DESIGN AND MODIFICATION OF A DX WINDOW AC INTO A WATER CHILLER

[1]Dr. Akash Langde, [2]Abhishek Kushwaha, [3]Palav Chahande, [4]Mohit Lakkewar, [5]Mohd. Mubasshir Ali

[1]Professor, Dept. Of Mechanical Engineering Anjuman College of Engineering and Technology, Nagpur, Maharashtra, India

[2345]Under graduate students, Dept. Of Mechanical Engineering, Anjuman College of Engineering and Technology, Nagpur, Maharashtra, India.

ABSTRACT:

Human comforts have now become a necessity in residential areas as the standard of living is rising.

This study deals to devise an optimal solution so that it can provide human comfort with safety and at the same time keeping the expenses to the minimum. Modification is done on a direct expansion (DX) AC unit into a water chiller, can be flexibly used in places where space is constrained. This is achieved by cooling the air in a secondary Heat Exchanger with chilled water as a cooling medium instead of vapour refrigerant as in the DX system. The water is first chilled in a primary heat exchange device. Plate Heat Exchanger (PHE) is used for the same. The chilled water lines will be then passed in evaporator coil of an Air Handler Unit (AHU) or a Fan coil unit, which will act as a cooling coil and cool the air. These water lines could be extended to almost any lengths if properly insulated and supplied with sufficient pumping power. Water being in them has no chance of proving hazardous if leaked, which is an advantage over Variable Refrigerant Flow (VRF) system. The chilled water lines can also be employed in shell and coil heat exchanger to create a refrigerated space.

The proposed modification can be done on a scrap Window AC with ease, with intent to use maximum parts available from it.

KEYWORDS: Used AC, Plate Heat Exchanger, Chilled water, Non-Hazardous, small scale.

1. INTRODUCTION:

Nowadays, need for intelligent and environment friendly cooling systems have been on exponential rise. So, attending to these needs of technological enhancements have become a top priority of Engineers and innovators. This study shows that how a currently outdated system can be functionally employed to design a more viable equipment meeting the comfort and safety needs required in current times. The study proposes the modification of a direct expansion air cooled window air conditioner to be profitably modified into a air cooled water chiller. The modified product can effectively replace the existing system in small commercial and residential buildings. The DX AC employs a Vapour Compression Refrigeration System for air conditioning and the condenser is generally air cooled, with the vapour refrigerant establishing a direct contact with the air sucked in. The condenser fan and blower being connected on the same shaft differentiates the AC into two compartments viz, condenser (outdoor) unit and evaporator (indoor) unit.

Modification is performed on the indoor unit by removing the evaporator coil and passing the refrigerant through a Heat exchanger to cool water supplied from the reservoir by the use of a pump. The water which gets chilled is now employed in a different cooling coil and fan for air conditioning.

2. Working Principle:

A Plate Heat Exchanger (PHE) is incorporated between the outdoor and indoor unit of the window AC. Refrigerant passes from its usual path from compressor to condenser, then expansion and instead of evaporator it is made to flow in PHE.

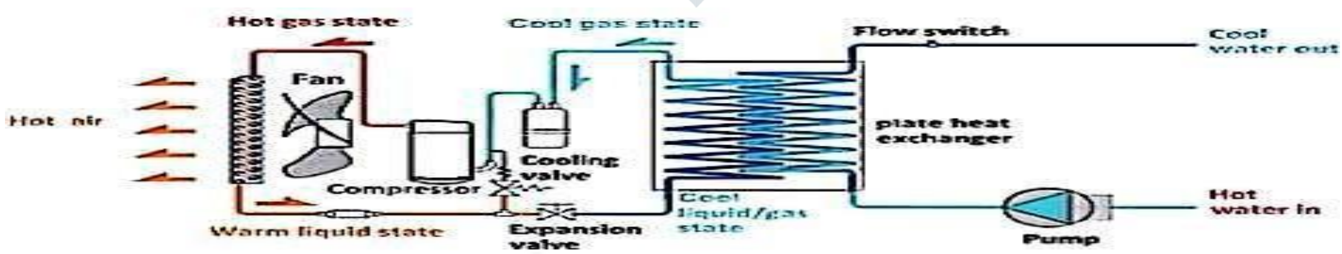

Fig-No-1 System layout

PHE works as a secondary Heat Exchanger and exchanges heat between vapour refrigerant and water. The water is temporary stored in a tank of at least 100 litres. A 1/2 HP pump is used to keep the water circulating throughout the water lines.

