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A Review on Fabrication of Combine Heater and Cooler for Domestic Applications

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Abstract: *This paper presents a modified design of Vapour Compression Cycle. Heating and cooling are very important parameters in day to day life. Various machines and instruments are made to achieve the required atmospheric conditions. While studying the cycle of All weather AC, we found the solution to use the evaporator as condenser as well during winter for heating purpose. All we need to do is use the Bypass valve and reverse the cycle. The three central functions of heating, ventilation, and air conditioning are interrelated, especially with the need to provide thermal comfort and acceptable indoor air quality within reasonable installation, operation, and maintenance costs. HVAC systems can be used in both domestic and commercial environments. HVAC systems can provide ventilation, and maintain pressure relationships between spaces. The means of air delivery and removal from spaces is known as room air distribution. Most of conventional all weather AC have set a standard of conditioning the air at optimum level so as to increase the human comfort. But still the expectation of providing heat in winter and cooling in summer is the basic requirement which is the biggest aim of the project. The objective or the plan of action says that we are providing these all objective by keeping structure in limitations i.e. least number of component, and at minimum cost.*
Keywords: *Heating, Cooling, VCC, All weather AC, Bypass valve, reverse cycle, HVAC, room air distribution, human comfort, cost.*

I. Introduction

Ventilating or ventilation (the V in HVAC) is the process of exchanging or replacing air in any space to provide high indoor air quality which involves temperature control, oxygen replenishment, and removal of moisture, odors, smoke, heat, dust, airborne bacteria, carbon dioxide, and other gases. Ventilation removes unpleasant smells and excessive moisture, which introduces outside air by keeping interior building air circulating, and thus it prevents stagnation of the interior air.

The three central functions of heating, ventilation, and air conditioning are correlated with each other, whose main aim is to provide thermal comfort. This system is helpful in indoor air quality within reasonable installation, operation, and its maintenance cost is more. HVAC systems can be used in both domestic and commercial environments. HVAC systems can provide ventilation, and maintain pressure relationships between spaces. The means of air delivery and removal from spaces is known as room air distribution. In modern buildings, the design, installation, and control systems of these functions are integrated into one or more HVAC systems. For very small buildings, contractors normally estimate the capacity and type of system needed and then design the system, selecting the appropriate refrigerant and various components needed. For larger buildings, building service designers, mechanical engineers, or building services engineers analyze, design, and specify the HVAC systems. Specialty mechanical contractors then fabricate and commission the systems. Building permits and code-compliance inspections of the installations are normally required for all sizes of building.

The basic requirement of HVAC system is to get heating in winter and cooling in summer. If we consider all the above mentioned parameters in the system its cost will get increased and also it is based on weather cycle. But we are going to introduce a system which will do the same function as that of HVAC but the cycle used is vapour compression cycle.

II. Literature Review

Natural Resources Canada's Office of Energy Efficiency [1] studied the three cycles in heat pump namely Cooling cycle, Heating cycle and Defrost cycle. The components used in their system are indoor and outdoor coils, the reversing valve, the expansion device, the compressor, and the piping, also fans are provided to blow the air over the coils and heat source is provided as supplementary. They described about Energy Efficiency considerations, Selection considerations, Sizing considerations, Installation considerations Operation considerations, Energy savings and Maintenance of air-source heat pump. They concluded that, at 10°C the COP of air-source heat pump is near about 3.3. This means that 3.3kWh of heat is transferred per kWh of electricity supplied to the heat pump. At -8.3°C, the COP is near about 2.3. They also concluded that, If we convert all electric furnace to air-source heat pump we may be able to reduce our heating cost by upto 50%.

Iain staffell [2] et al aims to increase the awareness and understanding of heat pumps for the domestic sector. To this end, the physics, technologies, modes and practical aspects of operation are discussed, the capital and running costs are considered, and the commercial landscape explored. In order to derive a better understanding of the actual performance of heat pumps, the various ways of describing efficiency are presented and used to examine the performance that can be obtained in real-world operation, surveying the published efficiency figures for hundreds of air source and ground source heat pumps. A straightforward method to relate these to the actual performance measured in UK and German field trials is presented, accounting for climate, the building's heating system and auxiliary components of the heat pump. The striking difference in results from these trials highlights the importance that non-technical factors, such as design, installation and operation have on the energy and CO2 savings that heat pumps can attain. There is much that can be learnt from both the best and worst performing systems. Awareness of these issues within government, industry and people's homes must be heightened in order to reap the substantial benefits that heat pumps can offer.

