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# Heat Transfer Performance Improvement in the Split Units in Humid Environment through Drain Water Circulation

***Abstract***- *The only way to ease extremely hot days during the summer is to resort to cooling systems to feel comfort. This idea brings an end to failure in cooling process to hot summer days, energy saving, and lets you rest. By recycling the water drained from the indoor unit through simple distributor fixed on the outdoor unit. There is two advantages due to rapid vaporization of the compensating draining by fan during hot air of weather: avoid the corrosion due to using the drain water in the cooling process, and get rid and consumption of the draining water to avoid any problem where place drained. The drain water is almost high purity (TDS < 50 ppm), and dust-free by filters of indoor unit lead to no salts accumulation, and reduce probability of fins corrosion of outdoor heat exchanger in salt medium. Experimental results indicate that the increasing of the heat transfer is obtained by using low temperature water, which ranging (5-15 °C) and the decreasing depend upon the hot air (30-55 °C), over the temperature during the summer in Iraq as well as the difference values in heat capacities between air and water. Applying this idea will result in power consumption reduction by the range (1 – more than 4 Amperes).*

***Keywords***- *Heat transfer, Split units, Drain water, Humid environment, Outdoor unit.*

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## 1. Introduction

Air conditioners are increasingly used to improve the comfort levels, and quality of life as well in modern civil life. The heating and the cooling are making up around 50% of Europe's energy demand [1]. The mainly difference between the system based on cooled of water mechanism and the condensation of air system is the first uses levels the lower of degree of the temperatures in the cooling equipment, so power consumption and equipment cost, performance maybe lower. Yet, the using of water as a condensation tool in evaporative condensers and cooling tower has connection with maintenance complications and biological dangers as well as, as the case with legion ellosis outbreaks [2]. Based on above-mentioned concepts, medium and small energy air conditioning use air as a technique of condensing [3]. The widely used approach for improving the performance of split is to decrease the surrounding inlet airflow degree of temperature by using a pad as evaporative cooling. Experimental work are conducted in a split unit where the condensing unit is adjusted by doubling various pads with different thickness. The effect of the various pads of the cooling on split unit's performance generally is experimentally calculated by gauging the airflow conditions and the power consumption of the split unit as a whole, including the condenser fan and the pump of water recirculation fixed on the pads of cooling. The objective is to learn about the power efficiency improving done by precooling the surrounding airflow compared to a traditional air-condensed part and to determine the best thickness of pad, generally that highly increase the total Coefficient of Performance (COP) of air-conditioner [4]. Many researches have been achieved to enhance the cooling capacity but nobody have tried to use drain water, which is condensing by cooling process. Table 1 shows the comparison for some thermal properties of air and water.

**Table 1: Air and water properties [5]**

| Fluid | T °C | Latent heat, $L_v$ (Kj/kg) | Heat Capacity j/kg K |
|---|---|---|---|
| Water | 5 | 2489 | 4202 |
| | 10 | 2478 | 4192 |
| | 15 | 2470 | 4186 |
| Air | 30 | --- | 1005 |
| | 40 | --- | 1007 |

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The heat should gains from latent, tending to cause a rise in the temperature of air, or sensible, causing an increase in relative humidity. In comfort air-conditioning sensible gains from the sources:

1. Radiation of the solar into walls, roofs, and windows.
2. Transmission through the building envelope and by the natural infiltration of warmer air from surrounding.
3. People.
4. The heat of lighting causes by the electric power.
5. Machines for business.

Latent heat gains are due to the presence of the natural infiltration of humid air from outside [6].

The experimental results show the coefficient of performance (COP) reaches 3.45 at wet-bulb temperature 27$^o$C at split water-cooled air conditioner [7].

The objectives of this work are:

1. Improve the cooling performance of the split unit through circulation of water drain.
2. Investigation of energy saving when using drain water for cooling outdoor unit of the split.

## 2. Experimental Work

The total dissolved solids (TDS) contain are the total amount of the minerals and impurities. TDS level could be monitored to make sure that the drain water does not cause corrosion or blocks problems in fins of outdoor unit.

Water drain distributor like triangular prism 45-angled 80 cm long has seven holes 10 cm between each one hole and the next, put up to heat exchanger of outdoor unit. In this distributor, the drain has been collected and distributed over fins of outdoor heat exchanger as shown in Figure 1. Amperes has been measured by clamp meter device for various temperature range (30-55 $^o$C) before and after drain water using.

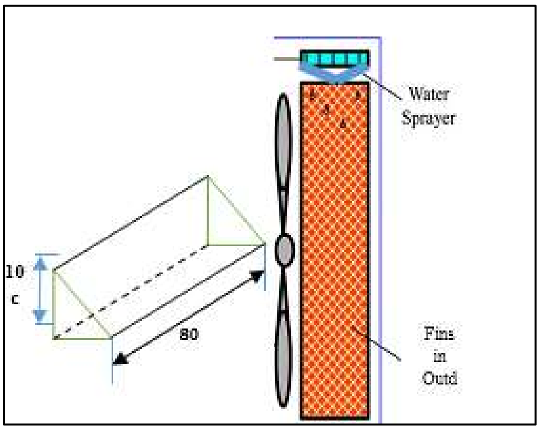


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**Figure 1: Triangular prism distributor for drain water**

## 3. Results and Discussion

In this regarding here, we have to discuss the advantages and limitations of using drain water circulation to improve the performance of the split unit, exactly the outdoor unit of air conditioning.

