Journal of Research and Applications in Mechanical Engineering
ISSN: 2229-2152 (Print); 2697-424x (Online)
(2020) Vol. 8, No. 1, 77-83
DOI: 10.14456/jrame.2020.9

Research Article

PERFORMANCE EVALUATION OF THE SEMI-AUTOMATIC CLEANER FOR SPLIT TYPE AIR CONDITIONER

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Received 7 January 2020
Revised 6 May 2020
Accepted 14 May 2020

ABSTRACT:
This article aims to experimental investigate the application of a semi-automatic cleaner as cleaner for split type air conditioner. The study focused the evaporator where is located inside the room. The evaporator has a disadvantage when dust is accumulated on the outside of the evaporator tube. To solve this problem, in this investigation we used a semi-automatic cleaner as a cleaner instead of hand washed by human. Experiments will be divided into three cases: before washing, after hand washed and after being rinsed by the semi-automatic cleaner. Each test will be tested of three times. The semi-automatic cleaner for split type air conditioner was designed using two high pressure nozzles for cleaning both sides of the evaporator panel and controlled by a microcontroller. Finally, all three test results will be compared by Coefficients of performance (COP) and the energy efficiency ratio of the air conditioner (EER), respectively. It was found that the COP of the three cases, before washing, after hand washed and after rinsed by semi-automatic cleaner were 2.9, 3.4 and 3.8, respectively. While the EER with the same three tests were 9.8, 11.7 and 12.9, respectively. When the case of the after rinsed by semi-automatic cleaner was compared with the case in before washing and after hand washed, it was found that the COP in case after rinsed by semi-automatic cleaner were increased by about 31 and 11.8 %, respectively. In addition, EER in case after rinsed by semi-automatic cleaner were increased by about 31.6 and 10.3 %, respectively. It can be concluded that the semi-automatic cleaner for split type air conditioner saved more electrical power for the system.

Keywords: *Semi-automatic cleaner, Split type, Air conditioner, COP, EER*

1. INTRODUCTION

The refrigeration and air conditioning system is applied to use in various applications such as food industry, chemical industry and air conditioning for sustainable well-being. The air conditioning system is commonly used in a wide range of residential and commercial buildings. The system is the process of moving heat from one location to another by means of refrigerant in a closed refrigeration cycle. Most of the air conditioner types used for this purpose are called “split type”. This type of air conditioner is divided to two parts, a fan coil unit and a condensing unit which the fan coil unit is located inside the room and another one is located outside the room. The split type air conditioner based on the vapor compression refrigeration is shown in Fig. 1 [1-4].

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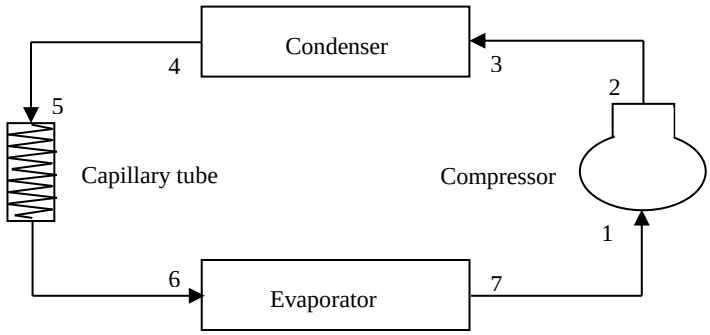

7-1: the suction line
2-3: the discharge line
4-5: the liquid line

Fig. 1. Vapor compression refrigeration [1, 3]

This study focused only evaporator where is located inside the room. The evaporator has a disadvantage when dust is accumulated on the outside of the evaporator tube. This affects compressor power and results in a decrease in the coefficient of performance (COP) and energy efficiency rating (EER). In general, most of split type air conditioner is cleaned about three times per year or four months per time by hand washed. There are two main disadvantages with the hand washed cleaning. Firstly, many of manpower number, at least 4 persons will be arranged to work together. Secondly, the cleaning need more than an hour in working per time per unit and also need more working area around the air conditioner. Moreover, human can't clean in narrow space especially in the back side area of the fan coil and this affect to COP and EER. To decrease number of manpower and working time, in this investigation we used a semi-automatic cleaner as a cleaner instead of hand washed by human. Then three cases of before washing, after hand washed and after being rinsed by the semi-automatic cleaner were compared by using COP and EER, respectively.

