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Performance Analysis of a Solar Assisted Hybrid Air-Conditioning System Worked in Hot Regions of the Iraqi Climate

Mukhtar N. Saddam [1*]
Mushtaq I. Hasan [2]
[1*] Department of Mechanical, College of Engineering, University of Thi-Qar, Thi-Qar, 64001, Iraq.
[2] Department of Mechanical, College of Engineering, University of Thi-Qar, Thi-Qar, 64001, Iraq.
1) mukhtarnoori@utq.edu.iq
2) mushtaq76h@gmail.com

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Abstract
A numerical analysis was presented in this study to investigate the thermal effectiveness of a hybrid air-conditioning system that uses solar power. The climate of Iraq, and specifically the city of Nasiriyah, was adapted to solar radiation. The hybrid evacuated tube solar air heater was used in this investigation. The system was created and produced to withstand Iraq's scorching heat. Ten evacuated tubes were assembled in a solar system that measured 1.8 square meters. This system was tested from 8:00 AM to 7:00 PM in June under the effects of sun radiation. The effectiveness of solar collectors in terms of energy conservation and system efficiency was discussed. The experiment described in this study was carried out twice. First: In the first scenario, the solar heater was connected before the compressor. According to the results, average heater temperatures increased from 25% to 55% of the total energy used for the cooling cycle each day, resulting in increased energy savings. The gas was heated to temperatures between 45 and 65 °C, with a continuous cooling rate of 3.43. Second: In the second instance, the solar heater was connected following the compressor. With an average system performance factor of 5.1 to 13 and energy consumption ranging from 15% to 24%, the solar heater significantly increased system efficiency. Take note of the increase in cooling load from 3.43 to 5.54 kW. In the second instance, the rate of thermal heating increased steadily from 100 to 160 ° C. The system has improved as a result of increasing the cooling load while reducing energy consumption and raising the overall performance of the system factor as a result of the improvement of the special conditions of the coolant used in the (R-410a) cycle, it should be noted that the second case has a much greater service advantage and economic viability than the first.

Keywords: Solar radiation, evacuated tube hybrid solar air heater, compressor.

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1. Introduction

Iraq's high demand for air conditioning as a result of summer temperatures that can reach over 50 degrees Celsius has increased electricity consumption. The process of modifying an air's characteristics—such as temperature, humidity, purity, and distribution strategy—to fit an application is known as air conditioning. A method of eliminating heat is air conditioning, commonly referred to as air-cooling. Energy is needed for this operation, and electricity is typically the source of that energy. Once built, solar energy becomes more appealing as the electrical load rises. One of the renewable energy sources, solar energy is perhaps the best option for installation in subtropical nations. The system is an excellent choice for the effective and affordable use of solar energy in refrigeration applications because it has the most straightforward capacity management, simple mechanism, easy implementation, high reliability, silent operation, long service life, and low maintenance cost. The invention and enhancement of ordinary air conditioners, using solar energy as an auxiliary system for conventional compressors to minimize energy consumption, pollution, and noise, is the main topic of this article. A realistic substitute for using traditional electricity to power air conditioners is solar energy. Many studies and experiments have been conducted to learn how vacuum tube solar energy systems and air conditioning systems are built and function in order to better comprehend solar air conditioning systems. The rise in electric energy consumption is directly correlated with the rise in fossil fuel consumption as a result of the population growth over the past few decades. Fuel-related carbon emissions are the primary driver of environmental pollution, climate change, and global warming [1]. According to statistical studies, nations with hot temperatures specifically consume the most electricity and fossil fuels for air conditioning in order to provide comfortable circumstances [2].

Providing cooling loads during the hot summer in Iraq, as it is among the most important countries that enjoy a high abundance of sustainable energy. In the literature, several researchers have studied the feasibility of using clean solar energy to provide a cooling load and reduce the consumption of hybrid air conditioning systems. Vakiloroaya V. et al (2013) [4] presented a project aiming to reduce the amount consumed for savings at a rate of 25% to 45% per month, with a cooling capacity of 6 kW during climatic conditions of the city of Baghdad. He worked on developing the performance of the hybrid air conditioning system, by adding an inline solenoid valve after the compressor that controls the amount of gas flowing to the solar heater. M. K. Assadi et al (2016) [5] presented a theoretical analysis of a hybrid air conditioning system using ANSYS-FLUENT simulation software. The amount of energy saved was 45% of the total energy. A comparison between the cooling systems with a cooling capacity of 3.5 KWand with different dimensions for evacuated tube solar collectors was studied during this research with the conventional cooling system. Kaidir, Mulyanef, and Burmawi (2017) [6] used a three, 51 KW, (12,000 Btu/h) hybrid air conditioning system. Refrigerant type R22, in the climatic conditions of the city of Indonesia. A hot water tank with a capacity of 22.5 liters to 120 liters was used. In the first tank, the temperature was raised at a rate ranging from 50 to 65 degrees Celsius, which has a capacity of 22.5 liters within 105 minutes, while the temperature of the second tank with a capacity of 120 liters was raised from 27 to 62 degrees Celsius within 240 minutes. A saving rate was obtained. The energy rate is 60% of the total electrical energy and the performance factor for the three hybrid systems with different capacities and the traditional tanks is COP= (3.35, 8.86, and 9.85) for the A, R, and C systems, respectively. The operating rate of the system was 6 hours per day for the maximum temperature of the hot water was recorded at 88.5 °C. Ch. Pramankar et al. (2018) [7] Presented a study on the performance of the system in India's climatic conditions. The results of the research summarized that the electrical energy saving rate amounted to 29% to 30% of the total energy consumed after comparing the two hybrid and conventional units, and thus helped reduce the amount of carbon emitted from energy and its generation. Shek Rahman et al. (2019) [8] Optimization of a solar hybrid cooling system was done by adding 5% secondary single-wall tube size in the cooler. The temperature range was recorded between (283 to 308) in addition to reducing the cooling load by misleading the building, reflective walls and ceilings, reducing the size of the windows, and adding double glazing to the windows, which led to a reduction of 31.5% of the total cooling load. The results of the material's thermal conductivity were Cooling (R-407c) at 305k with an increase in pressure rate of 4%. SWCNT /R-407c Nano refrigerant shows a notable improvement of COP at about 17.02% for thermal conductivity and at about 10.06% for specific heat, which saved 34% of the total electrical energy consumed in the system, and increased COP by 4.39% compared to the traditional adaptation regime.

