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Energy and Exergy analysis of HFO1234yf for Air conditioner application

Pardeep Kumar[1], Maman Singh[2], Anil Jaglan[3]

[1]Assistant Professor, R N College of Engg. and Tech., Matlauda, Panipat
[2,3]Student, R N College of Engg. and Tech., Matlauda, Panipat

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Abstract: In this work Exergetic analysis of the vapour compression refrigeration cycle with CFC12, HFC134a, HFO1234yf refrigerants has been done. Coefficient of performance and Exergetic efficiency, Effect of Evaporator temperature, Condenser temperature, Superheating of Evaporator, Effectiveness of liquid vapour heat exchanger, Sub cooling of condenser all these terms are computed. It is found that HFO1234yf is better refrigerant than CFC12 and HFC134a.HFO1234yf shows highest exergetic efficiency. HFO1234yf has Global warming potential only 4 so much environmental friendly than selected refrigerants.

Keywords: Coefficient of performance, Exergetic efficiency, Ozone depletion potential, Global warming potential, Liquid suction heat exchanger.

Nomenclature

EX_w = Work done by or on the system

Ψ_I = Exergy at inlet

Ψ_o = Exergy at outlet

S_{gen} = Entropy generation

W_c = Work consumption

T_0 = Ambient temperature

T_k = Temperature of heat source or sink

$I_{destroyed}$ = Irreversibility

m = mass flow rate

$\eta_{second\ law}$ = Second law efficiency

Introduction

Domestic refrigerator and air conditioning system consists the major part of any middle class household and heating ventilation and air conditioning (HVAC) system shares the major portion of domestic electricity bill. Their demand will further grow with the increase in urbanization. Most heating ventilation and air conditioning system based on Vapour Compression Refrigeration System.

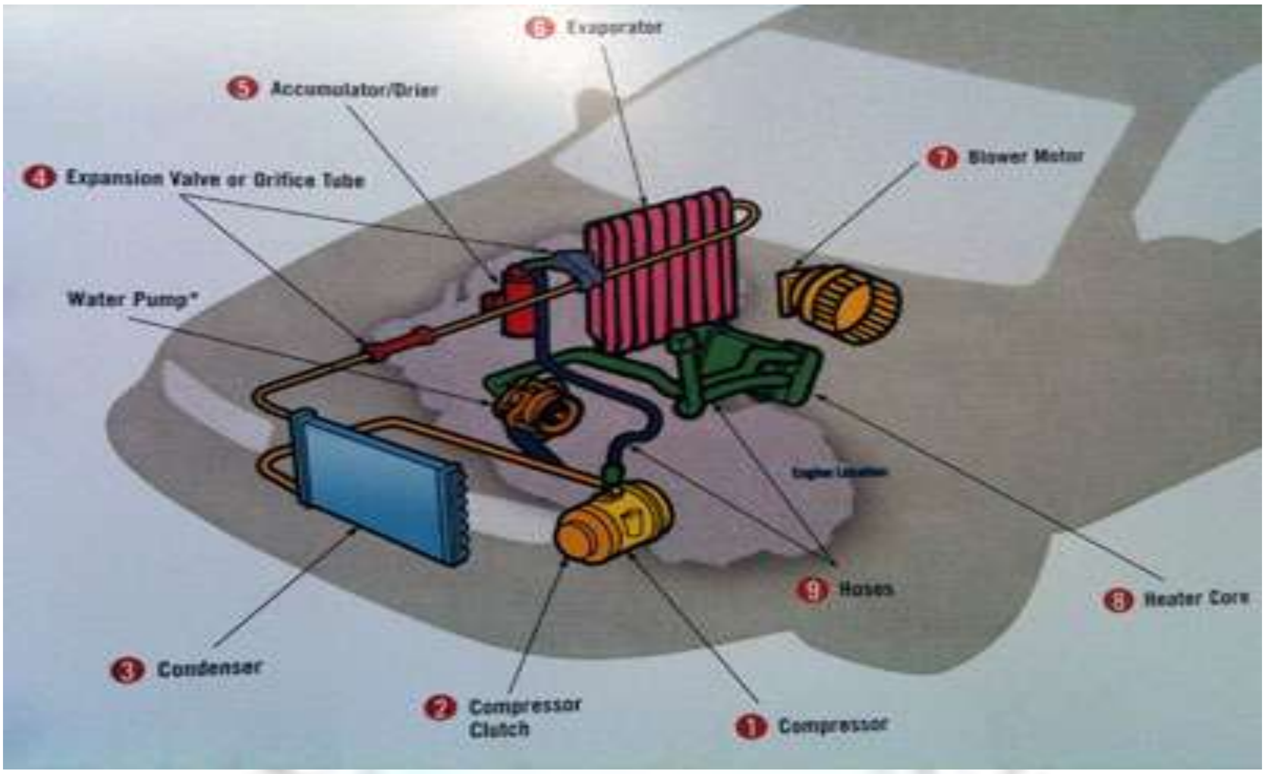

Figure 1: Automotive air conditioner system (Carparts, 2015)

Chloroflorocarbons (CFCs) has been used in domestic refrigerators and air conditioner over a long period of time. They are molecules composed of carbon, chlorine and fluorine. It contributes to the destruction of the ozone layer. Hydrochloroflorocarbons (HFCs) are other refrigerants used in Vapour compression refrigeration system having Zero ozone depletion potential. (Agrawal and Matani, 2012) HFO-1234yf is a new environment friendly sustainable refrigerant for automobile air conditioner which has 99.7% better Global Warming Protocol than HFC134a. Table 1 showing the Global warming potential comparison between HFC134a and HFO1234yf (Dupont, 2015)

Table 1: Global warming potential comparison between HFC134a and HFO1234yf (Dupont, 2015)

Refrigerant	Global warming potential(GWP)
HFC-134a	1430
HFO-1234yf	4
Mobile air conditioning Directive Requirement	150 or less

Table 2: Physical properties of Refrigerants for car air conditioner (Kri, 2015)

Refrigerant	**Chemical formula**	**Molecular mass** (g/mol)	**Normal boiling point** (°C)	T_c (°C)	P_c (bar)
CFC12	CF_2Cl_2	120.9	-29.8	112	41.15
HFC134a	CF_3CH_2F	102.03	-26.1	101.1	40.64
HFO1234yf	$C_3H_2F_4$	114	-30	94.85	34

Therefore, the refrigerants having high ODP and GWP are required to be replaced with eco friendly refrigerants to protect the environment from Ozone depletion & Global warming with refrigerants having low ODP and GWP. The hydro fluorocarbon (HFC) having zero ODP can be considered as alternatives (Mani and Selladurai, 2008). According to the Montreal Protocol the Substances that Deplete the Ozone Layer must be banned. The production of such kind of substances must be phase out to protect the ozone layer. India signed to Montreal protocol on September 17, 1992 (Ozonecell, 2015).

According to the Kyoto Protocol the industrialised countries must advance them to reduce emissions of greenhouse gases. India signed to the Kyoto Protocol on 26 August 2002(Envfor, 2015).It has been observed that most of the analysis of refrigeration cycle regarding performance analysis is done with energy approach e.g coefficient of performance. Energy approach are not able to make the real energetic losses is refrigeration cycle (Arora and Kaushik, 2008).Energy analysis is the most commonly used method in the analysis of thermodynamic systems. Energy analysis shows only with the conservation of energy.

It does not provide information on how where and the amount of performance is poor. Exergy analysis provide the improved and deeper insight view into the process, as well as new unknown ideas for advancement.(Saidur, 2007) .Apera and Greco, 2002 did exergy analysis of HCFC22 substitution carried out with experimental results. Gong et al. 2007 did the selection optimization of cooling and heating sources based exergetic analysis. Arora and kaushik, 2008 presents a detailed exergy analysis of actual vapour compression refrigeration cycle with HCFC502, HFC404A, HFC507A.The results shows HFC507A is better refrigerant among the selected refrigerants.

Bayrakci et al. 2009 did the Energy and exergy analysis of vapor compression refrigeration cycle with pure hydrocarbon. Energetic and exergetic efficiency calculations found out with HO1270 and HC600 are higher than HC600a and HC290. The purpose of this study is to investigate the theoretical performance analysis of CFC12, HFC134a and HFO1234yf based on energy and exergy terms.

