Performance of Domestic Refrigerator with low side Float Valve at the Evaporator Outlet using SiO_2 Nano fluids along with R-134a as a Refrigerant

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Abstract : The abstract reports on the performance analysis of a VCR system with low side float valve by using SiO_2 Nano particles as a refrigerant. Majority of the refrigerators today works on the VCR system. This system consists of the following important components like Compressor, Condenser, Expansion valve and Evaporator.

The main aim of this research work is to analyse the performance of the Vapor Compression Refrigeration system by keeping the low side float valve at the evaporator outlet using SiO_2 Nano particles along with R-134a as a Refrigerant. Here R-134a, which is a commonly used refrigerant, is compared with R-134a along with SiO_2 Nano particles. The low side float valve controls the flow of the liquid refrigerant and increases the life span of the compressor. Thus Coefficient of performance (COP) of the Vapor Compression Refrigeration system improves.

The performance parameters such as Refrigeration effect, mass flow rate, compressor work and coefficient of performance are calculated. Finally the performance of VCR system with low side float valve is compared.

IndexTerms **- vapor compression Refrigeration System, low side float valve, coefficient of performance.**

I.INRTODUCTION:

Most of the domestic refrigerators operate on VCR system and run for usual C.O.P. which pays attention to intensify the cop with some alternation made on the components assembled in the system. Fig shows the simplified diagram of components of a VCR system.

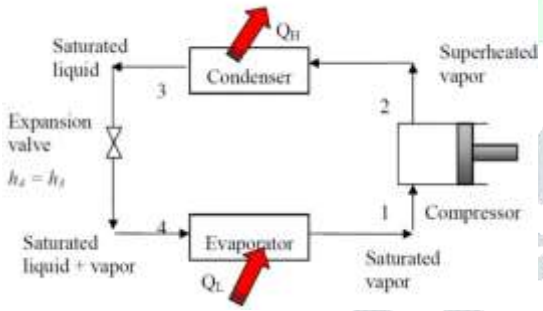

fig1.1: Outline of VCR System.

The Vapor refrigerant R-134a enters into the compressor. The vapor refrigerant is compressed into the hermetically sealed compressor to high pressure and high temperature at constant entropy. Then this high pressure and high temperature gaseous refrigerant sent into the condenser coil and condenses into a liquid from vapor state by removing extra heat at constant pressure and temperature. After that the liquid refrigerant passes through the expansion valve, where its pressure diminishes suddenly. Finally it is sent into the evaporator coil at low pressure and low temperature liquid refrigerant absorbs the heat present in the evaporator and transforms into vapor form, with this one cycle completes. Now again the refrigerant sent into the compressor then starts the new cycle.

II.EXPERIMENTAL WORK:

This research work is concentric about domestic refrigerator with low side float valve of refrigerator (R134 a) holding 165litres capacity.

2.1. COMPONENTS USED

- Base stand Domestic refrigerator of 165 litres capacity consists of hermetically sealed compressor, condenser, capillary tube, Evaporator.
- Low pressure float valve.
- Thermocouple.
- Stop watch
- Pressure gauges

- SiO_2 Nano particles
- R-134a Refrigerant
- Power supply(230V AC, 50 HZ)

The domestic refrigerator selected for the research work has the following specifications:

- Refrigerant used : R-134a, R-134a along with SiO_2 nano particles.
- Capacity of the Refrigerator : 165 litres
- Compressor capacity : 0.14H.P.
- Condenser sizes
  Length : 7.3152 m
  Diameter: 4.76mm
- Evaporator
  Length : 7.62 m
  Diameter: 6.4 mm
- Capillary
  Length : 3.048m
  Diameter: 0.036mm


Fig:2.1. Existing system


fig:2.2. Proposed System


fig:2.3.Low Pressure float Valve

2.2. LOW SIDE FLOAT VALV E

1. The low side float valve is a metering device that controls the flow of refrigerant on the side of low pressure (low side) metering valve. It maintains a constant level of liquid in the evaporator. As the cooling load on the evaporator increases, the liquid boiled away and the level of the liquid in the evaporator and the float chamber falls. As a float drops, it opens the metering orifice. This discovery is recognised fluid from high pressure side.
2. It is also used as an expansion device for flooded system. The high-pressure float valve is located on the high-pressure side of the system and is in open connection to the condenser. It controls the evaporator level indirectly by maintaining a constant level of refrigerant inside the float chamber.