M. Anup Kumar and D. Patel (2020) [9] presented an analytical comparison for the research findings of a hybrid air-conditioning system with a conventional refrigeration system. The results showed that the energy saving rate ranged from 25% to 40%. The selected system has an average energy saving of 1.3% in the on-off mode of operating the compressor while if the compressor is in continuous operation, there is no energy saving. Through this process, 30% of the total energy can be saved.

N. Kinnal et al. (2020) [10] addressed a unique sort of solar system that can be created at home by (those who work to obtain information) without the requirement for (ability to do things very well) or significant difficulty. It was designed in a simplified method and with readily available components. The inside of the water tank was painted with a black material or paint to absorb (like a towel) as much solar energy as possible. The glass front of the water tank was constructed to allow the penetration and (mental concentration/picking up a liquid) of solar radiation. The purpose of the hot water tank was to raise the temperature and pressure of the gas-electric vehicle cooling system or (liquid that boils at a low temperature) while it was leaving the evaporator and was being forced into a smaller space (an ordinary air conditioner connected to a solar collector). The study was conducted and completed in April and May for a cooling system with a capacity (to store or perform anything) of 3.5 kilowatts, and at the peak summer temperatures, readings were taken from 1:30 pm to 4:00 pm at a temperature of 51 degrees Celsius during the period from 3:00 to 3:30 pm. Over the course of the three months, energy savings were on average 32%, compared to 45% during the busiest summer months. Performance of the system has increased from 2.85 to 4.04 = COP. It was discovered that it is feasible to lower the electric power use of the (push or force into a smaller space)or by 30–40% after comparing the two systems throughout the entire operation. It is economical and environmentally friendly to use this two-in-one gas-electric vehicle air conditioning system.

2. System description

Combination of two things/gas-electric vehicle solar air conditioning system as shown in Fig .1.a.b, the working basis of the system consists of a (shorten/change from gas to liquid)r, (press or force into a smaller space)or, evaporator, pressure valve, and helical coil heat exchanger with a vacuum tube solar heater collector. In this paper, two cases have been suggested. In the first case, the heat exchanger is connected between the (press or force into a smaller space)or and the evaporator. It is assumed that during this process, firstly, the (press or force into a smaller space)or voltage is reduced, and secondly, which exists along with a decrease in electricity use. The cooled gas is passed through the spiral heat exchanger, which is installed inside the hot water tank coming from the solar collector increases the temperature of the (liquid that boils at a low temperature) and so leads to an increase in vapor pressure according to the ideal gas equation PV = M.R.T. To heat a constant (total space occupied by something) as shown in the process 1-x-2-3-4.

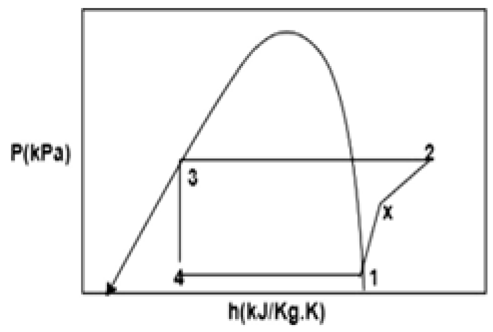


Fig .1.b Pressure-Enthalpy Diagram for case one

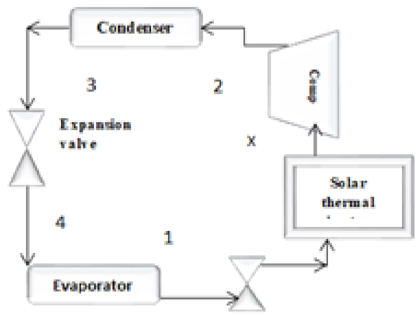


Fig .1.a The Hybrid solar air conditioning system in case one

As shown in (Figure .2 a) heat exchanger in the second case was installed between the compressor and the condenser Therefore, it is claimed that the purpose of this process is to improve the performance of the cooling system and to reduce electricity consumption by reducing the compressor runtime (compressor off). The hot water coming from the solar collector is discharged to tank, and the temperature of the refrigerant is increased via a solenoid, with the aim of carrying out the heat exchange process between the hot water and the refrigerant pressurized from the compressor toward the condenser. Thus, the refrigerant is heat Edina constant volume according to the equation of state of an ideal gas, as shown in the process line (1-2-x-3-4) inFigure.2.a.b.