Exergy analysis of Vapour compression refrigeration system

Exergy is a term related to quality which always gets lower and lower because of irreversibility in thermodynamic system. For steady state flow, the exergy balance can be given by ignoring kinetic and potential energy changes

$$EX_w=\sum_{k=1}^{n}(1-T0/Tk)Q_k+\sum_{k=1}^{n}[(m\Psi)i-(m\Psi)o]-T_0S_{gen} \text{ (Cengel, 2012)} \quad (1)$$

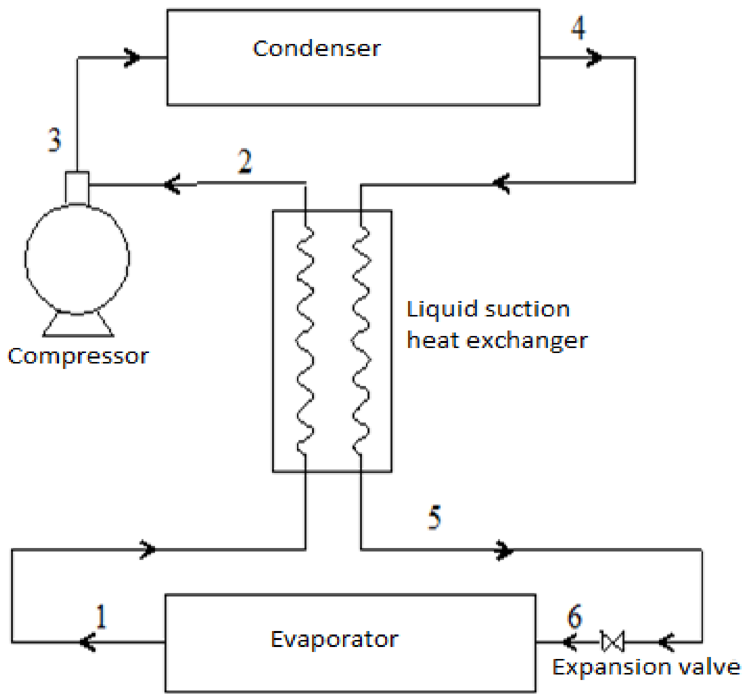

Figure 2: Vapour Compression Refrigeration cycle

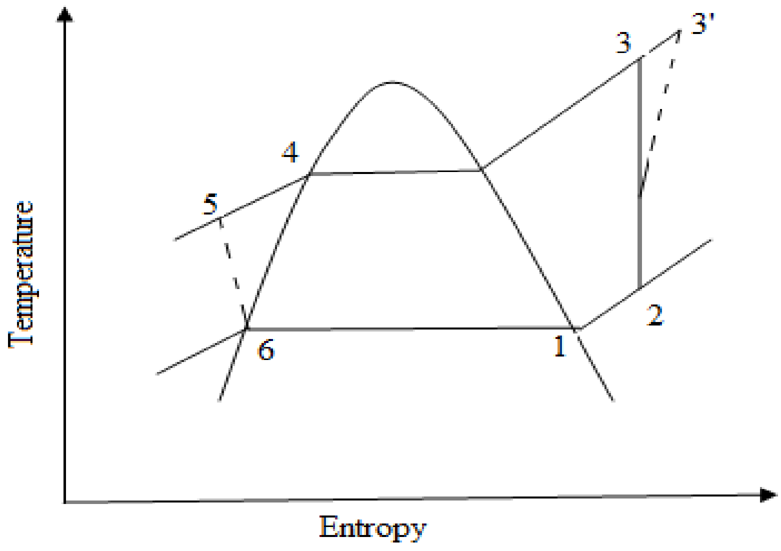

Figure 3: Temperature Entropy (T-s) diagram of Vapour Compression Cycle

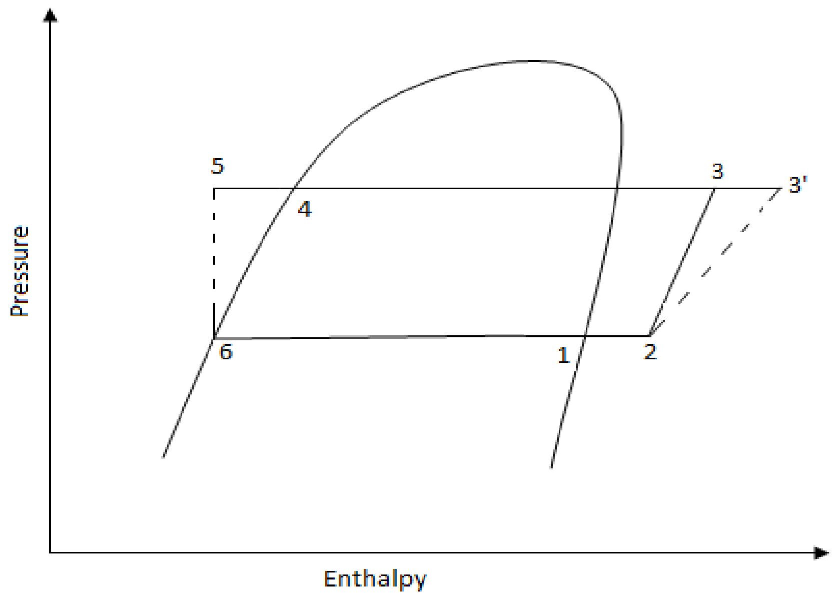

Figure 4: Pressure Enthalpy diagram (P-h) of Vapour Compression Cycle

Mathematical Modeling

Exergy balance equation that is equation 1 is employed for various components of VCR system.

Exergy balance for compressor

$T_0S_{gen}=m_1(\Psi_2-\Psi_3)+W_c$ (2)

$I_{destroyed}=T_0S_{gen}=m_1T_0(S_3-S_2)$ (3)

From here we can find out Entropy generation (S_{gen}) and Irreversibility ($I_{destroyed}$) occurring within the Compressor

The $\eta_{second\ law}=1-(I_{destroyed}/W_c)$ (4)

From this equation we can find out the Second law efficiency of the compressor.

Exergy balance for condenser

$T_0S_{gen}=m_3(\Psi_3-\Psi_4)-\sum(1-T_0/T_k)Q_k$ (5)

$I_{destroyed}=T_0S_{gen}=(m_1(h_3-h_4)-T_0(m_3(S_3-S_4))-\sum(1-T_0/T_k)Q_k$ (6)

From here we can find out Entropy generation (S_{gen}) and Irreversibility ($I_{destroyed}$) occurring within the condenser.

Exergy balance for heat exchanger

$T_0S_{gen}=m_4(\Psi_4-\Psi_5)-m_1(\Psi_2-\Psi_1)$ (7)

$I_{destroyed}=T_0S_{gen}=(m_4(h_4-h_5)-m_1(h_2-h_1))-T_0(m_4(S_4-S_5)-m_1(S_2-S_1))$ (8)

From here we can find out Entropy generation (S_{gen}) and Irreversibility ($I_{destroyed}$) occurring within the Heat exchanger.

$\eta_{second\ law}=1-(I_{destroyed}/m_4(\Psi_4-\Psi_5)$ (9)

From this equation we can find out the Second law efficiency of the heat exchanger.

Exergy balance for Throttle valve

$T_0S_{gen}=m_5(\Psi_5-\Psi_6)$ (10)

$I_{destroyed}=T_0S_{gen}=m_5((h_5-h_6)-T_0(S_5-S_6)$ (11)

From here we can find out Entropy generation (S_{gen}) and Irreversibility ($I_{destroyed}$) occurring within the throttle valve.

Exergy balance for evaporator

$I_{destroyed}=T_0S_{gen}=(m_6(h_1-h_6)-T_0(m_6(S_1-S_6))-\sum(1-T_0/T_k)Q_k$ (12)

Energy analysis

This is done in the form of evaluating COP. (Ballaney, 2012)

$COP=(h_1-h_6)*F*\eta_{iso}*\eta_g/(h_3-h_2)$ (13)

Exergy analysis

This is done in the form of evaluating Second law efficiency. (Cengel, 2012)

$\eta_{second\ law}=COP/(T_1/(T_4-T_1))$ (14)

Vapour compression refrigeration Energy analysis is done by calculating the Coefficient of Performance(COP) and Exergy analysis is done by calculating the value of $\eta_{second\ law}$ (Second law efficiency

Flowchart:

A program has been prepared in Engineering Equations solver version 9.163D and algorithm in terms of flowchart has been presented in figure 4.