Dr. T. Hari Prasad [3] et al presented a computational model based on exergy analysis for the investigation of the effects of the evaporating temperature, condensing temperature, degree of sub cooling and degree of super heating on the exergy losses, the second law efficiency and COP of the vapor compression refrigeration cycle.

It is found that the evaporating and condenser temperatures have strong effects on the exergy losses in the evaporator and condenser, second law efficiency and COP of the cycle but little effects on the other components of exergy losses.

It is also found that degree of sub cooling and degree of superheating have strong effects on exergy loss in each component, second law efficiency and COP of the cycle. The second law efficiency decreases with increase of evaporator temperature. COP increases with increase of evaporator temperature. Total exergy losses decreases with increases of evaporator temperature. The second law efficiency decreases with increase of condenser temperature. COP decreases with increase of condenser temperature. Total exergy losses increases with increases of condenser temperature. The second law efficiency increases with increase in degree of sub cooling.

COP in creases with increase in degree of sub cooling. Total exergy losses decreases with increase in degree of sub cooling. The second law efficiency decreases with increase in degree of super heating. COP increases with increase in degree of super heating. Total exergy losses decreases with increase in degree of super heating.

It this work, It can be concluded that the exergy losses are due to irreversibility of the process leading to the reduction of the useful effects of the process and the exergyanalysis of vapour compression refrigeration system can locate the inefficient areas and point out the areas with great potential for the improvement. This exergy analysis is used to evaluate and optimize the performance of the vapour compression system.

It is concluded that every irreversible phenomenon causes exergy losses leading to the reduction of the useful effects of the process or to an increased consumption of energy from whatever the source the energy was derived.

Thus it is obvious that, the purpose of exergy analysis is to improve analysis of system by introducing ways of concurrently suggesting improvements to the analyzed system. One way in which Tribus justifies the method as fallows: it is much more important to be able to survey the set of possible systems approximately than to examine the wrong system exactly. It is better to be approximately right than precisely wrong.

III. Components Required

III.1) Compressor

KONOR GQR80TG fridge compressor 200-220V/50Hz 220-230V/60Hz R134A

Specifications: i) Height- 186 mm, Net Weight- 10.8 kg
ii) Displacement- 8.1cm^3, Cooling Capacity- 730 W, Power- ¼ HP, COP- 10.8
iii) Motor Type- CSIR

Technical Features: i) Standard, medium, high and very high levels of efficiency.
ii) Available for R-134A, R-600A and R-290.

Fig.1: A hermetically sealed compressor

They are the best selling high-tech compressors sold in the world. They are ideal for domestic refrigeration and also for small commercial applications. They are small, have low noise and vibration levels, they achieve the highest levels of efficiency available in the market for this category.

III.2) Condenser

Air Cooled Copper Tube Aluminum Fin Condenser

Condenser Specification: i) Aluminum condenser Coils;
ii) Can be customerized;
iii) Work Pressure: 0.2~3.1MPa;
iv) Fin space: 1.2~3.5mm;
v) Tube Diameter: 9.52 mm

Condenser Features: i) Material: Copper, aluminum, galvanized plate;
ii) Aluminum foil: Bare fin;
iii) Fin type: Corrugated fin;
iv) Copper pipe: Diameter 9mm, grooved or smooth tube;
v) Pitch of fins can be adjusted between 2.0mm.;
vi) Suitable for R134A, R22, R404A, R407C refrigerant and so on;
vii) Voltage: 220V/1/50Hz

III.3) Evaporator

Double side rollbond evaporator with aluminium plate covered.

Technical Standards: i) Size: width 590 (max), length 2050 (max), Thickness 1.1-2.0 mm
ii) Can produce according to the drawing or sample supplied by clients, also can help the clients design and produce different models of roll bond evaporator.
iii) Surface treated with powder painting to prevent the corrosion
iv) Inner cleanness can meet the requirement of R134a & CFC cooling system.
v) Can satisfy the cooling capability requirements.

III.4) Copper Tubing

Copper tubing is most often used for supply of hot and cold tap water, and as refrigerant line in HVAC systems. There are two basic types of copper tubing, soft copper and rigid copper. Copper tubing is joined using flare connection, compression connection, or solder. Copper offers a high level of corrosion resistance, but is becoming very costly. Generally tube of thickness 4-7mm is used in refrigerator.

