



PROCEEDINGS

4th Rajabhat University National and International Research and Academic Conference (RUNIRAC IV)

“Creative Innovation and Research, Production and Development
of Educational Personnel with High Standards, and Brain Bank via
Academic Services for Community’s Strength and Sustainability”

22nd - 24th November 2016
Buriram Rajabhat University





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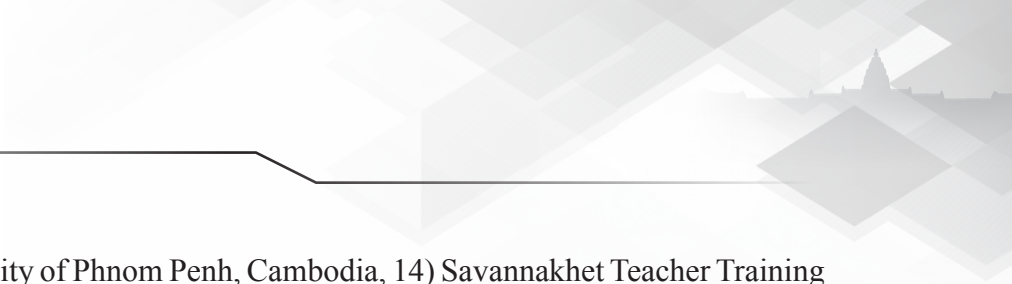
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PREFACE

The 4th Rajabhat University National and International Research and Academic Conference (RUNIRAC IV) is organized during the 22nd - 24th of November 2016 under the theme “Creative Innovation and Research, Production and Development of Educational Personnel with High Standards, and Brain Bank via Academic Services for Community’s Strength and Sustainability”. The objectives are as follows:

1. To provide both national and international forums for presenting research and creative innovation of Thai and foreign students, lecturers, scholars and researchers from all Rajabhat Universities and other institutions;
2. To promote efficient research and innovation created by lecturers, personnel and students of Rajabhat Universities and university networks both at home and abroad;
3. To promote learning activities to improve the quality and standards of research, creative works and innovation that can be truly utilized in developing a local community, society and country as a whole;
4. To provide a platform and an opportunity for lecturers, students and researchers to present good research and to exchange their knowledge that will lead to the development of the country;
5. To utilize the research results, creative innovation and knowledge obtained from the conference for developing the society;
6. To promote international understanding and to build collaboration with other national and international organizations and institutions; and
7. To honor and praise researchers with distinctive research and innovation.

This conference is co-organized by Buriram Rajabhat University (BRU) and other organizations and institutions in Thailand: 38 Rajabhat Universities, Kalasin University, Suan Dusit University, National Research Council of Thailand (NRCT), The Thailand Research Fund (TRF), Thai Health Promotion Foundation, Knowledge Network Institute of Thailand, Research Network of the Higher Education Commission (Higher Northeastern Isan Region), Research Network of the Higher Education Commission (Lower Northeastern Isan Region), Four Buriram Educational Service Area Offices, and Council of the Graduate Studies Administrators of Thailand (CGAT). The conference is also co-hosted by 15 well-known universities from 14 countries as follows: 1) Niagara University, U.S.A., 2) University of Winnipeg, Canada, 3) Akdeniz University, Turkey, 4) Institute of Advanced Studies in English, India, 5) Kathmandu University, Nepal, 6) Qiannan Normal University for Nationalities, China, 7) Shangrao Normal University, China, 8) Hue University College of Foreign Languages, Vietnam, 9) Ton Duc Thang University, Vietnam, 10) Philippine State College of Aeronautics, the Philippines, 11) Universiti Putra Malaysia, Malaysia, 12) National Pingtung University,



Taiwan, 13) Royal University of Phnom Penh, Cambodia, 14) Savannakhet Teacher Training College, Laos PRD, and 15) Mandalay University of Distance Education (MUDE), Myanmar.

The organizing committee greatly appreciates the tight collaboration between BRU and other institutions. It is highly hoped that at this conference, the academic connections among these co-hosts will be strengthen and their better understanding and further cooperation will also be enhanced.

On behalf of the organizing committee of RUNIRAC IV, sincere thanks are expressed to all sectors for the support and contribution to the success of this conference.

The RUNIRAC IV Organizing Committee



Message from the Chairman of the Council of Rajabhat University Presidents of Thailand

Research is regarded as an academic work that is very significant because research results can be utilized for the social and economic development of the country, creating values and benefits for communities, localities and the nation as a whole. Moreover, the results are the effective tools for solving problems and establishing growth and progress within the nation with sustainability and stability. The university personnel, therefore, should be encouraged and supported to conduct research, utilize research results and disseminate these results to the public.