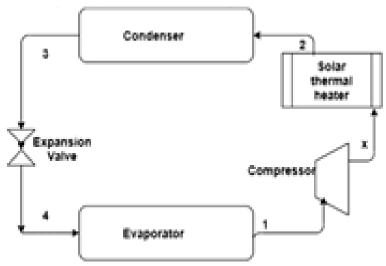


Fig .2.a The Hybrid solar air conditioning system in case two

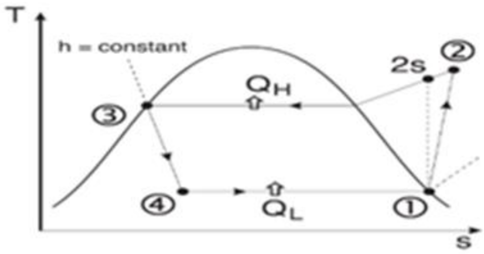


Fig .2.b Pressure-Enthalpy Diagram for case two

During this period, the pressure is assumed to increase with temperature, so it is suggested that the pressures provided by the solar vacuum collector be used to continue the work of the refrigeration cycle even when the compressor is idle in the off phase. Finally, there are two claims that must be proven by empirical analysis of the attempts that have been made in these attempts.

3. Mathematical

3.1 Thermal analysis of conventional Air conditioner system (CVCRC):

A thermodynamic analysis of the system was conducted to try to reach the possibility of energy savings and to determine the impact of different operating conditions on its performance. By applying the energy balance equation to the system and its various components, we can arrive at the following relationships [13]:

Cooling capacity of the evaporator (q_{evap})

$$q_{evap} = \mathrm{m}(h_1 - h_4) \qquad \text{... (1)}$$

Refrigerant mass flow rate through the compressor:

$$m = \frac{TR}{(h_1 - h_4)} \qquad \text{... (2)}$$

Compressor work (W_{comp})

$$W_{comp} = m(h_2 - h_1) \qquad \text{... (3)}$$

Coefficient of performance of system, (COP_c)

$$COP_c = \frac{(h_1-h_4)}{(h_2-h_1)} \quad \dots (4)$$

Heating Capacity at Condenser, (q_{cond})

$$q_{cond} = \mathrm{m}(h_2 - h_3) \quad \dots (5)$$

Where: h_1 and h_2 are the enthalpy at inlet and exit of compressor, respectively, h_3 is the enthalpy at exit of condenser and h_4 is the enthalpy at inlet of evaporator, h_{out} and h_{in} (KJ/Kg) are the enthalpy at inlet and exit of water or collector .

3.2 Analysis of modified Air conditioner system:

3.2.1 Case 1:

In the standard system, an attempt is made to heat the refrigerant before entering the compressor and before exiting the evaporator, turning on the first state point 1-x-2-3-4. AsshowninFigure1.a.b, the compressor is compressed from state one to steady state 2 and the specific cooling effect value can be calculated by the following equation [11]

Cooling capacity of the evaporator (q_{evap})

$$q_{evap} = \mathrm{m}(h_1 - h_4) \quad \dots (6)$$

Refrigerant mass flow rate through the compressor:

$$m = \frac{TR}{(h_1-h_4)} \quad \dots (7)$$

Compressor work (W_{comp})

$$W_{comp} = m(h_2 - h_x) \quad \dots (8)$$

Coefficient of performance of modified system, (COP_c)

$$COP_c = \frac{(h_1-h_4)}{(h_2-h_x)} \quad \dots (9)$$

Heating Capacity at Condenser, (q_{cond})

$$q_{cond} = \mathrm{m}(h_2 - h_3) \quad \dots (10)$$

Energy saving (ES) which represent the ratio of saving in work due to adding solar comes to the total work [12]:

$$ES = \frac{(h_2-h_1)-(h_x-h_1)}{(h_2-h_1)} * 100\%$$

$$\mathrm{ES} = 1 - \frac{(h_x-h_1)}{(h_2-h_1)} * 100\% \quad \dots (11)$$

Heating Capacity at collector, (q_{coll})

$$q_{coll} = m_w(h_{W\,out} - h_{W\,in}) \quad \dots (12)$$

To calculate the average pressure at point x through the following relationship:

$$P_x = P_2 - \frac{M_{hx}R(T_2 - T_x)}{V_{hx}} \quad \dots (13)$$

To calculate the heating of the refrigerant mass in the heat exchanger:

$$M_{hx} = \frac{V_{hx}}{V_x} \quad \dots (14)$$

Where: M_{hx} is mass in the heat exchanger, m_w is the mass flow rate of water in collector, $h_{W\,out}$ and are the entropies of water exit and inlet to the water heater, V_{hx} is the volume of the coil of the heat exchanger ($0.01185\, m^3$) and V_x is the specific heat of the refrigerant vapor in the x state. The performance factor of the hybrid system is calculated based on the amount of electrical energy consumed in the compressor [13]. While the heat generated by solar radiation is free and is not considered in terms of energy input (free energy):

$$COP_h = \frac{(h_1 - h_4)}{(h_x - h_1)} \quad \dots (15)$$

Where: h_x is the enthalpy at state x.

3.2.2 Case 2:

In this case, the solar collector is added after the compressor (between the compressor and the condenser) in the second case 1-2-x-3-4, as shown in Figure 2-a. The refrigerant moves from state 2 to state x and from state x to state 3, the process works in process points such as the second state heat exchanger, volume continuous heating of the standard 1-2-x-3-4 vapor pressure system, the specific cooling effect is according to the material Cooling Capacity is calculated using the following formula [13]:

Evaporator cooling capacity (q_evap)

$$q_{evap} = \mathrm{m}(h_1 - h_4) \quad \dots (16)$$

Refrigerant mass flow rate through the evaporator:

$$m = \frac{TR}{(h_1 - h_4)} \quad \dots (17)$$

Compressor work input, (W_{comp})

$$W_{comp} = m(h_2 - h_1) \quad \dots (18)$$

Coefficient of performance of modified system, (COP_c):

$$COP_c = \frac{(h_1 - h_4)}{(h_2 - h_1)} \quad \dots (19)$$

Condenser heating capacity, (q_{cond})

$$q_{cond} = \mathrm{m}(h_x - h_3) \quad \dots (20)$$

Energy saving (ES)

$$ES = \frac{(h_2 - h_1) - (h_2 - h_x)}{(h_2 - h_1)} * 100\%$$

$$ES = 1 - \frac{(h_2 - h_x)}{(h_2 - h_1)} * 100\% \quad \dots (21)$$

Calculated Solar collector heating capacity or cycle additive work (free heat energy added from the solar collector), (q_{coll})or (W_s) radiation energy comes from thermal solar collector tube.