2.3. REFRIGERANT (Tetrafluoro-ethane)

Fig: R-134a cylinder


fig: SiO_2 Nano Particles

TABLE 1: R-134a properties

S:NO	REFRIGERANT	R134a
	Name	Tetrafluoro-ethane
1	Formula	(CH_2FCF_3)
2	Critical temperature in ^OC	101
3	Molecular weight in KG/Kmol	102
4	Normal boiling point in ^OC	-26.5
5	Pressure at -25^{o}C in bar (absolute)	1.07
6	Liquid density at -25^{o}C in Kg/I	1.37

2.4.SiO_2 NANO PARTICLES:

The SiO_2 Nano Particles does not react with R-134a, but it enhances the rate of Heat transfer in refrigerator. In this process, SiO_2 acts as a catalyst. The SiO_2 Nano Particles is proposed as a promising lubricant to enhance the Performance of Vapor Compression Refrigerator. Concentration of about 0.2% is used in Current Experimental Work.

It is essential to develop energy efficient refrigeration and air conditioning systems with nature friendly refrigerants. The rapid advances in nanotechnology have lead to emerging of new generation heat transfer fluids called nano fluids. Nano fluids are a relatively new class of fluids which consist of a base fluid with nano-sized particles (1–100 nm) suspended within them. These particles, generally a metal or metal oxide, increase conduction and convection coefficients, allowing for more heat transfer out of the coolant. The thermal conductivities of nano refrigerants are higher than traditional refrigerants. It was also observed that increased thermal conductivity of nano refrigerants is comparable with the increased thermal conductivities of other nano fluids.

III.EXPERIMENTAL PROCEDURE:

The following procedure is adopted for experimental setup of VCR system.

1. The domestic refrigerator working on VCR system (R134 a) and having capacity of 165 litres is taken.
2. Pressure and temperature gauge are installed at each and exit of the components. Along with this one thermocouple is placed at the evaporator.
3. Flashing of the system is done by pressurised nitrogen gas.
4. R-134 a refrigerant is charged into the VCR system.
5. Leakage tests are done by using soap solution, in order to further test the condenser and evaporator pressure and check purging for 12 hours and found that there is no leakage which required absolutely the present investigation to carry out further experiment.
6. Switching on the refrigerator and observations is required nearly for 50 to 60 min and take the pressure and temperature readings at each section.
7. By using these temperature and pressure gauge reading the performance of the existing system is found out.
8. The temperature and pressure gauge reading are taken and then and calculate the performance by using these valves. Then compare the performance parameters for both the system.

IV.RESULTS AND DISCUSSIONS:

Various performance parameters for both Existing and proposed systems are calculated and Compare the Values as shown below.