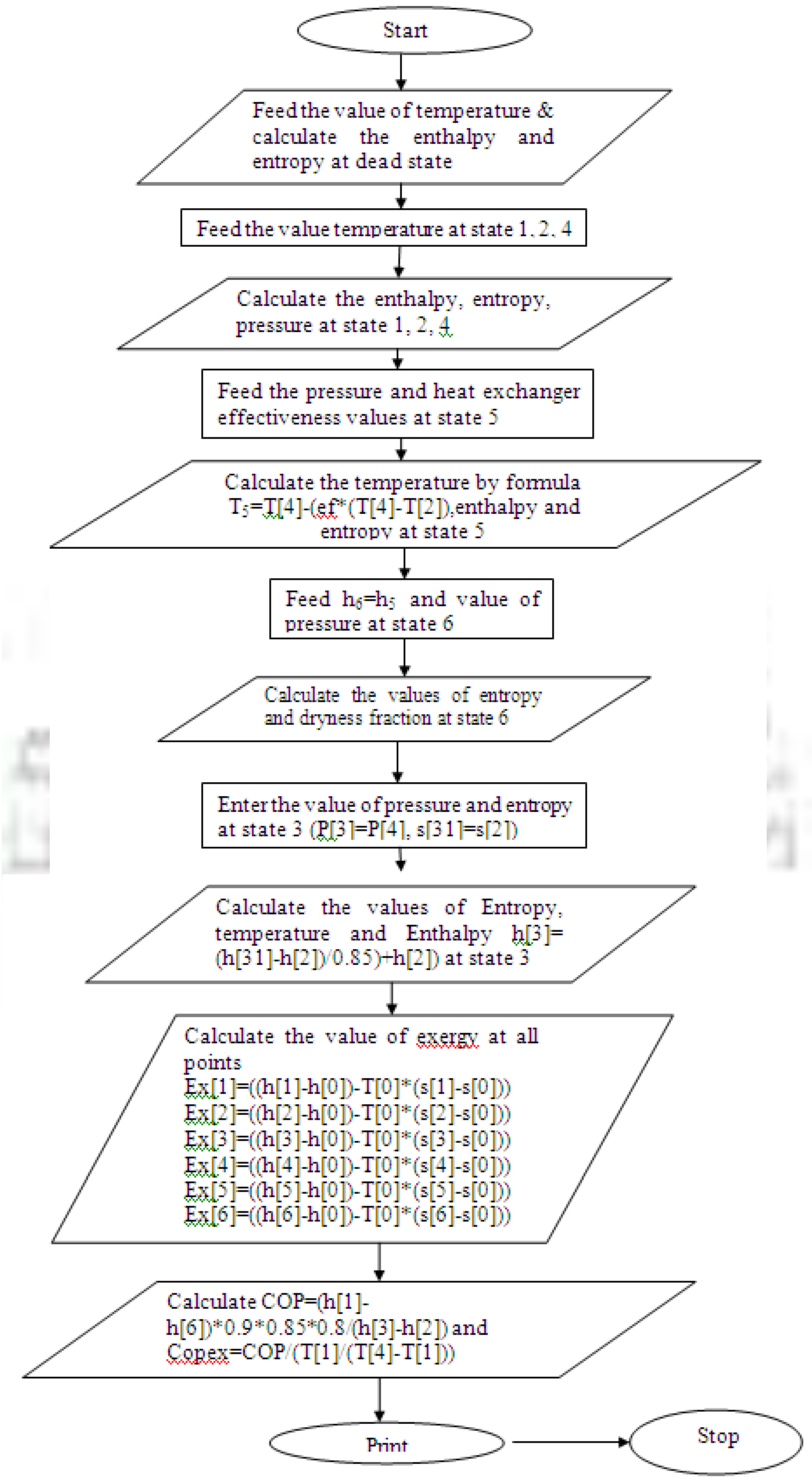

Figure 4: Flowchart for energy and exergy analysis

Results and Discussion

Algorithm of the computational model has already been explained. The operating temperature range is 278K to 333K (Arora, 2000). Here are some assumptions observed for this work and are summarised in table 3.

Table 3: Assumptions for car air conditioner

m(kg/s)	1(Constant)
T_0(K)	278K
T_e(K)	246K to 293K
T_c(K)	323K to 343K
T_{Sub}(K)	5K
T_{Super}(K)	5K
Effectiveness	0.8
F	0.8
η_c	0.85
η_{motor}	0.9

In this section we are going to see the variation of Coefficient of performance and Exergetic efficiency with Condenser temperature, Evaporator temperature, liquid suction heat exchanger and sub cooling temperature. Energy and Exergy analysis is done by taking all these parameters into consideration.

Exergy destruction and Entropy generation in the Components of VCR system

Exergy destruction and entropy generation for CFC12, HFC134a and HFO123yf are compared in table 4, 5 and 6 respectively.

Table 4: Exergy destruction and Entropy generation for CFC12 based Vapour compression refrigeration components

Components	$I_{destroyed}$ (kJ)	$S_{generation}$ (kJ/K)	W_c (kJ/kg)
Compressor	3.697	0.0133	30.6
Condenser	19.21	0.06911	
Heat exchanger	4.556	0.01639	
Throttle valve	1.168	0.0042	
Evaporator	0.0016	0.00005755	

Table 5: Exergy destruction and Entropy generation for HFC134a based Vapour compression refrigeration components

Components	$I_{destroyed}$ (kJ)	$S_{generation}$ (kJ/K)	W_c (kJ/kg)
Compressor	4.726	0.017	39
Condenser	24.31	0.08746	
Heat exchanger	6.82	0.02453	
Throttle valve	1.446	0.0052	
Evaporator	0.0102	0.00003669	

Table 6: Exergy destruction and Entropy generation for HFO1234yf based Vapour compression refrigeration components

Components	$I_{destroyed}$ (kJ)	$S_{generation}$ (kJ/K)	W_c (kJ/kg)
Compressor	3.892	0.014	31.1
Condenser	19.03	0.06846	
Heat exchanger	6.76	0.02432	
Throttle valve	1.668	0.006	
Evaporator	0.676	0.002432	

Irreversibility in compressor is highest for HFC134a as compare to other two refrigerants.CFC12 shows lowest irreversibility that is 3.697 kJ and 3.892 kJ for HFO1234yf evaporator temperature 278K and condenser temperature 333Kdepending upon the change in entropy in the compressor.Entropy values for HFC134a at outlet of compressor is 0.9557 kJ/K and 0.9387 kJ/K at the inlet of compressor at same temperature range.Entropy values for HFO1234yf at same temperature range at outlet of compressor is 1.623 kJ/K and 1.609 kJ/K at the inlet of compressor.Same trend is following in all selected refrigerants based on their properties.The irreversibility obtained for the compressor for different refrigerants is observed from the figure 5.

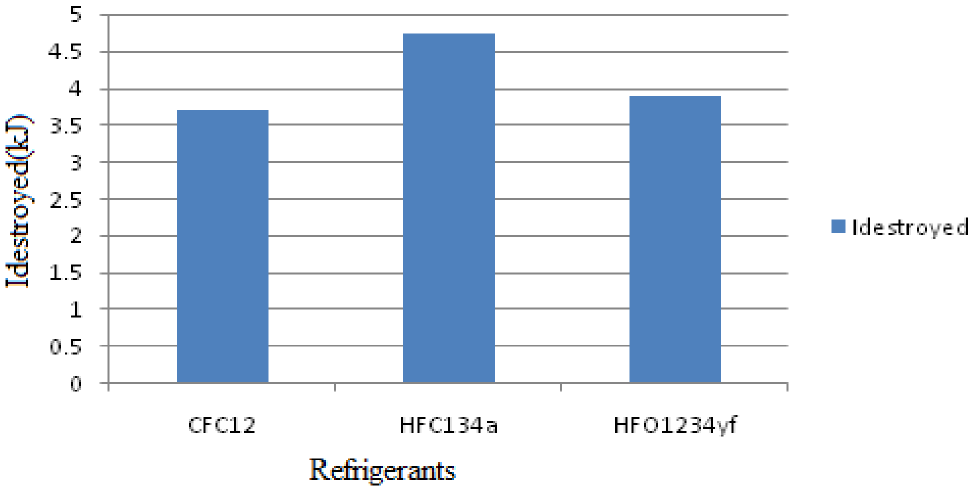

Figure 5: Variation of irreversibilty in compressor with selected refrigerants

Irreversibility in condenser is lowest for HFO1234yf that is 19.03 kJ and highest for HFC134a that is 24.31 kJ at evaporator temperature 278K and condenser temperature 333K because of the variation in enthalpy and entropy values.Condenser is the worst component in the system as large heat is rejected to surrounding.The enthalpy value for HFO1234yf at state point 3 is 400.4 kJ/kg and at state point 4 is 284.2 kJ/kg at specified temperature range.The entropy values for HFO1234yf at state point 3 and state point 4 are 1.623 kJ/K and 1.275 kJ/K respectively.The enthalpy and entropy values for HFC134a at state point 3 and state point 4 are 295 kJ/kg, 139.1 kJ/kg and 0.9557 kJ/K,0.4885 kJ/K respectively at 333K condenser temperature.Same trend can be observed for other selected refrigerants at specified temperature

