TO STUDY THE EFFECT OF MAGNETIC FIELD ON THE PERFORMANCE OF VAPOUR COMPRESSION SYSTEM BY USING VARIOUS REFRIGERENTS

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ABSTRACT- The refrigeration system contribute significantly to building energy consumption. Therefore, it is necessary to develop new technologies that can achieve a higher coefficient of performance (COP). Employing a magnetic field (MF) on the condenser tube (between the condenser outlet and the capillary tube) is a new technique that helps in improving efficiency and cooling capacity of air-cooled vapour compression cycle (VCC). In this work, four pairs of the permanent magnet of different gauss field strength were installed on the condenser tube (between exit of the condenser and inlet of the capillary tube) of the VCC. The performance of the setup was compared by applying and removing an MF from the condenser tube to estimate an enhancement in the VCC system with an MF.

Keywords— COP; Magnetic flux; Energy saving; Evaporator capacity; compressor power

INTRODUCTION: Vapor compression cycle is the most frequently used refrigeration cycle, traced in 1748 by Professor Williams Cullen of Glasgow University who produced refrigeration by partial vacuum over ethyl ether. Several studies have reported the use of magnetic elements for the improvement in the vapor compression cycle. Magnetism is a property of materials that respond at an atomic or subatomic level to an applied magnetic field. The study of magnetic refrigeration was started with the discovery of magneto caloric effect.

Warburg first discovered the thermal effect of metal iron when applying it in a varying magnetic field in 1881. Magnetic refrigeration is a cooling technology based on the magneto caloric effect (MCE).

Application of the magnetic field is important in many aspects of research and practical applications. This is essential so as to utilize the high specific energy content of liquid hydrocarbon refrigerant since conversion of hydrocarbon refrigerant to power even with a relatively low efficiency would pave the way for increased lifetime as well as reduced weight of an electronic or mechanical system. A possible means to achieve the realization of these hydrocarbon fuelled power devices/sources could be the application of magnetic fields to fluid flow. This is concerned with the interactions between magnetic fields and electrically conducting fluids. However, this interaction is not limited to electrically conducting fluids. Magnetic fields can affect fluids that can exhibit paramagnetic and diamagnetic behavior (even if the fluid is not electrically conducting).

LITERATURE REVIEW:

[1]Ajaj Attar et.al 'Experimental Investigation of Effect of Magnetic Field on hydrocarbon refrigerant in

Vapor Compression Cycle' International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 8Page No.4 August – 2013: This research paper estimates the effect of magnetic field on refrigerant it reports use of permanent magnetic of varying intensity permanent magnet creates magnetic field which is varying as per intensity of magnets hydrocarbon fluids shows improvement in COP while non hydrocarbon fluid molecules does not respond to magnetic field the properties of hydrocarbon refrigerants like viscosity, surface tension decreases with increase in magnetic field strength. But there is a limit to the maximum field strength which can be applied beyond this performance of VCC degrades.

[2]Krushad Shinde et.al 'Experimental Investigation on the Effect of Magnetic Field on Refrigerants' International Journal of Science Technology & Engineering Volume 2 Issue 12 Page No. 3 June 2016: In this research paper performance of vapour compression cycle is carried out by using magnet and without magnet four pair of magnet is used at refrigerant liquid line performance is carried out by using one by one magnetic pair from this it is observed that by increasing the number of magnetic pair specific heat of refrigerant increases due to this heat transfer rate increases and more vaporisation of refrigerant in the evaporator due to this refrigerating effect increases due to more vaporisation of refrigerant no liquid is entering into the compressor and due to this compressor work decreases and COP of vapour compression cycle increases.

[3]Sagar patil 'Effect of Magnetic field on Hydrocarbon refrigerant' International Conference on Ideas, Impact and Innovation in Mechanical Engineering Volume 5 Issue 6 June 17: In this research paper results of various refrigerants under various conditions of magnetic field are discussed. By using permanent magnet having strength 3000 gauss between exit of condenser and expansion valve magnetic field is applied. Also it uses various refrigerants namely R600a and r290a. By comparing COP of system with magnet and without magnet it is found that system with magnetic field shows positive influence on COP of system.

