International Journal of Engineering Research And Advanced Technology (IJERAT)
ISSN: 2454-6135 [Volume. 02 Issue.05, May-2016]

"COP Enhancement Of Domestic Refrigerator By Subcooling And Superheating Using Shell &Tube Type Heat Exchanger"

[1]Prof.Gaffar G.Momin, [2] Sagar B. Tupe, [2] Swapnil A. Parate
[2] Omkar G. Yewale [2] Aakash P. Thite
[1] Assistant Professor in Mechanical Engg.[2]Under graduate Student
PimpriChinchwad College of Engg.
Pune, India.

ABSTRACT

Engineers are continually being asked to improve processes and increase efficiency.These requests may arise as a result of the need to increase process throughput,increase profitability, or accommodate capital limitations. Processes which use heattransfer equipment must frequently be improved for these reasons. This paperprovides method for increasing performance shell-and-tube exchanger . Themethods consider whether the exchanger is performing correctly to begin with, andenhanced heat transfer.

Refrigerator is one of the home appliances utilizing vapour compression cycle in its process. Performance of the system becomes main issue and many researches are still on going to evaluate and improve efficiency of the system. The main objective is to improve performance of the refrigeration system in term of refrigeration Capacity, Compressor work and Coefficient of performance (COP) by determining three importantparameters during in operating mode which are temperature, pressure and refrigerator flow rate. A household refrigerator designed to work with R-12 which is use as an investigation unit to assess the prospect of using refrigerants.Work on condenser in domestic refrigeration is pretty development. We are going to introduce the thermoelectric module in a model of domestic refrigerator for sub cooling the refrigerant and the effect of condenser temperature on COP and refrigerating effect is in investigated. The energy consumption of the refrigerator during experiment with refrigerant R-134a will be measured.

Keywords:- *Fin Type Condenser of Domestic Refrigerator, Shell and tube type heat exchanger, subcooling and superheating, Cop enhancement.*

1. INTRODUCTION

The state of the refrigerant entering the expansion device of conventional vapor compression cycles is usually assumed to be saturated liquid. However, liquid cooling below saturation reduces the throttling losses and potentially increases COP. Subcooled liquid prior to expansion process can be obtained by adding extra components such as internal heat exchangers in single-stage cycles and in two-stage cycles.

Subcooling can also be achieved by an auxiliary cooling system such as a thermoelectric device , a secondary vapor compression system – also known as mechanical subcooling or using available coolant supplies, such as condensate water from evaporator.

An additional heat-sink cooled heat exchanger, usually denominated subcooler, can also be used to obtain subcooling. Typically, a high-side pressure receiver is installed between the condenser and the subcooler in order to separate liquid from vapor before liquid runs through the subcooler. One can think of the subcooler not only asseparate heat exchanger but as part of a then larger condenser which has some of its surface allocated to subcoolliquid. In fact, the most conventional way to obtain subcooling in systems without a liquid receiver is by utilizing part of condenser heat transfer area to cool down the liquid below the saturation temperature. Rather than in a high side pressure receiver, the liquid-vapor interface is eliminated inside the tubes of the condensers, as liquid refrigerant accumulates towards the exit of the heat exchanger.

The so-called condenser subcooling is typically obtained during a refrigerant charging procedure. The question raised by Gosney (1982) is whether one would be better off using the subcooling heat transfer surface, either within the condenser or in a separate subcooler, to reduce the condensing pressure and consequently the compression work.Linton et al. (1992) experimentally investigated the effect of condenser liquid subcooling on a refrigeration system performance. Results showed that the cooling COP and refrigeration capacity of all three refrigerants benefited from subcooling increase (from 6°C to 18°C): R134a (12.5%), R12 (10.5%) and R152a (10%), while condensing temperature was kept artificially constant. Subcooling has also been subject of publications related to automotive air conditioners. These systems are usually equipped with either a high-side liquid receiver or a low-side accumulator in order to absorb fluctuations in refrigerant charge. Yamanaka et al. (1997) presented a concept of a sub-cool system in which the liquid receiver is installed before the last pass of a parallel flow micro channel condenser rather than at the exit of the condenser.

COP would benefit from subcooling due to an increase in enthalpy difference across International Refrigeration and Air Conditioning Conference at Purdue, July 16-19, 2012evaporator. Condensers with integrated receiver and subcooler pass have become standard in state-of-the-art automotive air conditioning systems. Pomme (1999) also presented a similar study in which subcooling was generated by a pre-expansion valve between the condenser exit and the liquid receiver.

