Journal of Science and Engineering Applications Vol. 8, No. 2, pp. 101–172, October 2026

Journal of Science and Engineering Applications

Contents are available at https://jsea.iujournals.com

Improving the performance of a split air conditioner system using dual fans

Zaid Dakhil Hadi [1,2*], Hassan J. Dakkama [3], Wisam A. M. Al-Shohani [1]

[1]*Department of Mechanical Power Engineering, Technical Engineering College-Baghdad, Middle Technical University, Baghdad, Iraq*
[2]*Refrigeration and Air-conditioning Department, Technical Engineering College, The Islamic University, Najaf, Iraq*
[3]*Department of Mechanical Power Engineering, Technical Engineering College-Baghdad, Middle Technical University, Baghdad, Iraq*

ARTICLE INFORMATION

Received date: 14-03-2026
Revised date: 18-06-2026
Accepted date: 22-08-2026

Keywords

split air conditioner
coefficient of performance
dual fan

ABSTRACT

Air conditioning systems such as split air conditioner (SAC) systems are commonly used in homes, offices and commercial buildings, leading to increasing in energy consumption. In this paper, an experimental study has been carried out to investigate the performance of a split type with a dual fan during the season summer in Iraq. The aim of using a dual fan in the SAC unit is to improve heat transfer in the condenser of the unit. Thus, this improves the heat transfer of the condenser, increases the cooling effect, and enhances the coefficient of performance (COP). The maximum air flow rate of the two fans is 0.7 m3/s at an outdoor air temperature of 42ºC, and the minimum is 0.3 m3/s for one fan. The results showed that using dual fans reduced power consumption by 2%, while the COP increased by 9.1% at ambient temperature 42°C.

1. Introduction

Air conditioner systems are commonly used in residential home, such as window or split units, to remove heat during the operational cycle. The coefficient of performance (COP) of a vapor compression refrigeration system (VCRS) decreases by about 2–4% when 1 °C increases the condenser temperature [1]. Split air conditioner (SAC) are easy to install, small, and used in hotels, commercial offices, and homes for cooling and heating [2]. In the United States in 1993, air conditioning accounted for about 67% of electricity consumption, while in 2009, electricity consumption rose to 87 % [3]. As the air temperature rises, the compressor's electricity consumption increases, reducing its cooling effect. As a result, the energy efficiency of the VCRS system is reduced. The energy consumption of appliances such as air conditioners and refrigerators accounts for approximately 20% of total electricity consumption.
Improving the efficiency of the refrigeration cycle can be achieved by reducing power consumption, enhancing the heat rejection of the condenser, or minimizing the pressure difference between the condenser and evaporator [4]. The air conditioning systems can be improved by reducing the energy consumption of the compressor, pressure ratios of the condenser and evaporator, and increasing the heat rejection of the condenser [5].
Researchers worldwide use many techniques [6]. Benamer and Clodic [7] investigated to compare the

Corresponding authors: Refrigeration and Air-conditioning Department, Technical Engineering College, The Islamic University, Najaf, Iraq.
E-mail addresses: zaidabedi586@gmail.com (Zaid Dakhil Hadi)

energy consumption of variable-speed and fixed-speed scroll compressors in a refrigeration system. The findings indicated that as the heat load decreases, the energy savings associated with variable-speed compressors increase. In fact, a variable-speed compressor can achieve up to 40% savings in power consumption. Jiang et al. [8] assessed the impact of condensing heat recovery on the dynamic behaviour and efficiency of air conditioning systems. [4] Studied the effect of airflow rate on COP and power consumption. Used a 2.64 kW capacity air conditioner utilizing R-22. The study was conducted at the highest air flow rate of 0.43 m³/s and the lowest of 0.28 m³/s, with an ambient temperature of 42°C. Additionally, the refrigerant flow rate was varied according to the evaporator load. The room temperature was maintained at 24-26 ºC during the test. The results indicated a 28% increase in the COP of SAC at a condenser entering air temperature of 42ºC. Additionally, the compressor power was reduced by 15%.

The study showed that condensing heat recovery adversely impacts cooling capacity during the first phase of the heat recovery process, but the average COP of the system is enhanced.

Based on previous reviews, the dual-fan system has been used mainly in large-scale systems, such as commercial chillers. The use of this technology in residential SAC has not been extensively studied. This research primarily aims to investigate the effect of improving condenser temperature using a dual-fan system on the energy consumption and COP of SAC during the summer session in Iraq.