[4]Mayur K. Chavhan 'Experimental Investigation and Performance Improvisation Methods of Domestic Refrigerator' International Conference on Ideas, Impact and Innovation in Mechanical Engineering Volume 5 Isuue 6 2017: The main aim of this research paper is to improve the efficiency of the traditional VCC by applying magnetic pairs the refrigerants used are R134a and R600a the magnetic effect will reduce the viscosity of refrigerants and thus resulting increase the flow velocity of refrigerant thus it will reduce the compression work and increase COP of VCC

[5]A Kotb, H. E. Saad 'Experimental Investigation for the Magnetic-Caloric Effect on the Refrigeration Cycle Performance' Scholars Journal of Engineering and Technology 2014: In this research paper performance of vapour compression cycle is carried out by using magnet and without magnet four pair of magnet is used at refrigerant liquid line performance is carried out by using one by one magnetic pair from this it is observed that by increasing the number of magnetic pair specific heat of refrigerant increases due to this heat transfer rate increases and more vaporisation of refrigerant in the evaporator due to this refrigerating effect increases due to more vaporisation of refrigerant.

- ## EXPERIMENTAL SETUP:

Fig. 1. Experimental setup of vcc

- ## OBSERVATION TABLE

Table 1.Experimental VCRS using R600

Condition	AverageTime for 10 pulses(Sec) (t_p)	Average Refrigeration Effect (KW)	Average Compressor Work (KW)	Average Coefficient Of Performance
Without magnetic pair	51	0.2505	0.2205	1.1360
With one magnetic pair	57.30	0.2463	0.1963	1.2547
With two magnetic pair	56.6	0.2735	0.1987	1.3764
With three magnetic pair	56.4	0.2401	0.1994	1.2041

Table.2 Experimental VCRS using R134a

Condition	AverageTime for 10 pulses(Sec) (t_p)	Average Refrigeration Effect (KW)	Average Compressor Work (KW)	Average Coefficient Of Performance
Without magnetic pair	43.6	0.2004	0.2580	0.7767
With one magnetic pair	44.72	0.2484	0.2551	0.9876
With two magnetic pair	47.16	0.1920	0.2385	0.8050
With three magnetic pair	44.66	0.2150	0.2519	0.8535

Table 3 Experimental VCRS using R404a

Condition	AverageTime for 10 pulses(Sec) (t_p)	Average Refrigeration Effect (KW)	Average Compressor Work (KW)	Average Coefficient Of Performance
Without magnetic pair	49.1	0.2255	0.2291	0.9844
With one magnetic pair	51.6	0.2276	0.2180	1.044

With two magnetic pair	52.8	0.2443	0.2130	1.147
With three magnetic pair	54.5	0.2401	0.2064	1.16

Table 4. Experimental VCRS using R290

Condition	AverageTime for 10 pulses(Sec) (t_p)	Average Refrigeration Effect (KW)	Average Compressor Work (KW)	Average Coefficient Of Performance
Without magnetic pair	45.8	0.2046	0.2456	0.8332
With one magnetic pair	46.7	0.2088	0.2408	0.8672
With two magnetic pair	48.8	0.2192	0.2305	0.9512
With three magnetic pair	49.3	0.2443	0.2281	1.07