A few publications that examined the influence of the refrigerant charge on the COP indirectly explored the relationship between subcooling and COP. Corberan et al. (2008) maximized COP by varying the refrigerant chargein an R290 heat pump equipped with a thermostatic expansion valve.

They explained that the system responded to increasing charge by rising the condenser subcooling since no receiver was installed.

The COP maximizing charge was related to a COP maximizing subcooling. Primal and Lundqvist (2005) had also optimized the charge of a R290domestic water heat pump and found the corresponding subcooling to be 4-5°C.Although condenser subcooling is a practical issue in the everyday of refrigeration and air conditioning systems, to the best of authors' knowledge, this topic has not been the subject of a systematic study in the open literature so far. This study is an attempt to start filling up this gap. First, this paper will theoretically explore the performance tradeoff associated with condenser subcooling using cycle analysis. Then, important thermodynamic properties related to this trade-off will be identified and a sensitivity analysis will be presented for different refrigerants. Second, acomprehensive simulation model of an air conditioner will be used estimate potential for COP improvement with condenser subcooling for different refrigerants. Finally, the effect of subcooling on the performance of an actual vehicular air conditioning system will experimentally investigated for two refrigerants (R134a) under the same operating conditions.

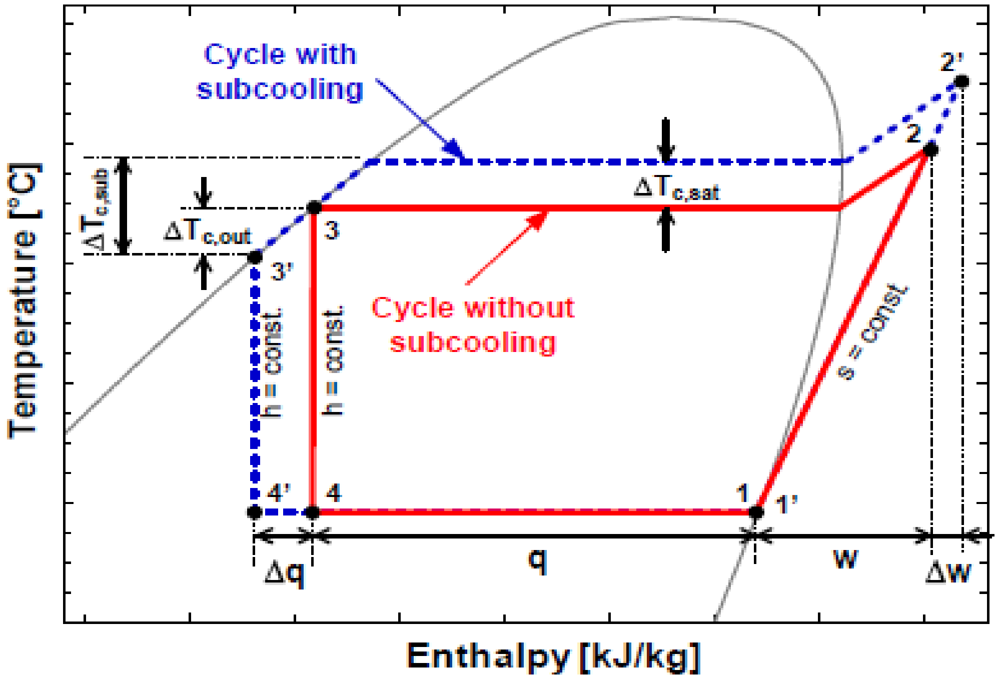

Fig.1. Subcooling cycle analysis

2. OPERATION

Project consists of increasing COP of refrigeration system by using both subcooling and superheating processes.

1) When the refrigerant leaves evaporator at that time refrigerant have some amount of low temperature.

2) Condenser is used for the purpose of removing heat from refrigerant to the atmosphere, to reduce temperature of refrigerant and make phase change of refrigerant.
3) Super heating is done at the inlet of compressor. andsubcooling is done at exit of condenser.
4) We are using both evaporator and condenser heat to make subcooling and superheating at the same time and in same device.
5) Heat exchanger is used to make this heat exchange between hot and cold refrigerant.
6) From the inner tube evaporator outlet refrigerant (low temp refrigerant) flowing and from outer tube condenser outlet refrigerant (High Temp refrigerant) flowing.
7) Heat exchange between both refrigerantproducesan superheating at entry of compressor and subcooling at exit of condenser
8) Heat exchange between both refrigerant produces an superheating at entry of compressor and subcooling at exit of condenser. produces an superheating at entry of compressor and subcooling at exit of condenser
9) Hence refrigeration effect considerably increased with same amount of work supplied and Hence overall COP of system increases