2. Mathematical Equations

The total power input is calculated using Eq. (1) [9].

$$P_T=P_{comp}+P_{fan\ Cond}+P_{fan} \quad (1)$$

Where P_{Comp} the compressor work (W), $P_{Fan\ Cond}$ refers the fan condenser work, P_{Fan} refers to the power of the additional fan (W).

The compressor power input is calculated using Eq. (2) [10].

$$P_{comp}=V_{comp}\times I_{comp}\times COS\theta \quad (2)$$

Where V comp refers to the voltage supplied to the compressor (V), I Comp is the compressor's current (A), and cos θ represents the power factor, which is typically about 0.85.

Using Equation (3) to determine the refrigeration effect [11].

$$RE=h_1-h_4 \quad (3)$$

Where Q_e the refrigeration effect of the system (kJ/kg), and h_4 the enthalpy before the evaporator (kJ/kg).

The COP is the ratio of the refrigeration effect (RE) to the work input (W_T), as expressed in Eq. (4)[11].

$$COP=RE/W_T \quad (4)$$

The improvement in the COP can be calculated as in Eq. (5) [12].

$$\varepsilon=\frac{COP_{\text{Dual Fan}}-COP_{single\ fan}}{COP_{with\ single\ fan}} \quad (5)$$

Where $COP_{\text{Dual Fan}}$ is the COP of SAC unit with dual Fan, and $COP_{\text{single fan}}$ is the COP of split type unit with Fan.

3. Experimental setup

In the experiment, a 3.5 kW SAC, using R-410A, was used to test the improvement in condensate heat rejection and its effect on split system performance and electrical power consumption, as shown in the Figure 1. A SAC system consists of the basic components of a vapor compression system: a compressor, a condenser, a capillary tube, and an evaporator. It also includes a fan in both the evaporator and condenser, as shown in the Figure 2. The experiment was conducted in a room measuring 3 m in length, 3 m in width, and 2.8 m in height, with the temperature maintained at 26 °C. The specifics of data recording for each test were as follows: Evaporator inlet temperature (T_3) and evaporator outlet temperature (T_4). Condenser inlet temperature (T_1) and condenser outlet temperature (T_2). Condenser inlet pressure (p_1) and evaporator outlet pressure (p_4).

The table shows the results using a conventional single-fan split system and a two-fan split system as shown in the table 1. The fan is positioned behind the condenser unit, which is constructed from galvanized iron. The condenser unit is equipped with an additional 100W maximum power fan operating at 1430 RPM and an airflow rate of 1,400 cubic meters per hour.

Table 1. Results from Experiments with One Fan and Two Fans.

Parameter	Unit	One fan of SAC	Dual fan of SAC
Condenser inlet air temperature	ºC	42	42
Condenser inlet air relative humidity	%	33	33
Compressor inlet temperature	ºC	22	21
Condenser inlet temperature	ºC	83	81
Condenser exit temperature	ºC	49	47
Evaporator inlet temperature	ºC	21	20
Condenser pressure	psi	450	445
Evaporator pressure	psi	145	140
Input Power consumption of split	kW	0.935	0.916



Figure 1.Photo of the SAC unit.

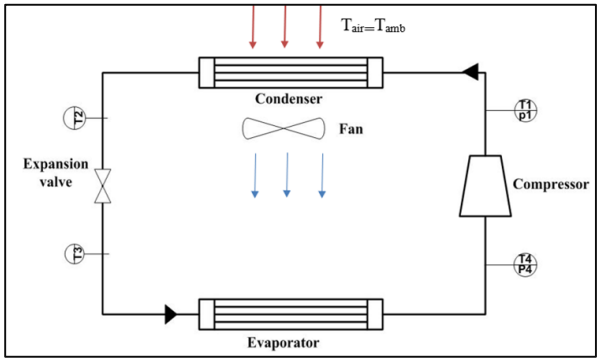


Figure 2. Conventional SAC system.

The measuring devices used in this test are: 1) thermocouples to measure the temperatures of the condenser, and refrigerant at different points in the cycle, 2) Bourdon gauge to measure the pressure in the cycle, 3) a clamp meter to measure the current and voltage, and 4) digital thermometer to measure the ambient temperature. The ambient air temperature, humidity, and gas temperatures before and after the condenser and evaporator, as well as their pressures, were then recorded. The experiment also recorded the power consumption of both the compressor and fan in the split type. After the additional fan was switched on, data were recorded for half an hour and every five minutes. Figure 3 shows a split unit with two fans and a measurement device.

