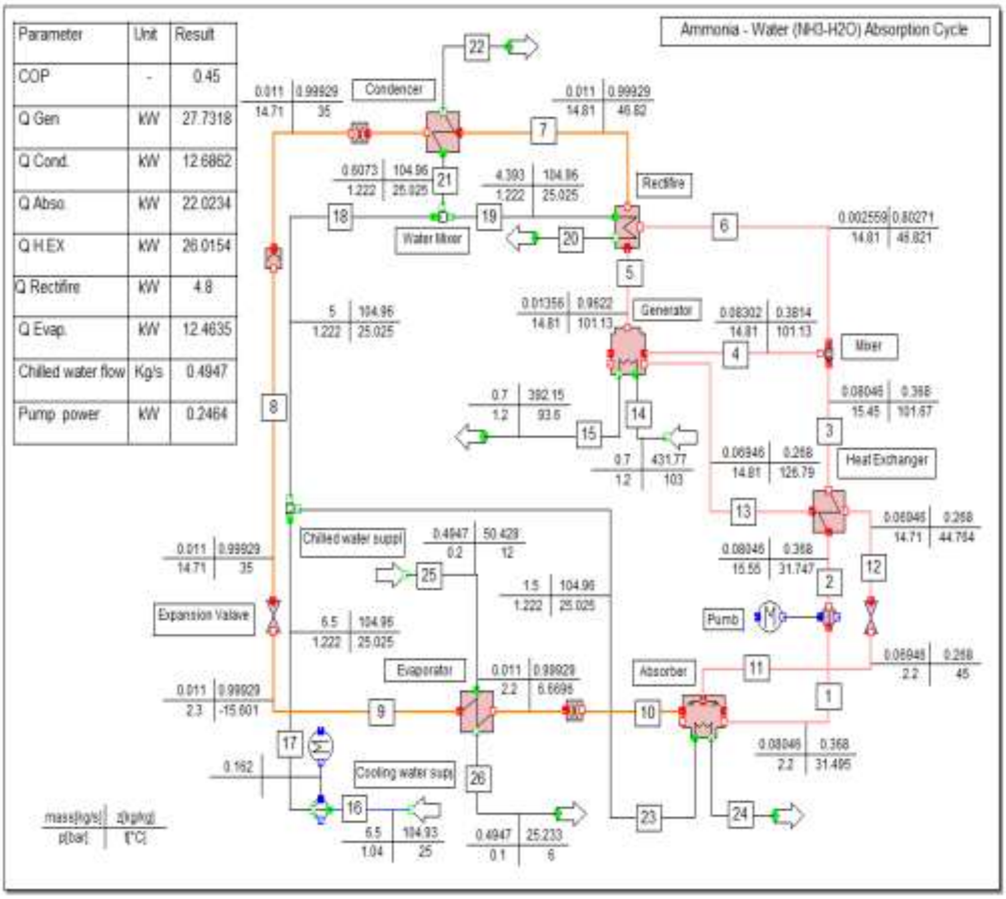

Figure 1. Schematic diagram of the water-cooled absorption chiller

2.1. Results and discussion

According to [6] and from high number of successful simulated trials which have been carried out during the modelling stage of this study, the most common variables, that have an influence on the other cycle parameters, were: the generator inlet temperature (T_{14}), the inlet chilled water temperature (T_{25}) and the coolant temperatures (T_{21}&T_{23}).

2.1.1. Influence of generator inlet temperature variations for increase COP

The simulated models were successfully run within a small generator inlet temperature range of 70-180 ºC without touching the crystallisation line or violation. The generator outlet temperature (T_{15}) is fixed at a temperature of 93.6 ºC and the influence of the generator inlet temperature variation (T_{14}) on the chiller COP is clearly shown in Figure 2. The COP was increased from approximately 0.3463 at a temperature of 70 ºC to reach the maximum value of 0.5121 at the inlet generator temperature of 180ºC, a difference of 0.1401; the relative difference was 0.274, 27.4 %. This increase in the COP value was due to the range of the inlet generator temperature. Figure 3 shows the refrigeration capacity from a low value of approximately 6.8 kW at 70ºC to reach 18.6 kW at 180ºC.

