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# TESTING, PERFORMANCE AND COMPARATIVE ANALYSIS OF HOUSEHOLD REFRIGERATOR WORKING WITH CONVENTIONAL CONDENSER AND SPIRAL COIL TUBE SHAPED CONDENSER USING REFRIGERANT R-134A & ECO-FRIENDLY REFRIGERANT HC-12A

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## ABSTRACT:

*Global warming and ozone layer depletion is the most important issue at all over world. Montreal Protocol is mainly concern with the regulation of amount of ozone layer depleting constituents from the various refrigerants. The refrigeration system is consisting of essential components called condenser, compressor, evaporator and expansion device. The present study specially focused on equipment called a condenser which is very much important and essential part for working of refrigeration system and also suitable refrigerant. We replaced conventional condenser with spiral coil tube shaped condenser and made a comparison by using refrigerant R-134a with eco-friendly refrigerant HC-12a at various loading conditions in household refrigerator.*

**Keyword:** Conventional Condenser, Eco-friendly refrigerant HC-12a, Household Refrigerator, Refrigerant R-134a, Spiral coil tube shaped condenser.

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## 1. INTRODUCTION

The refrigeration system is working on conventional condenser by using refrigerant R-134a which is having zero ozone depletion potential (ODP) but it is having some amount of global warming potential (GWP). This experimentation is carried out by taking into consideration of alternative for R-134a as eco-friendly refrigerant HC-12a and for conventional condenser as spiral coil tube shaped condenser. A household refrigerator works on vapour compression refrigeration system. This system consists of four basic parts i.e. compressor, condenser, expansion device and evaporator. The refrigerant undergoes through phase change in condenser and evaporator which acts as a heat exchanger.

In this present study we used 165 liter household refrigerator and specially focused on a equipment called a condenser which is very important and essential for working of refrigeration system. We replaced conventional condenser with spiral coil tube shaped condenser and also we replaced the refrigerant R-134a with the eco-friendly refrigerant hydrocarbon-12a which is the blend of propane(R-290) and isobutene (R-600a) and made a comparison of household refrigerator with various loading conditions such as no load condition and 100W load condition. For loading condition we made an arrangement for holding the bulb inside a cabinet of refrigerator and use bulb of 100W etc.

## 2. LITERATURE SURVEY

Mahajan R. et al. (2014) [1], with the experimentation they have found that by using eco-friendly refrigerant HC-12a in domestic refrigerator with conventional condenser gave a higher COP than R-134a with reduced energy consumption, and also HC-12a is environmentally good refrigerant as it has zero ODP and negligible GWP.

Sushant Patil et al. (2017) [2] tested the household refrigerator by using spiral micro tube condenser and The data obtained from fabricated experimental set up used in analyzing performance of spiral micro -tube condenser & conventional condenser used as a part of vapor compression system. With introduction made for spiral micro-tube condenser, COP value found increased by 13.45% over the conventional refrigeration system. When conventional condenser is replaced by micro tube condenser there is increase in refrigeration effect and compressor power requirement decreases by 35.90.

B. Santosh Kumar et al. (2015) [3] performed the experimental investigation of vapour compression refrigeration system with spiral shaped condenser. The work is centric about COP of refrigeration system using conventional condenser made of MS with cu coating and the verifying effect of performance using conventional condenser made of copper material. Experiment was done on kelvinator refrigerator of 165 liters and hermetic compressor is used. Result obtained from the conventional condenser is compared with spiral shaped condenser with varying pitch from 1.5 inch to 2.25 inch. The optimum COP is 4.25 and it is obtained at 2 inch pitch of the coil. After experimental investigation of various condensers final result comes as spiral shaped condenser coil (cu) of diameter 6.35 mm, 8500mm length and 2 inch pitch is recommended for VCR system of household refrigerator of 165 liters capacity with R134a as refrigerant.

P.G. Lohote et al. [4] contributed by using spiral and micro channel condenser to raise COP of refrigerator to the value that was never before. The geometry, enhanced surface area of such micro channels are found adding positive results in the enhancement of COP value and work is elaborate through research work drafted in the paper. The Experimental work centric about performance study of spiral and micro channel shaped condenser used in refrigerator holding 165 liter's capacity. For spiral and micro channel shape condensers, COP value found increased by 5.06 % and 13.82 % respectively over the conventional refrigeration

system. When spiral condenser is replaced by micro channel there is increase in refrigeration effect and compressor work by 12.02 % and 6.25 % respectively with increase in rate of heat rejection considerably. The summarized observations from the performance of Micro channel shape base condenser and so the refrigeration System has better performance over conventional refrigeration system supported with regular shape condenser.

### 3. METHODOLOGY

In this present study household refrigerator of 165 liter is fitted with spiral coil tube shaped condenser having many changes in design and shape for testing and performance. Various loading condition has taken like no load, 100 watt and finding out the coefficient of performance.

