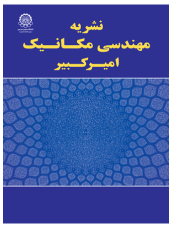


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# Experimental investigation and performance comparison of two types of microchannel and Fin-tube condensers with R407c refrigerant in compression refrigeration cycle

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**ABSTRACT:** The present research deals with the experimental investigation and comparison of microchannel and fin-tube condensers in a refrigeration cycle. This research investigates the effect of the type of condenser on the efficiency of the duct-split with a cooling capacity of 2.5 tons of refrigeration using experimental tests. For this purpose, two microchannel and fin-tube condensers have been used in a refrigeration cycle that has R407c refrigerant. Except for the condenser, the rest of the components of the refrigeration cycle, such as the fan, compressor, expansion valve, and evaporator are the same in both refrigeration cycles. The effect of the type of condenser on the performance coefficient of the refrigeration cycle has been evaluated at three different speeds of the condenser fan. Also, compressor power, evaporator cooling power, condenser thermal power, and temperature-entropy diagram (T-s) were extracted. Six different experiments have been conducted, and each experiment has been repeated three times to ensure the results. The results show that the use of the microchannel condenser in the same conditions and with 700 g less refrigerant charge in the entire refrigeration cycle, increases the performance factor by about 4% compared to the system that has fin-tube condenser.

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## 1- Introduction

Evaluation of the performance of the home cooler system with microchannel condensers has been investigated by Kim and Bullard [1]. They investigated the characteristics of the system such as capacity, energy efficiency rate, temperature, and suction and discharge pressure, and compared it with the conventional system. In this research, the heat transfer rate per unit volume of the central core of the microchannel heat exchanger was between 14 and 331% higher than heat exchangers with finned circular tubes. The refrigerant charge requirement for a window cooler with a microchannel condenser was reported to be about 35% lower than for a conventional base system. In an experimental study, Garimella [2] presented the detection of flow in micro- and mini-channels to develop models of heat transfer and pressure drop during the condensation of refrigerants. He documented flow condensation mechanisms for rectangular, square, and circular pipes with hydraulic diameters of 1 to 5 mm with a special laboratory detection technique. Jeong et al. [3] investigated the performance of three microchannel condensers that had different lateral air heat transfer areas (including tubes and fins) but had the same frontal area (by adjusting the tubes and fin pitches). Li and Hrnjak [4] conducted experiments to investigate the effect of microchannel heat exchanger lubrication on heat transfer, pressure drop, and transmission characteristics of the cooling fluid. Zanetti et al. [5] designed and tested a microchannel heat exchanger (as condenser and evaporator). They used R32 refrigerant. Tosun et al. [6] tested the use of a microchannel condenser in a refrigerator with different refrigerant charges. They determined the most suitable refrigerant charge. In this research, the performance of the type of condenser (microchannel and fin-tube) and the effect of the speed of the air passing through the condenser on the performance coefficient of the refrigeration cycle has been investigated and compared.

## 2- Description of experimental experiments

Before starting data collection, it is necessary to connect the two indoor and outdoor units by copper pipes. The two return lines (from the outdoor unit to the indoor unit and vice versa) need to cover the copper pipe with elastomeric insulation. The GESCOOL duct split device has an external expansion valve that is placed in the pipeline before the evaporator inlet. Figure 1 shows a schematic of the refrigeration cycle and the data points taken in the cycle.

Inviscid Euler equations in 2D and axisymmetric form are used for internal flow solutions. The nodes cloud as shown in Figure 1 are used with first-order Taylor series for spacial discretization.