- **Results**

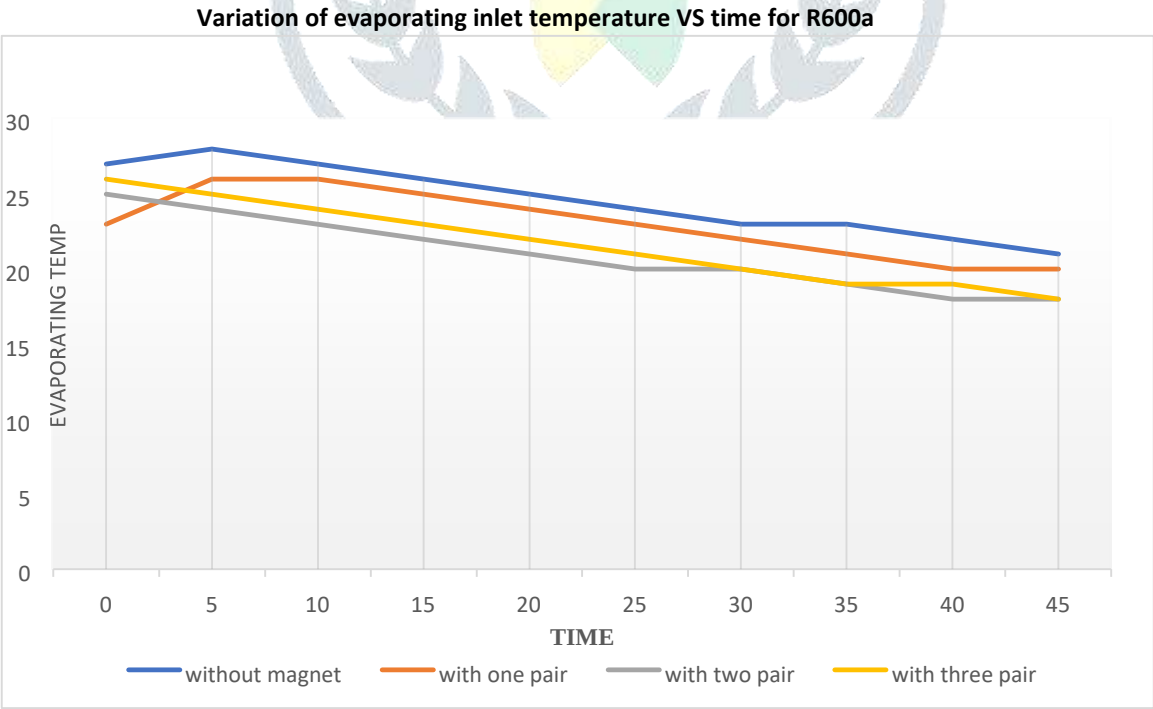


Fig.2 : Variation of evaporating inlet temperature VS time for R600a

The above graph shows the variation of evaporator inlet temperature with time.The graph is plotted with increasing number of magnetic pairs with magnetic field strength of 2000 gauss respectively and without any magnetic pair. The readings are considered with respect to the water temperature in the range of 33oC-18oC. It is found that after the application of magnetic field, time required to cool the water up to 18oC is reduced.When one magnetic pair is used, the time required for the refrigerant to cool the water temperature up to 18°C is reduced by 4% with respect to no magnetic pair applied. When further two magnetic pairs are used, the time reduction is by 16%. For three magnetic pairs, 8% time is reduced. The maximum time saved is found in case of two magnetic pairs. The reduction in time is obtained because of the increase in the specific heat of the refrigerant due to the magnetic field.

- **Average Refrigerating Effect vs Number of Magnetic Pairs**

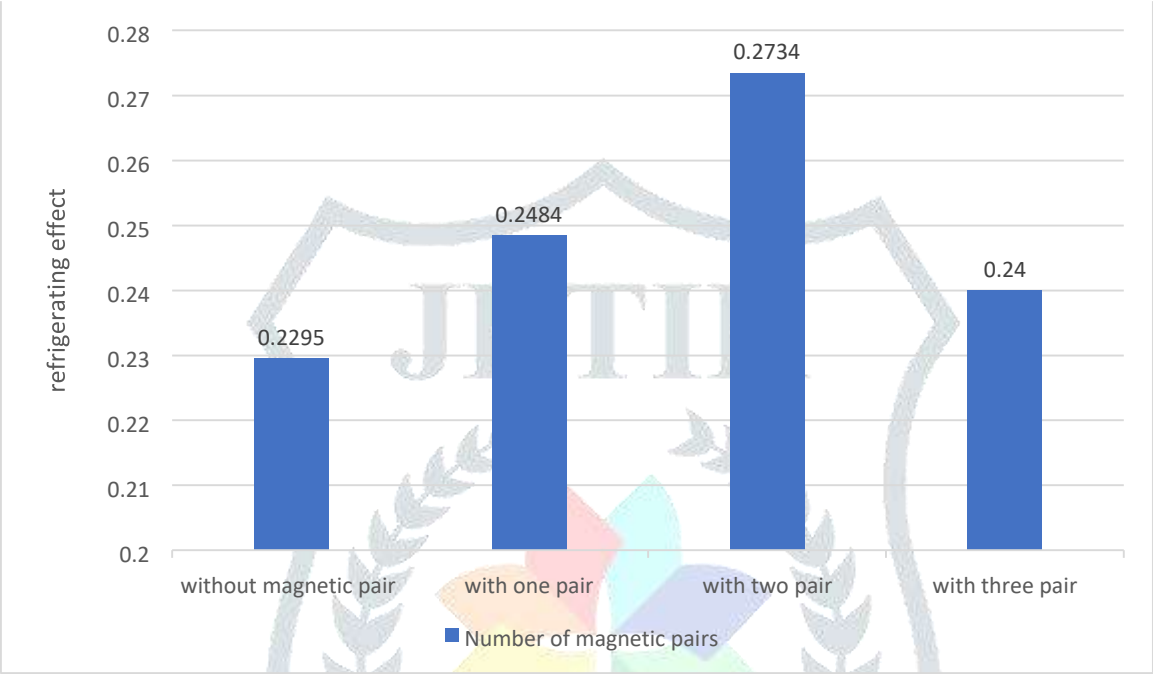


fig. 3 Average Refrigerating Effect vs Number of Magnetic Pairs

The above fig.3 shows the refrigerating effect with respect to the number of magnetic pairs. As the number of magnetic pairs increases, the refrigerating effect also increases up to 4 magnetic pairs. As the specific heat of the refrigerant increases, the heat transfer rate increases. As a result of the increased heat transfer rate, the refrigerant absorbs relatively more heat from the water and hence the refrigerating effect increases.