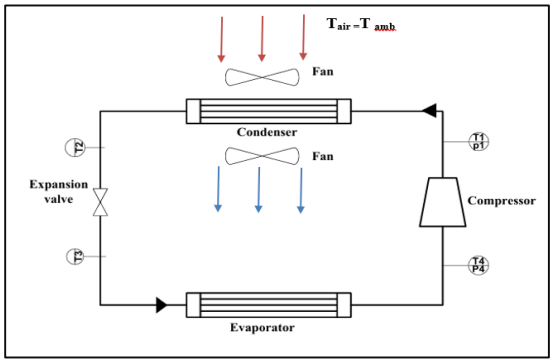


Figure 3. Modified SAC system with dual fans.

4. Results and discussion

The thermodynamic properties of refrigerant 410 A at different points in the cycle were determined from experimental results, as shown in Fig 4.

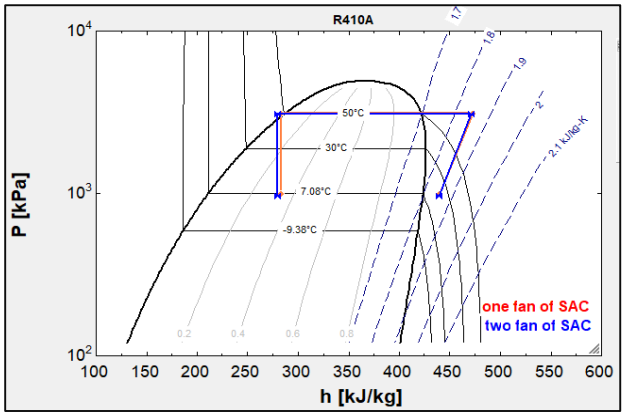


Figure 4. P-h diagram for a single fan and a two-fan SAC.

4.1 Effect dual fans on power consumption of SAC

The experiment used a dual fan and was conducted at an ambient temperature of 42 °C, as shown in Figure 5. The results demonstrated that the reduction in power consumption from 0.935 kW to 0.916 kW because of improving the effectiveness of the condenser, which led to a lower pressure ratio, which reduced the compressor's power consumption.

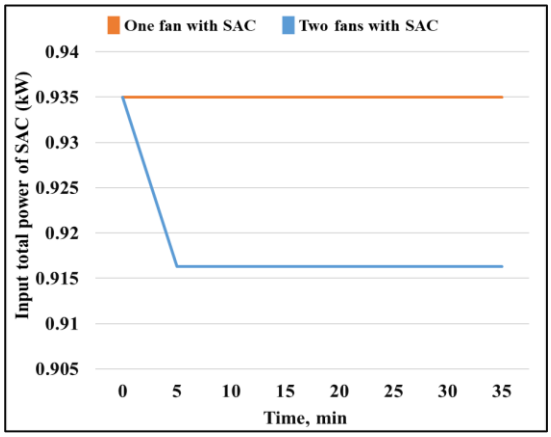


Figure 5. Power consumption of SAC with single and dual fans.

4.2 Effect dual fans on coefficient of performance of SAC

The experiment employed a dual fan system and was conducted at an ambient temperature of 42 °C, as illustrated in Figure 6. The results indicated an enhancement in the COP from 4.59 to 5.01, resulting from improved heat transfer in the condenser, which lowered the pressure ratio within the system.

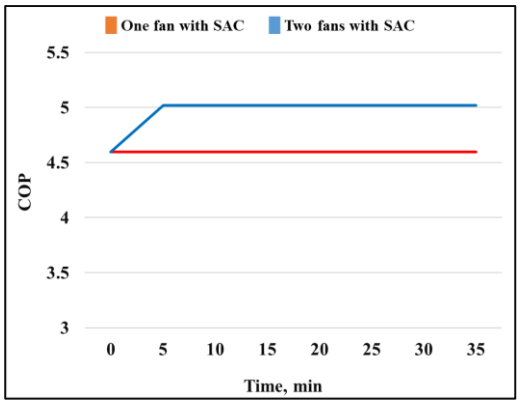


Figure 6. COP of SAC with a single and dual fan.

4.3 Effect of dual fans on refrigeration effect of SAC

Figure 7 illustrates that the experiment was conducted using a dual fan under an ambient temperature of 42 °C. The results showed an improvement in cooling capacity, which increased from 156.3 kJ/kg to 160.6 kJ/kg due to enhanced heat transfer in the condenser. This improvement led to a reduction in the pressure condenser, which decreased the load on the compressor, thereby further enhancing the cooling capacity of the system.