2. EXPERIMENTAL SETUP

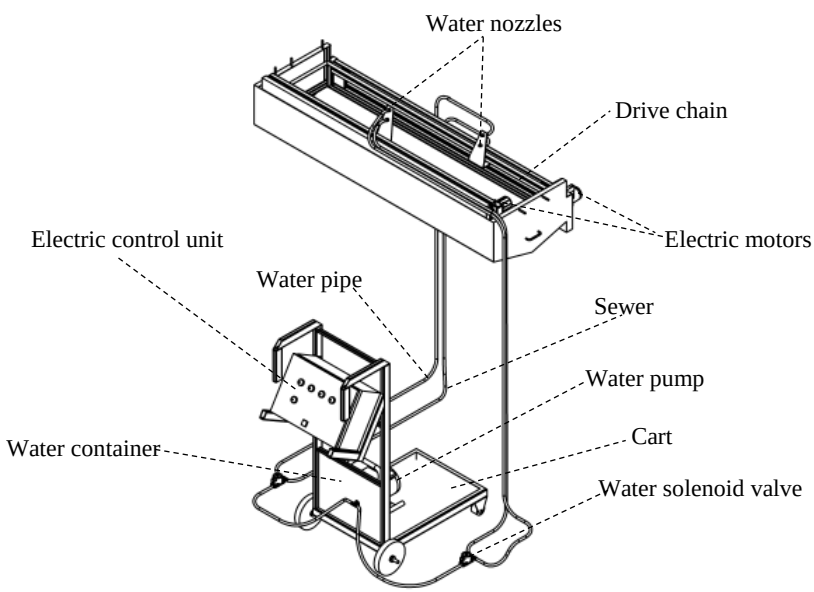

Fig. 2. The semi-automatic cleaner set

The semi-automatic cleaner set is shown in Fig. 2. Working principle of the semi-automatic cleaner will be started by pressing the power switch, water pump will suck water from the water container through the water filter to filter dirt. Then the water will flow through high pressure pipe into the water solenoid valve. Next, the water nozzle in the front side of evaporator will start to work and be driven by electric motor with chain to move from the left hand to the right hand after that return to the left hand again and stop working. In case of the back side of evaporator, after the water nozzle in the front side stop working, the water nozzle in back side will start to work as same as the first case.

3. DATA PROCESSING

Four main component locations of the split type air conditioner were shown in Fig. 1 and the performances were calculated as follow:

Ton of refrigeration (TR) can be written by

$$TR = 5.707x10^{-3}xCMMx(H_R - H_S) \quad (1)$$

While the H_R and H_S are enthalpy of return and supply air, respectively and obtained from Fig. 3.