Rajabhat Universities are the higher institutions with the mission of developing localities, empowering intelligence, promoting the power of learning, honoring local wisdom, creating arts and transferring technology to communities. In order to achieve the mission, Rajabhat Universities together with Suan Dusit University and Kalasin University have joined hands to organize different activities and projects. This year they co-host the 4th Rajabhat University National and International Research and Academic Conference (RUNIRAC IV). This conference is held under the theme “Creative Innovation and Research, Production and Development of Educational Personnel with High Standards, and Brain Bank via Academic Services for Community’s Strength and Sustainability”. The aim is to provide both national and international forums for research and creative innovation presentations by Thai and foreign students, lecturers, scholars, professors and researchers from all Rajabhat Universities and other private and public institutions from both Thailand and overseas.

On behalf of Rajabhat Universities, Suan Dusit University and Kalasin University, I warmly welcome experts, guest speakers, researchers, scholars, lecturers, students and all who are interested in taking part in the conference. Finally, I would like to wish all those taking part in the conference great success and achievement, and an enjoyable and fruitful experience.



(Associate Professor Dr. Sombat Kotchasit)
President of Valaya Alongkorn Rajabhat University
Chairman of the Council of Rajabhat University Presidents of Thailand

Message from the President of Buriram Rajabhat University

Buriram Rajabhat University received the consensus from Council of Rajabhat University Presidents of Thailand to be the main host to organize the 4th Rajabhat University National and International Research and Academic Conference (RUNIRAC IV). This conference is held under the theme “Creative Innovation and Research, Production and Development of Educational Personnel with High Standards, and Brain Bank via Academic Services for Community’s Strength and Sustainability”. The conference is organized on the 22nd-24th of November 2016 at Buriram Rajabhat University with the purposes of promoting efficient research and creative innovation, and providing a platform and an opportunity for scholars, researchers, lecturers and students of Rajabhat Universities and other institutions to present research and exchange knowledge. This conference is co-hosted by Buriram Rajabhat University and other institutions, including 38 Rajabhat Universities, Suan Dusit University, Kalasin University, the Higher Education Commission, National Research Council of Thailand (NRCT), the Thailand Research Fund (TRF), Thai Health Promotion Foundation, Knowledge Network Institute of Thailand, Council of the Graduate Studies Administrators of Thailand (CGAT), Research Network of the Higher Education Commission (Higher Northeastern Isan Region), Research Network of the Higher Education Commission (Lower Northeastern Isan Region), Four Buriram Educational Service Area Offices and 15 foreign universities from 14 countries: Niagara University, U.S.A., University of Winnipeg, Canada, Akdeniz University, Turkey, Institute of Advanced Studies in English, India, Kathmandu University, Nepal, Qiannan Normal University for Nationalities, China, Shangrao Normal University, China, Hue University College of Foreign Languages, Vietnam, Ton Duc Thang University, Vietnam, Philippine State College of Aeronautics, the Philippines, Universiti Putra Malaysia, Malaysia, National Pingtung University, Taiwan, Royal University of Phnom Penh, Cambodia, Savannakhet Teacher Training College, Laos PDR, and Mandalay University of Distance Education (MUDE), Myanmar.

On behalf of Buriram Rajabhat University, I warmly welcome experts, scholars, researchers, lecturers, students and participants from Thailand and overseas to the conference. It is hoped that this conference will be beneficent to everybody. I wish the RUNIRAC IV every success in all respects. Last but not least, I would like to extend my sincere thanks to the co-hosts, the organizing committee and all attendees.



(Associate Professor Malinee Chutopama)
President of Buriram Rajabhat University
Chairman of the Board of Organizing Committee

**4th Rajabhat University National and International Research and
Academic Conference (RUNIRAC IV)**
Date: 22nd – 24th November 2016
Venue: Buriram Rajabhat University, Buriram Province, Thailand

Rationale

At present research has become very important and effective tool used to solve problems and also to contribute to social and economic development of the country. Moreover, research is a significant indicator of Thailand competition and development. Knowledge-based society can also be possible in Thailand via research. Regarding the research significance, Article 7 of Rajabhat University Act 2004 states: Rajabhat Universities are the institutes established with the following main objectives: local development, intelligence empowerment, learning restoration, local wisdom promotion, arts creation for sustainable progress and development of public, and participation in preserving, maintaining and utilizing natural resources and environment with balance and sustainability. In addition, Thailand policy and development strategy has emphasized the crucial points covering development of full research capacities in the country, establishment of valuable knowledge base, application and development of appropriate science, learning and local wisdom expansion for commercial and public benefits, and development of life quality by using resources and research networks effectively.