#### 3.1. Experimental Setup:

In this, performance of household refrigerator having conventional condenser is compared with the spiral coil tube shaped condenser. To perform the experiment 165 liter refrigerator is selected which is designed to work with refrigerant R-134a which is recently used in refrigeration system and also for hydrocarbon refrigerant HC-12a which is eco-friendly refrigerant. As usual this system is also consisting of hermetically sealed compressor, condenser, evaporator, receiver and expansion device. Two pressure gauges are fitted, one at the inlet of compressor and another at outlet of the compressor. The temperature at seven different points is taken by seven temperature sensors are mounted to measure the compressor inlet temperature, compressor delivery temperature, evaporator inlet temperature, evaporator outlet temperature, the freezer temperature, cabinet temperature and atmospheric temperature. An ammeter is mounted at the inlet of the compressor to measure the power supply and voltmeter is also used for voltage of supply.



**Figure 1** Refrigerator with spiral coiled tube condenser

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Figure 2 Unloading Condition



Figure 3 Loading Condition with 100Watt bulb

#### 4. COMPARATIVE ANALYSIS OF CONVENTIONAL CONDENSER AND SPIRAL COIL TUBE SHAPED CONDENSER BY USING REFRIGERANT R-134A AND HC-12A AT VARIOUS LOADING CONDITIONS

##### a) At no load condition

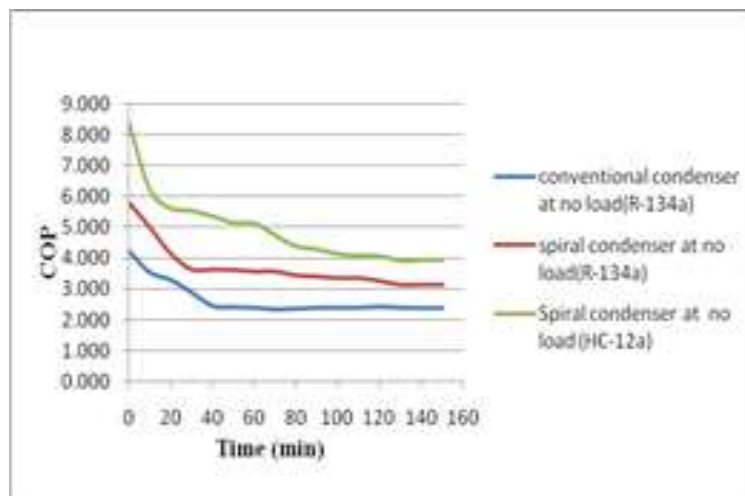


Chart 1 COP Vs Time

The above graph shows that comparison for coefficient of performance between of spiral coil tube shaped condenser and conventional type of condenser at no load condition by using both refrigerant R-134a and HC-12a. The steady state value of COP for Spiral coil tube shaped condenser with refrigerant HC-12a is 3.935, with R-134a is 3.130 and for conventional condenser with R-134a is 2.235. Thus the conclusion is made that the COP of spiral coil tube shaped condenser is higher than conventional type of condenser because of lower pressure difference between evaporator & condenser at no load condition. Moreover, we can also see that using eco-friendly refrigerant HC-12a, getting more COP than that of R-134a for spiral coil tube shaped condenser.

### b) At 100Watt load condition

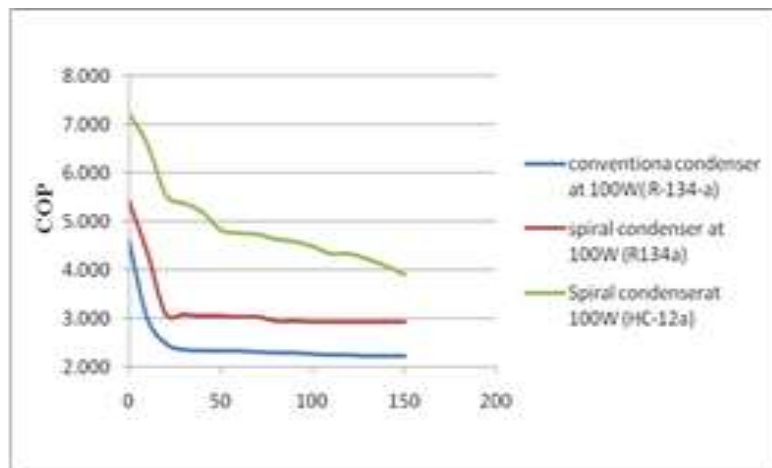


Chart 2 COP Vs Time

The above graph shows that comparison for coefficient of performance between of spiral coil tube shaped condenser and conventional type of condenser at 100Watt load condition by using both refrigerant R-134a and HC-12a. The steady state value of COP for Spiral coil tube shaped condenser with refrigerant HC-12a is 3.921, with R-134a is 3.130 and for conventional condenser with refrigerant R-134a is 2.397. Thus the conclusion is made that the COP of spiral coil tube shaped condenser is higher than conventional type of condenser because of lower pressure difference between evaporator & condenser at 100Watt load condition.

## 5. CONCLUSION

With this experimentation conclusion is made that by using spiral coil tube shaped condenser getting high coefficient of performance than by using a conventional type of condenser. And also by using eco-friendly refrigerant HC-12a, getting higher COP than that of refrigerant R-134a. Moreover as HC-12a is eco-friendly refrigerant having negligible ODP and negligible amount of GWP, it can be a alternative for R-134a.

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Testing, Performance and Comparative Analysis of Household Refrigerator Working with Conventional Condenser and Spiral Coil Tube Shaped Condenser Using Refrigerant R-134a & Eco-Friendly Refrigerant HC-12a

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