Heating Capacity at collector or work saved compassed (q_{coll}):

$$q_{coll} = W_s = \mathrm{m}(h_2 - h_x) \quad \dots (22)$$

3.3 Thermal analysis of solar thermal collector:

The main purpose of adding a solar collector to a conventional cooling system is to increase the temperature and pressure of the cooling water to improve system performance and reduce energy consumption, as described above. The solar water heater raises the temperature of the water by absorbing the solar radiation falling on a hollow glass tube. The tubes provide the maximum temperature from the solar radiation that is reflected inside the heater and kept out of the air, thus reducing energy loss and improving heat transfer to the outside for increased heat retention.

3.3.1 Thermal analysis of evacuated tube:

To obtain the appropriate thermal quantities to conduct the process of heating the water to the required temperatures to complete the heat exchange between the refrigerant inside the solenoid coil and the hot water inside the tank well. An analytical study was conducted for the required dimensions of the solar collector show in the Fig .4 and the required heat capacity through the mathematical relationships below [14].

To calculate the required heat capacity:

$$Q_{need} = \mathrm{m}C_{p(Material)}(T_{out} - T_{in}) \quad \dots (23)$$

The rate of heat loss per unit-absorbed area q_{Loss} can be expressed as

$$q_{Loss} = U_L(T_r - T_a)$$

Or

$$q_{Loss} = U_L.A_p(T_p - T_a) \quad \dots (24)$$

Where T_r is the receiver temperature, T_a is the ambient air temperature, T_p is the absorber plate temperature, T_{out} is the outlet temperature of water or refrigerant, T_{in} is the inlet temperature of water or refrigerant, U_L is the loss coefficient, A_p is the loss area .

Total thermal resistance $1/U_L$ is the sum of three resistances:

R1 = radiative exchange from absorber tube to cover tube

R2 = conduction through glass tube

R3 = convection and radiation to environment

The overall resistance is then

$$\frac{1}{U_L} = R_1 + R_2 + R_3 \quad \dots (25)$$

It was found that the recorded loss coefficient U_L varies between (0.5 and 1.0) W/m^2 ° C, according to experimentally proven data [14].

The actual total heat capacity that can be obtained from the solar collector after the process of subtracting the heat capacity Recorded losses:

$$Q_u = \tau_e.\alpha_r.I_{eff}\frac{A_t}{A_c} - U_L(T_r - T_a)\frac{A_r}{A_c} \quad \dots (26)$$

Or it can be write the mathematical equation in the following simplified form, through the process of abbreviation that took place from adding the area law to the main equation and calculated from the following law($A = \pi D_r/d$) to get the mathematical formula for calculating the total heat capacity of the solar collector

$$Q_u = \frac{D_t}{d}\left[\tau_c.\alpha_r.I_{eff} - \pi U_L(T_r - T_a)\right] \quad \dots (27)$$

Where: D_t is the outlet diameter tube (58mm), d is the center dimeter tube (47mm), τ_e is the transmittance of the collector caver (between 0.6 to 1%), α_r is the solar absorptance of the collector (between 0.96 and 0.91), I_{eff} is the effective solar radiation, A_t is the projected area, $A_c$is the cross section area[14].[15].

3.3.2 Thermal analysis of heat exchanger

There heat balance for heater shown in fig .5, as follows [15]:

The heat transferred to the refrigerant can be calculation from the following equation:

$$Q_{R-410a} = \mathrm{m}C_{p(R-410A)}(T_{out} - T_{in}) \quad \dots (28)$$

The heat loss transferred from the water can be calculation from the following equation:

$$Q_{Water} = \mathrm{m}C_{p(Water)}(T_{out} - T_{in}) \quad \ldots (29)$$

Fig .4: The evacuated tubes **(solar collector).**

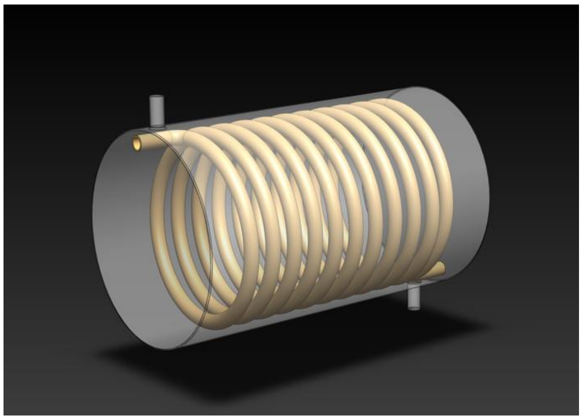


Fig .5: The heat exchanger (coil exchanger).

4. Results and discussion

This section describes the effectiveness of the system performance of the proposed method, in which two cases were inserted into the test facility, in the first case the solar collector was inserted before the compressor and in the second case; it was connected after the compressor to heat the refrigerant coming from the compressor.

The solar hybrid air conditioning system has proven to be highly effective in saving energy and improving practical cooling performance. Analytical study of a hybrid system with a cooling capacity of 1 ton (3.51 kW) using environmentally friendly R-410a refrigerant was conducted for the summer climate of the city of Nasiriyah in southern Iraq, where the solar radiation reaches (1000 W/m^2), and the numerical values that were made were Using official accounts is necessary for accounts.