Buriram Rajabhat University is the institute for local development with the mission: to produce high quality graduates; to conduct research; to establish bodies of knowledge and build research networks; to provide academic services, transfer technology, and strengthen the community; to preserve arts and cultural heritage and promote local wisdom; to produce and develop high quality teachers and educational personnel; to promote and continue royal projects; to support and participate in managing national resources and environment in a local community; and to expand academic collaboration with external organizations or institutes both at home and abroad. Thus, Buriram Rajabhat University by the Graduate School in collaboration with Research and Development Institute, and the Office of International Relations, organize the 4th Rajabhat University National and International Research and Academic Conference (RUNIRAC IV) under the theme “Creative Innovation and Research, Production and Development of Educational Personnel with High Standards, and Brain Bank via Academic Services for Community’s Strength and Sustainability”. The RUNIRAC IV, covering six areas in Education and Culture, Humanities and Social Sciences, Science and Technology, Health Sciences, Management and Tourism, and Creative Works and Innovation, is organized on the 22nd -24th of November 2016.



Objectives

1. To provide both national and international forums for presenting research and creative innovation of Thai and foreign students, lecturers, scholars and researchers from all Rajabhat Universities and other institutions;
2. To promote efficient research and innovation created by lecturers, personnel and students of Rajabhat Universities and university networks both at home and abroad;
3. To promote learning activities to improve the quality and standards of research, creative works and innovation that can be truly utilized in developing a local community, society and country as a whole;
4. To provide a platform and an opportunity for lecturers, students and researchers to present good research and to exchange their knowledge that will lead to the development of the country;
5. To utilize the research results, creative innovation and knowledge obtained from the conference for developing the society;
6. To promote international understanding and to build collaboration with other national and international organizations and institutions; and
7. To honor and praise researchers with distinctive research and innovation

Conference Disciplines

The conference proceedings include the following international disciplines:

1. Education and Culture
2. Humanities and Social Sciences
3. Science and Technology
4. Health Sciences

Expected Benefits

1. Researcher, lecturers, students and the general public will gain useful knowledge for improving the quality of life.
2. Research results and innovation can be used to contribute to the country development.
3. Collaboration among Rajabhat Universities, university networks and other Thai and foreign institutions will be established.
4. The quality research will be published in the conference proceedings and in both Thai and foreign journals.

Conference Hosts

1. Main hosts
 - 1.1 The Higher Education Commission
 - 1.2 Buriram Rajabhat University

2. Co-hosts

- 2.1 Thirty-eight (38) Rajabhat Universities
- 2.2 Kalasin University
- 2.3 Suan Dusit University
- 2.4 National Research Council of Thailand (NRCT)
- 2.5 The Thailand Research Fund (TRF)
- 2.6 Thai Health Promotion Foundation
- 2.7 Knowledge Network Institute of Thailand
- 2.8 Research Network of the Higher Education Commission
(Higher Northeastern Isan Region)
- 2.9 Research Network of the Higher Education Commission
(Lower Northeastern Isan Region)
- 2.10 Four Buriram Educational Service Area Offices
- 2.11 Council of the Graduate Studies Administrators of Thailand (CGAT)
- 2.12 Fifteen (15) foreign Universities from fourteen (14) countries:
 - 2.12.1 Niagara University, U.S.A.
 - 2.12.2 University of Winnipeg, Canada
 - 2.12.3 Akdeniz University, Turkey
 - 2.12.4 Institute of Advanced Studies in English, India
 - 2.12.5 Kathmandu University, Nepal
 - 2.12.6 Qiannan Normal University for Nationalities, China
 - 2.12.7 Shangrao Normal University, China
 - 2.12.8 Hue University College of Foreign Languages, Vietnam
 - 2.12.9 Ton Duc Thang University, Vietnam
 - 2.12.10 Philippine State College of Aeronautics, the Philippines
 - 2.12.11 Universiti Putra Malaysia, Malaysia
 - 2.12.12 National Pingtung University, Taiwan
 - 2.12.13 Royal University of Phnom Penh, Cambodia
 - 2.12.14 Savannakhet Teacher Training College, Laos PRD
 - 2.12.15 Mandalay University of Distance Education (MUDE), Myanmar

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A Study of Air Temperature Reduction before Entering the Condenser by Condensed Water of Evaporator Passing through Heat Exchanger

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Abstract

The aim of this research was to study the air temperature reduction before entering the condenser by condensed water of evaporator passing through heat exchanger. The experimental unit consisted of a vapor compression of 3.52 kW (12,000 BTU/hr) capacity with R-22 refrigerant and air cooled condenser. The heat exchanger was made of a copper u-turn bend tube with an external diameter of 6.35 mm, a length of 500 mm with 55 mm spacing between each tube. This copper tube bent into the shape with 7 turns. The results showed that the coefficient of performance was found to be 4.08, the power consumption of compressor of 866.25 W, and the heat transfer rate of condenser and evaporator were 4.40 and 3.54 kW, respectively. It also found that when the air flow passing through the heat exchanger, the average decrease of temperature was 2.1 °C.

Keywords: Heat exchanger, Air-conditioning system, Heat transfer, Condensation

1. Introduction

Presently, the trend of using energy especially the power of nature such as petroleum, coal, etc. has been increased which may caused an energy shortage in the future. Especially, the electrical energy consumption of air conditioning system is a major concern because the rate of using energy has been increased.

