International Journal of Research in Science and Technology http://www.ijrst.com

(IJRST) 2022, Vol. No. 12, Issue No. II, Apr-Jun **e-ISSN: 2249-0604, p-ISSN: 2454-180X**

Design and Implementation of a Novel Energy-Efficient Air Cooler[1]

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DOI:10.37648/ijrst.v12i02.001

Received: 08 March 2022; Accepted: 10 April 2022; Published: 17 April 2022

ABSTRACT

The Water air conditioner or cooler is considered to be one of the most common cooling devices that are used in the area of the Middle East due to its simplicity, low cost, easy to move, and eco-friendly compared to other devices such as the Gas air conditioner or the split. Therefore, to reduce the consumed energy, we propose a method to feed the evaporated pads without the need to keep the water pump working all the time. This method can save energy up to %40.

Keywords: *water air conditioner, cooler, thermodynamics*

INTRODUCTION

Due to the high demand for electrical power especially in the last couple of summers when the temperature exceeds 50c in Iraq, it is become necessary to find some solutions regarding especially in terms of air cooling systems. In Iraq, the national power is coming 3 hours every 5 hours. As an alternative, in these 5 hours, the electricity from small generators in the neighbourhood is used to fill the gap of power for households. These small generators only can provide a limited number of watts for each house, which makes the use of split air conditioning very limited, and hence the water evaporator air cooler becomes a good alternative, especially since it consumes a smaller number of watts.

In Iraq as evaporator air coolers are an alternative solution to the split air condition, where split needs a high amount of power. Evaporator air coolers have different shapes and sizes starting from 1000 to 6000 cubic feet per minute CFM. Different sizes require different motors. However, mostly all evaporator air coolers have the same water pump.

MODEL STRUCTURE

The size of evaporator air coolers that we propose is 2500 CFM from the same material and structure as the normal evaporator air coolers in Figure 1 plus a timer in Figure 2 and small water reservoirs at the top of the windows as in Figure 3. The proposed one has the same size only 10 cm deeper and the reservoir is included in the windows and needs to include some holes to allow the water to drop on the pads directly and let the pads become wet and hence the air that goes through to cool down. Furthermore, two pipes organize the water between reservoirs and let the water through to the pads to be wetter.

As the device start, the timer will work directly and the water pump will work and pump the water to the top of the reservoir on the top of the windows. Hence the water starts to spill over the pads. The three reservoirs take one T_{on} minutes to fill up. After filling the water reservoir, the timer shut down, for about time Toff minutes while the water spilled on the pads at the same time due to the gravity. After this T_{off}, the timer will turn on the water pump again and fill the reservoir one more time. We work to optimize the Ton and Toff to obtain the highest energy saved based on the size of the device.

$$Min)_{Ton,\ Toff)} \quad \text{consumed energy}$$

$$\text{s.t: size of the evaporator air cooler} \qquad (1)$$

$$\text{and } T_{off} > T_{on}$$

To find the Ton and T_{off}, we study the energy via some charts as in the next section.

IMPLEMENTATION OF THE PROPOSED METHOD:

A- The proposed method

Our method states that we turn on the water pump for one and half minutes and off for 10 minutes. Figure 1 shows the proposed water air conditioner, it looks the same as the ordinary one, but this has a timer as in Figure 2 and a reservoir on the top of the windows as in Figure 3.

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[1] *How to cite the article:*
Fadheel M.F., Design and Implementation of a Novel Energy-Efficient Air Cooler, IJRST, Apr-Jun 2022, Vol 12, Issue 2, 1-5, DOI: http://doi.org/10.37648/ijrst.v12i02.001

(IJRST) 2022, Vol. No. 12, Issue No. II, Apr-Jun **e-ISSN: 2249-0604, p-ISSN: 2454-180X**

Figure 1. The evaporator air cooler.