IV. 5) Expansion Device

Flow control, or metering, of the refrigerant is accomplished by use of a temperature sensing bulb, filled with a similar gas as in the system that causes the valve to open against the spring pressure in the valve body as the temperature on the bulb increases. As the suction line temperature decreases so does the pressure in the bulb and therefore on the spring causing the valve to close. An air conditioning system with a TX valve is often more efficient than other designs that do not use one.

A thermal expansion valve is a key element to a heat pump; this is the cycle that makes air conditioning, or air cooling, possible. A basic refrigeration cycle consists of four major elements: a compressor, a condenser, a metering device and an evaporator. As a refrigerant passes through a circuit containing these four elements, air conditioning occurs. The cycle starts when refrigerant enters the compressor in a low-pressure, moderate-temperature, gaseous form. The refrigerant is compressed by the compressor to a high-pressure and high-temperature gaseous state. The high-pressure and high-temperature gas then enters the condenser. The condenser cools the high-pressure and high-temperature gas to a high-pressure liquid by transferring heat to a lower temperature medium, usually ambient air.

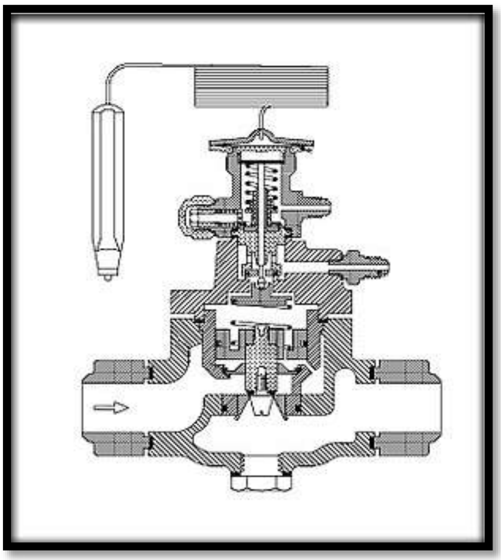

Fig.2: TX valve

The high pressure liquid then enters the expansion valve where the TX valve allows a portion of the refrigerant to enter the evaporator. In order for the higher temperature fluid to cool, the flow must be limited into the evaporator to keep the pressure low and allow expansion back into the gas phase. The TXV has sensing bulbs connected to the suction line of the refrigerant piping. The gas pressure in the sensing bulbs provides the force to open the TXV, therefore adjusting the flow of refrigerant and the superheat.

III.6) Manual on-off valve

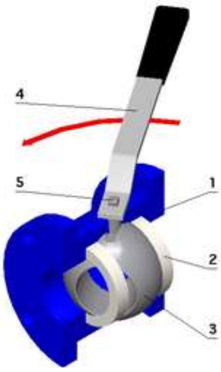

Fig.3: 1) body 2) seat 3) floating ball 4) lever handle 5) stem

A ball valve is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball to control flow through it. It is open when the ball's hole is in line with the flow and closed when it is pivoted 90-degrees by the valve handle. The handle lies flat in alignment with the flow when open, and is perpendicular to it when closed, making for easy visual confirmation of the valve's status. Ball valves are durable, performing well after many cycles, and reliable, closing securely even after long periods of disuse. These qualities make them an excellent choice for shutoff and control applications, where they are often preferred to gates and globe valves, but they lack their fine control in throttling applications. The ball valve's ease of operation, repair, and versatility lend it to extensive industrial use, supporting pressures up to 1000 bar and temperatures up to 752 °F (400 °C), depending on design and materials used. Sizes typically range from 0.2 to 48 inches (0.5 cm to 121 cm). Valve bodies are made of metal, plastic, or metal with a ceramic; floating balls are often chrome plated for durability.

