ADVANCED ENERGY EFFICIENT SPLIT AIR CONDITIONING SYSTEM BY LIQUID COOLING USING WATER AND ETHYLENE GLYCOL IN EQUAL RATIO

Balaji N.[1] and Suresh Mohan Kumar P.[2]

[1]Research Scholar, Department of Mechanical Engineering, Sathyabama University,
[2]Department of Mechanical Engineering Sri Venkateswara College of Engineering and Technology, Chennai, India
E-mail: [1]balajispark_1977@yahoo.co.in

Abstract

Energy saving is one of the key issues, not only from the view point of fuel Consumption but also for the protection of global environment. So, it is imperative that a Significant and concrete effort should be made for conserving energy. This paper discusses the energy conservation in single split Air Conditioning system addition of helical coil intercooler act as a heat exchanger. The fluid which consisted mixture of water and anti-freezing materials like ethylene glycol with ratio 50:50.The inter cooler reduces the refrigerant entry temperature in the evaporator from 18 to 13°C and also compressor outlet temperature from 70 to 45°C. The compressor's running time is reduced from 44 minutes 30 seconds to 29 minutes. The required indoor temperature of 18$C is reached in 15 minutes 30 seconds earlier. It is evident that the time taken for cooling by the modified system is 34.83 % less than that of the existing split air condition system. Time taken for cooling reduces means compressor running time reduces automatically improve the efficiency of the air conditioning system. The new system reduces the energy consumption and also indirectly reduces the global warming.

Key words: split air conditioner, helical coil, intercooler, heat exchanger, ethylene glycol, global warming

I. INTRODUCTION

Refrigeration is the science of moving heat from a low temperature to a higher one. Refrigeration as the action of cooling requires the removal of heat and discarding it at a higher temperature. Air conditioner is also a refrigerator which works for a longer time in order to cool a larger space for human comfort. It is more difficult to produce and maintain a temperature in the system lower than that of the surroundings than maintaining it at higher temperatures by simply heating. In a tropical country like India, cooling the living environment is much more desirable and there is a great need for multifarious activities such as food preservation and cold chain for life-saving medicines as against heating that is very common in colder countries. Refrigeration and air-conditioning absorb more than 25% of India's electricity generation. In many of the warmer countries around the world, air conditioning is one of the largest energy consumers in the residential, commercial and industrial sector. Air conditioning accounts for a large part of owners' energy bills. Millions of simple air conditioning Units wastes unbelievable amounts of energy every day. The environmental issues of ozone depletion and global warming have forced the refrigeration based industries to direct the research trend in search of alternative refrigerants and alternative technologies. The air conditioners are majorly classified in two types. They are Window air conditioner, Split air conditioner. Now days that split air conditioner are playing a major role than the window air conditioner, there are some reasons to choosing the split air conditioner is that the installation which is more simple while compared to the installation of window air conditioner. Extensive research work was under taken by Qi and Deng (1),Zhou et al.(2,3)had done the simulation and experimental validation of A VRV system using energy plus. Chen and Deng (4) on variable refrigerant flow volume (VRF/VRV) systems, and their significance was explained in modern HVAC applications in terms of thermal comfort. The study performed by Schiaven and Melikon(5) infers that the air movement in indoor environments caused by increasing the fan speeds to conserve the energy spent on cooling without sacrificing the occupant's thermal comfort. Parameshwaran et al (6) achieved air conditioning system energy conservation, by fuzzy

Chiou et al. (7) designed an energy saving system for multiunit room air conditioners using fuzzy control. Koloskotsa et al. (8) performed energy and indoor environmental quality management using a model-based predictive controller. Sathiamurthi et al. (9) designed a waste heat recovery system for air conditioning unit. lung-yue jeng et al.(10)designed

cooling system uses AL2O3/water nanofluid and hydrocarbon refrigerant as the working liquid and vapour compression system cooling for CPU.As an extension of our previous paper (11) inter cooler fitted window air condition system, this work investigates specifically a special helical coil inter cooler like a heat exchanger system, fitted for the split air conditioning system. In the present work, special helical coil inter cooling unit, is attached between the compressor and condenser, without disturbing the existing split air conditioning system.

II. EXPERIMENTAL WORK

The Present research work was based on the energy conservation in the single split air-condition system. For the testing purpose, an existing 1.5 ton capacity split air conditioning system was used. Initially the existing system was fitted in the test room. Inter cooler (heat exchanger) is used to reduce the hot fluid temperature by using cold fluid. It acts as a heat exchanger .Heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by a solid wall, so that they never mix. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing and sewage treatment. The applications of single-phase shell-and-tube heat exchangers are quite large because these are widely used in chemical, petroleum, power generation and process industries. In these heat exchangers, one fluid flows through tubes while the other fluid flows in the shell across the tube bundle. The design of a heat exchanger requires a balanced approach between the thermal design and pressure drop. The pressure drop results in the increase of the operating cost of fluid moving devices such as pumps and fans. This shows that along with the design for the capacity for heat transfer, the pressure drop determinations across the heat exchanger are equally important. The estimations for pressure loss for the fluids flowing inside the tubes are relatively simple, but complex in the shell-side flow. Heat exchangers are used in industrial process to recover heat between two process fluids. Shell-and-tube heat exchangers (STHEs) are the most widely used heat exchangers in process industries because of their relatively simple manufacturing and their adaptability to different operating conditions. Inter coolers are very efficient in the air conditioners because the existing condensers are used as air coolant to the refrigerant. The proposed Helical shaped inter cooler is shown in Fig.1.