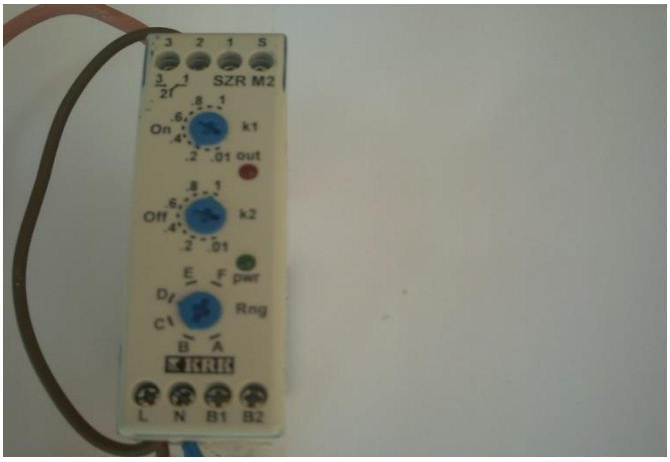

Figure 2. The timer

Figure3. The proposed evaporator windows

B-The performance metrics

To find the impact of our proposed method we used two home meters, as in Figure 4, to measure the energy consumed for the conventional and the proposed method to see the impact. The air conditioner that is used to implement the ordinary and the proposed methods have the same specifications: for the motor and water pump in terms of size and speed and also the same pads.

Figure 4. Two home meters A and B to compare the energy consumption of the proposed and the conventional air conditioner.

RESULTS AND DISCUSSION

The temperature and the humidity have been measured for one day in June, which is a very hot month in Iraq, and the results have been recorded and compared to display the performance of both methods.

i- Calculating the cooling air efficiency:
The formula to calculate the efficiency is as follow:

$$\eta = (t1-t2)/(t1-tw) \qquad (2)$$

where t1 is the temperature in the surrounding air of the conditioner, t2 is the temperature of the air out of the condition are vent, tw is the inside temperature. The efficiency of both air conditioners A the proposed one and B the old one is listed in the following table

Table 1. The calculation of the cooling efficiency for both air conditioners.

	t1	**t2**	**tw**	**η**
Conditioner A	36.7	22.4	22.1	97.7
Conditioner B	36.7	22.4	22.1	97.7

From Table 1, we notice that both conditioners are good to provide cool air out.

As the Psychrometric chart program report represents the cooling efficiency of an air conditioner, Figure 5 shows the Psychrometric chart program for AC (A) and Figure 6 shows the Psychrometric chart program for AC (B). Both figures show similar results, which also emphasize the state of both conditioners have the same cooling efficiency.