IV. Proposed Model

One of the items that is often overlooked during the planning and construction of a new home is the potential for an enhanced air conditioning (A/C) system. In many cases, the new homeowner is not aware of the various system options available beyond the system that comes standard with the house. Often home builders

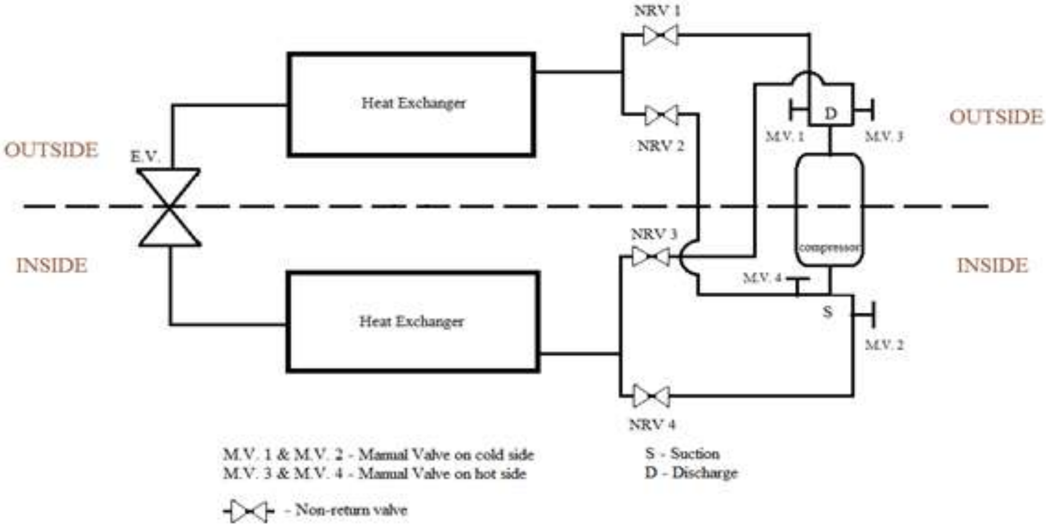

Fig.4: Construction & detailed view of system

themselves are not educated on the potential value that an enhanced comfort A/C system can provide to a new homeowner. Many new homes today are being built with minimum standard A/C systems or systems that meet the minimum efficiency required to obtain energy credits or rebates. That does not mean that there is anything wrong with these systems, as a matter of fact because of the increases in efficiency standards over the last several years even a basic system being installed today could be called high efficiency by early 2000 standards. But what has not changed and where value is being missed is in the area of increased comfort. Operational cycle is same as that of regular refrigeration cycle (reversed carnot cycle) which consist of compressor, condenser, throttling valve and evaporator which operates sequentially.

The modified cycle consist of using bypass valve located at the beginning of the condenser and exit of evaporator thereby connecting the compressor directly to the evaporator to replace it as condenser with reference to regular refrigeration cycle. Also the throttling valve has been added in modified refrigeration cycle.

V. Principle of Operation

The system refrigerant starts its cycle in a gaseous state. The compressor pumps the refrigerant gas up to a high pressure and temperature from there it enters a heat exchanger (sometimes called a condensing coil or condenser) where it loses energy (heat) to the outside, cools, and condenses into its liquid phase.An expansion valve (also called metering device) regulates the refrigerant liquid to flow at the proper rate. The liquid refrigerant is returned to another heat exchanger where it is allowed to evaporate, hence the heat exchanger is often called an evaporating coil or evaporator. As the liquid refrigerant evaporates it absorbs energy (heat) from the inside air, returns to the compressor, and repeats the cycle. In the process, heat is absorbed from indoors and transferred outdoors, resulting in cooling of the building. In variable climates, the system may include a reversing valve that switches from heating in winter to cooling in summer.

A. Summer cycle –

- Refrigeration cycle starts from compressor. The refrigerant in vapour form is compressed in compressor thereby increasing its pressure and temperature.
- Then it enters the condenser. In condenser refrigerant extracts the heat to atmosphere and is in high pressure liquid form.
- Then the high pressure liquid refrigerant enters the throttling valve. There its pressure is reduced along with temperature.
- Then it enters the evaporator, where it absorbs the heat from evaporator and is converted into vapour again and cycle continues. Thus, we obtain a cooling effect in the evaporator section.