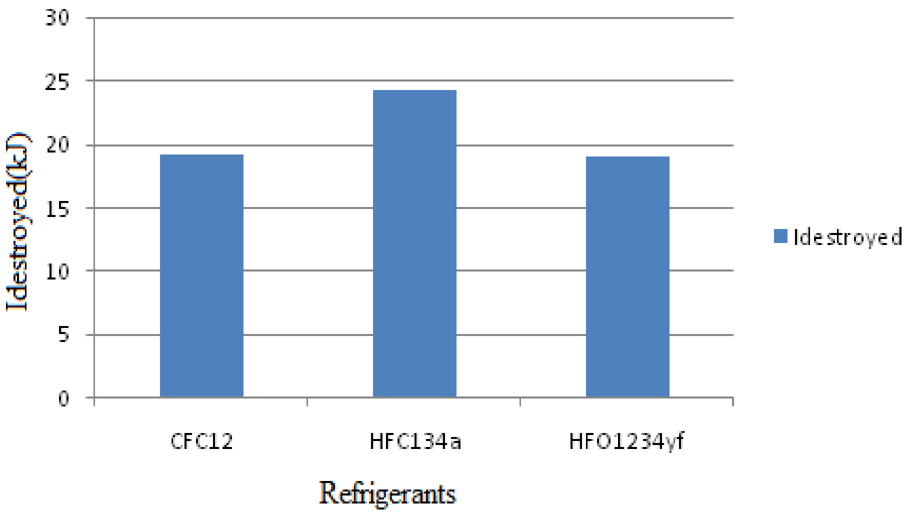

Figure 6: Variation of Irreversibilty in condenser with selected refrigerants

Irreversibility in heat exchanger is highest for HFC134a that is 6.82 kJ followed by HFO1234yf that is 6.76 kJ at evaporator temperature 278K and condenser temperature 333K because of the variations in enthalpy and entropy values from subcooling state to superheating state.The enthalpy and entropy values for HFO1234yf at corrosponding temperatures at subcooling state are 284.2kJ/kg,224.5kJ/kg and 1.275kJ/K,1.084kJ/K.At superaheating state the properties values are 366.4kJ/kg,369.3kJ/kg and 1.598kJ/K, 1.609kJ/K.For HFC134a the enthaphy and entropy values at subcooling state are 139.1kJ/kg,-76.99kJ/kg and 0.4885kJ/K and 0.2896 kJ/K respectively.At superheating enthalpy and entropy values 253.3kJ/kg,256kJ/kg and 0.9288 kJ/K,0.9387 kJ/K respectively at same condenser and evaporator temperature.Same trend is following in all the selected refrigerants.

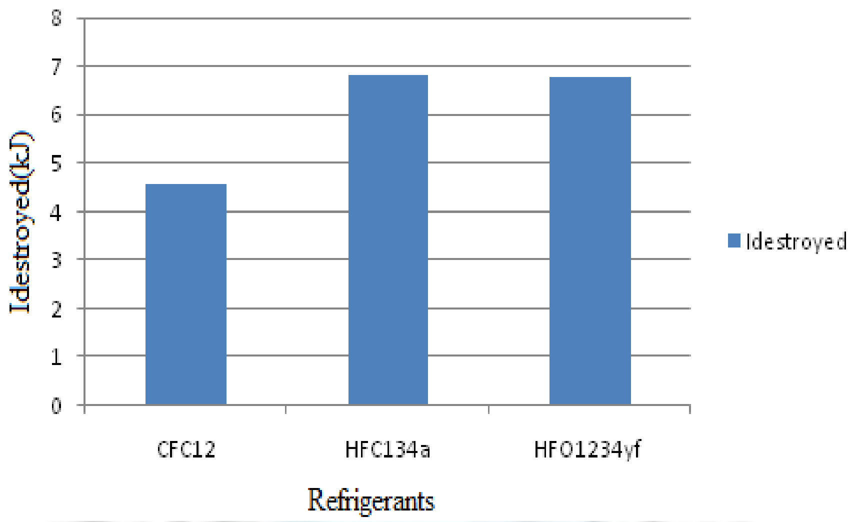

Figure 7: Variation of Irreversibilty in heat exchanger with selected refrigerants

Irreversibility in throttle valve is highest for HFO1234yf that is 1.668 kJ and lowest for CFC12 that is 1.168 kJ because of variation in entropy and enthalpy values at evaporator temperature 278K and condenser temperature 333K. The enthalpy value for HFO1234yf at the inlet and outlet of the throttle valve is 224.5 kJ/kg and entropy value at the inlet is 1.084 kJ/K and 1.09 kJ/K at the outlet of throttle valve at specified temperature range. The enthalpy value for CFC12 at the inlet and outlet of the throttle valve is 53.92 kJ/kg and entropy value at the inlet is 0.202 kJ/K and 0.2062 kJ/K at the outlet of throttle valve at specified temperature range Same trend is following by the selected refrigerants.

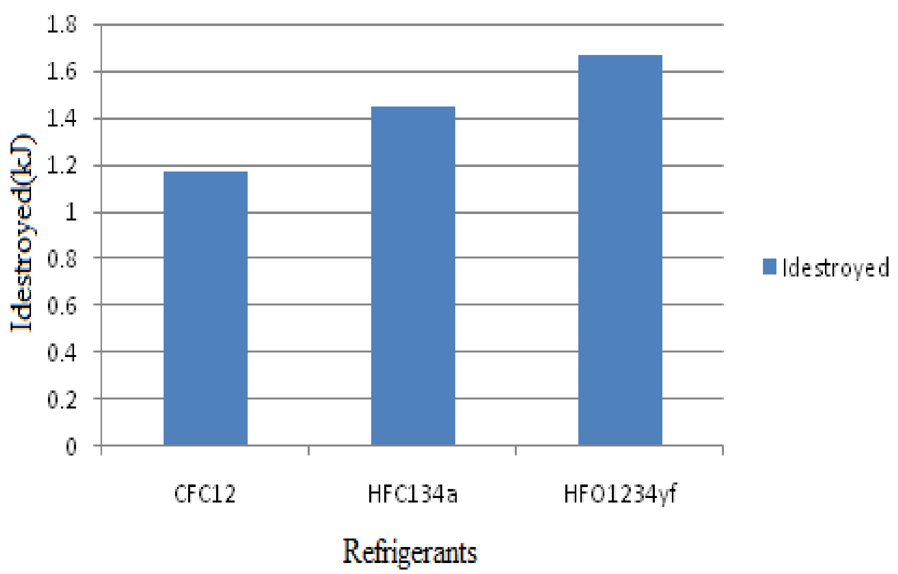

Figure 8: Variation of Irreversibilty in Throttle valve with selected refrigerants

Irreversibility in Evaporator is highest for HFO1234yf that is 0.676 kJ and lowest for CFC12 that is 0.0016 kJ at evaporator temperature 278K and condenser temperature 333K because of the variations in quality of energy during the process . The enthalpy and entropy values for HFO1234yf are 366.4 kJ/kg,224.5kJ/kg and 1.598 kJ/K,1.09 kJ/K respectively at evaporator temperature 278K.For CFC12 enthalpy and entropy values at same evaporator temperature are 189.6kJ/kg,53.92kJ/kg and 0.6942kJ/K,0.2062kJ/K respectively. Same trend is following by the selected refrigerants.

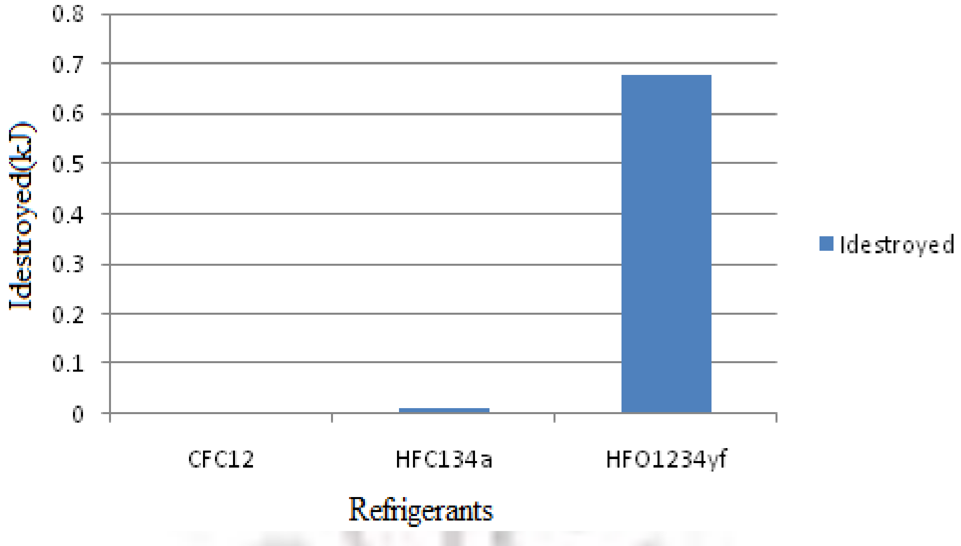

Figure 9: Variation of Irreversibilty in Evaporator with selected refrigerants

Entropy generation for different components for VCR system are summarised here under:

Entropy generation in compressor is highest for HFC134a that is 0.017 kJ/K followed by HFO1234yf that is 0.014 kJ/K .CFC12 shows lowest entropy generation because work consumed in compressor for CFC12 is lowest that is 30.6 KJ and highest for HFC134a that is 131.6 KJ at evaporator temperature 278K and condenser temperature 333K. Entropy generation increase as the work consumed increases. .Same trend is followed for other referigerants at corrosponding temperature values.