The analytical study of the previous two cases was conducted on the hot climatic conditions in the city of Nasiriyah, southern Iraq, located at longitude (46.14 degrees) and latitude (31.15 degrees), which have a direct impact on the angle of incidence of solar radiation. Moreover, a solar radiation rate of up to 1000 W/m^2 measured with a radiometer. The required values shown in Tables (1, and 2) below were obtained:

Table (1): It shows the values and results for both cases studied (case one).

T Collector	h_x KJ/Kg	W_s KW % ES	COP	QL KW	QH KW	W_{comp} KW	Flow rate (m) Kg/s	$Q_{Collector}$ KW
case 1								
30	432.1	-15%	3.85	3.43	4.2	0.8904	0.017	-0.105
35	438.2	1%	4.31	3.43	4.2	0.7944	0.017	0.021
40	443.1	23%	5.75	3.43	4.2	0.5964	0.017	0.189
45	448.2	34%	6.69	3.43	4.2	0.5124	0.017	0.273
50	452.4	46%	8.87	3.43	4.2	0.3864	0.017	0.399
55	457.1	51%	11.34	3.43	4.2	0.3024	0.017	0.483
60	461.3	59%	22.07	3.43	4.2	0.1554	0.017	0.641
65	464.5	63%	34.23	3.43	4.2	0.1002	0.017	0.714
70	469.3	67%	51.12	3.43	4.2	0.0810	0.017	0.797

Table (2): It shows the values and results for both cases studied (case two).

T Collector	h_x KJ/Kg	W_s KW % ES	COP	QL KW	QH KW	W_{comp} KW	Flow rate (m) Kg/s	$Q_{Collector}$ KW

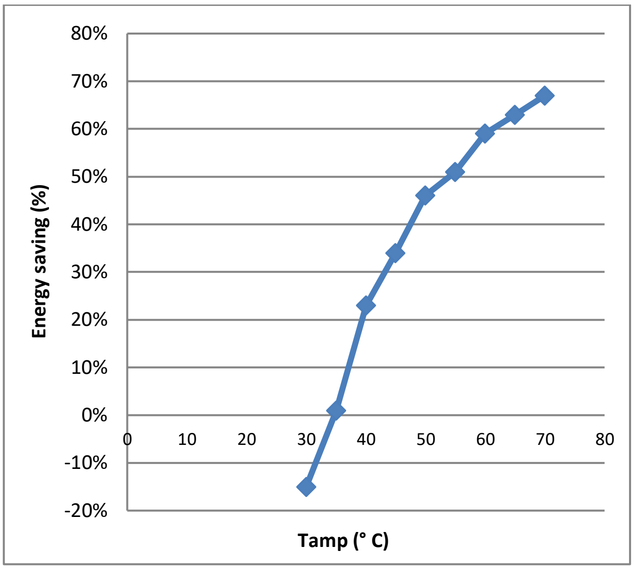
case 2								
100	498.4	12%	5.1	3.5	4.2	0.6868	0.017	0.119
110	510.7	14%	6.1	3.8	4.6	0.6243	0.016	0.328
115	516.5	15%	6.7	4.0	4.8	0.5935	0.016	0.411
120	522.4	17%	7.3	4.2	5.1	0.5723	0.015	0.527
130	531.4	18%	8.5	4.5	5.5	0.5283	0.013	0.681
140	542.7	19%	9.8	4.8	5.9	0.4907	0.012	0.872
150	556.2	21%	11.2	5.1	6.3	0.4578	0.011	1.102
155	561.2	22%	12.2	5.3	6.4	0.4347	0.011	1.204
160	567.3	24%	13	5.5	6.7	0.4293	0.011	1.291

Figures (6.a) and (6.b) depict how overall temperatures changed and how much energy was saved in two scenarios (first and second). due to lower pipes, to compare and circulate refrigerant. However, the ideal refrigerant temperature at which the compressor can run is no more than 55 ° C. In the case of modulation, the energy savings can reach 67% if the employed rotary compressor can handle high refrigerant return temperatures of up to 70 ° C higher. Therefore, the greatest amount of electrical energy that can be saved by the available refrigeration compressor will not be greater than 51% of the amount used to maintain the temperature of the refrigerator. While the highest average temperature of a refrigerator is up to 55 °C, in this second example, utilizing a solar collector and a pool measuring 1.8 square meters, the energy savings rate is up to 24%. In the first case, a higher temperature was measured from the collector than in the second.

Figures (7.a) and (7.b) show the change in the temperature of the comparative collector between the two cases (case 1 and case 2). From these figures, it can be seen that COP starts from 3.37 in the original case. The original values were selected from the mentioned sources and relied upon in the calculations of this paper. The rate increases from 3.85 to 51 as the temperature of the collected water increases in the first case. From this figure, it can be seen that the COP increased in the second case from the average from 5.1 to 13. The main reason for the increase in the performance factor in the first case is higher than in the second case is the decrease in the amount of energy consumed in the compressor cycle and as a result of the increase in the temperature of the refrigerant transmitted To the compressor at a temperature of 30 to 70 ° C. The transfer of particles is directly proportional to the temperature of the refrigerant in the pressure tube, and the gas is expelled and compressed towards the condenser. Thus, the improvement for drain significantly necessitates a reduction in the compressor's working effort to drive the gas into the condenser, while in the second case; the gas is heated after the compressor. Which only reduces 20% of the consumed compressor voltage and helps to increase the amount of cooling from three to five, which is one of the advantages of the second case and is more beneficial than the first. From this shape, the cup of the second case can also be small for the first, and this is due to a much smaller amount of energy expended in the first case.