3. Components:

3.1 Plate Heat Exchanger

A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids. This has a major advantage over a conventional heat exchanger in that the fluids are exposed to a much larger surface area because the fluids are spread out over the plates. This facilitates the transfer of heat, and greatly increases the speed of the temperature change.

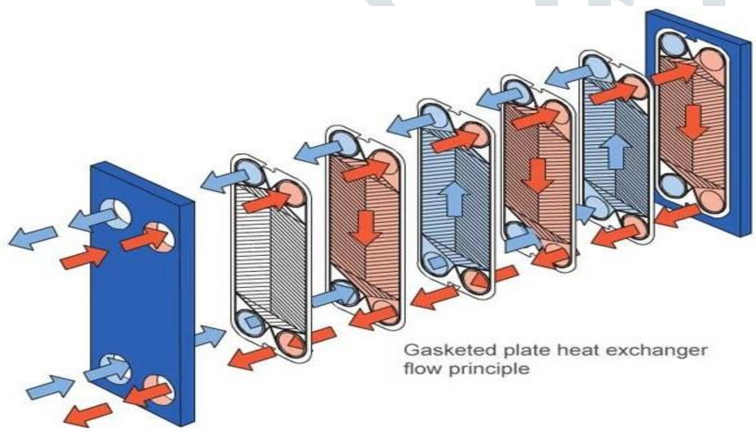

Fig-No-2 working principle of PHE

Fig-No-3 Plate heat exchanger

It uses metal plates to transfer heat between two fluids. This has a major advantage over a conventional heat exchanger in that the fluids are exposed to a much larger surface area because the fluids spread out over the plates. This facilitates the transfer of heat, and greatly increases the speed of the temperature change. The plate heat exchanger (PHE) is a specialized design well suited to transferring heat between medium- and low-pressure fluids.

3.2 Window Air Conditioner:

Window AC selected for this project has the following specifications;

1. Model No. Videocon VWF53.WE1 QL.
2. Capacity. 1.5 Ton.
3. Dimensions. 660 X 660 X 428 mm.
4. Power Input. 1750 Watts
5. Air Circulation. 725 cfm (cubic feet per minute).

Selected window air conditioner consists of following major parts,

1. Rotary compressor (Operating pressure between 4 to 16 bar).
2. Capillary tube.
3. Condenser.
4. Evaporator.
5. Blower & Fan.

3.3 Fan coil unit:

The chilled water coming from the plate heat exchanger is made to pass through into a fan coil unit, which consists of copper coils and a fan.

The fan can be positioned in two ways either in blow through arrangement or draw through arrangement.

The evaporator coil of the window AC can be utilized as a cooling coil in the fan coil unit. The same motor can be used for running both blowers for condenser and fan for fan coil unit.