- **Compressor work vs Number of Magnetic Pairs:**

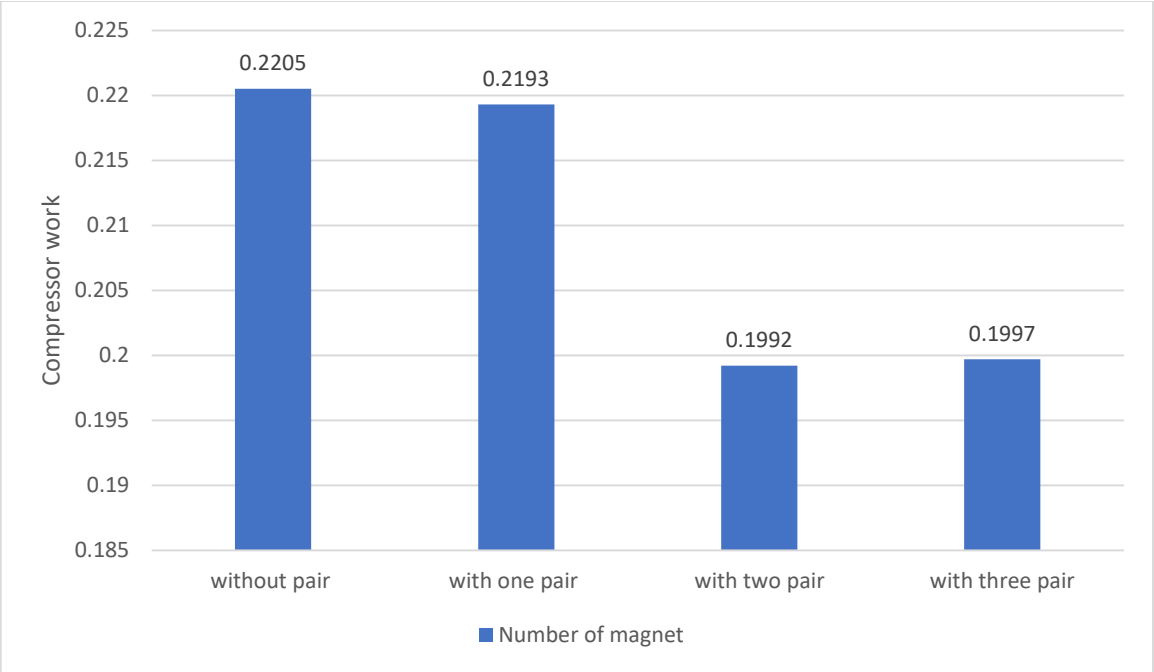


Fig.4. compressor work vs Number of Magnetic Pairs

The above graph shows the average compressor work with respect to the number of magnetic pairs. With increase in the magnetic pairs, the compressor goes on decreasing. As the number of magnetic pairs is increased, the vaporization of the refrigerant in the evaporator goes on increasing. As the vaporization increases, the amount of liquid refrigerant entering the compressor reduces. As a result of this, the compressor power required to convert this liquid refrigerant into the vapour state is reduced. Hence, the average compressor work reduces with the increasing number of magnetic pairs.