Split type air conditioning system is the most commonly used air conditioner for single room, building, resident and office. The split type air conditioning system has been widely used because of their ease of installation and inexpensive. Split type air conditioning system uses the air from the environment as heat transfer leave from the condenser. (Stoecker & Jones, 1982) It is well known that Thailand's climate all year around is more hot than cold, and the average temperature has a tendency to increase every year, this is the cause of the overload of air conditioner consumption which resulted in the decreasing of performance because lowly heat transfer rate of condenser.

Air temperature reduction before entering the condenser is the one method for increasing the performance and decreasing the energy consumption of air conditioning system. A review of prior studies indicates that researchers have tended to consider the development of air conditioning systems from the perspective of reduced energy consumption. Shah and Sekulic (2003) studied the heat exchanger device and heat exchanger design methodology including energy and heat transfer analysis. Juengjaroennirachon et al. (2006) examined the heat transfer performance of condenser using water and air. Hajidavalloo (2007) applied a new design with high commercialization potential that incorporated evaporative cooling on the condenser of

a window air conditioner. Lee et al. (2008), and Deamda and Yamtripat (1990) examined the air temperature reduction before entering the condenser. From the cycle of air conditioning system as shown that the air conditioner was turned on and the water was condensed by evaporator. These condensed water had low temperature enough to reduce the air temperature before entering the condenser. For these reasons, condensed water has been widely used in the form of heat transfer devices for enhancing the performance and reducing the energy consumption of air conditioning system.

The purpose of this research was thus to experimentally study the air temperature reduction before entering the condenser by condensed water of evaporator passing through heat exchanger. In order to increase the performance, decrease energy consumption, worthy energy using and decrease global warming.

2. Research Objectives

2.1 To design and build the heat exchanger for air temperature reduction before entering the condenser.

2.2 To study the efficiency of air conditioning system.

3. Literature Review

3.1 Principle of vapor compression refrigeration system cycle

In order to apply the heat exchanger from air conditioning system, it can be explain that when the air conditioner was turned on and the gas refrigerant was absorbed by compressor. The compressor compressed the high temperature and pressure refrigerant in order to cooling and condensed the liquid at the condenser before decreased the pressure at the capillary tube and then refrigerant flows to the evaporator. While the liquid refrigerant within the evaporator absorbed the heat from the air in order to decrease the air temperature, then evaporated to low pressure gas and flow to the compressor as the cycle as shown in Fig.1 (Stoecker & Jones,1982).

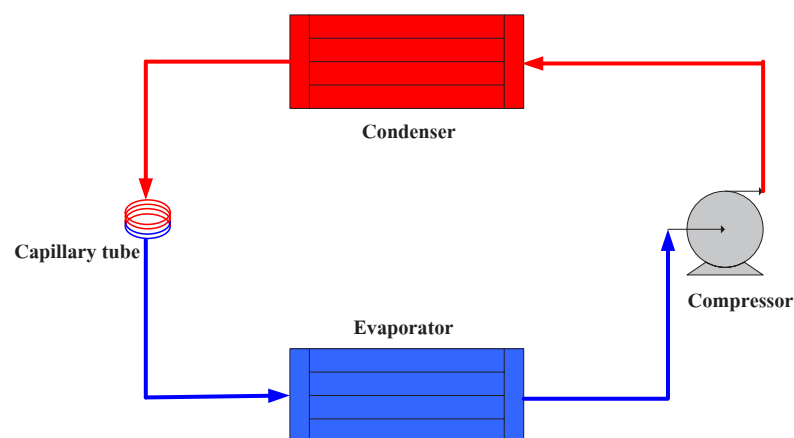


Figure 1. vapor compression refrigeration system cycle

Equations (1)-(4) were used to calculate the desired parameters. When considering the full speed of the compressor, pressure ratio compressor at both suction and compress sides of the compressor are related to the flow rate and

refrigerant temperature as shown in the following equation. The compressor power can be using by Eq. (1).

$$W_{comp} = \dot{m}_r (h_{comp,o} - h_{comp,i}) \quad (1)$$

Here, W_{comp} is the compressor power, $\dot{m}_r$ is the mass flow rate of the refrigerant, $h_{comp,o}$ and $h_{comp,i}$ are the enthalpies at the compressor outlet and inlet of the system, respectively.

The heat transfer rate from the refrigerant in the condenser and evaporator can be using by Eqs. (2 -3) consequently.

$$Q_{cond} = \dot{m}_r (h_{cond,i} - h_{cond,o}) \quad (2)$$

Here, Q_{cond} is the heat transfer rate from the refrigerant in the condenser, $h_{cond,i}$ is the enthalpy at the condenser inlet, and $h_{cond,o}$ is the enthalpy at the condenser outlet.

$$Q_{evap} = \dot{m}_r (h_{evap,o} - h_{evap,i}) \quad (3)$$

Here, Q_{evap} is the heat transfer rate from the refrigerant in the evaporator, $h_{evap,o}$ is the enthalpy at the evaporator outlet, and $h_{evap,i}$ is the enthalpy at the evaporator inlet.

