IMPROVING THE PERFORMANCE OF VAPOUR COMPRESSION REFRIGERATION SYSTEM USING MAGNETIC FIELD

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Abstract

This Project presents experimental investigations carried out to study the effect of magnetic field on energy savings in vapor compression system. Application of magnetic field to fluid flow breaks the molecule resulting in a decrease in the viscosity of the fluid. This drop in the viscosity reduces the pumping power required by the compressor as well as enhances the heat transfer rates in the condenser and evaporator due to increased mass flow rates. The net impact is improvement in the COP of the system. Considering the number of refrigerators and air conditioning systems sold globally every year any improvement in the COP could considerably save the energy bills as well as the energy requirement. The main benefit of this investigation is improvement in the system performance, improvement in Evaporator capacity or drops in compressor power or increased COP at no cost i.e. no additional input energy. Only cost involved is the initial cost of magnets to be procured for applying suitable magnetic field. The present work was focuses on establishing the effect of magnetic field on the performance of the vapour compression system. The magnetic field strength was varied by increasing the number of magnet pairs applied to the liquid line (from condenser outlet to entry of expansion valve). The COP is initially measured without application of magnetic field, and then magnetic field is applied to liquid line by increasing the number of the magnets. The result will be assessed for increasing the COP of the system.

Keywords: VCR System, Magnets in Refrigeration, COP Improving Techniques, Power consumption.

1. Introduction

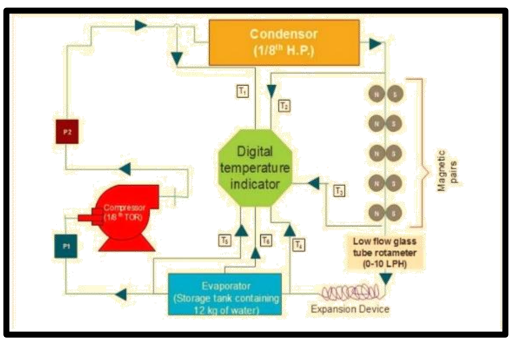
Vapour compression refrigeration systems are available to suit almost all applications with the refrigeration capacities ranging from few watts to few megawatts. A wide variety of refrigerants can be used in these systems to suit different applications, capacities etc. The actual vapour compression cycle is based on Evans-Perkins cycle, which is also called as Reverse Rankine cycle. Before the actual cycle is discussed and analysed, it is essential to find the upper limit of performance of vapour compression cycles. This limit is set by a completely reversible cycle. A magnetic field is the magnetic effect of electric currents and magnetic materials. The magnetic field at any given point is specified by both direction and a magnitude (or strength); as such it is represented by a vector field.This magnetic field is invisible but is responsible for the most notable property of a magnet, a force that pulls on other ferromagnetic materials, such as iron, and attracts or repels other magnets. A permanent magnet is an object made from a material that is magnetized and creates its own persistent magnetic field. An everyday example is a refrigerator magnet used to hold notes on a refrigerator door.

2. LITERATURE REVIEW

In this experiment four pairs of permanent magnet of 3000 gauss field strength; are installed at fixed distance on the refrigerant liquid line (exit of condenser) of the VCC setup. The comparison of the set up performance is done with and without application of magnetic field to estimate the improvement in the VCC system. Experiments are carried International Conference on Ideas, Impact and Innovation in out on Tetrafluoroethane (R-134a) refrigerant. The test results mainly focus on the application of magnetic field which has a positive effect on the COP and power consumption of the system for the refrigerant.

3. Experimental Set-Up and Methodology

The working fluid used was R134a. Drop-in experiments were carried out without any modifications to the experimental apparatus. An experimental setup of a vapour compression refrigeration system was established to investigate the performance of R134a. A schematic diagram of the experimental setup is shown in Fig.



The main loop is composed of a compressor, condenser, capillary tube valve and evaporator. The compressor is a sealed rotary type of 1/4th TOR capacity. The condenser and evaporator were of both copper single tubes. In the single tube condenser, the refrigerant flows through the inner tube. The refrigerant then flows into the evaporator through the capillary tube. The expansion valves are used to control the mass flow rate of the refrigerant into the evaporator coils and also to set the pressure difference. In the single tube evaporator, the refrigerant flow through the inner tube. For minimizing the heat loss, the tube is well insulated. Five magnetic pairs with a Gauss level of 450 each were employed in this study and placed in the system on liquid line.