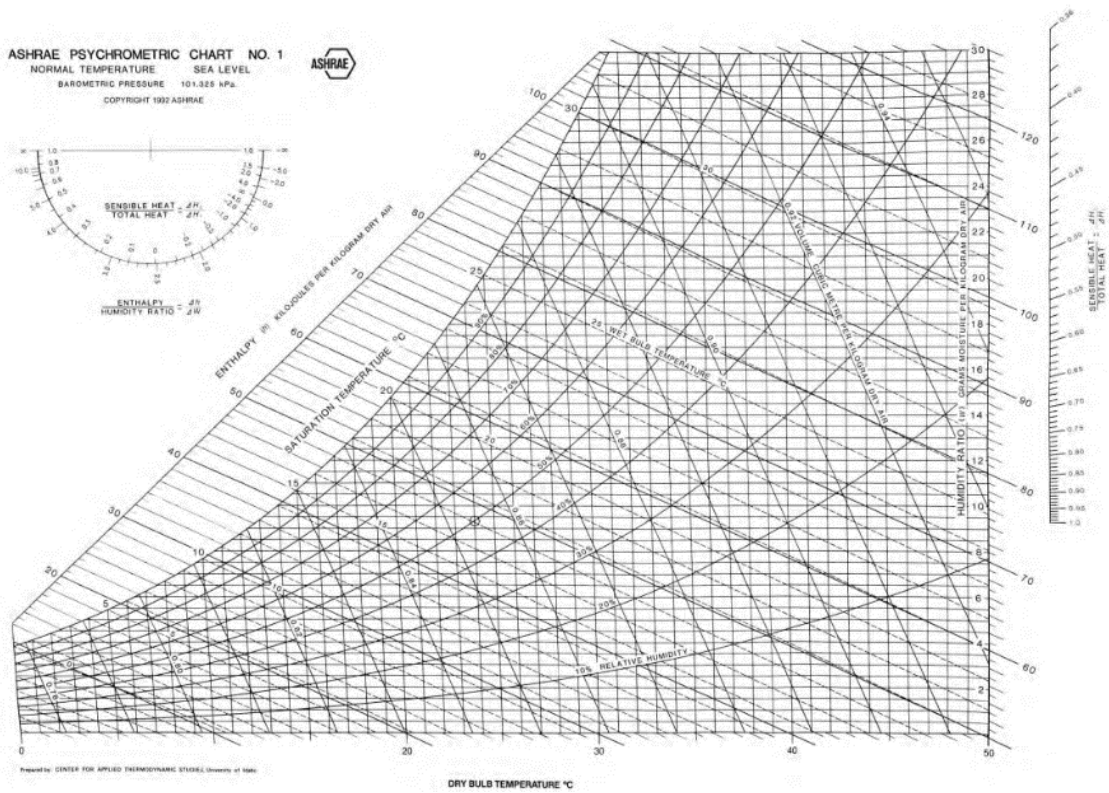

Fig. 3. Psychometric chart [1, 2]

Energy Efficiency Rating (EER) is given by

$$EER = \frac{TR}{P} \quad (2)$$

Coefficient of performance (COP) can be calculated by

$$COP = \frac{EER}{3.412} \quad (3)$$

To provide more data of these experiments therefore design conditions, measuring equipment and experimental procedure are explained. Dimension of testing room were 6x8x3 m (width x length x height). Cooling capacity of the air conditioning unit was 40,488 Btu/hr and R22 is used as refrigerant. The semi-automatic cleaner was controlled by PLC. Two water nozzles were located on drive chain and moved by electric motors. Moreover, the nozzles produced water pressure about 30 bar. In addition, the nozzles can worked by moving together with drive chain in left and right direction of both side of evaporator or fan coil. Air temperatures of the fan coil unit were measured by K-type thermocouples at seven locations for supply and return air of wet and dry bulb temperature and one location for ambient. Thermocouples were calibrated in a water bath with an accuracy of ±0.5 °C (5-90 °C) and connected to data logger interface with a desktop computer. Electrical power input measurement power input of the entire system was measured by a digital power clamp meter. The experiments were divided to three main parts: before washing, after hand washed and after being rinsed by the semi-automatic cleaner. Each main experiment, all of the data were recorded at an interval of ten minutes and a period of three hours. Before each experiment was conducted, the data logger and the desk top computer were turned on to make sure all the measuring equipment were ready. The experimental set-up was turned on for twenty minutes to ensure that the system has reached steady state, and then all data were recorded. The power input and all data were recorded at an interval of ten minutes and a period of three hours. The semi-automatic cleaner was assembled with evaporator of fan coil unit is shown in the left picture of Fig 4. While the right picture of Fig. 4 showed the working of the semi-automatic cleaner.