4. Theoretical calculations.

Refrigerant – R22

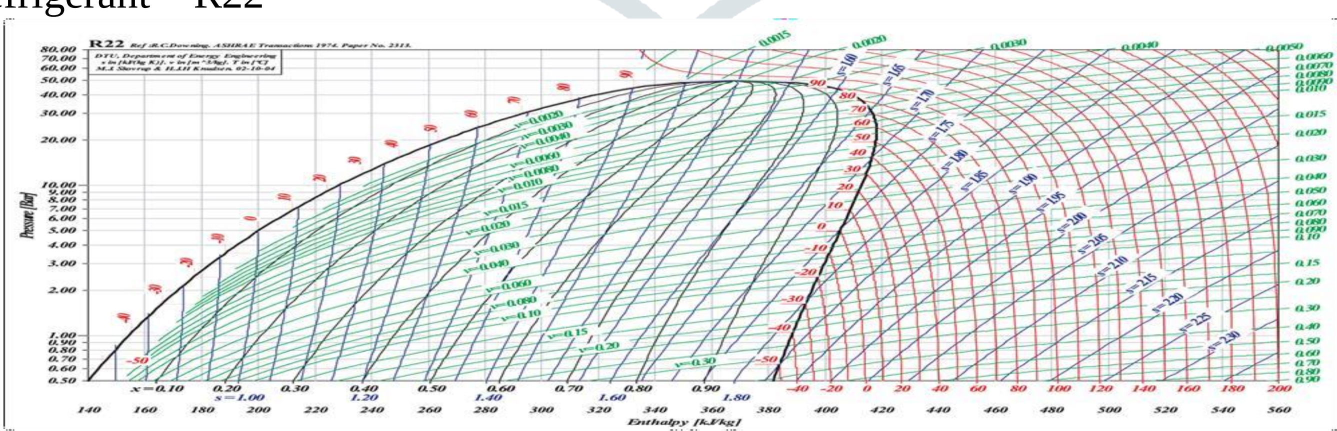

Fig-No-4 P-h chart for R-22 refrigerant

Refrigerating effect – 1.5 Ton=5.27 Kwatts
Suction pressure=P_1 = 4.13 Bar
Delivery Pressure=P_2 = 16.52 Bar
Suction temperature = T_1 = -6 °C
Delivery temperature = T_2 = 42 °C

Enthalpy at inlet of compressor = h_1 = 403 KJ/Kg
& Entropy = s_1 = 1.89 KJ/KgK

Since compression is isentropic ,
Entropy at inlet of compressor = Entropy at outlet of compressor
$\therefore s_1 = s_2$

Therefore , temperature at outlet of compressor T_{sup}= 70.54 °C

Enthalpy at outlet of compressor, h_2=443 KJ/Kg

Enthalpy at condenser outlet = Enthalpy at inlet of heat exchanger
$\therefore h_3 = h_4$ = 250 KJ/Kg

Mass flow rate of refrigerant,
RE = $m_R (h_1 – h_4)$
Therefore, m_R = 0.035 Kg/s

Heat rejected in condenser = $m_R (h_2 – h_3)$ = 6.75 Kwatt

Mass flow rate of water through the chiller,

Assuming inlet and outlet temperatures to be 30°C and 6°C respectively &
C_{pw}= 4.186 KJ/KgK.

Therefore,
RE = $m_w C_{pw} (30 – 6)$, which gives

m_w = 0.052 Kg/s

5. Advantages:

- A DX System Is Limited To Use For A Small Sized Room Only OR Different Room On The Same Floor, which is its limitation. But a chiller being used as a central unit and fan coil system in different rooms on different floors can be employed to remove this problem.

- A chiller requires less Maintenance Compared To DX System as the evaporator contains water.

- Only A Central Chilling Unit Is Required.

- Chilling Water Can Also Be Employed For Various Purposes. For EX:- Cooling of tool tip , Chilling Of water bottles , Air Conditioning Etc.

6. Conclusion:

Today's energy scenario demands us to be more energy efficient and eco-friendly in the most possible way possible. This paper proves that how our energy and comfort requirements can be met without the need of installing and purchasing newer systems which are also way too costlier for common man. By using basic retrofitting methods and employing creative thinking, a non-usable and outdated system can be converted into a lower cost system utilized for air conditioning. It also proves the fact that the modified system clearly surpasses its previous form in providing safe comfort situation as it gives now. The chilled water other than being used in air conditioning can also be used as a cooling media in a shell and coil Heat Exchanger, which can in turn used to cool water bottles or small vessels containing food products.

7. Acknowledgement:

Working on this Project has been a great learning experience. The Authors express their sincere appreciation and gratitude to Md. Waseem Quraishi sir for his right orientation, valuable knowledge, constructive criticism for uplifting our confidence level at all stages of endeavor. The Authors also express their gratitude and respect towards Mr. Saif sir for lending his workplace and his valuable time during the course of our project.

References:

[1] Jessica Dahlkvist, Development and Optimization of a Portable Air Conditioner (2013). Master of Science Thesis, Stolkholm , Sweden.
[2] https:// www.jcyounger.com
[3] https:// www.fraserengineering.com
[4] https:// www.westlandhvac.com
[5] Refrigeration and Air Conditioning by R.S. Khurmi, J.K. Gupta
[6] Basic Refrigeration and Air Conditioning by P.N. Ananthanarayan