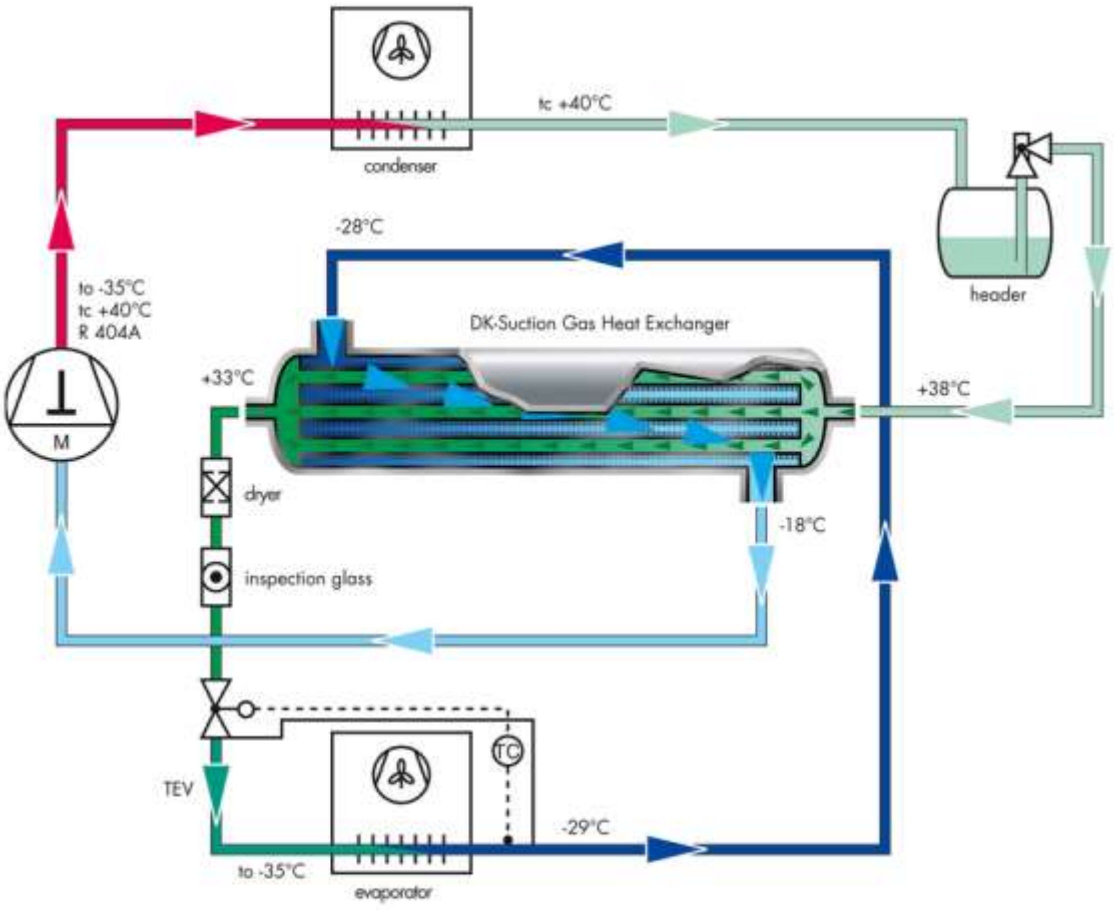

Fig.2. Refrigeration Cycle with Heat exchanger

3. DESIGN OF HEAT EXCHANGER

1. Condenser inlet Temp = 55°C
2. Condenser outlet Temp = 43°C
3. Evaporator Temp = -10°C
4. Compressor power plant(W)= 96 watt
5. Cooling Capacity (Q2)=179 watt
6. Max Pressure =15 bar
7. Mass flow rate= 3.29 kg/hr.
8. U= overall heat transfer coefficient = 300 w/m^{2}k
9. Specific Heat of R134a = gas -: 0.823 kj/kgK