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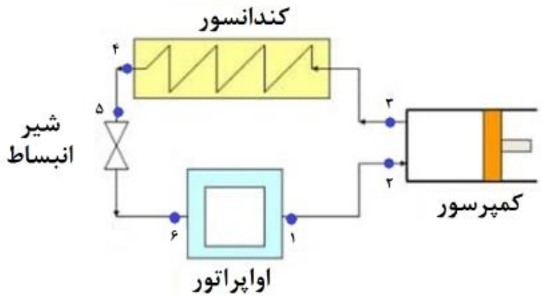


**Fig. 1. Schematic of the refrigeration cycle and data points taken**

**Fig. 2. Microchannel condenser used in the experiment**

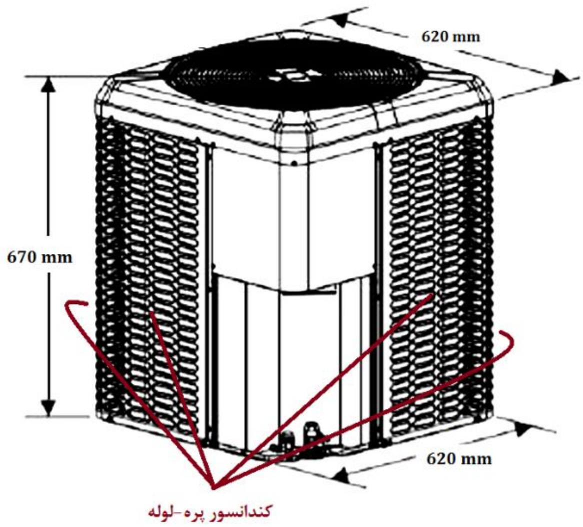


**Fig. 3.Schematic of the dimensions of the external unit and fin-tube condenser**

## 3- Introducing different parts of the refrigeration system

Ductsplit indoor unit
External unit
Compressor
Microchannel condenser (Figure 2)
Fin-tube condenser (Figure 3)
expansion valve
Data acquisition equipment
Barometer and thermometer
vacuum pump
air flow measurement

## 4- Results and discussion

In this section, the results of the experiments designed in the previous sections are presented. Data analysis was done using EES software. The analyzes are based on the tables of thermodynamic properties of the refrigerant and the introduced formulas. As mentioned earlier, six tests have been performed. The data and results of each title are presented in the form of several tables. A T-S diagram is also provided for each section.

In general, the results show that the pressure drop in the microchannel condenser is lower than that of the fin-tube condenser, because the dimensions of the microchannel condenser are smaller than the fin-tube condenser, and as a result, the path taken by the refrigerant to reach the inlet to the outlet of the condenser is reduced. It causes the pressure drop in the microchannel condenser to be lower than the fin-tube condenser. In general, the advantages of using a microchannel condenser can be reduced dimensions, increased heat transfer coefficient, and reduced refrigerant volume in the entire system, thus reducing environmental effects.

Due to the fact that the hydraulic diameter of the microchannel channels in the microchannel condenser is smaller than the diameter of fin-tube condenser tubes, as a result, the reduction of the hydraulic diameter increases the heat transfer coefficient [2], that is why the performance of the microchannel condenser is more suitable than the fin-tube condenser. . The results show that with the increase of the air flow rate, the outlet temperature of the condensers decreases, which is due to the increase of heat transfer in the condenser. But as it is clear from the data, the reduction of condenser outlet temperature in the system with microchannel condenser is more than the system with fin-tube condenser, which is due to the more suitable heat transfer of the microchannel condenser.

Table 1 shows the comparison of the performance coefficient of split duct 2.5 with fin-tube and micro-channel condenser which has R407c refrigerant. The performance factor of the refrigeration cycle with the microchannel condenser is about 4% higher than the fin-tube condenser.

**Table 1. Comparison of performance coefficient of fin-tube and microchannel condensers with R407c refrigerant**

| Condenser type | Airflow speed | COP |
|---|---|---|
| Microchannel | High Speed | 4.159 |
| | Medium Speed | 4.073 |
| | Low Speed | 4.018 |
| Fin-Tube | High Speed | 4.017 |
| | Medium Speed | 3.956 |
| | Low Speed | 3.889 |

## 5- Conclusions

In this research, the experimental investigation and comparison of the performance of a condensation refrigeration cycle with microchannel and fin-tube condensers has been done. For this purpose, a split duct device with a cooling capacity of 2.5 tons has been used and the effect of the condenser type on the performance coefficient has been investigated. The performance coefficient of the refrigeration cycle has been evaluated at three different velocities of the air passing through the condenser. The results show that the use of the microchannel condenser under the same conditions and with 700 grams less refrigerant charge for the entire cycle increases the performance factor by about 4% compared to the system that has fin-tube condenser.

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