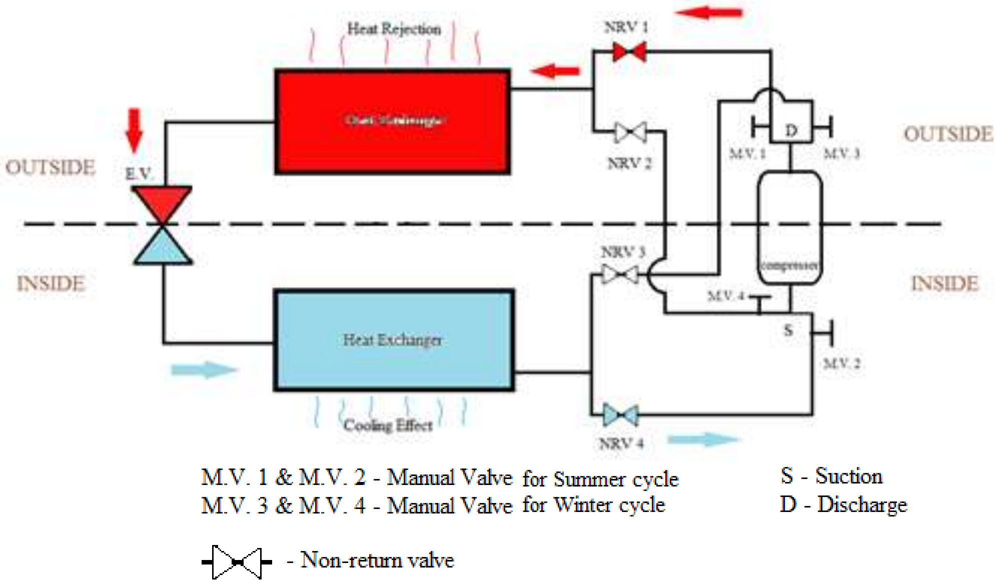

Fig.5: Summer cycle

B. Winter cycle:-

- Refrigeration cycle starts from compressor. The refrigerant in vapour form is compressed in compressor thereby increasing its pressure and temperature.
- Then all we do is reverse the cycle using bypass valves.
- The refrigerant then follows a bypass valve and enters the evaporator of summer cycle, which acts as condenser in winter cycle. In condenser refrigerant extracts the heat to atmosphere and is in high pressure liquid form. Thus we obtain the heating effect which is requirement in winter.
- Then it enters the bypass throttling valve. There its pressure is reduced along with temperature. As the throttling valve is one way valve, so we need to place the valve in reverse manner during the winter cycle.
- At last it enters the condenser of summer cycle which acts as evaporator in winter cycle, where refrigerant absorbs the heat and is converted into vapour again and cycle continues by entering into compressor.

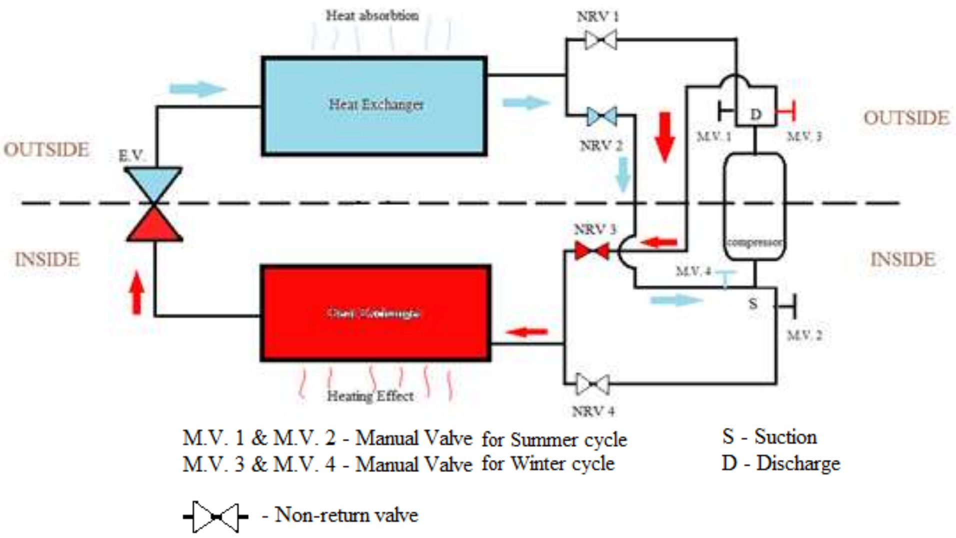

Fig.6: Winter cycle

VI. Conclusion

Heating and cooling are very important parameters in day to day life. Various machines and instruments are made to achieve the required atmospheric conditions. While studying the cycle of All weather AC, we found the solution to use the evaporator as condenser as well during winter for heating purpose. The existing system consists of different heating and cooling automation systems which is very advanced and complicated. Also the various AC are based on All weather cycle which include various devices like humidifier, dehumidifier, filters, which makes the system costly. So to overcome this problem single compartment system is designed which plays both the roles of heating and cooling which is efficient.

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