- **Average Water Temperature Vs Time**

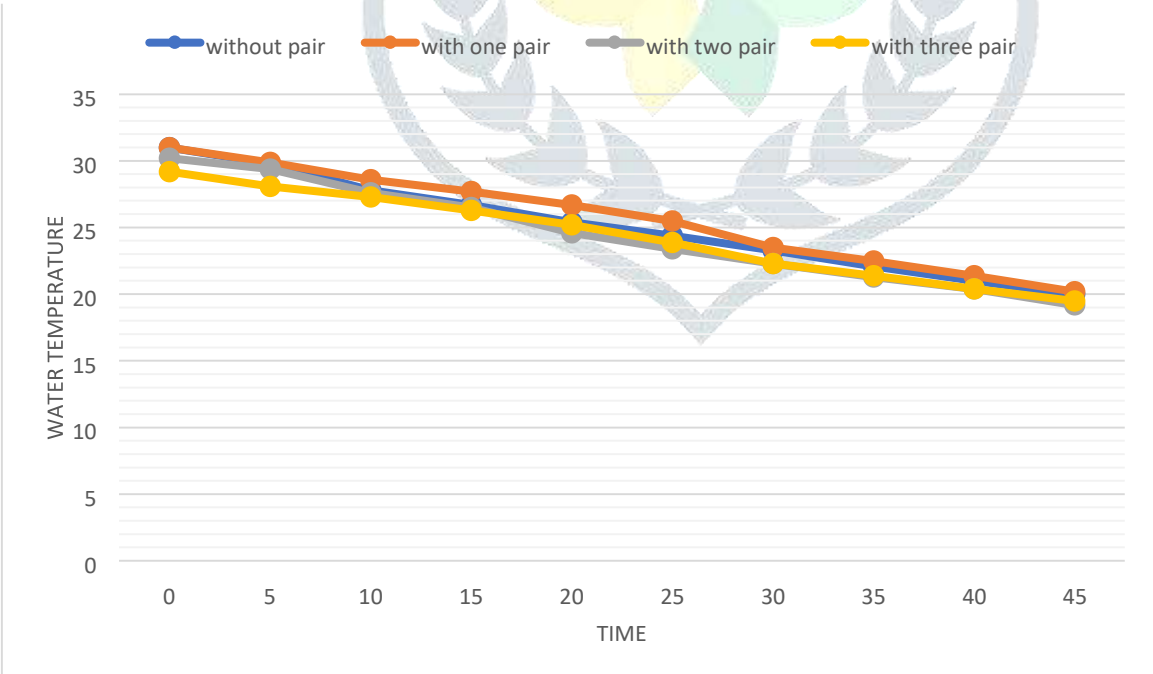


fig.5 . Average Water Temperature Vs Time

The above graph shows the average water temperature with respect to number of magnetic pairs. As the magnetic pairs are applied cooling capacity increases which can seen from the above figure easily.