The performance analysis of vapor compression refrigeration system can be considered in terms of the system *coefficient of performance* as can be using by Eq. (4).

$$COP = \frac{Q_{evap}}{W_{comp}} \quad (4)$$

Here, COP is the *Coefficient of performance*

3.2 Mechanism of heat transfer There are three main ways that heat is transferred between substances or objects; thermal conduction, thermal convection and thermal radiation as shown in Fig.2. (Cengel & Boles, 2006)

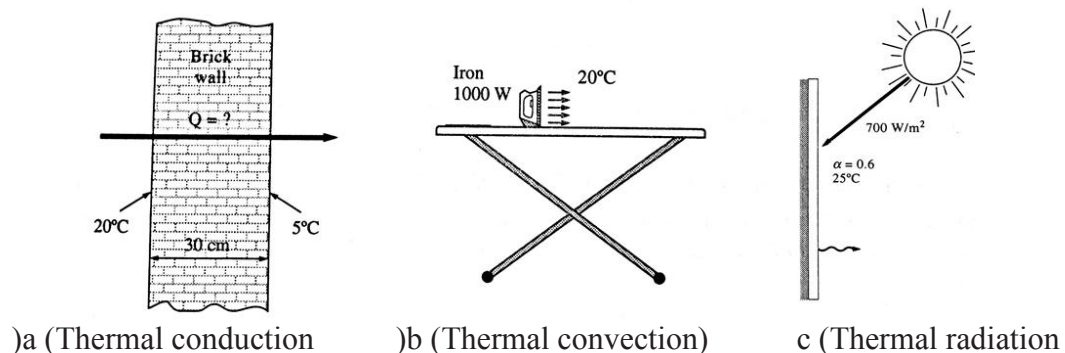


Figure 2. Mechanism of heat transfer

Thermal conduction

Thermal conduction is the property of a material to conduct heat. The heat moves from a high temperature to areas with lower temperatures within the same or an intermediary between different adjacent. Which heat transfer is generated by the movement of molecules inside an intermediate as shown in Fig.2)a(.

Thermal convection

From Fig.2(b), heat energy transferred between a surface and a moving fluid at different temperatures is known as convection. Convection is the transfer of thermal energy from one place to another by the movement of fluids. Two types of convective heat transfer may be distinguished:

1. Forced convection: when a fluid is forced to flow over the surface by an external source such as fans, by stirring, and pumps, creating an artificially induced convection current.
2. Free convection: when fluid motion is caused by buoyancy forces that result from the density variations due to variations of thermal temperature in the fluid. At heating the density change in the boundary layer will cause the fluid to rise and be replaced by cooler fluid that also will heat and rise. This continue phenomena is called free convection.

Thermal radiation

Thermal radiation is the transfer of heat energy without intermediate or radiation occurs without the involvement of a physical substance as the medium. The radiant heat will move in the form of electromagnetic wave motion which the radiation will be great on vacuum area such as the transfer of heat energy from the sun through the earth as shown in Fig.2)c(.

4. Experimental apparatus and methods

The experimental unit consisted of a vapor compression of 3.52 kW (12,000 BTU/hr) capacity with R-22 refrigerant and air cooled condenser. The heat exchanger was made of a copper u-turn bend tube with an external diameter of 6.35 mm, a length of 500 mm with 55 mm spacing between each tube. This copper tube bent into the shape with 7 turns as shown in Fig.3.