Fig. 4. The semi-automatic cleaner was assembled with evaporator and worked

4. RESULTS AND DISCUSSION

Figure 4 and 5 showed outside picture of the evaporator tube for before washing and after being rinsed by the semi-automatic cleaner, respectively. Referring to Fig. 5, it was found that the outside tube of evaporator was accumulated by a lot of dust. While Fig. 6, the outside tube of the evaporator was very clean after being rinsed by the semi-automatic cleaner. When these two systems were compered, it was found that manpower need per time of hand washed cleaning were four persons and the semi-automatic cleaner need only two persons. In addition, working time of the hand washed cleaning was spent about an hour per time per unit while the semi-automatic cleaner was spent about 20 minutes. Figure 7 and 8 show the results of experiments conducted on COP and EER for the three main parts: before washing, after hand washed and after being rinsed by the semi-automatic cleaner. All trends of three experiments were similar. Referring to Fig. 7, the average of COP with the case of before washing, after hand washed and after being rinsed by the semi-automatic cleaner were 2.9, 3.4 and 3.8, respectively. When these three parts were compared with three hours of running time, it was found that COP of the case after being rinsed by the semi-automatic cleaner were higher than before washing, after hand washed by about 31 and 11.8 %, respectively. In case of before washing, the outside of evaporator tube was covered by a lot of dust as shown in Fig. 5 caused an increase of thermal resistance outside the tube. Whenever the thermal resistance was increased caused heat transfer rate, refrigerating effect and COP was decreased [5-8]. Moreover, the hand washed method, the narrow area of evaporator tube had not been cleaned by human therefore the COP was lower than the semi-automatic cleaner. While the EER of the case after being rinsed by the semi-automatic cleaner were higher than before washing, after hand washed by about 31.6 and 10.3 %, respectively. The result of EER agreed with COP at the same experiment.

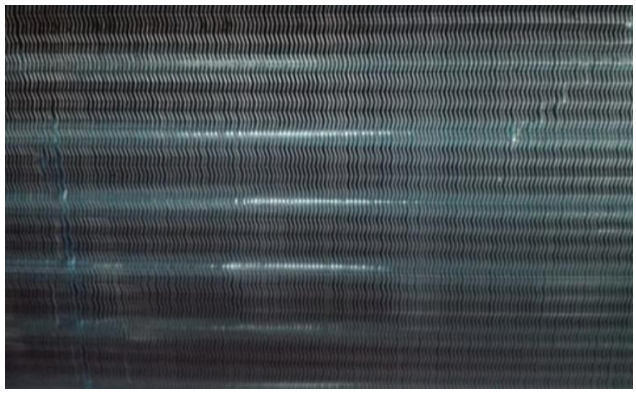

Fig. 5. The outside picture of the evaporator tube for before being rinsed by the semi-automatic cleaner

Fig. 6. The outside picture of the evaporator tube for after being rinsed by the semi-automatic cleaner