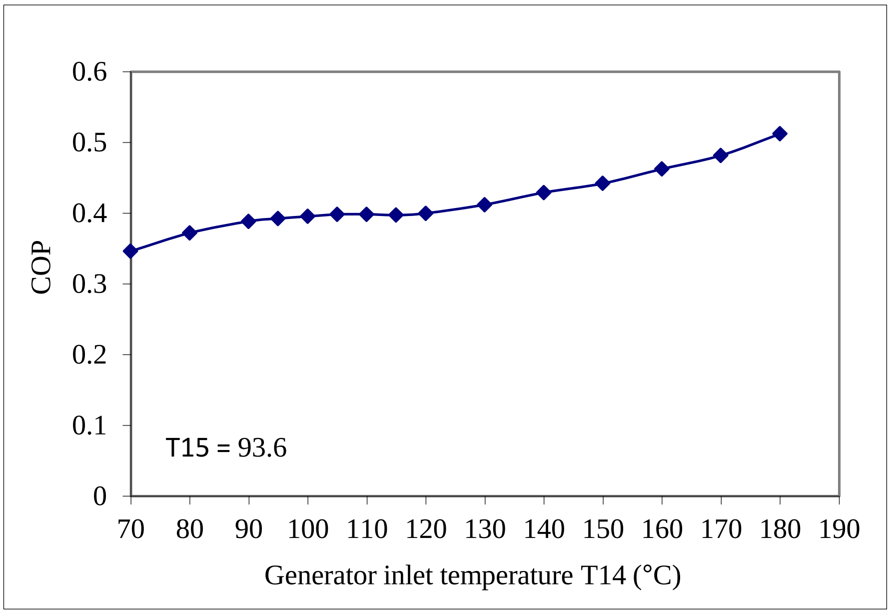

Figure 2. Effects of the generator inlet temperature on the COP

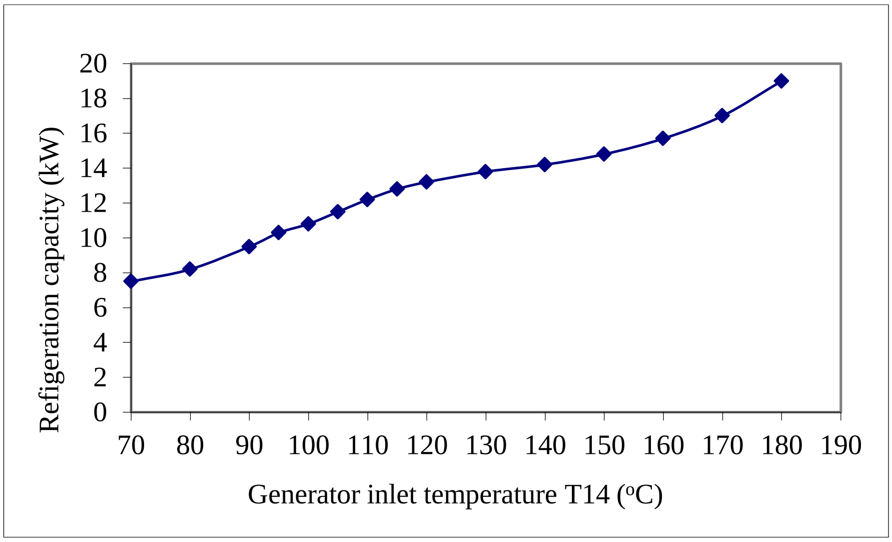

Figure 3. Effects of the generator inlet temperature on the refrigeration capacity

2.1.2. Influence of evaporator temperature variations

Figure 4, presents the influences of the evaporator temperature to the COP. Along with an increase of the evaporator temperature, the COP also increases from 0.9323 at a temperature of -20 ºC to 0.4227 at a temperature of 5ºC. This proves the fact that the lower the evaporator temperature, the lower the system COP (difference of 2.2 %).