4.1. COMPARISION OF COP

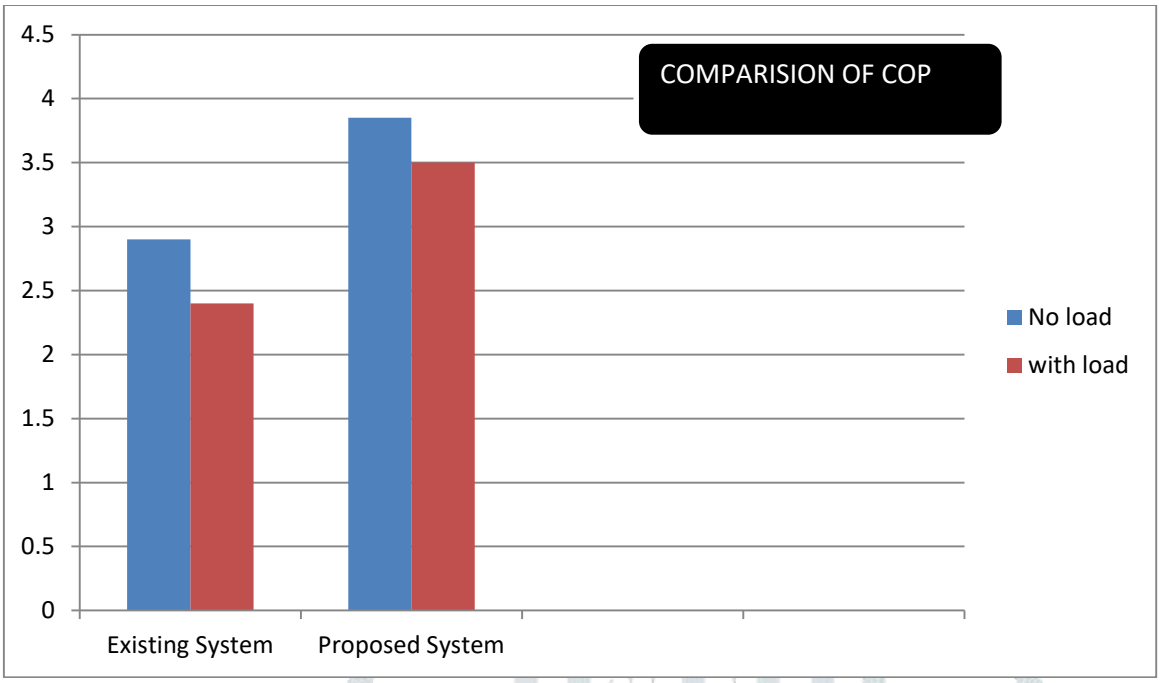

Fig 4.1: Comparision of COP

From the above fig, it is shown that the Coefficient of Performance has been increased to 15.08% from 3.5 to 3.85