liquid -: 1.145 kj/kgK

1. COP (carnot)= T2/(T1-T2)

= 263/(328-263) = 4.04

2. COP (actual)= Q2/W

= 179/96

= 1.833

3. Heat rejected in condenser (Q1) = Q2+W

= 96+179

=275 watt

4. Heat exchanger Calculation=

$Q = U*A*\Delta T_m$

$Q = m*Cp*\Delta T$

$= 9.138e\text{-}4*1145*(316-306)$

$Q = 10.46$ watt

5. L.M.T.D.

$\Delta T_1 = Th1 - Tc2$

$= 316 - 268$

$= 48$

$\Delta T_2 = Th2 - Tc1$

$= 306 - 263$

$= 48$

$$\Delta T_m = \frac{\Delta T2 - \Delta T2}{\ln(\frac{\Delta T1}{\Delta T2})}$$

$$\Delta T_m = \frac{48-43}{\ln(\frac{48}{43})}$$

$\Delta T_m = 45.45°C$

$Q = U*A*\Delta T_m$

$10.46 = 30*A*45.45$

$A = 7.6714e\text{-}3\ m^2$

$A = \pi * d * L$

$7.6714e\text{-}4 = \pi * 0.006 * L$

$L = 0.406\ m$

$L = 406\ mm.$

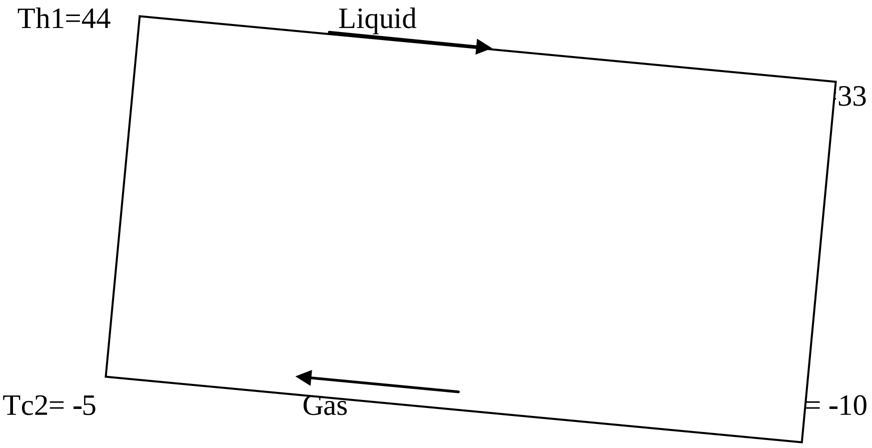

Fig.3. Heat Exchanger

Reading	Time	T1	T2	T3	T4	Cop
1	30 min	60	48	40	-6	
2	120 min	77	50	43	-16	2.331
3	240 min	96	68	47	-17	

Table14.1 - Reading with interval of time

4. CALCULATION AFTER HEAT EXCHANGER INSTALLATION

Specification :-

Condenser inlet Temp = 50°C

Condenser outlet Temp= 43°C

Compressor inlet temp.= 42°C

Compressor outlet temp.= 77°C

Evaporator Temp.= -16°C

Heat exchanger Temperature

Outer Tube-

Inlet- 45°C

Outlet- 43°C

Inner Tube-

Inlet- 27°C

Outlet- 42°C

Calculation:-

$$COP = \frac{RE}{Wc} = \frac{h1-h4}{h2-h1}$$

$$COP = \frac{420.2-388.3}{433.87-420.2}$$

COP = 2.331

Fig.4. Experimental Setup

5. CONCLUSION

Because of the use of heat exchanger possible heat exchange between high temperature fluid and low temperature fluid which gives an result of Subcooling and Superheatting of heat exchanger.

Hence the COP of the system increases by installation of the heat Exchanger, which gives the effect of subcooling and superheating.

6. FUTURE SCOPE

We tried our best to get maximum possible heat exchange between hot fluid and cold fluid but by using plate type heat exchanger and material used in heat exchanger we can further increase heat transfer rate and able to achieve further more effectiveness of heat exchanger.

Also the by studying more parameters of refrigerant and refrigeration system we can able to increase further more COP of refrigeration system.

LIST OF ABBREVIATIONS:

COP	coefficient of performance
h	enthalpy (kJ kg-1)
q	enthalpy difference across the evaporator (kJ kg-1)
SH	superheated vapor region
SC	subcooled liquid region
T	temperature (°C)
TP	two-phase region

w	specific compression work (kJ kg-1 K-1)

Subscripts:

avg	average
c	condenser
e	evaporator
fg	liquid-vapors
in	inlet
out	outlet
sat	saturation
sub	subcooling

REFERENCES

1. Books

[1] R.S. KHURMI & J.K. GUPTA, “A Textbook of Refrigeration and Air Conditioning” PAGE NO.111, ISBN 81-219-2781-1,Fluid Power with Applications by Esposito

Heat Transfer by P.K. Nag page no 4.18

2. Research Papers

Effect of Condenser Subcooling of thePerformance of Vapor Compression Systems:Experimental and Numerical Investigation (2012)

To Improve Cop of Domestic Refrigerator with the Help of Water Cooling Condenser (2015)

Subcooled flow boiling heat transfer of R-134a and the associated bubble characteristics in a vertical plate heat exchanger (2001).