- **Cop vs Number of magnet:**

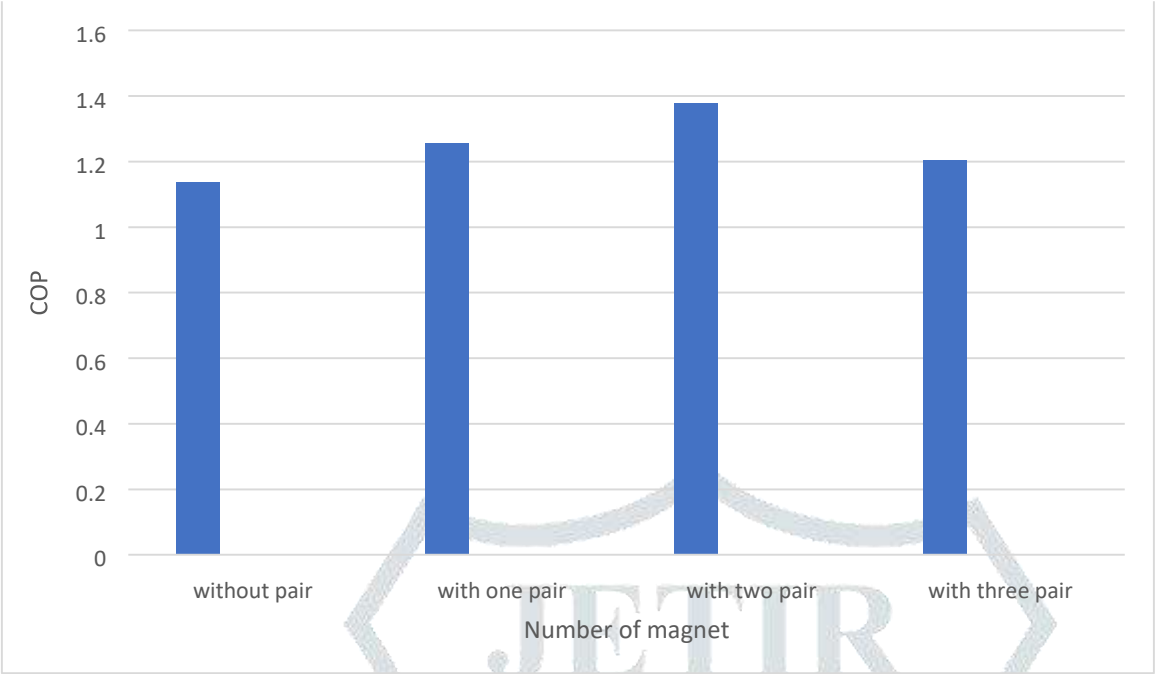


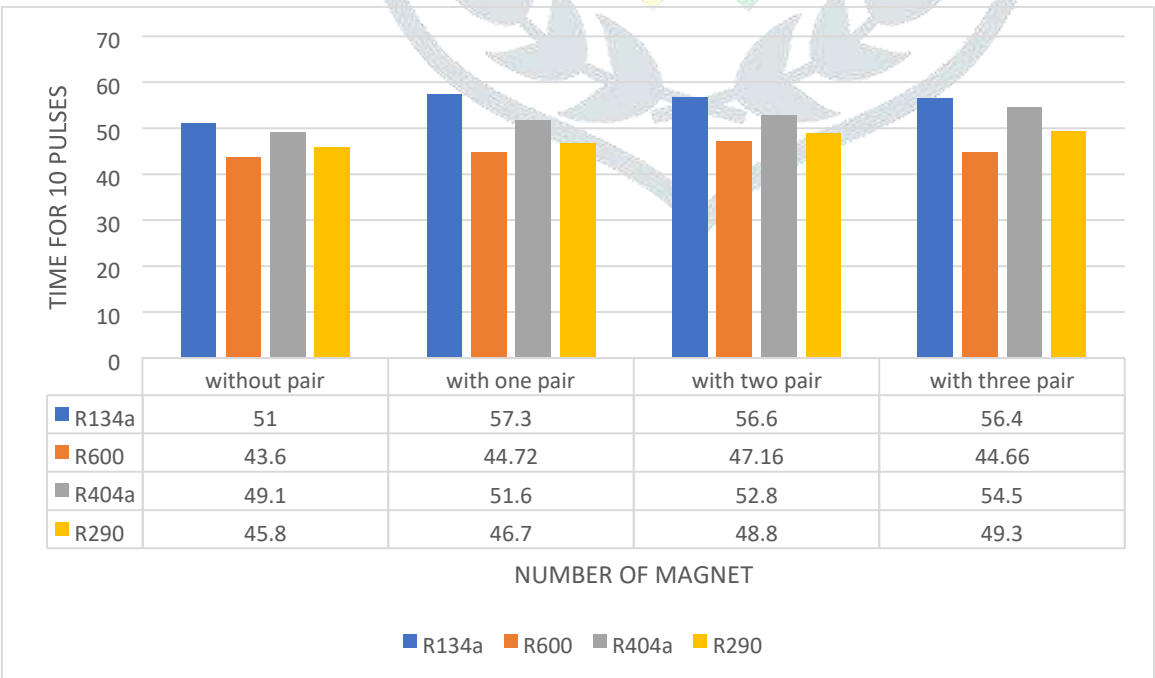
Fig.6.Cop vs Number of magnet

In case of R600a COP increases with number of magnetic pair . it show maximum cop for two pairs of magnet and least for without pair of magnet. In case of VCC under the magnetic field refrigerent effect increases and compressor work reduces thus COP increases.

- ## COMPARISON:

Comparison between R134a, R600, R404a and R290

- **Variation of Average time for 10 pulses (sec) VS number of magnet**



	without pair	with one pair	with two pair	with three pair
R134a	51	57.3	56.6	56.4
R600	43.6	44.72	47.16	44.66
R404a	49.1	51.6	52.8	54.5
R290	45.8	46.7	48.8	49.3

Fig.7.Variation of Average time for 10 pulses (sec) VS number of magnet

Above fig.shows that as we increase number of magnetic pair time required to count 10 pulses on energy meter goes on increasing thus the compressor work reduces. As the compressor work reduces COP of VCC increase.