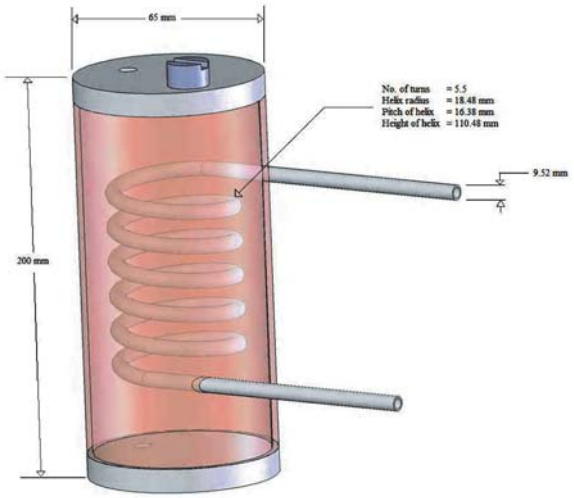

Fig. 1. Helical coil inter cooler

The inter-cooler coil tube is made of copper. The shape of the intercooler coil is helical. It increases the area of contact between the coolant and the helical coil tube. The modified air condition system shown in Fig.2.

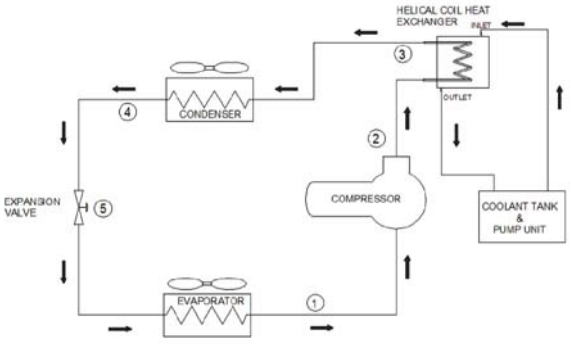

Fig. 2. Modified split air conditioning system

In modified system inter-cooler like a shell and tube heat exchanger attached in between the compressor and condenser. It will reduce the compressor work and also reduce the condenser work.

III. RESULTS AND DISCUSSION

On a particular day, the existing split air conditioning system without the inter cooler is tested. Initially, the room and atmospheric temperatures are measured. The room temperature is 28°C.The required

cooling temperature fixed in of 26°C is fixed in the existing air conditioning system. The time required to reach the cooling temperature is recorded by a stop watch. The Condenser entry and exit temperatures are measured. The Compressor inlet and outlet temperature are measured. The same parameters are measured for the cooling temperatures of 24°C, 22°C, 20°C, and 18°C .Similarly,the modified system is also tested. The comparison of the compressor outlet temperature for the existing and modified intercooler fitted air conditioning is shown in Fig.3.

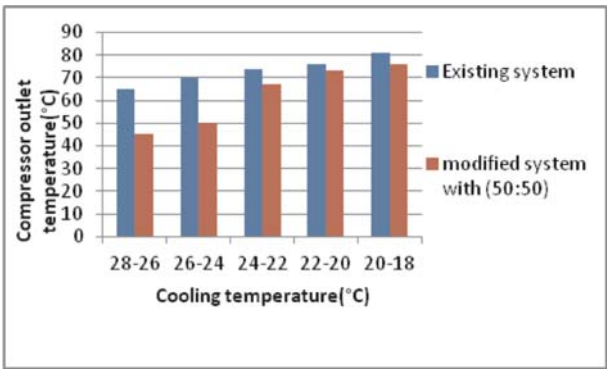

Fig. 3. comparision of compressor outlet temperature

The effect of intercooler the compressor outlet temperature is always lesser in the modified system. The comparison of evaporator outlet temperature shown if Fig.4

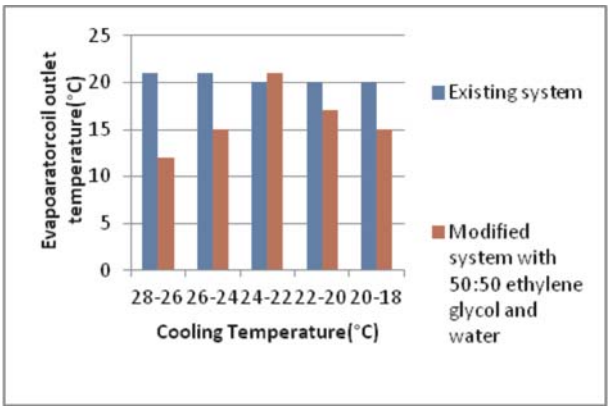

Fig. 4. Comparision of evaporator outlet temperature

Above figure shows the evaporator outlet temperature always lesser in the inter-cooler fitted modified system. The comparison of evaporator inlet temperature is shown in fig.5