Figures (8.a) and (8.b) show changes in cooling capacity using temperature collectors in two cases (cases 1 and 2). From these figures, it can be seen that the average cooling capacity remains a constant 3.43 kWincase1, but increases from 3.5 kW to 5.5 kW as the collector temperature increases. It is accompanied by an increase in the flow rate inside the pressure valve. Thus, a faster phase change and a lower coolant temperature are possible. As a result, it can be seen that the improvement in enthalpy helps to increase the cooling process and heat exchange and stabilize the cooling rate in the first case as a result of not changing the temperature and pressure of the refrigerant leaving the compressor, going to the condenser and to the pressure valve in the original state, without improvement in the conditions of the coolant. Exceeding the practical conditions of the annular compressor can also be expected, when the refrigerator temperature in the vents is 70 °C higher, the cycle compressor stops working (which leads to shutdown) and the cooling stops. The temperature obtained from the collector in the first case, resulting in a change in the state of the cooling water, a process that increases the tangible temperature (enthalpy) of the cooling water.

Figures (9.a) and (9.b) show heat removal in capacitor servers the collector temperature for two cases (cases 1 and 2). The two figures show that in the first case, the working capacity of the capacitor is constant at 4.2 kW, while in the second case it increases from 4.2 kW to 6.7 kW at a water temperature of 100 ° C. °C The increase in the amount of heat added to the coolant from the group indicates that the heating rate is stable in the first case because the temperature of the coolant in the condenser does not change. The conditions that the refrigerant goes through in the first case are very similar to the conditions in the original state of the modified system in the condenser stage. The reason for this is that the solar heater connected before the compressor is limited only to aid in compressor circulation without improving enthalpy ($\uparrow \Delta h$), since the gas exit from the compressor is similar to the conditions of the original case, within the possible heating limits that can be added to the gas before inside the gas compressor, as is the case, as previously discussed with respect to the first case. From this figure, we can also that the heating capacity of the first case is constant and the heating capacity of the second case is much smaller than that of the second case because the amount of heat obtained and added to the coolant at a rate of 100-160°C from the collector in the second case is higher than the combined temperature 30-70 ° C in the first case. Figure 10 shows the variance in COP system amplitude and system intensity with work required for the two studied cases (case 1 and case 2). It can be seen that the capacity of the refrigerant is constant in the first case, with an increase in the coefficient of performance due to a decrease in the amount of electrical energy consumed by the compressor, and on the other hand, in the second case, an increase can be expected with a decrease in the workload due to a decrease in the workload. From the heat added to the coolant from the freezer, and as a result, the physical conditions of the coolant are improved, including the saturation temperature, the proximity of the reflection point on the saturation line, increased particle movement, and the results of a change in the cooling phase. This leads to an improvement of the gas due to an increase in the flow velocity in the pressure valve stage, an increase in the cooling of the coolant temperature, and an increase in the heat exchange rate loading. Low heat immediately before compression or abandoned before entering the condenser stage, reduce the amount of energy consumed without exceeding the ultra-high temperature, which leads to stable cooling and performance efficiency, and increases the working pressure drop. It can be seen that there are characteristics of refrigerants in a conventional air conditioning system. From there, we can also that the refrigerant capacity of the first case is much lower than that of the second because the temperature and pressure obtained to improve the properties of the refrigerant for the second case help reduce the workload, reduce the heat and energy consumption of the compressor on the combined temperature of the containers First, the amount of Pressure to compress power is limited.



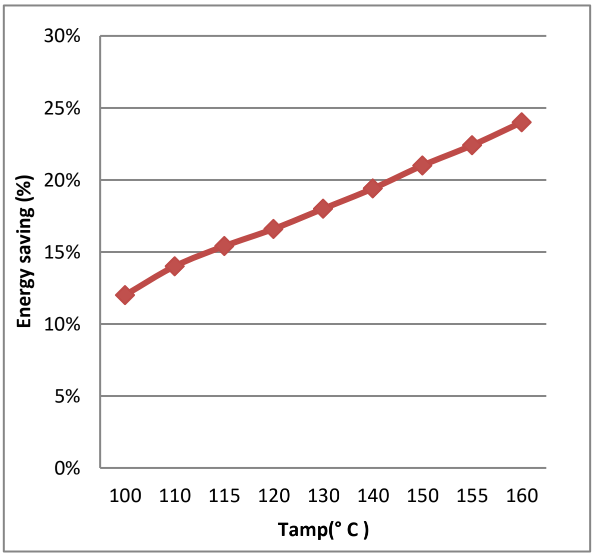
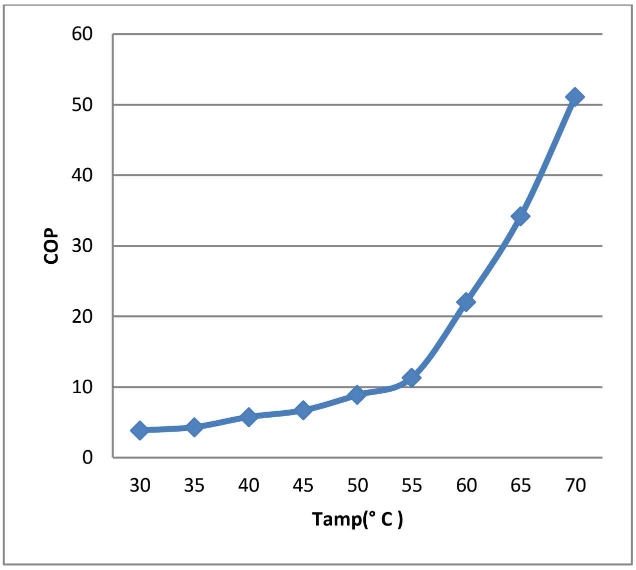


Fig (6.a): Energy saving case one. **Fig (6.b): Energy saving case two.**

Fig (6): Variation of energy-savings with the collector temperature for two cases (case one and case two).