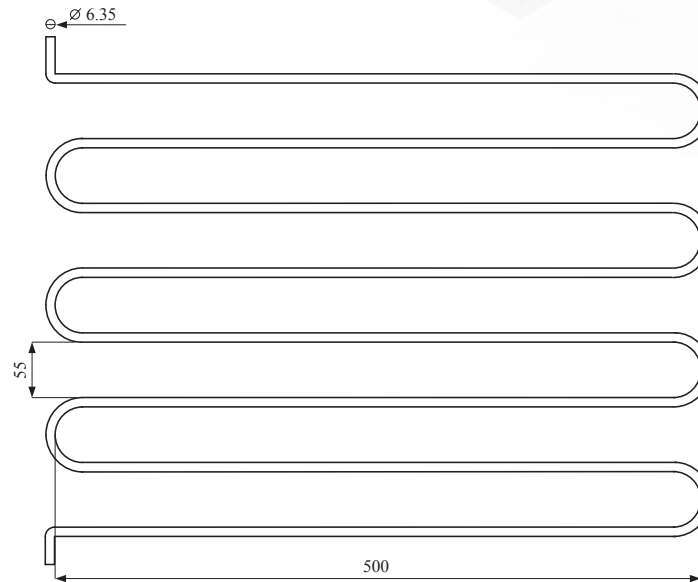


Figure 3. Heat exchanger device

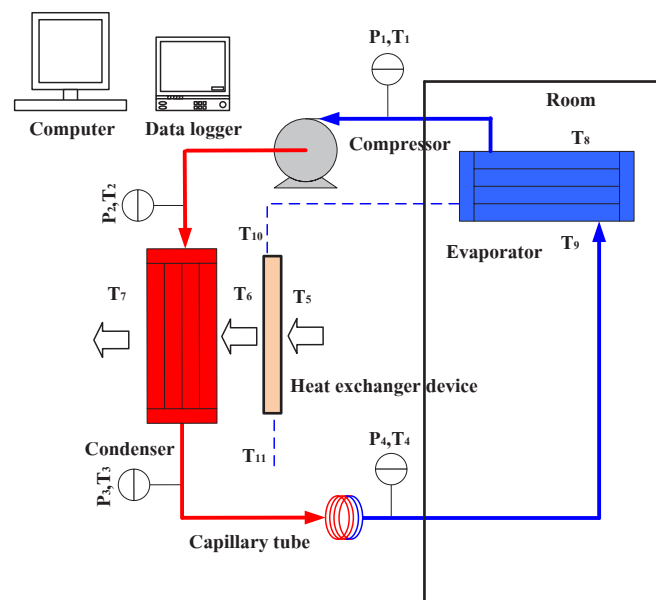


Figure 4. Schematic diagram for temperature and pressure measure points of air conditioning system

From Fig.4, the experiments were conducted over a period of 12 h, during which the relevant parameters were recorded every 30 min. The experimental data were recorded after a steady state condition was established. The temperatures of refrigerant, air and condensed water were recorded using type-K thermocouples. The air flow rates were recorded using anemometer. The temperatures were recorded at each position three times. The temperatures measured at each position were averaged over the time period.

Here, $P_1 - P_4$ are the measure points of refrigerant pressure, $T_1 - T_4$ are the measure points of refrigerant temperature, $T_5 - T_9$ are the measure points of air temperature, and $T_{10} - T_{11}$ are the measure points of condensed water temperature.

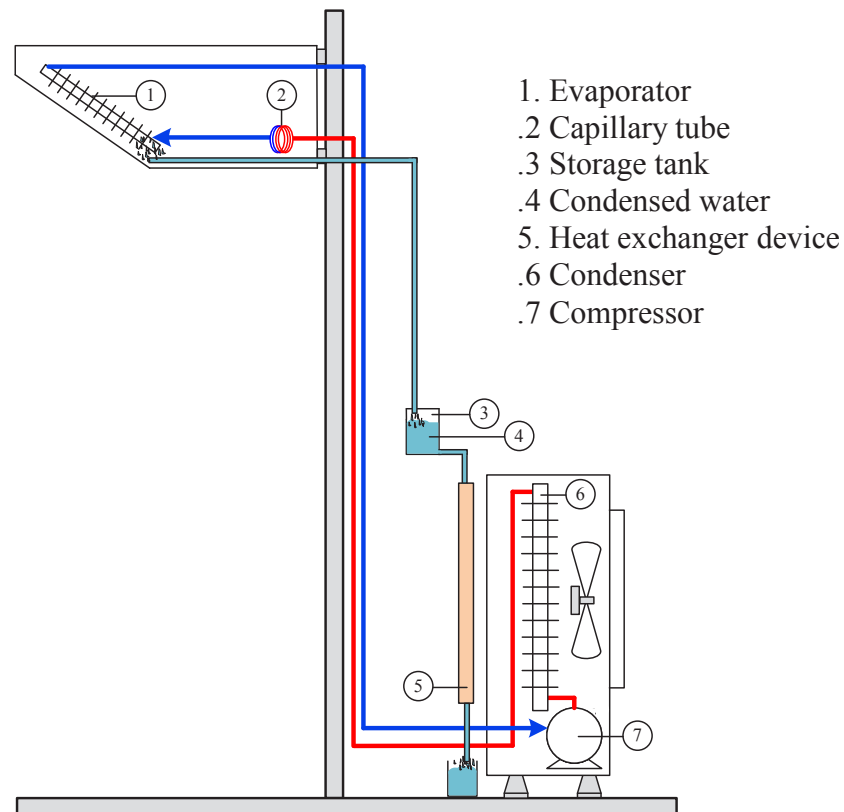


Figure 5. Experimental installation of air conditioning system

For the experiments in Fig.5, the water was condensed at evaporator section and this condensed water flowed through heat exchanger that was installed at the condenser inlet. When the air flowed through heat exchanger, the temperature was decrease in order to cooling the condenser.

5. Results and Discussion

The research results of the air temperature reduction before entering the condenser by condensed water of evaporator passing through heat exchanger show as follow.