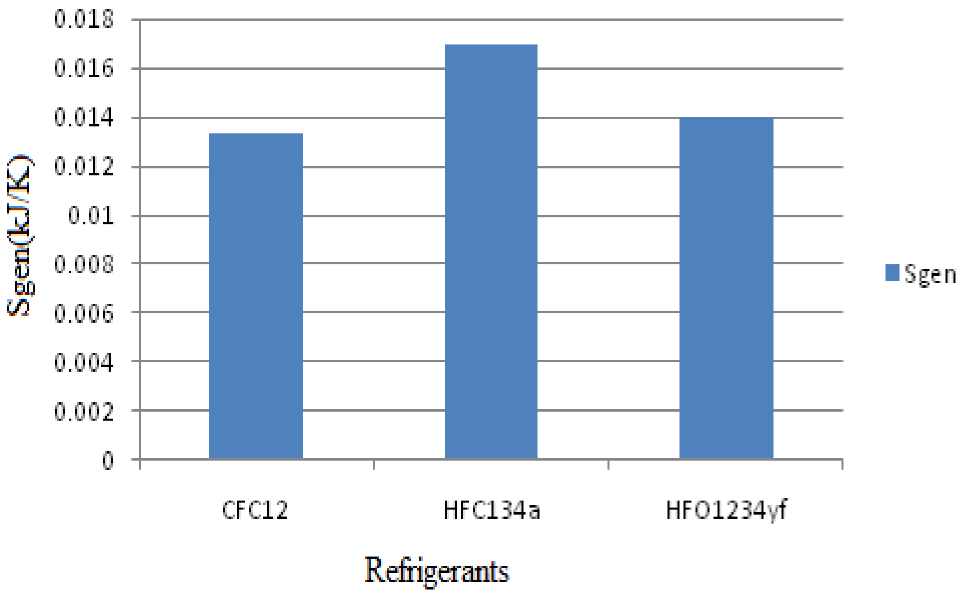

Figure 10: Variation of Entropy generation in compressor with selected refrigerants

Entropy Generation in condenser is lowest for HFO1234yf that is 0.06846 kJ/K and highest for HFC134a that is 0.08746 kJ/K because of the variation in enthalpy and entropy values at state point 3 and state point 4.The values of enthalpy and entropy for HFO1234yf are 400.4 kJ/kg,284.2 kJ/kg and 1.623 kJ/K and 1.275 kJ/K respectively at 333K condenser temperature.For HFC134a these properties values are 295 kJ/kg,139.1 kJ/kg and 0.9557 kJ/K and 0.4885 kJ/K at specified temperature range.Same trend is following with CFC12.

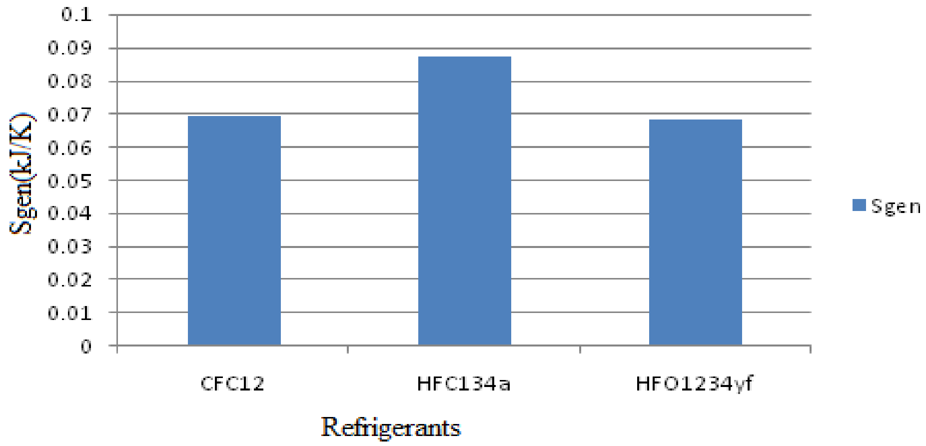

Figure 11: Variation of Entropy generation in condenser with selected refrigerants

Entropy generation in heat exchanger is highest for HFC134a that is 0.02453 kJ/K and CFC12 have lowest entropy generation that is 0.01639 kJ/K because of the variations in enthalpy and entropy at state point 4 and state point 5 during sub cooling state to variations in enthalpy and entropy at state point 1 and state point 2 during superheating state.The enthalpy and entropy values for HFC134a during sub cooling state are 139.1 kJ/kg,76.99kJ/kg and 0.4885 kJ/K,0.2896kJ/K respectively for condenser temperature 333K and evaporator temperture 278K.At superaheating state these values are 253.3kJ/kg ,256kJ/kg and 0.9288 kJ/K,0.9387 kJ/K at specified temperature.Same trend is followed by other selected refrigerants.

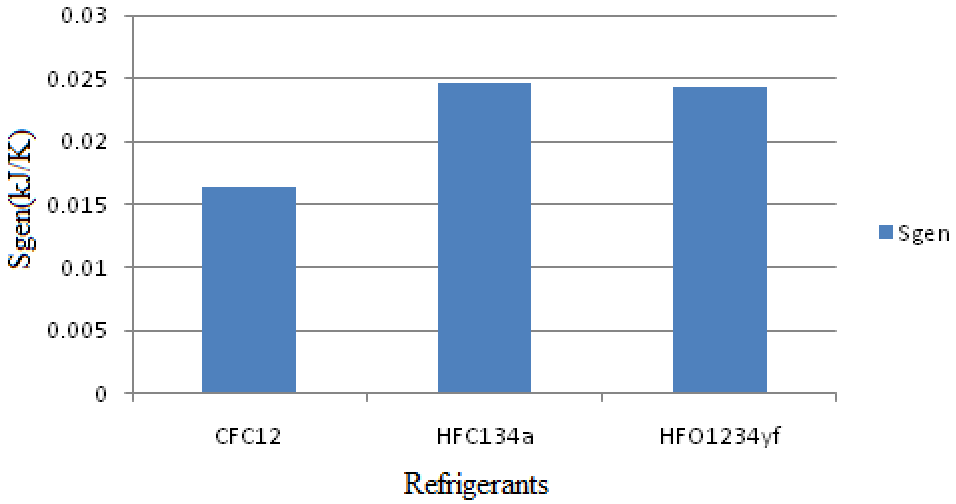

Figure 12: Variation of Entropy generation in heat exchanger with selected refrigerants

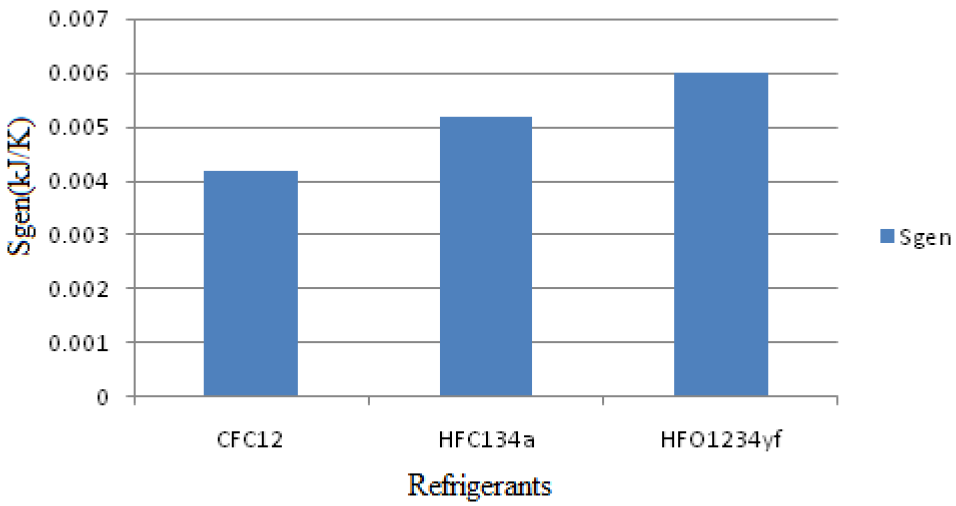

Figure 13: Variation of Entropy generation in throttle valve with selected refrigerants

Entropy generation in throttle valve is maximum for HFO1234yf that is 0.006 kJ/K and lowest for CFC12 because of the variations in the enthalpy and entropy values at state point 5 and state point 6.The enthalpy and entropy values for HFO1234yf at state point 5 and state point 6 are 224.5 kJ/kg and 1.084 kJ/K, 1.09 kJ/K respectively at condenser temperature 333K and evaporator temperature 278K.The enthalpy and entropy values for CFC12 at state point 5 and state point 6 are 53.92 kJ/kg and 0.202 kJ/K,0.2062 kJ/K respectively at specified temperature.Same trend is followed by the other selected refrigerants at specified tempertaure range.