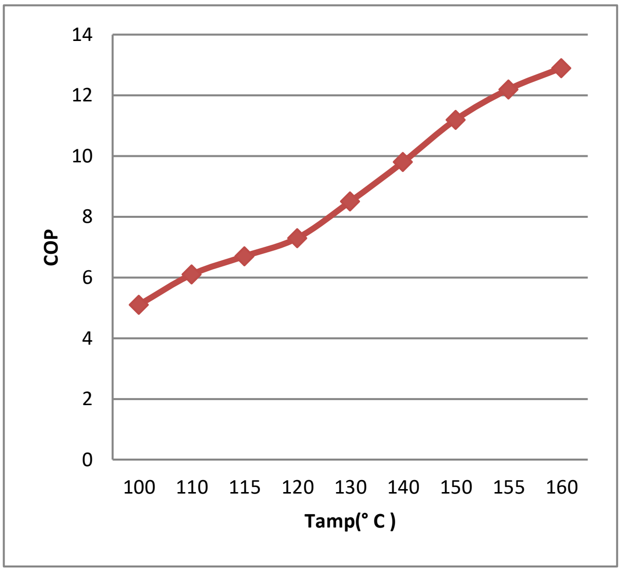
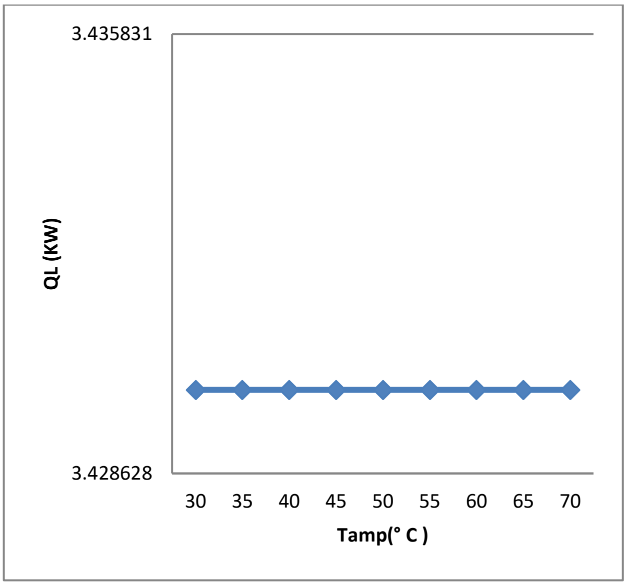


Fig .7.a: The COP with the temperature for in case one. **Fig.7.b: The COP with the temperature for case two.**

Fig.7 variation of the temperature refrigerant supplied from the solar collector tube with Coefficient of disease COP in two cases (case one and case two).



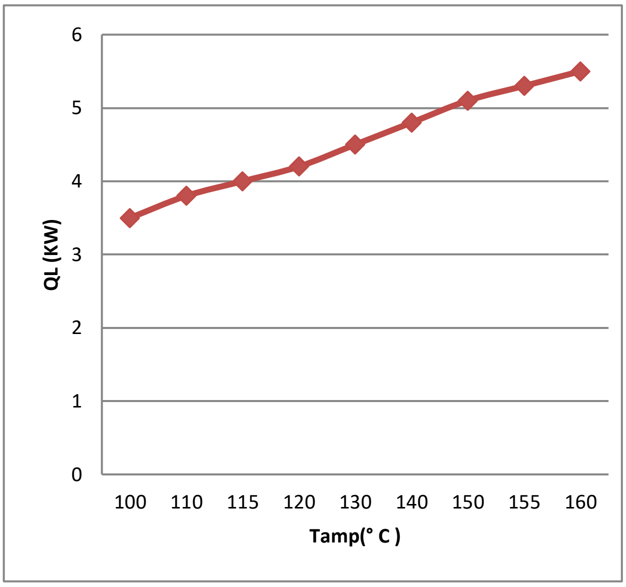
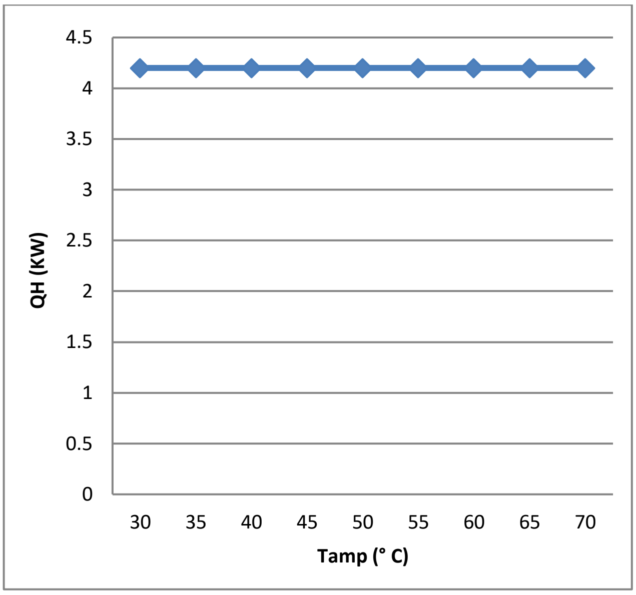


Fig (8.a): The Cooling capacity of the evaporator with Temperature for case one.
Fig .8.b: Cooling capacity of the evaporator with Temperature in case two.
Fig .8 Variation of the cooling capacity of the evaporator with collector temperature for two cases (case one and case two).