**Fin corrosion:** The drain water is almost high purity of average level of TDS < 50 ppm, and dust-free by filters of indoor unit lead to no salts or dust accumulation, and reduce probability of fins corrosion of outdoor heat exchanger in salt medium, as shown in Figure 2.

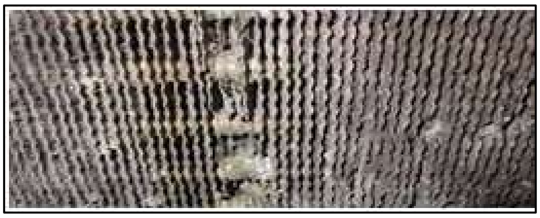

**Figure 2: Fins corrosion and salts accumulation of outdoor heat exchanger**

Air expands in the case of high temperature, thus reducing the amount of mass flow in the outdoor unit and thereby reducing heat transfer in the unit rate (decreasing in the cooling rate). However, there was an urgent need to improve to get rid of the accumulated heat using drain water. Relative humidity rises if the temperature have increased, and thus the value of the relative humidity is higher the hotter days, that is led to increase the flow rate of the drain water. When the temperature increased, the best of the efficiency in this work by increasing the efficiency of the cooling process in the outdoor unit.

Table 1, shows the heat capacity of water has four times higher than the heat capacity of air and this makes the cooling efficiency multiply when using drain water. The total heat transfer through outdoor unit are by the vaporization process of drain water and the heat convection.

$$q = mL_v + h_a A(T_{fins} - T_a) \quad (1)$$

Where:

q: heat flux has rejected, KW.

m: mass flow of drain water, kg/s.

$L_v$: Latent heat of water vaporization, Kj/kg.

$h_a$: Heat transfer coefficient, Kw/m$^2$K.

A: Total surface area of fins in outdoor unit, m$^2$.

$T_{fins}$-$T_a$: Temperatures of fins and ambit.

Figure 3, shows the deviation between experimental and theoretical number of Amperes saved in this work, this deviations might due to the heat could loss into the surrounding.

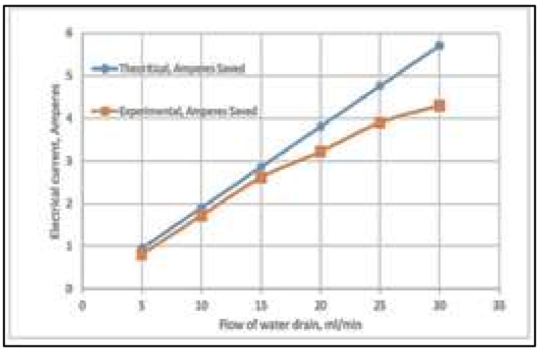


**Figure 3: Relationship between flow of drain water and number of Amperes saved in this work**

The first term of equation 1 is responsible of the increasing in the heat transfer flux by vaporizing of drain water drops that have be sprayed on the fins surface. Equation 3 has been obtained by least squared regression line in Excel software with square correlation coefficient ($R^2$) equal to 0.9836, as shown in Figure 4. Theoretical electrical current have saved in this work could be calculate by equalizing of the power $mL_v$=Voltages x number of Amperes, with average voltages in Iraq/Baghdad are 217 volts. The power P in watts (W) equals to the current *I* in Amperes (A), multiply the voltage *V* in volts (V).

$$P_{(W)} = I_{(A)} \times V_{(V)} \quad (2)$$

Watt = amp × volt

$$TheoA=0.378ExA + 0.3 \quad (3)$$

Where:

**TheoA:** Theoretical electrical current have saved and obtained by equation (1), Amperes.

**ExA:** Experimental electrical current have saved and measured, Amperes.

This research should has the two following advantages due to rapid vaporization of the humidity condensation by fan during hot air:

- Avoid the corrosion due to using the discard water in the cooling process.
- Get rid and consumption of the draining water to avoid any problem where place drained.

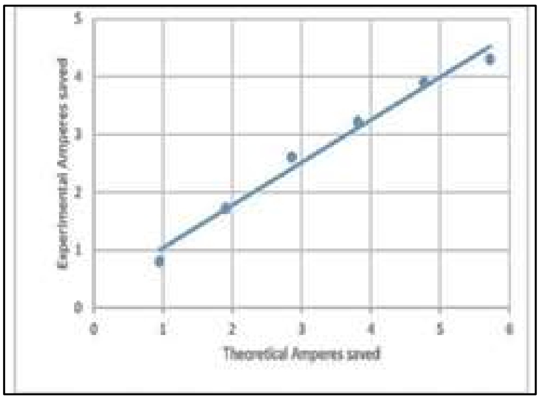


**Figure 4: Correlation between experimental and theoretical number of amperes saved with $R^2$ =0.9836**

### Limitations

- Most suitable in humid environment, for example south of Iraq or Gulf states (i.e. this point means advantage in these areas).
- Outdoor unit could be put at location level lower than indoor unit to transfer the drain water by gravity anything else should use small pump.

## 4. Conclusions

This work has gave many advantages have been concluded in the following points:

1.Increasing the heat transfer due to the use of water vaporization at a low temperature ranging from 5 to 15 °C beside the convection of the hot air (30-55 °C), over the temperature in the summer in Iraq as well as the difference values in heat capacities of air and water.

2. Usually the consumption electrical power was increasing that has related to increasing of weather temperature.

3.Meets the demanding needs to solve the failing of cooling process at so hot days or peak time (>`45 °C) by increasing of heat rejection in outdoor unit by using drain water.

4. Reject heat by vaporization process of the drain water on the outdoor heat exchanger.

5. Synchronous washing for outdoor heat exchanger by water discard.

6. No additional power has needed.

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