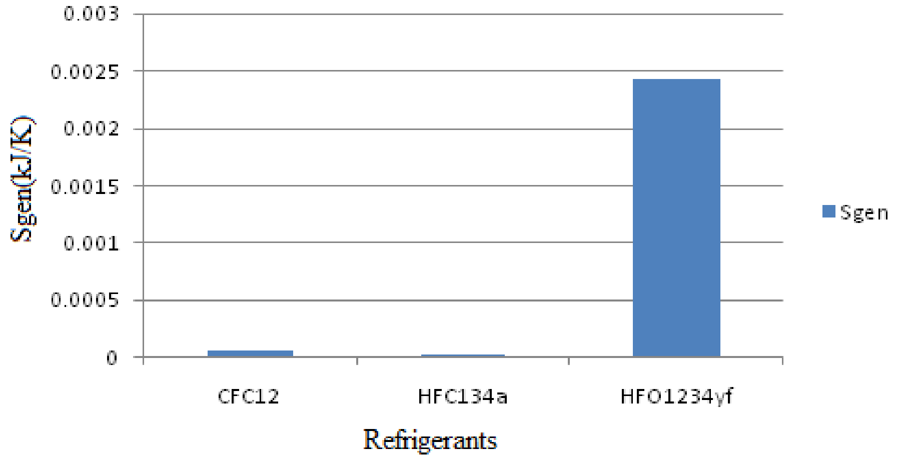

Figure 14: Variation of Entropy generation in Evaporator with selected refrigerants

Entropy generation in evaporator is maximum for HFO1234yf that is 0.002432 kJ/K as compare to seleted refrigerants.HFC134a shows lowest entropy generation that is 0.00003669 at evaporator temperature 278K because of the variations in values of enthalpy and entropy of refrigerants.The enthalpy and entropy values for HFO1234yf at T_e 278K are 366.4 kJ/kg,224.5 kJ/kg and 1.598kJ/K,1.09 kJ/K respectively.These values for HFC134a are 253.3 kJ/kg,76.99 kJ/kg and 0.9288 kJ/K,0.2949 kJ/K at corrosponding evaporator temperature.Same trend is followed by the other selected refrigerants

Study of COP and Exergetic efficiency of VCR system based on refrigerants for car air conditioner

In this section the variation of Coefficient of performance and Exergetic efficiency with condenser temperature, evaporator temperature, liquid suction heat exchanger and sub cooling temperature is being studied. Energy and Exergy analysis is presented by taking variation in above said parameters.

Effect of condenser temperature

The effect of condenser temperature on COP of the system is observed from the figure 15. Condenser inlet temperature varies in the range of 323K to 343K.As the condenser temperature increases the COP of the system with selected refrigerants decreasing because of the change in enthalpy value at point 3 and at point 6 so due to this reason refrigeration effect decreases and increase in the work consumed in compressor. The highest COP that is 3.334 was calculated with HFO1234yf at condenser temperature 323K whereas the CFC12 shows minimum COP that is 3.272 at same condenser temperature. Among the selected refrigerants HFO1234yf shows better COP. The enthalpy values for HFO1234yf at state point 3 and state point 6 are 395.8kJ/kg and 221.9kJ/kg at corresponding temperature. The properties of refrigerants vary with temperature variations. Same trend is following with other refrigerants.

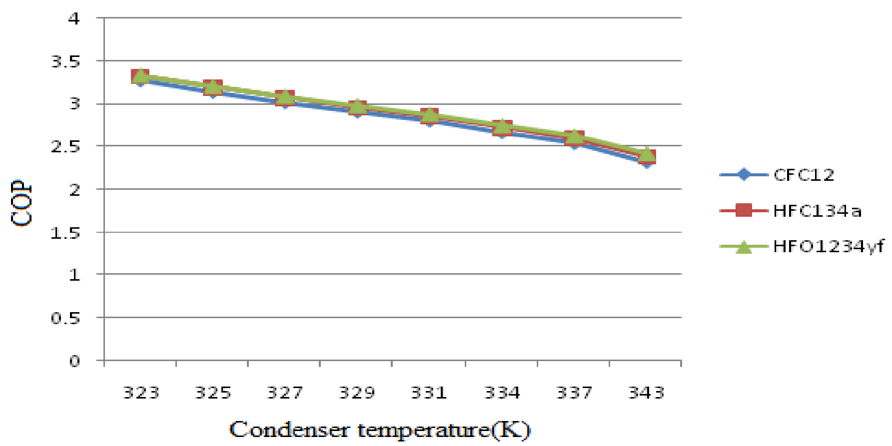

Figure 15: Variation of COP with condenser temperature

Effect of condenser temperature on exergetic efficiency is observed from the figure 16.Exergetic efficiency of CFC12, HFC134a, HFO1234yf was increased with corresponding temperature because of the change in enthalpy values of refrigerants and the value of the term (T_1/T_4-T_1) goes on decreasing at varying condenser temperatures. HFO1234yf shows highest exergetic efficiency at all the corresponding condenser temperature. The enthalpy values for HFO1234yf are 404.5kJ/kg and 300.9kJ/kg at condenser temperature 343K. The variation in the properties causes the variation in exergetic efficiency at selected temperature range. Similar trend is following in all other selected refrigerants.

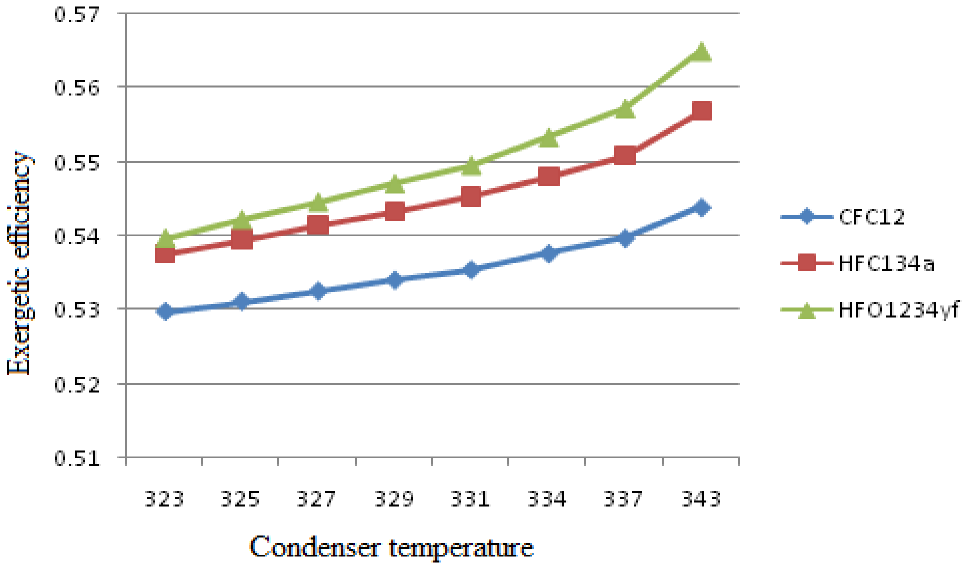

Figure 16: Variation of Exergetic efficiency with condenser temperature

Effect of liquid suction heat exchanger effectiveness

It is observed from the figure 17 effectiveness of liquid suction heat exchanger varies in the range of 0.5 to 1.COP of the system increases corresponding to increase in evaporator effectiveness because of variation in value of enthalpy at point 6 and value of enthalpy goes on decreasing due to this reason COP increases. COP of HFO1234yf is 1.485 at 0.5 and its increase by 3.821 at effectiveness 1.HFO1234yf shows better COP among selected refrigerants HFO1234yf shows better COP that is 2.35 among selected refrigerants. The enthalpy for HFO1234yf is 211kJ/kg at selected temperature range and effectiveness value 1. This enthalpy value varies with the variation of effectiveness of heat exchanger. Similar trend is following in all other selected refrigerants.