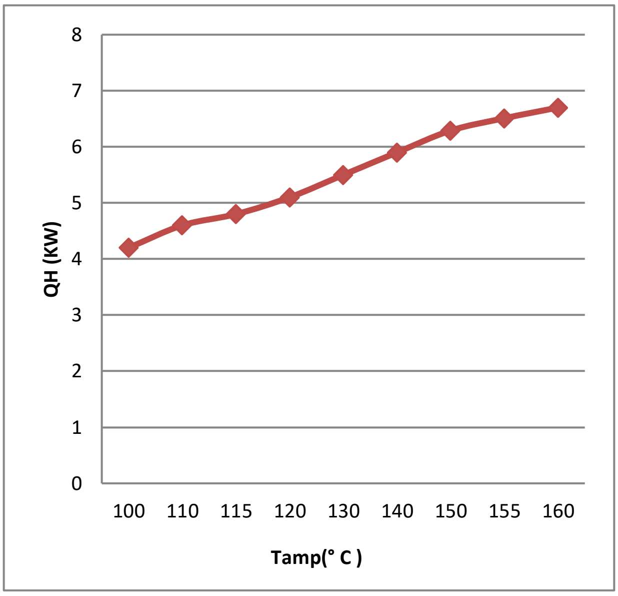


Fig .9.a: The condenser heat with the temperatures for case one. Fig .9.b: The rate of the heat removed in the condenser with the case of the temperature two.

Fig .9 Variation of the rate heating capacity for the condenser with the collector temperature for two cases (case one and case two).

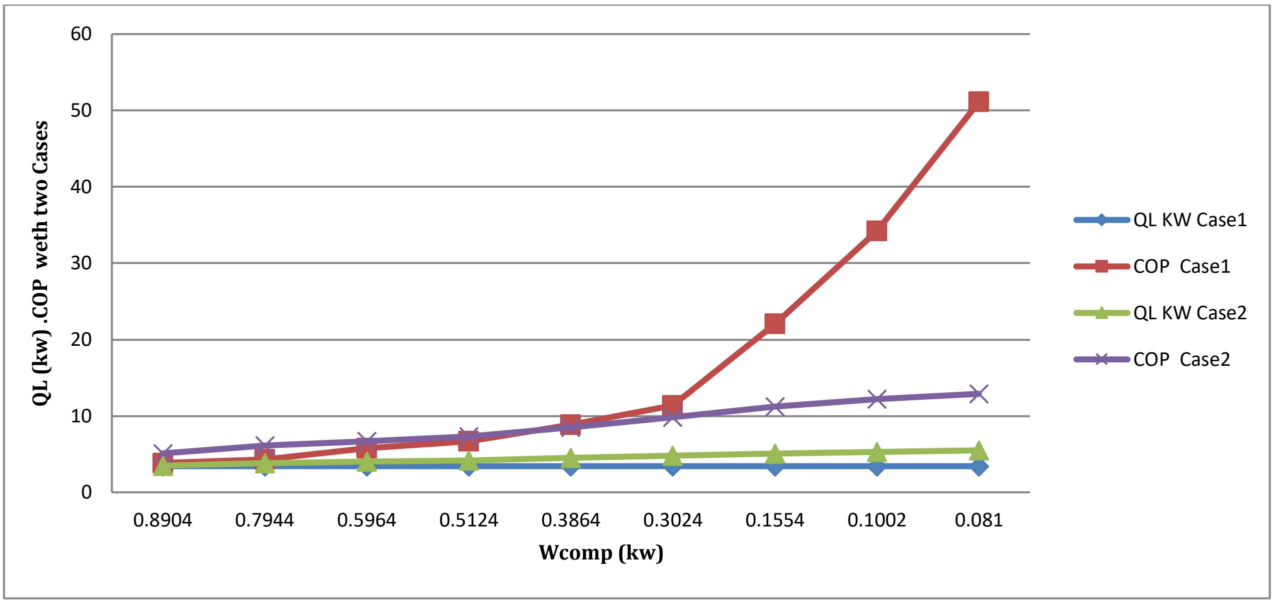


Fig .10 variations of COP and system cooling capacity QL with required work for two cases studied.

5. Conclusion

The results discussed for the performance of hybrid air conditioning systems with solar energy in the weather of the city of Nasiriyah has been made in two cases. The refrigerant gas of the type R-410a associated with the environment was used. In the first was the solar heater was connected before the compressor, while the heater was connected after the compressor in the second case. From the obtained rustle the following conclusions con be made:

- Renewable energy has been utilized. The heat emitted by solar radiation ranges from zero to 1000 W/ m^2 and averages 947 W/ m^2 per day.
- The solar heater was connected before the compressor in the first case, and the gas was heated from 30 to 70 degrees Celsius through the heater. The recorded results showed an increased energy savings with the increase in heater temperatures with an average of between 25% to 55% of the total energy consumed in the refrigeration cycle per day. The average work of the compressor ranges between 0.8904 to 0.016 where the gas is heated to temperatures ranging from 45 to 60 degrees Celsius, the highest temperature that the compressors can tolerate.
- The solar heater was connected after the compressor in the second case. The solar heater provided a significant improvement in the system's performance coefficient with an average range of 5.1to 13 and an amount of energy ranging from 12% to 24% of the total energy consumed. Thus, the improvement of the cooling load can be observed from 3.43 to 5.5 kW with temperatures from 100 to 160 ° C gradually.
- Through the results, it can be seen that the second case has a service advantage and much greater economic feasibility than the first case.
- Solar energy in terms of consumption Electric energy, economic cost and its impact on environment, be more effective of commercial refrigeration systems
- This proposed solar system is incompatible, economical and efficient with the weather in Iraq.

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