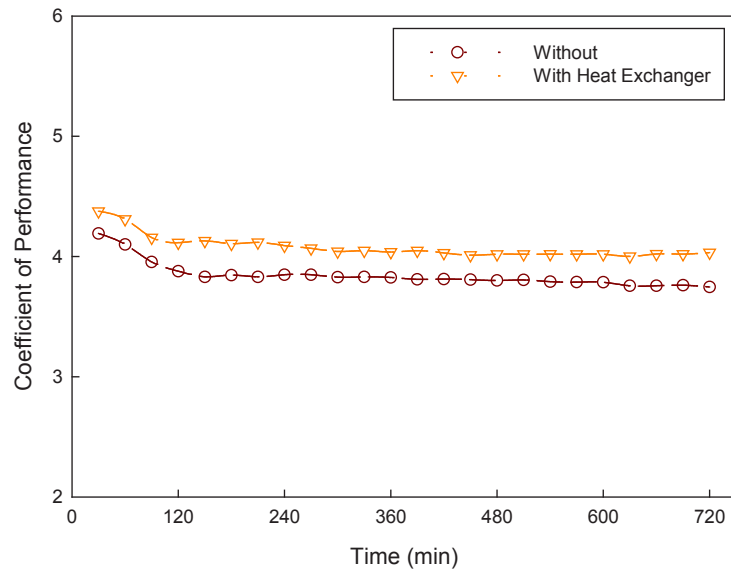


Figure 6. The comparison of coefficient of air conditioning system performance with time

Figure 6 illustrates the COP for the air conditioning systems with and without the heat exchanger. This figure shows that the COP of the air conditioning system with the heat exchanger is higher than that of the system without heat exchanger. This is because the more subcooled refrigerant exit from condenser, more refrigerant quantity flows through evaporator, and more aerosol therefore the heat transfer rate of evaporator is increased, as indicated by Fig. 7, which shows the heat transfer rates of evaporator were 3.40kW and 3.54kW, respectively. Therefore, the result shows that the COP and heat transfer rate of evaporator of the air conditioning system with heat exchanger is higher than that of the system without heat exchanger.

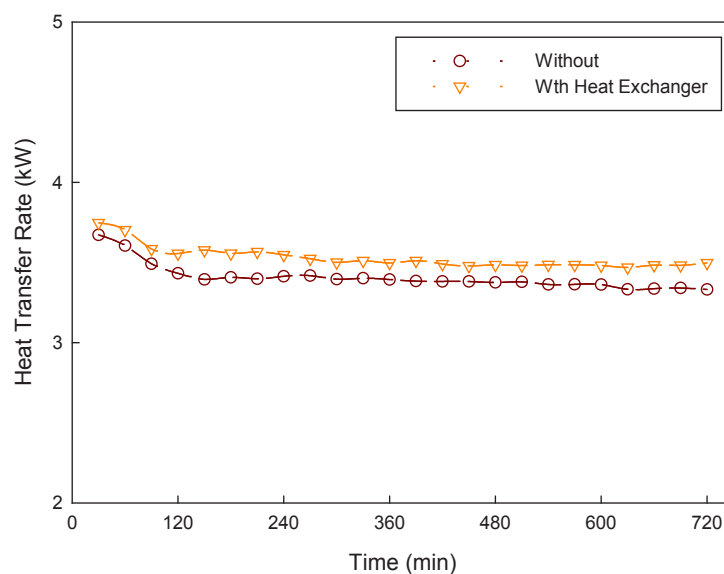


Figure 7. The comparison of heat transfer rate of evaporator with time

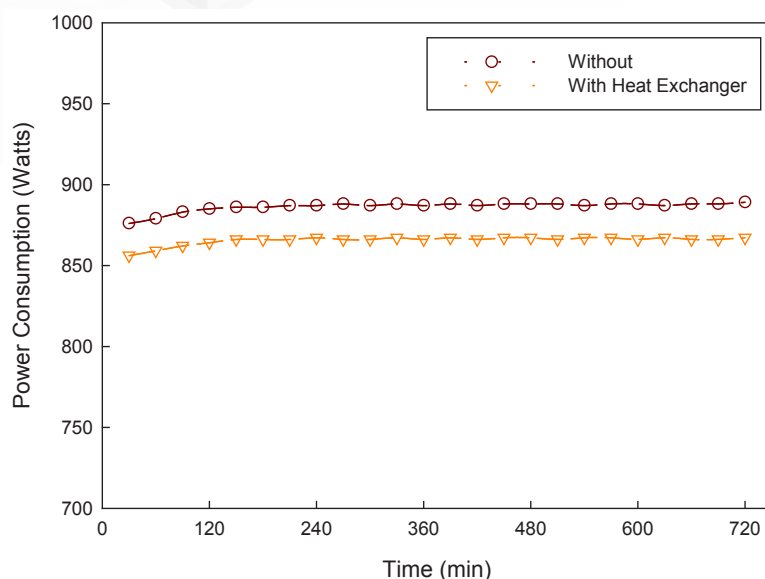


Figure 8. The comparison of power consumption with time

Figure 8 shows the comparison of the power consumption with time for the air conditioning systems with and without the heat exchanger. The figure shows that the power consumptions of the air conditioning system were 866.75 W and 888.75 W, respectively. The power consumption of the air conditioning system with heat exchanger is lower than that of the systems without heat exchanger, this is because the heat transfer rate of condenser is higher. As a result, the lower power consumption obtained from refrigerant heat transfer leads to energy savings for the air conditioning system.