The readings were taken with increasing number of magnetic pairs. Two pressure gauges were placed in the system to note down the compressor inlet and outlet pressure. Temperatures at various points in the system were noted with the help of a six k-type digital thermocouple sensor with the range -200°C to 1260°C/2300°F were used to measure the temperature at different locations in the refrigeration loop and Power consumed by the compressor was measured by an energy meter. The two calibrated pressure gauges at the compressor inlet and outlet were used to measure the suction and discharge pressure respectively.

Where,

T_1-Condenser inlet temperature

T_2-Condenser Outlet temperature

T_3-Temperature at inlet of flow meter

T_4-Evaporater Inlet Temperature

T_5- Evaporator outlet Temperature

T_6- Water temperature

P_1-Compressor inlet pressure (Suction Pressure)

P_2- Compressor outlet pressure (Discharge Pressure)

4. EXPERIMENTAL SET UO OF THE VCR SYSTEM TEST

1. Compressor
2. Condenser
3. Capillary tube
4. Evaporator
5. Magnets
6. Presser gauge
7. Temperature indicator 1
8. Thermocouples K-type 6

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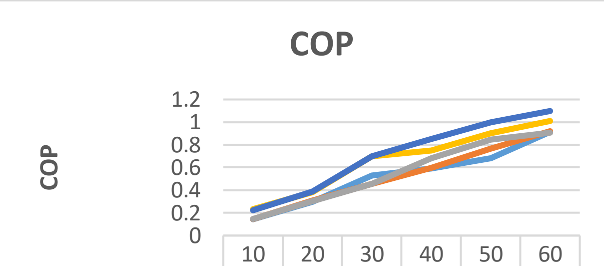
- **Refrigerant use in system:**
  R134a (Tetrfluroethane)
- **R134a properties:**
  Chemical Name:- CH2FCF3
  Molar mass:- 102.03gm/mole
  Density:- 0.00425 gm/c.m3.gas.

5. RESULTS



	10	20	30	40	50	60
without magnet	0.144	0.298	0.529	0.594	0.684	0.914
1 magnetic pair	0.145	0.31	0.456	0.598	0.764	0.92
2 magnetic pair	0.146	0.302	0.458	0.683	0.848	0.907
3 magnetic pair	0.233	0.381	0.698	0.752	0.901	1.01
4 magnetic pair	0.223	0.387	0.698	0.852	0.998	1.098

Chart 1: COP vs. Time (min)

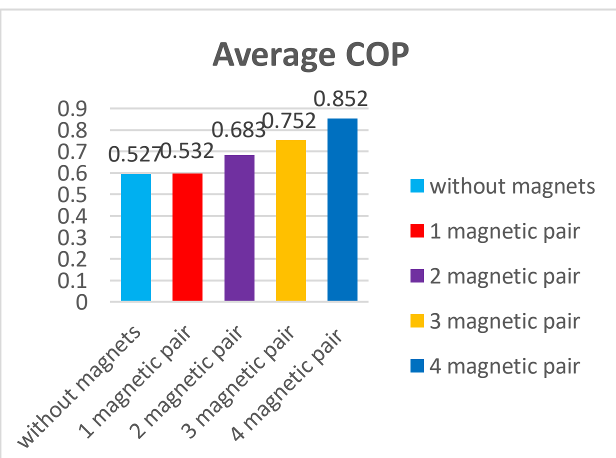
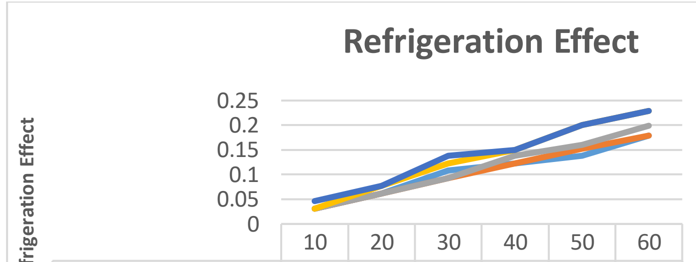


Chart 2: Coefficient of performances vs. No. of pairs

The graph shown Coefficient pf Performance vs. number of magnetic pairs is shown in diagram above.