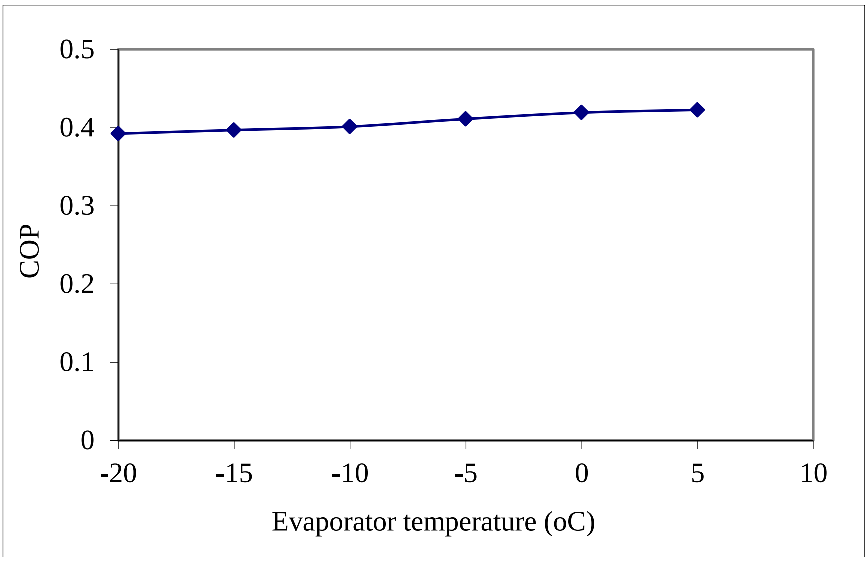

Figure 4. Effects of the evaporator temperature on the COP

2.1.3. Influence of absorber temperature variations on COP

The effects of the absorber temperature to the system COP shows in figure 5. the COP will drop as the absorber temperature increases, a COP value from 0.4577 at 15ºC of the absorber temperature descends to 0.3712 at 40 ºC of the absorber temperature and the relative difference is 18.9 %.

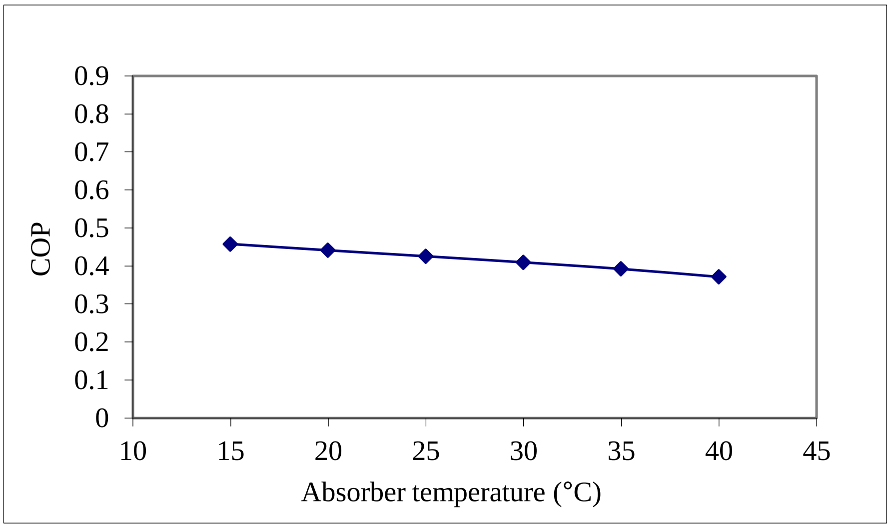

Figure 5. Effects of the absorber temperature on the COP

2.1.4 Influence of chilled water inlet temperature variations

Figure 6 presents an effect of the inlet chilled water temperature variations on the chiller COP and cooling capacity. A small linear increase in the COP, compared with that obtained due to the difference was 0.1659 in Figure 3 of the generator inlet temperature (70-180°C). During the increase of the inlet chilled water temperature and while fixing the generator input temperature at 103ºC, the COP increased linearly. The difference of COP between the maximum and the minimum is 0.0865 and the relative difference is 18.9 %.