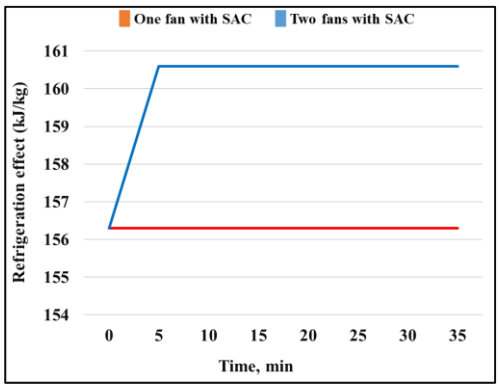


Figure 7. Refrigeration effect of SAC with single and dual fans.

5. Conclusions

In this study, an experimental investigation was conducted to enhance the cooling capacity and reduce the power consumption of a conventional SAC by employing a dual fan during the summer season in Iraq. Based on the findings presented above, it can be concluded that:

- Increasing the COP by 9.1% of the SAC unit.
- Decreasing the power consumption by 2% under outdoor weather conditions of 42°C DBT and 32% RH.
- Improving the refrigeration effect by 2.92%.

Overall, it can be concluded that the using of the dual SAC can enhance the overall performance of the SAC specially that used in the harsh environment countries.

References

1] Y. A. Cengel, “Thermodynamics: an engineering approach.” McGraw-Hill, 2011.

[2] M. Ramzan, M. S. Kamran, M. W. Saleem, H. Ali, and M. I. M. Zeinelabdeen, “Energy Efficiency Improvement of the Split Air Conditioner Through Condensate Assisted Evaporative Cooling,” *Arab. J. Sci. Eng.*, vol. 46, no. 8, pp. 7719–7727, Aug. 2021, doi: 10.1007/s13369-021-05494-x.

[3] B. Hojjati and S. H. Wade, "US household energy consumption and intensity trends: a decomposition approach," *Energy Policy*, vol. 48, pp. 304–314, 2012.

[4] A. O. Elsayed and A. S. Hariri, "Effect of Condenser Air Flow on the Performance of Split Air Conditioner," *Proc. World Renew. Energy Congr. – Sweden, 8–13 May, 2011, Linköping, Sweden*, vol. 57, pp. 2134–2141, 2011, doi: 10.3384/ecp110572134.

[5] K. Harby, D. R. Gebaly, N. S. Koura, and M. S. Hassan, "Performance improvement of vapor compression cooling systems using evaporative condenser: An overview," *Renew. Sustain. Energy Rev.*, vol. 58, pp. 347–360, 2016, doi: 10.1016/j.rser.2015.12.313.

[6] K. J. Chua, S. K. Chou, W. M. Yang, and J. Yan, "Achieving better energy-efficient air conditioning - A review of technologies and strategies," *Appl. Energy*, vol. 104, pp. 87–104, 2013, doi: 10.1016/j.apenergy.2012.10.037.

[7] A. Benamer and D. Clodic, "Comparison of energy efficiency between variable and fixed speed scroll compressors in refrigerating systems," *Proc. Technol. Innov. Refrig. air Cond. food Ind. into third Millenn.*, pp. 1–8, 1999.

[8] M. L. Jiang, J. Y. Wu, Y. X. Xu, and R. Z. Wang, "Transient characteristics and performance analysis of a vapor compression air conditioning system with condensing heat recovery," *Energy Build.*, vol. 42, no. 11, pp. 2251–2257, 2010.

[9] E. Hajidavalloo and H. Eghtedari, "Performance improvement of air-cooled refrigeration system by using evaporatively cooled air condenser," *Int. J. Refrig.*, vol. 33, no. 5, pp. 982–988, Aug. 2010, doi: 10.1016/j.ijrefrig.2010.02.001.

[10] E. Hajidavalloo, "Application of evaporative cooling on the condenser of window-air-conditioner," *Appl. Therm. Eng.*, vol. 27, no. 11–12, pp. 1937–1943, Aug. 2007, doi: 10.1016/j.applthermaleng.2006.12.014.

[11] B. Shah, S. Dwivedi, and A. Singhal, "Energy saving in split air conditioner using evaporative cooling pad at the ODU," *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 1, pp. 1858–1862, Nov. 2019, doi: 10.35940/ijitee.A4765.119119.

[12] K. Harby and F. Al-Amri, "An investigation on energy savings of a split air-conditioning using different commercial cooling pad thicknesses and climatic conditions," *Energy*, vol. 182, pp. 321–336, Sep. 2019, doi: 10.1016/j.energy.2019.06.031.