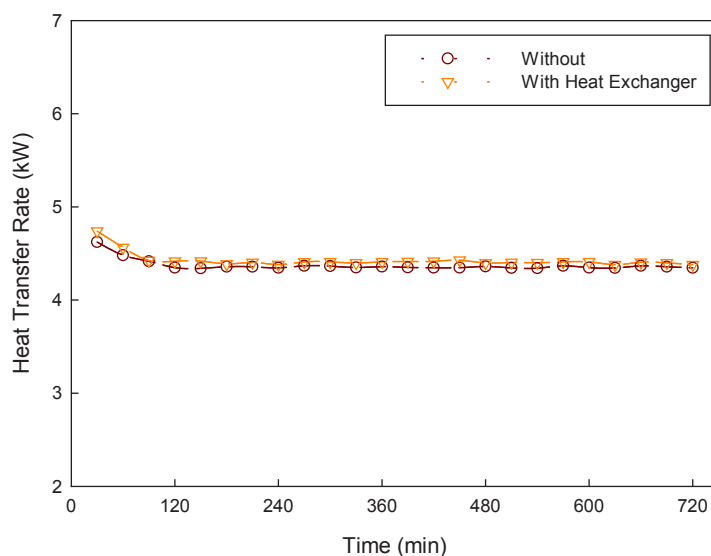


Figure 9. The comparison of heat transfer rate of condenser with time

Figure 9 shows the comparison of heat transfer rate of condenser with time for the air conditioning systems with and without the heat exchanger. The results show that the heat transfer rates of condenser were 4.40 kW and 4.34 kW, respectively. This is because the more subcooled refrigerant before passing through the condenser thus the heat transfer is increased as shown in this figure.

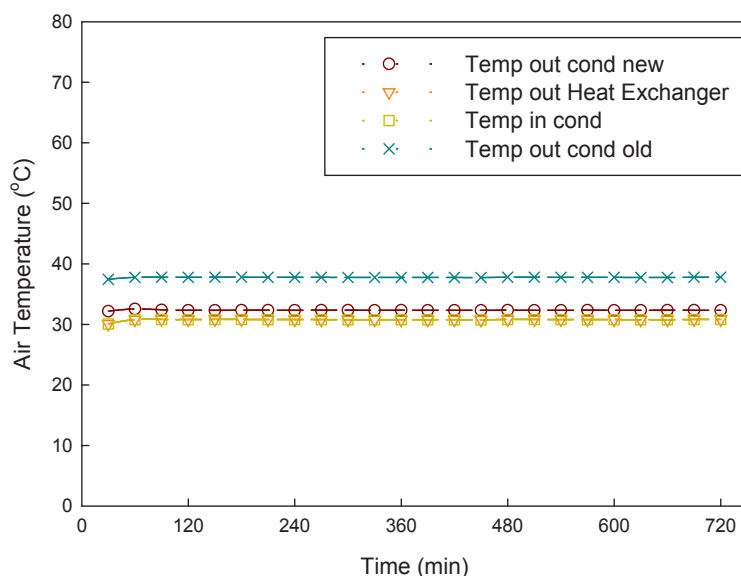


Figure 10. The comparison of air temperature with time

Figure 10 shows the comparison of air temperature with time for the air conditioning systems with and without the heat exchanger. The result shows that the air temperature before entering through heat exchanger was 32.2 °C, then the air conditioning system with heat exchanger could reduce the air temperature to 2.1 °C.

6. Conclusion

The aim of this research was to study the air temperature reduction before entering the condenser by condensed water of evaporator passing through heat exchanger. The experimental unit consisted of a vapor compression of 3.52 kW (12,000 BTU/hr) capacity with R-22 refrigerant and air cooled condenser. The results showed that the coefficient of performance (*COP*) of the system was 4.08, the power consumption of compressor was 866.25 W, the rate of heat transfer in condenser and evaporator were 4.40 and 3.54 kW, respectively. And the air conditioning system with heat exchanger could reduce the air temperature to 2.1 °C.

7. Recommendations

Future research should emphasize the increasing of heat transfer area on the application of heat exchanger device that affected the heat transfer rate of heat exchanger device.

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