- **Variation of Average Refrigeration Effect VS number of magnet**

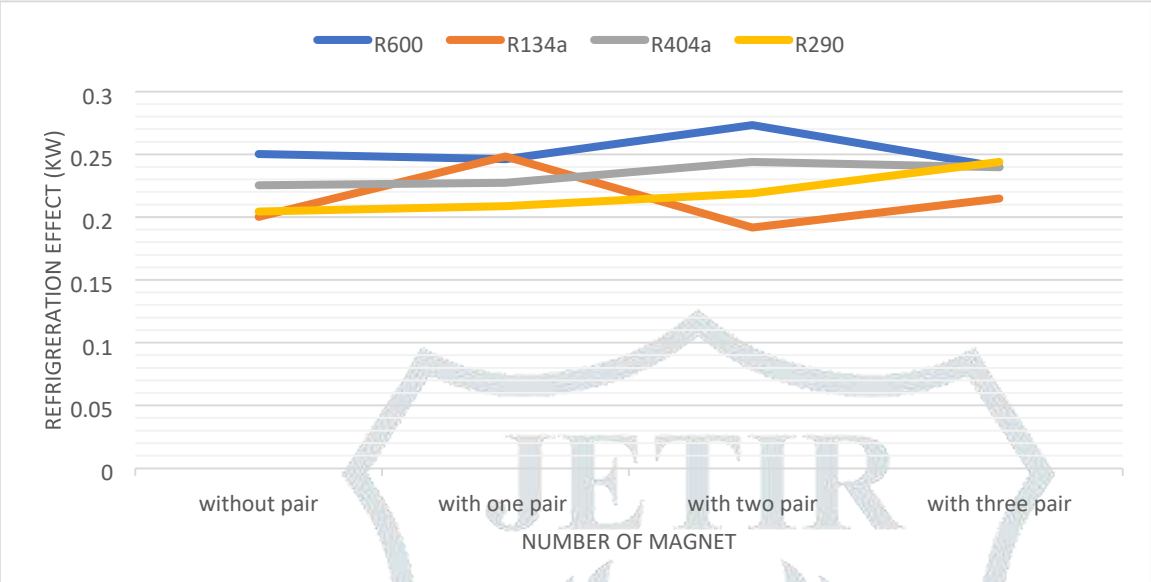


Fig.8. Variation of Average Refrigeration Effect VS number of magnet

Above graph shows that as we keep on increasing magnetic pairs the refrigerating effect increases. It is seen that maximum RE achieved with two pairs of magnetic pairs. As we increase pair of magnet more than two then RE decreases due to heating of refrigerant.

- **Variation of Average compressor work (KW) VS number of magnet**

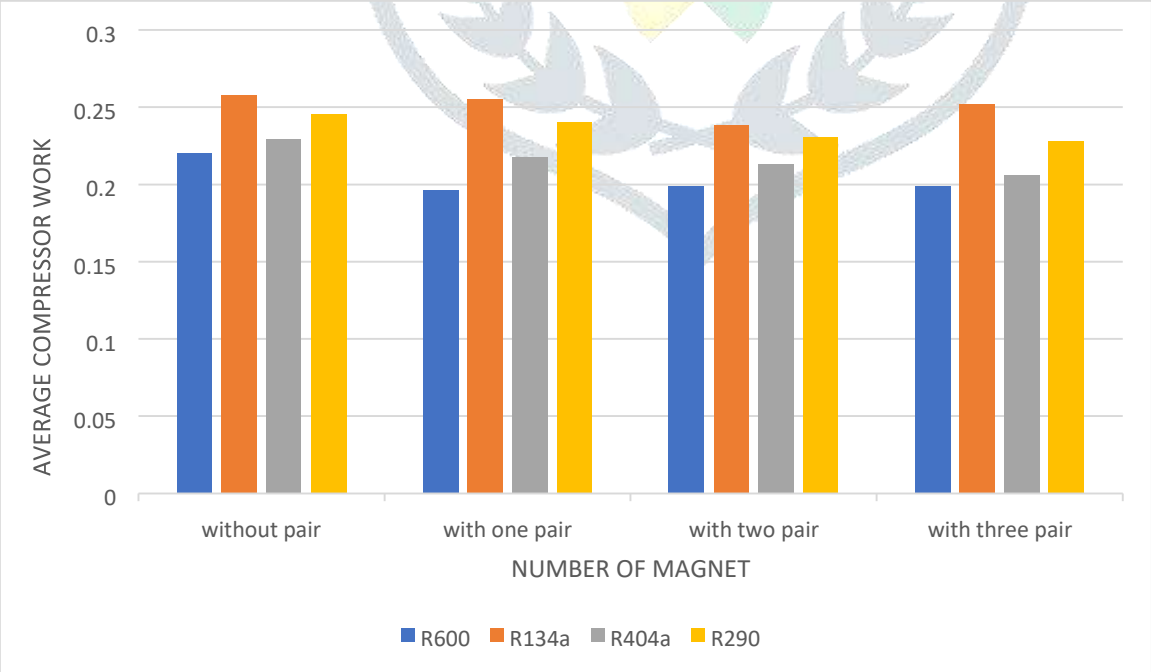


Fig.9 Variation of Average compressor work (KW) VS number of magnet

Maximum average compressor work is recorded for without magnetic pair for all the refrigerants.The maximum average compressor work is recorded for all the refrigerent the vapour compression system with two pairs of magnet shows the minimum

compressor work for refrigerent R600 it also shows reduce in compressor work by other refrigerent but it is relatively less. Graph shows that as the number of magnetic pairs increases the compressor work reduces upto certain limit.