4.2. COMPARISION OF NET REFRIGERATION EFFECT

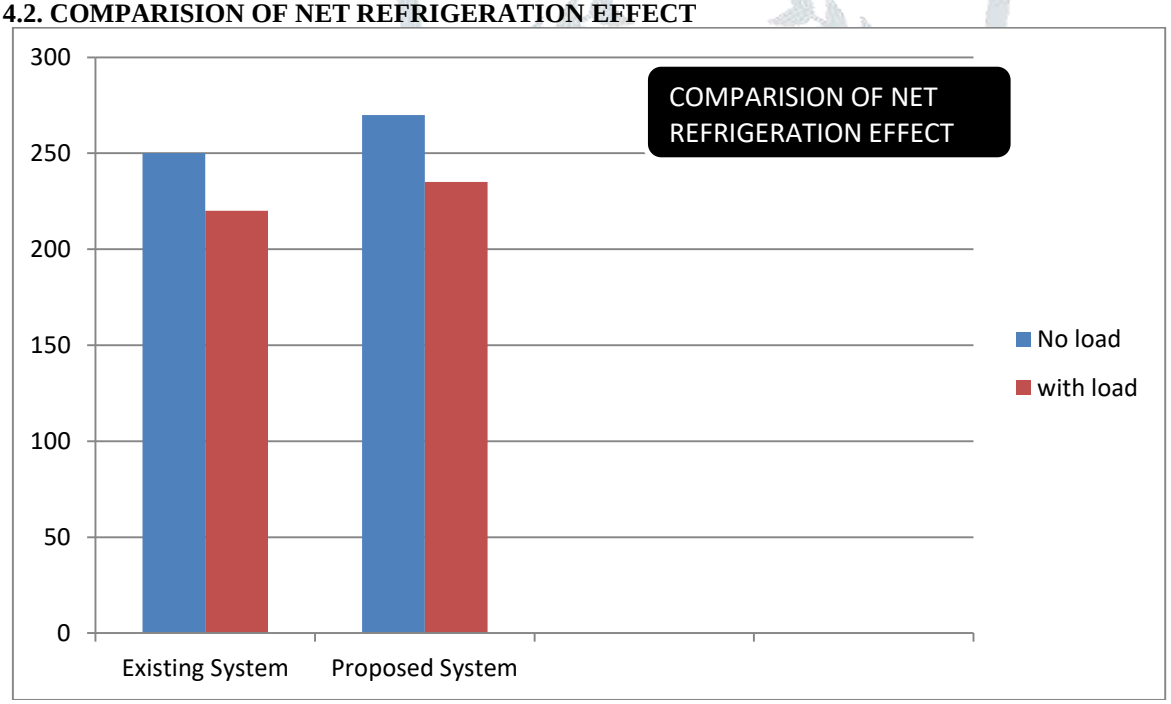

Fig 4.2: Comparision of Net Refrigeration Effect

4.3.COMPARISION OF MASS FLOW RATES:

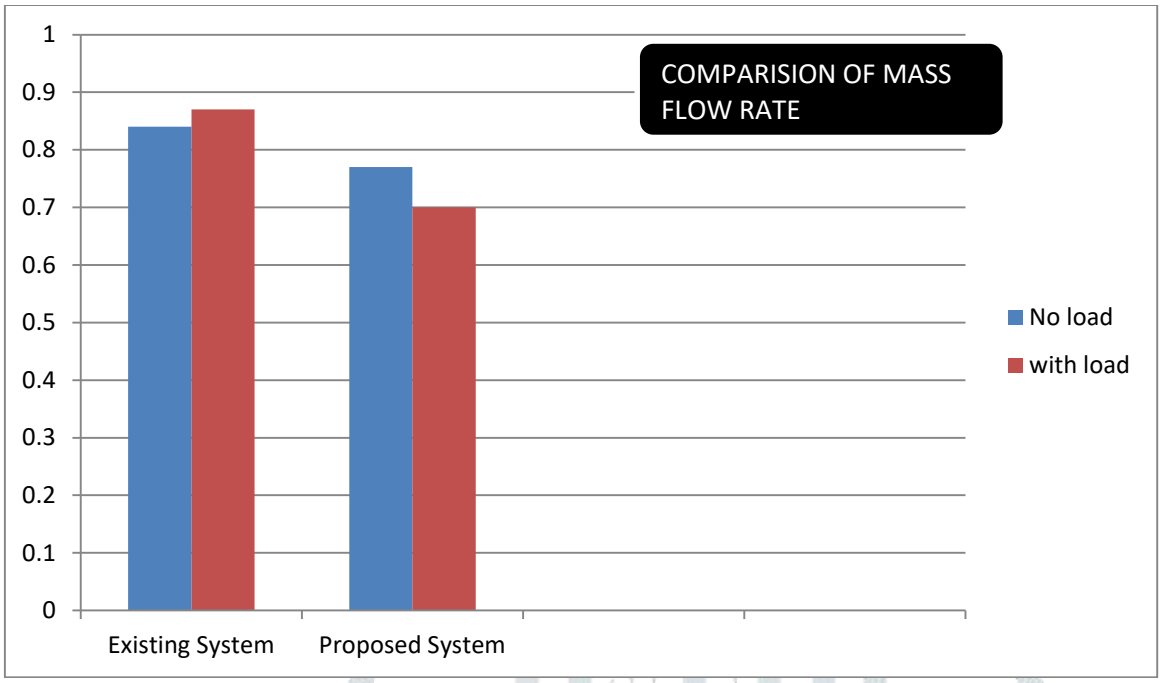

Fig 4.3: Comparision of Mass Flow Rate

From the above result, it is clear that the mass flow rate has been reduced to 10% from 0.82 Kg/min to 0.713 Kg/min