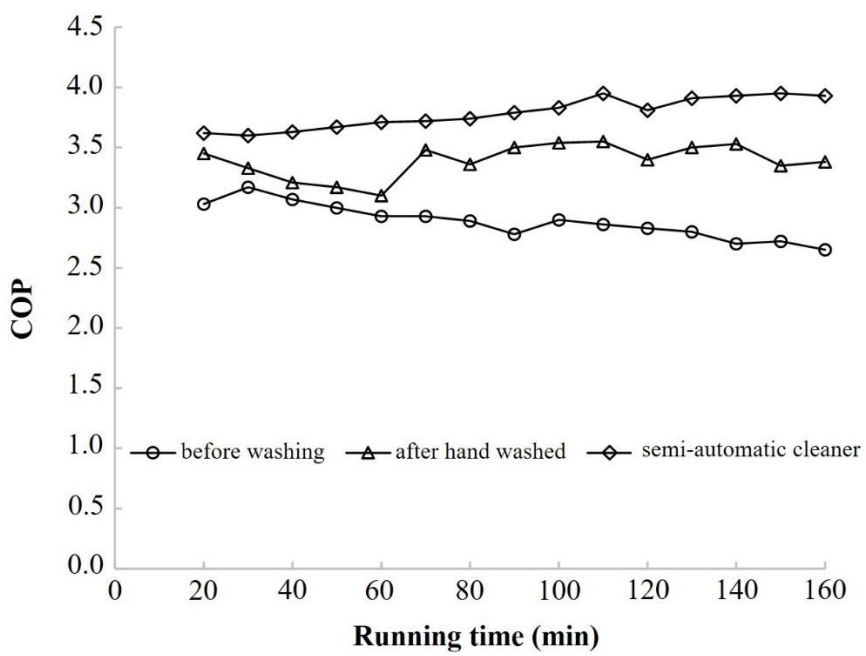

Fig. 7. Comparison of COP between three main parts: before washing, after hand washed and after being rinsed by the semi-automatic cleaner

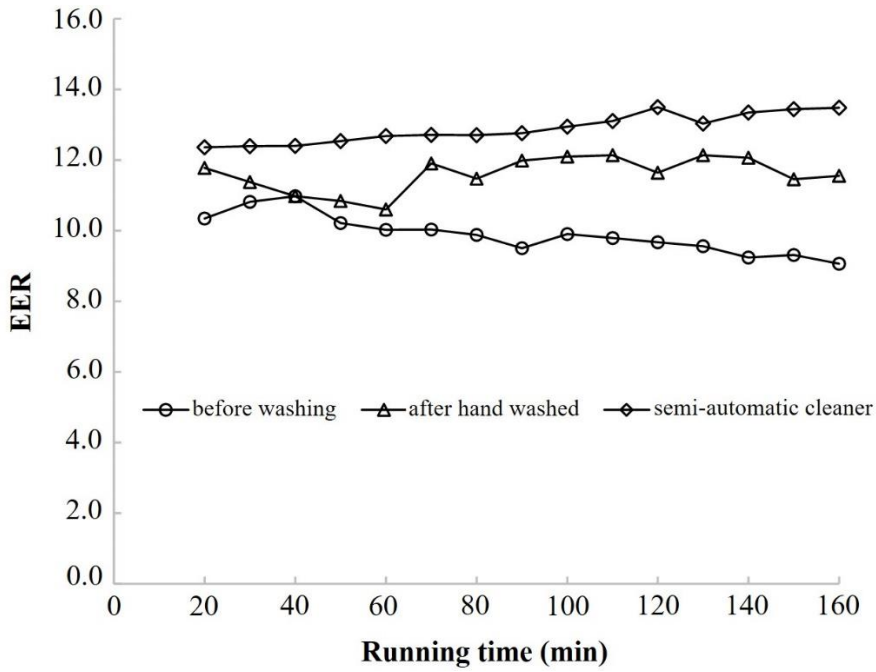

Fig. 8. Comparison of EER between three main parts: before washing, after hand washed and after being rinsed by the semi-automatic cleaner

5. CONCLUSION

- The manpower need and working time of the semi-automatic cleaner were decreased about 50 and 70 %.
- The COP of the case after being rinsed by the semi-automatic cleaner were higher than before washing, after hand washed by about 31 and 11.8 %.
- The EER of the case after being rinsed by the semi-automatic cleaner were higher than before washing, after hand washed by about 31.6 and 10.3 %, respectively.

NOMENCLATURE

TR	ton of refrigeration, ton
CMM	flow rate of air circulating, m^3/min
H	enthalpy, kJ/kg
P	electric power, W
COP	coefficient of performance, -
EER	energy efficiency rating, -

Subscripts

R	*return air*
S	*supply air*

ACKNOWLEDGEENT

This research was conducted under the support of Rajamangala University of Technology Lanna (RMUTL).

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