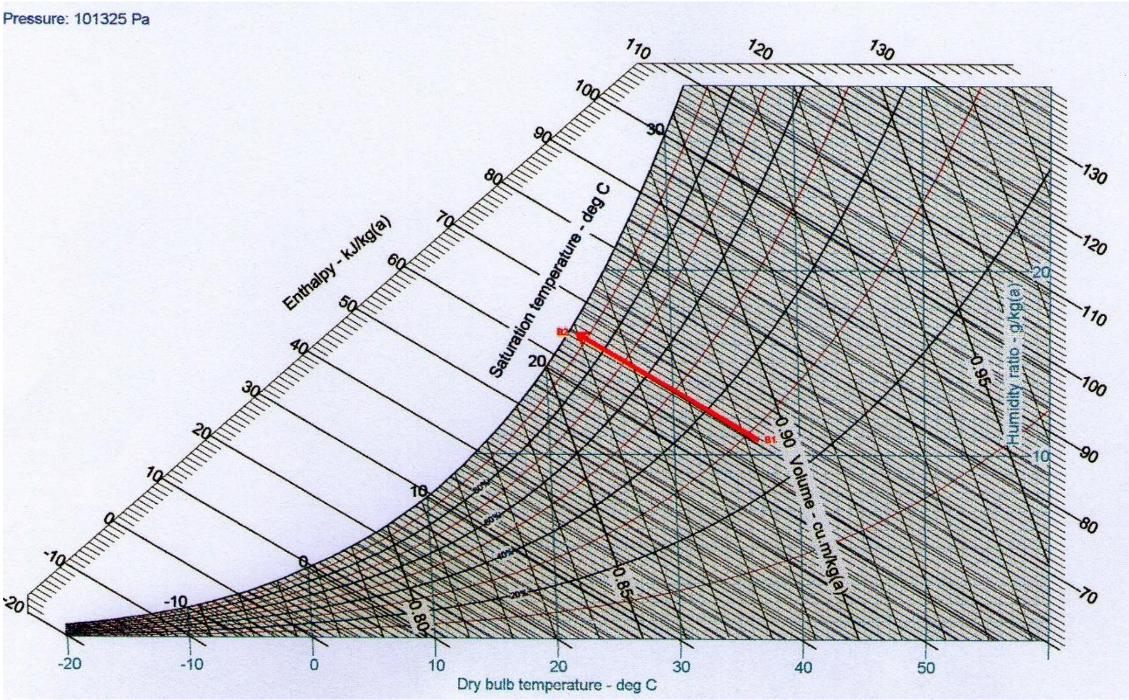

Fig 5 Psychrometric chart program for AC (A).

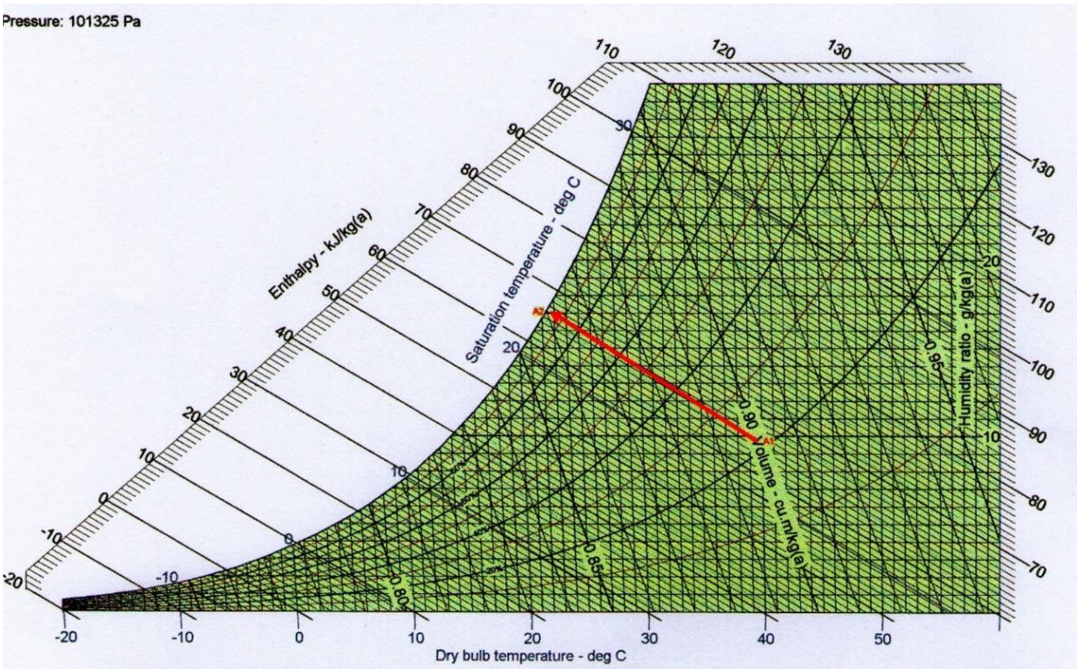

Fig 6, Psychrometric chart program for AC (B).

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However, in terms of energy consumed, it will be discussed next.

ii- Calculating the consumed energy

The energy consumed for air conditioner (A) was 7.7kW for 24 hours, while for (B) was 9 kW for the same period. To calculate the amount of saved energy:

9-7.7 =1.3 kW for 24 hours or 0.05416 kWh i.e., 54.16 watt-hour.

This means we saved around 54 watt-hour in the new conditioner for the same cooling efficiency. Now, for about 10 million conditioners that we have in Iraq, we can save up to 541600 kWh or 541.6 MWh, which will save money and keep the environment clean.

CONCLUSIONS

By adding a small reservoir on top of the windows of the water-air conditioner, we are able to save energy up to 541.6 Mwh for the same cooling performance. The proposed method uses a water reservoir and a timer to control the water cycle inside the conditioner to keep the water pump off for some time. This has a high potential to perform very well on energy saving.

ACKNOWLEDGMENT

The author would like to acknowledge the General Directorate of Electricity Production / Northern Region and the Ministry of Electricity for all the support.

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