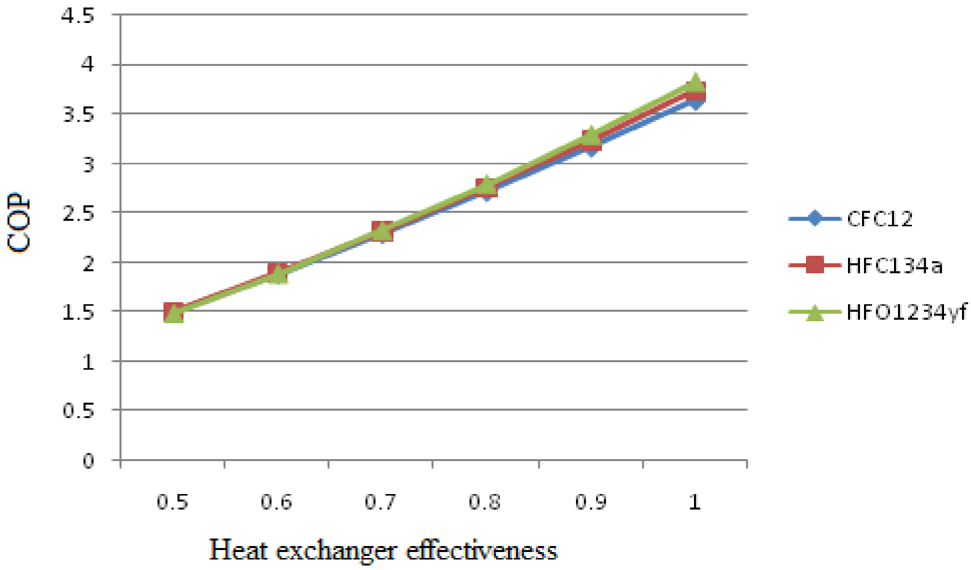

Figure 17: Variation of COP with heat exchanger effectiveness

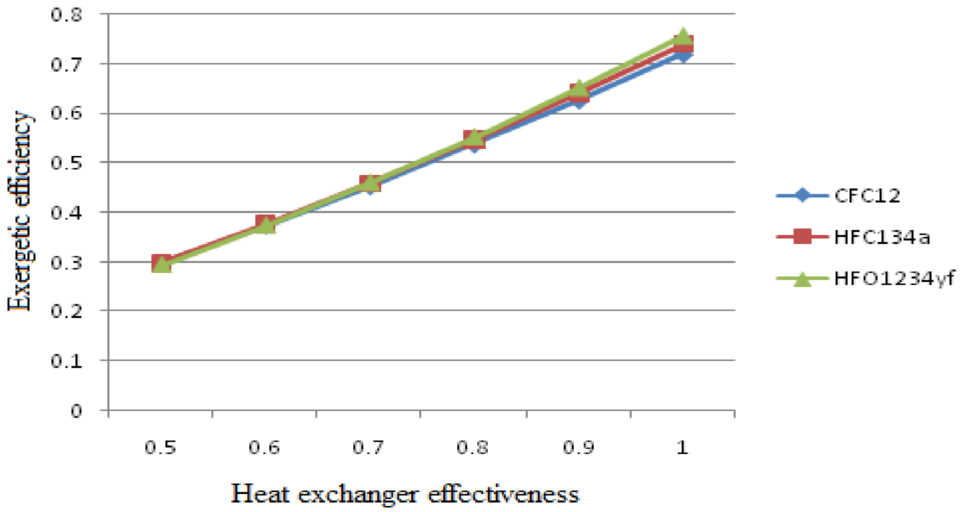

Figure 18: Variation of Exergetic efficiency with heat exchanger effectiveness

It is observed from the figure 18 the effect of effectiveness of liquid suction heat exchanger on exergetic efficiency. Exergetic efficiency increases as effectiveness increases because of the variation in enthalpy of evaporator its value decreases in the specified temperature range so increase the COP. HFO1234yf shows better exergetic efficiency as compared to selected refrigerants.HFO1234yf shows better exergetic efficiency as compared to selected refrigerants. The enthalpy value for HFO1234yf is 211kJ/kg at effectiveness 1. The enthalpy value goes on decreasing so causing the variation in exergetic efficiency. Similar trend is following in all selected refrigerants.

Effect of Evaporator temperature

The effect of evaporator temperature on COP is observed from the figure 19.The evaporator temperature varied in the range of 246K to 293K.As evaporator temperature increases COP of the system increases because the refrigeration effect increases and its goes on increasing due to further increase in evaporator temperature. Work consumed by the compressor decreases so value of COP increases. COP of HFO1234yf is 3.875 at 293 K which is maximum among the selected refrigerants. Similar trend is following in all selected refrigerants.

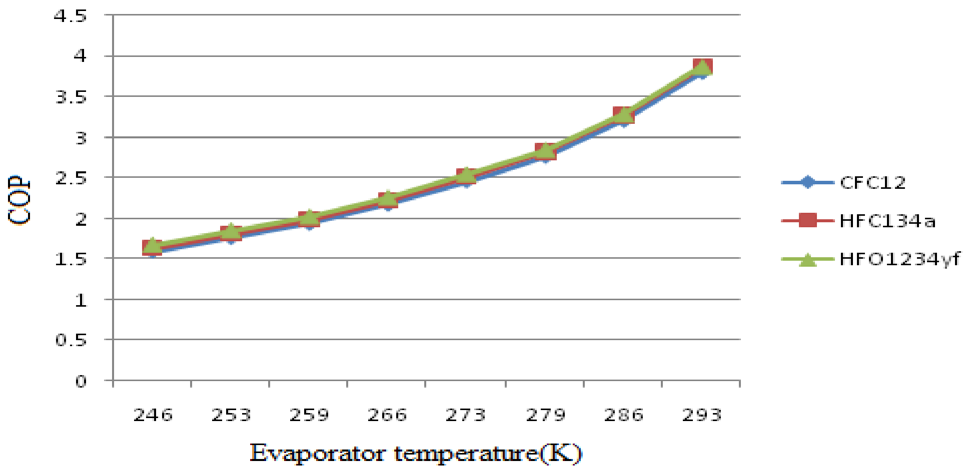

Figure 19: Variation of COP with evaporator temperature

The effect of evaporator temperature on exergetic efficiency is observed from the figure 20.The value of exergetic efficiency decreases with increasing evaporator temperature because of increase in enthalpy values. It was observed that enthalpy values in evaporator and compressor goes on increasing with the increase in evaporator temperature. HFO1234yf shows better exergetic efficiency than CFC12 and HFC134a. The enthalpy values for HFO1234yf in evaporator is 191.8kJ/kg and for compressor inlet is 347.7kJ/kg at evaporator temperature 246K and these values goes on increasing with the increase in evaporator temperature. Same trend is following in all selected refrigerants.

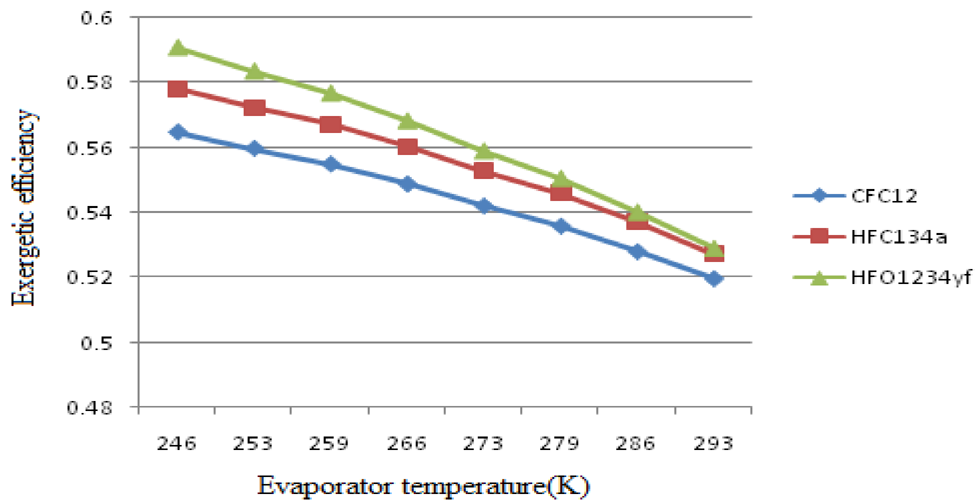

Figure 20: Variation of Exergetic efficiency with evaporator temperature

Effect of Sub cooling of condenser outlet

The sub cooling temperature was kept between 286.2K to 290.2K.COP during sub cooling decreases as we increase the temperature because the sub cooling rate decreases so the refrigeration effect decreases. HFO1234yf shows highest COP 2.924 at 286.2K.The enthalpy values for HFO1234yf are 284.2kJ/kg and 217.7kJ/kg at specified temperature. Similar trend is following with all the selected refrigerants.