- **Variation of Coefficient of performance VS number of magnet**

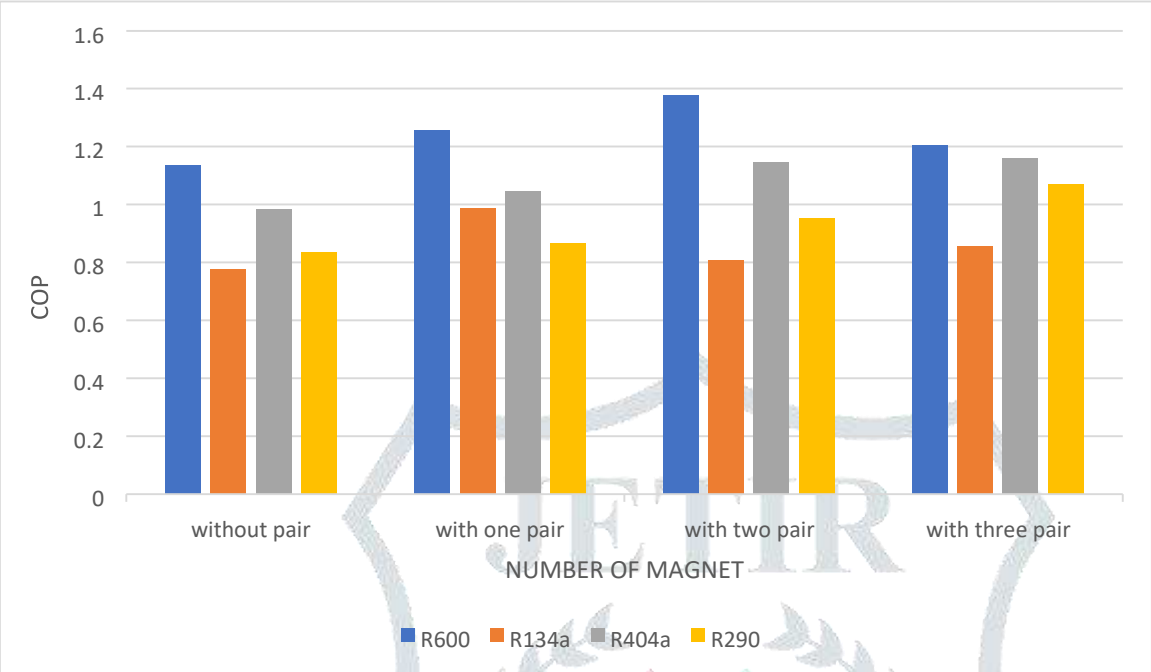


Fig.10.Variation of Coefficient of performance VS number of magnet

Above graph show graph of cop vs number of magnet . it is seen that cop increases with increase in the magnetic pairs . the maximum cop is achieved for two pairs of magnet and if keep on increasing the pair of magnet then cop reduces and effect is equal to without pair of magnet.

- # CONCLUSIONS AND FUTURE SCOPE

- **CONCLUSIONS**

The four refrigerants are used (R600, R143a, R404a, R290) and we found that R600 is most effective refrigerants under the magnetic field. R600 is hydrocarbon refrigerant and only hydrocarbon shows improvement in performance under application of magnetic field. Non-hydrocarbon did show improvement in performance under application of magnetic field. Increase in the magnetic field shows increase in COP, RE and decrease in compressor work up to certain limit.

Only Hydrocarbon fluids (R600) show improvement in performance on application of magnetic field. OnHydrocarbon refrigerant (R134a) did not show improvement in performance on application of magnetic field.
As the field strength was increased the cooling performance was enhanced till certain magnetic field strength. For higher magnetic field strength and beyond cooling performance detreated possibly due to heating of the refrigerant due to excessive magnetic field. There is a limit to the maximum field strength which can be applied beyond this limit the performance of the vapor compression system degrades

- **FUTURE SCOPE**

In the future your refrigerator might keep your food cold by using a magnet. Not only would it use less power and run quitter than your current fridge, but it also would not contain any hydrofluorocarbons, gases which can add tremendously to greenhouse effect if not properly disposed of. It all comes down to something called magnetocaloric effect, where in a changing magnetic field within a material causes it to get colder.

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