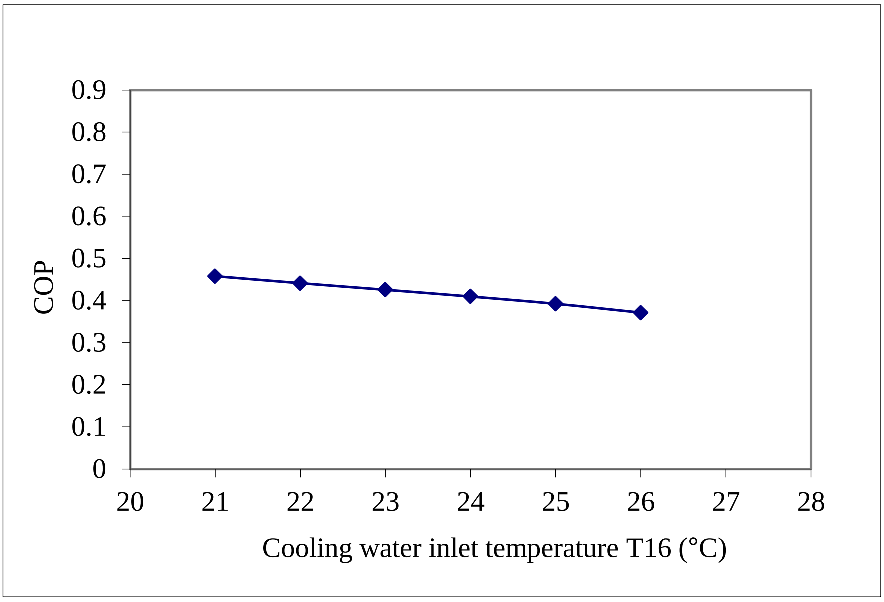

Figure 6. Effects of the cooling water inlet temperature on the COP

The obtained parametric results, of the proposed chiller model, such as the coefficient of performance (COP), the refrigeration capacity, the main cycle components heat transfer, the hot water supply energy, the cooling water mass flow, The water cooled Ammonia-water absorption chiller output result before the improve and after are listed in Table 1.

Table 1: *The water cooled Ammonia-water absorption chiller output new results*

Description	Unit	Last Result	New Result
Temperature input	Cº	70	180
COP	-	0.45	0.53
Refrigeration capacity	kW	6.8	18.6
Cooling capacity	kW	12.46	19.8

3. Results summery

From the results above, it can be seen that any changes in any one of the system parameters will cause a change in the performance of the overall system:

- The impact of inlet temperature is a factor of the largest effect to the COP. The difference was 0.1401, 27.4 %.
- The cooling water inlet temperature (T16) is the second largest effect to the COP. The difference between the max and the min value is 0.0865 with cooling capacity 12 kW.
- The impact of evaporator temperature to the COP is also minimal with only 2.2 % difference.
- The influence of absorber temperature and condenser temperature to the COP are almost identical, the relative difference is 19.2% and 18.9% respectively.

4. Conclusion

May improve and increase of COP was successfully simulated using the IPSEpro software of absorption chiller powered by a low temperature solar source. The COP obtained was 0.45 and may increase from approximately 0.3463 at a temperature of 70 ºC to reach the maximum value of 0.53 at the inlet generator temperature of 180ºC, a difference of 0.1401; the relative difference was 0.274, 27.4 % and the refrigeration capacity from a low value of approximately 6.8 kW at 70ºC to reach 18.6 kW at 180ºC. It was found that the COP of the cooling cycle was very sensitive to the difference of the inlet temperature of the generator and the chilled water temperatures. The cooling water mass flow used for rejecting the heat from the cycle components was remarkably high, mainly due to the high cooling water temperature (22 - 25ºC) and low temperature heat source (70 – 180 ºC) that was used directly to energise the generator of the chiller.

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