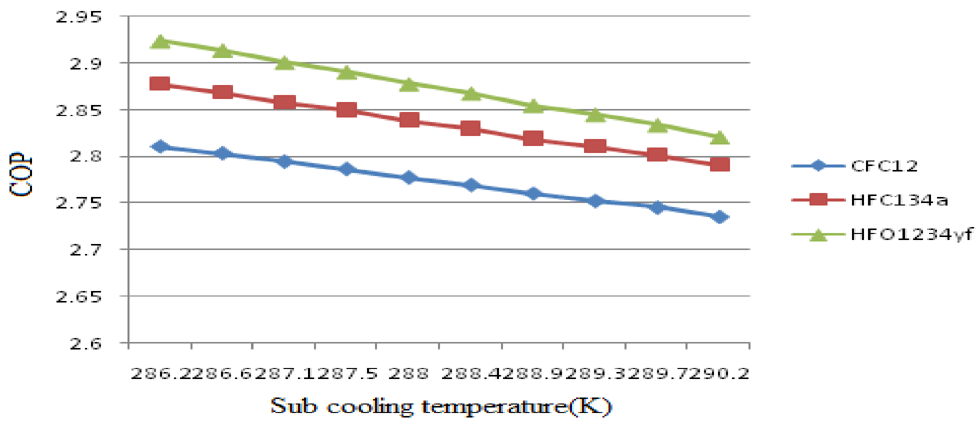

Figure 21: Variation of COP with sub cooling temperature

It is observed from the figure 5.58 the effect of Sub cooling on exergetic efficiency. Exergetic efficiency decreases the value of COP gets lower by decreases in refrigeration effect as variation of refrigerants properties.HFO1234yf shows the better exergetic efficiency as compared to CFC12 and HFC134a.

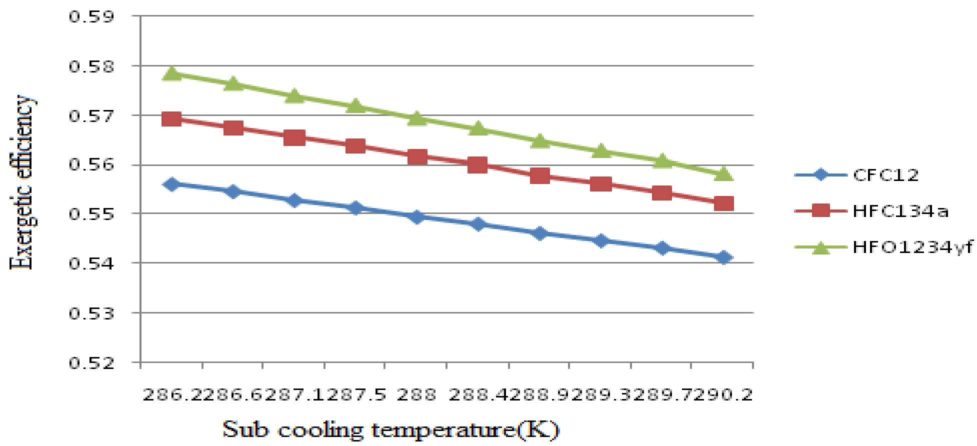

Figure 22: Variation of Exergetic efficiency with sub cooling temperature

Effect of Superheating of Evaporator outlet

When superheating takes place in the evaporator, the enthalpy of the refrigerant is raised, extracting additional heat and increasing the refrigeration effect of the evaporator. The operating temperature was kept between 278.2K to 283.2K.COP increases with increase in evaporator temperature.HFO1234yf shows highest COP that is 3.096 than CFC12 and HFC134a at 283.2K. Similar trend is following in all the refrigerants with the variation in properties of refrigerants at corresponding superheating temperature.

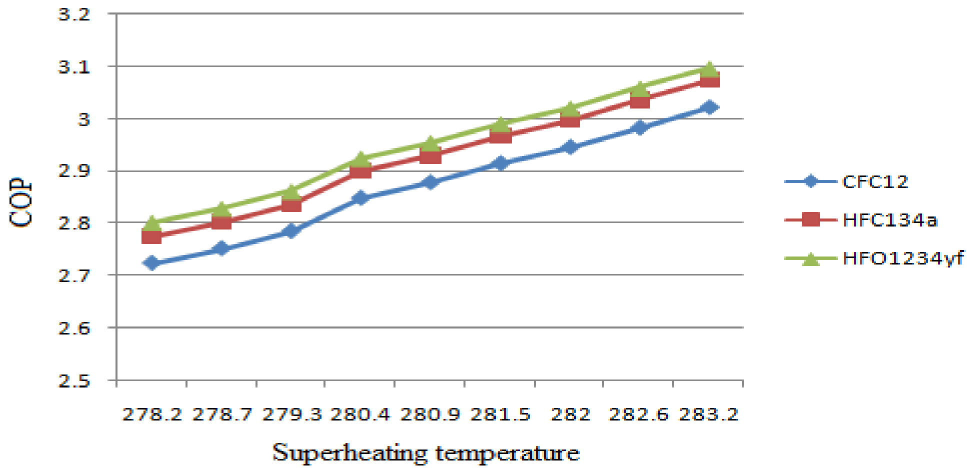

Figure 23: Variation of COP with superheating temperature

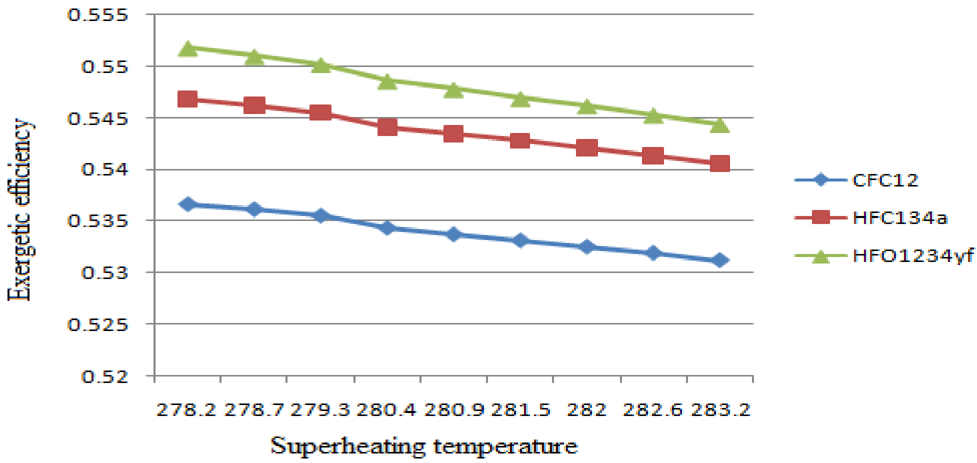

Figure 24: Variation of Exergetic efficiency with superheating temperature

The effect of superheating temperature on exergetic efficiency is observed from the figure 24.The value of exergetic efficiency decreases with the increase in superheating temperature because of increase in enthalpy values at the inlet of compressor and evaporator. HFO1234yf shows better exergetic efficiency than CFC12 and HFC134a. The enthalpy values in compressor and evaporator for HFO1234yf are 369.4kJ/kg,224.7 kJ/kg respectively at superheating temperature 278.2K.Similar trend is following in all the refrigerants selected refrigerants.

Conclusion

HFO1234yf is very good alternative to HFC134a and CFC12. HFO1234yf have high value of coefficient of performance and Exergetic efficiency than HFC134a.The value of Global warming potential is very low that is only 4 of HFO1234yf and ozone layer depletion zero. Exergy destruction and entropy generation is less for HFO1234yf as compared with selected refrigerants. It was found from observation condenser is highly irreversibly component among all component. From the graphs we came to know $I_{destroyed}$ and entropy generation is highest in condenser Work consumed for HFO1234yf is low as compared to HFC134a and high as compared to CFC12 So according to work done required CFC12 is better than two selected refrigerants but it is to be replaced as per Environmental issues HFO1234yf is very long time alternative eco friendly refrigerant.

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