4.4.COMPARISION OF POWER CONSUMPTION

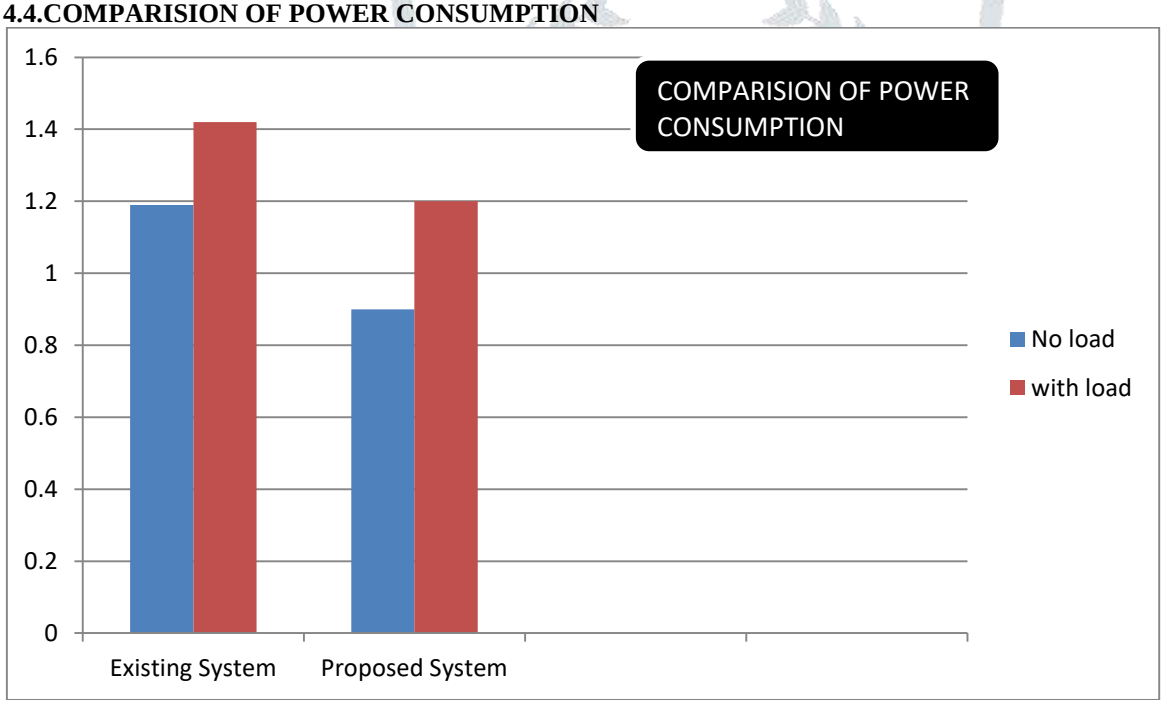

Fig 4.4: Comparision of Power Consumption.

It is clear that the Power Consumption has been reduced to 20% from 1.8KW to 0.9KW

From the above results,

The performance parameters for both Existing and Proposed Systems with load and without load for R-134 along with SiO_2 Particles have been calculated.

COP improves to 15.08%, Mass flow rate reduces to 10%, Refrigerant Effect increases to 25%, Power Consumption decreases to 20%.

V. FUTURE SCOPE OF WORK:

There are many ways to improve the Performance Parameters of the VCR System. One such ways is the usage of Nano fluids. The Performance will increase depends on the Concentration of the nano fluid. Nanofluids stability and its production cost are major factors that hinder the commercialization of nanofluids. By solving these challenges, it is expected that nanofluids can make substantial impact as coolant in heat exchanging device.

7. REFERENCES

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