The Coefficient pf Performances of the system is observed to be affected by the magnetic field.

According to the above graph above, COP increased by 2.28 percent for a 1 magnetic pair, 9.43 percent for 2 magnetics pairs, 27.96 percent for 3 magnetics pairs, and 30.10 percent for 4 magnetics pairs. The cop increases for pairs of magnets due to an gain refrigerant effect and a drop-in compressor power



	10	20	30	40	50	60
without magnet	0.0309	0.0618	0.108	0.122	0.138	0.179
1 magnetic pair	0.0309	0.0618	0.0927	0.122	0.152	0.179
2 magnetic pair	0.0309	0.0618	0.0927	0.138	0.16	0.199
3 magnetic pair	0.0309	0.0772	0.122	0.15	0.2	0.229
4 magnetic pair	0.0463	0.0772	0.138	0.15	0.2	0.229

Chart 3: Refrigeration effect vs. Time (min)

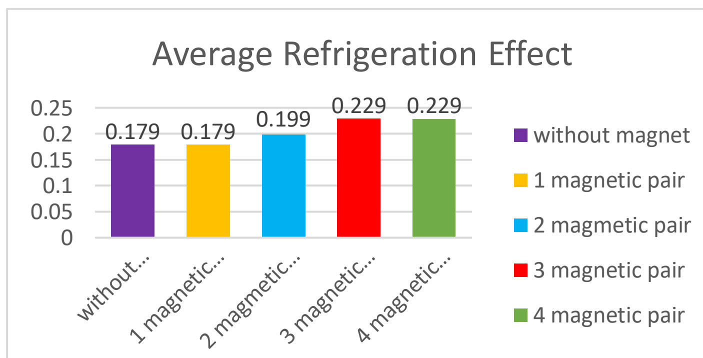


Chart 4: Refrigeration effect vs. No.of pairs

The refrigerating effect is depicted in the graph above as a function of number of magnetic pairs.

Refrigerant effect rises with the number of magnetic pairs, up to 4 magnetic pairs. Heat transmission rate rises as the refrigerant's specific increases.

The refrigerant absorbs substantially more heat from the water as a result of the enhanced heat transfer rate, and thus the refrigerating effect increases. When a 1 magnetic pair is utilize, the refrigerating impact increases by 1.74 percent compared to when no magnetic pair is used. When 2 magnetic pairs is utilize, the refrigerating impact increases by 8.03 percent, while when 3 magnetic pairs are used, the refrigerating effect increases by 27.28 percent. The refrigerating impact increased by 29.27 percent for 4 magnetic pairs.

Condition	Average time for 10 blinks (sec)	Average refrigeration effect (Kw)	Average Compressor Work (Kw)	Average COP
Without Magnets	56.2	0.122	0.2001	0.609
With 1 magnetic pair	56.56	0.124	0.1989	0.619
With 2 magnetic pairs	56.90	0.133	0.1977	0.667
With 3 magnetic pairs	57.10	0.156	0.1970	0.791
With 4 magnetic pairs	57.18	0.158	0.1968	0.804

Experimental VCRS using 134a with magnets

6. CONCLUSION

The test results shows application of magnetic field has positive effect on the COP of the system for Tetrfluroethane refrigerant.

Thus this study has been able to validate the reported phenomena of improvement in COP refrigerant systems on application of magnetic field between condenser outlet. By application of magnetic field to vapour line (i.e. compressor inlet) there is no change in refrigeration capacity or compressor power consumption.

Without magnets in working condition:

Refrigerant Effect = m Cp $(T_2 - T_1)$

Where,

M = Mass of 1 liter of water

Cp = 4178.23 J/kg-K

T_1 = Inlet of the refrigerant

T_2 = Outlet of the refrigerant

Performance defoliates after certain magnetic field strength

COP=Mwater*CPw*(Tinitial–Tfinal)/ Compressor power Mwater,

Cp = 4178.23 J/kg-K

Improvement in COP = (COP with application of magnetic field/ COP without application of magnetic field) * 100.

30.10% COP improvement is experimentally observed with application of the magnetic field on R134a.

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