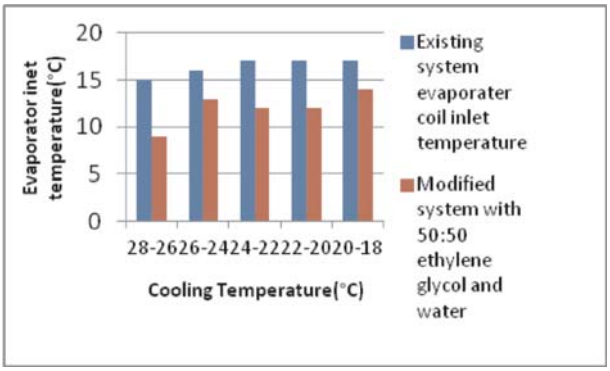

Fig. 5. Comparision of evaporator inlet temperature

The evaporator inlet temperature is always is lesser in the inter-cooler fitted modified system. This means that the effect of inter cooler reduces the evaporator entry temperature. If evaporator entry temperature reduces increases the cooling effect of the air conditioning system. The comparisons of compressor running time for existing modified system is shown in Fig.6

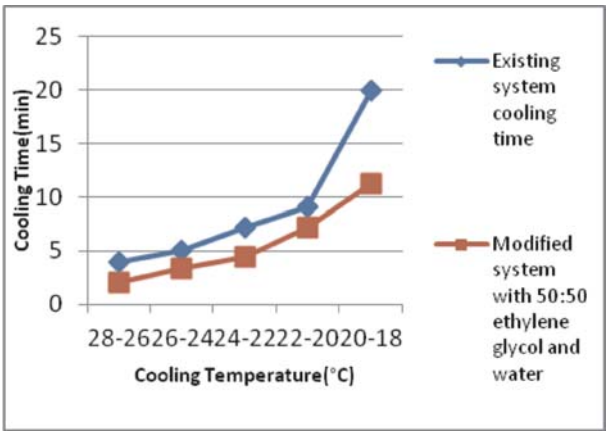

Fig. 6. Comparision of cooling time

In the modified air condition system, the final required cooling temperature is achieved as earlier than in the existing system by the effect of the intercooler. The final required cooling temperature is achieved by the modified system, 15 minutes 30 seconds earlier than the existing system. If the Cooling time reduces, it means the compressor running time also reduces,

automatically reducing the energy consumption of the air conditioning system. From the graph, it is evident that the time taken for cooling by the modified system is 34.83 % less than that of the existing system.

IV. CONCLUSION

An intercooler was attached to the modified split air conditioning system. Comparing the existing and modified Split air conditioning systems, the time taken to reach the required cooling temperature in the modified air conditioning system was lesser than that in the existing air conditioning system. It directly reduces the compressor's work. The reduction of the compressor's work improves the energy saving. The modified air conditioning system proves to be the long term solution for conserving energy in operating the split air conditioner, and also cost effective.

REFERENCES

[1] Qi Q., Deng S., 2009, "Multivariable control of indoor air temperature and humidity in a Direct expansion (DX) air conditioning (A/C) system", Building and Environment 44(8) 1659–1667.

[2] Zhou Y.P., Wu J.Y., Wang R.Z., Shiochi S., 2008, Simulation and experimental validation of the variable-refrigerant-volume (VRV) air-conditioning system in Energy Plus, Energy and Buildings 40 (6) 1041–1047.

[3] Zhou Y.P., Wu J.Y., Wang R.Z., Shiochi S., 2007, Energy simulation in the variable Refrigerant flow air-conditioning system under cooling conditions, Energy and Buildings 39 (2) 212–220.

[4] Chen W., Deng S., 2006, Development of a dynamic model for a DX VAV air conditioning System, Energy Conversion and Management 47 (18–19) 2900–2924.

[5] Schiavon S., Melikov A.K., 2008, Energy saving and improved comfort by increased air Movement, Energy and Buildings 40 (10) 1954–1960.

[6] Parameshwaran R., Karunakaran R., Vinukumar C., Iniyan S., 2010,energy conservative building air conditioning system controlled and optimised using genetic algorithm, energy and buildings (5), 745-762.

[7] Chiou C.B., Chiou C.H., Chu C.M., Lin S.L., 2009, The application of fuzzy control on energy saving for multi-unit room air-conditioners, applied thermal engineering, 29, 310-316.

[8] Kolokotsa D., Pouliezos A., Stavrakakis G., Lazos C., 2009, Predictive control techniques for energy and indoor environmental quality management in buildings, building and environments 44,1850-1863.

[9] Sathiamurthi P., Srinivasan PSS., 2011, design and development of waste heat recovery system for air conditioner, European Journal of Scientific Research.54 (1) 102-110.

[10] Lung-yue Jeng, Tun-Ping Teng, 2013, Performance evaluation of a hybrid cooling system for electronics chips, experimental thermal and fluid science. 45, 155-162.

[11] Balaji N., Suresh Mohan Kumar P., 2012., Eco-friendly energy conservative single window air conditioning system by liquid cooling with helical inter cooler, European Journal of Scientific Research. 76(3) 455-462.