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Analysis of Nano Refrigerants Used in Automobile Air Conditioning System

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ABSTRACT

The research work focuses on studying the losses caused by irreversibility's in a vapor compression refrigeration system. The evaporator temperature is considered as the influential parameter, and the analysis includes examining energy destruction and second law efficiency. The study specifically investigates the behavior of six halocarbon ethane series nano refrigerants: R-123, R-124, R-125, R-134a, R-143a, and R-152a, with variations in the evaporator temperature. The results of the analysis indicate that the second law efficiency increases as the evaporator temperature rises. For R-123, the efficiency remains almost constant with increasing evaporator temperature. Furthermore, it is observed that R-123 exhibits the same efficiency as R-134a at a temperature of 233K (-40°C). Overall, this research work provides insights into the losses and efficiency of different halocarbon ethane series nano refrigerants in a vapor compression refrigeration system, with a focus on the evaporator temperature as a significant parameter.

Keywords- Nano refrigerant, Energy Destruction, Work Lost, Irreversibility, Exergetic Efficiency, Second Law Efficiency

1. INTRODUCTION

Refrigeration and air conditioning systems are designed to remove heat from a cooler space or product and transfer it to a warmer environment. These systems utilize the principles of thermodynamics to achieve the desired cooling effect.In a refrigeration or air conditioning system, a working fluid (commonly referred to as a refrigerant) is circulated through a closed loop. The refrigerant undergoes a cycle of compression, condensation, expansion, and evaporation to transfer heat effectively.

The basic operation of a refrigeration system involves the following components:

- Evaporator: This component is located in the area or product to be cooled. The low-pressure and low-temperature refrigerant enters the evaporator, where it absorbs heat from the surroundings, causing the refrigerant to evaporate into a gas.
- Compressor: The evaporated refrigerant in gas form is then compressed by the compressor, which increases its pressure and temperature. Compression requires energy input, typically provided by an electric motor.
- Condenser: The high-pressure and high-temperature refrigerant vapor leaving the compressor enters the condenser. Here, the refrigerant releases heat to the surroundings, causing it to condense into a liquid state.
- Expansion Valve: The condensed refrigerant passes through an expansion valve, which reduces its pressure and temperature. This process prepares the refrigerant for the next cycle in the evaporator.

By continuously repeating this cycle, the refrigeration or air conditioning system transfers heat from the cooler space (evaporator) to the warmer environment (condenser), allowing for cooling to occur. This enables the system to maintain the desired temperature and provide a comfortable or controlled environment for various applications, such as residential and commercial buildings, food storage, and industrial processes.

The purpose of the thesis is to examine whether carbon dioxide (CO2) can serve as a viable alternative solution for supermarket refrigeration systems. The research aims to evaluate the performance of CO2 systems both theoretically and experimentally, comparing them to conventional or alternative system solutions. The thesis seeks to identify the strengths and weaknesses of CO2 system solutions in order to optimize their performance. By conducting a thorough analysis, modifications can be proposed and tested to enhance the CO2 system's efficiency and effectiveness. The investigation will likely involve studying various aspects of CO2 refrigeration systems, including their thermodynamic properties, operational characteristics, energy efficiency, environmental impact, and overall performance. The research may include theoretical modelling, simulations, and experimental tests to assess the performance of CO2 systems in different scenarios and operating conditions.

By comprehensively evaluating CO2 as a refrigeration solution for supermarkets, the thesis aims to provide insights into its potential as an alternative to conventional systems. The findings and recommendations from the research can inform the industry about the suitability and optimization strategies for CO2 systems, contributing to more sustainable and efficient refrigeration practices in the supermarket sector.

2. PROBLEM IDENTIFICATION

The findings suggest that different refrigerants require varying amounts of compression work to achieve a specific desired exergy. Specifically, R123 and R134a require more compression work compared to R11 and R12. However, these differences are not substantial at high evaporation temperatures. Therefore, it is concluded that R123 and R134a should not be disregarded as alternative coolants despite their slightly higher compression work requirements.

3. OBJECTIVES

The research aims to investigate various parameters of vapor compression refrigeration systems, specifically focusing on pressure and temperature. Additionally, a comparative analysis is conducted on six halocarbon refrigerants: R-123, R-124, R-125, R-134a, R-143a, and R-152a. The analysis examines these refrigerants within a vapor compression refrigeration system, considering different condensation temperatures and pressures.

The research likely involves experimental or theoretical investigations where the refrigeration system is operated under varying conditions of condensation temperature and pressure. The objective is to analyze the behavior and performance of each refrigerant at different operating points.

Parameters such as pressure and temperature play crucial roles in determining the efficiency, capacity, and overall performance of the refrigeration system. By evaluating these parameters for different refrigerants, a comparative analysis can be performed to assess their suitability and effectiveness in various operating conditions.

The analysis may involve studying thermodynamic properties, energy consumption, heat transfer characteristics, and system performance metrics. The research findings can provide insights into the advantages, limitations, and optimal operating conditions for each refrigerant, aiding in the selection and design of efficient vapor compression refrigeration systems.

Overall, this investigation aims to deepen the understanding of the behavior of various halocarbon refrigerants in vapor compression refrigeration systems and their response to different condensation temperatures and pressures.

4. RESULT

Table-4.1 (Comparison of R-152a & R-134a)

	R-152 a	R-134a
1200Kpa	2.38	2.23
1100Kpa	2.5962	2.4289
1000Kpa	2.7093	2.642971
900Kpa	2.95327	2.903188
800Kpa	3.1583	3.218002
700Kpa	3.381	3.594276
600Kpa	3.756	4.137719

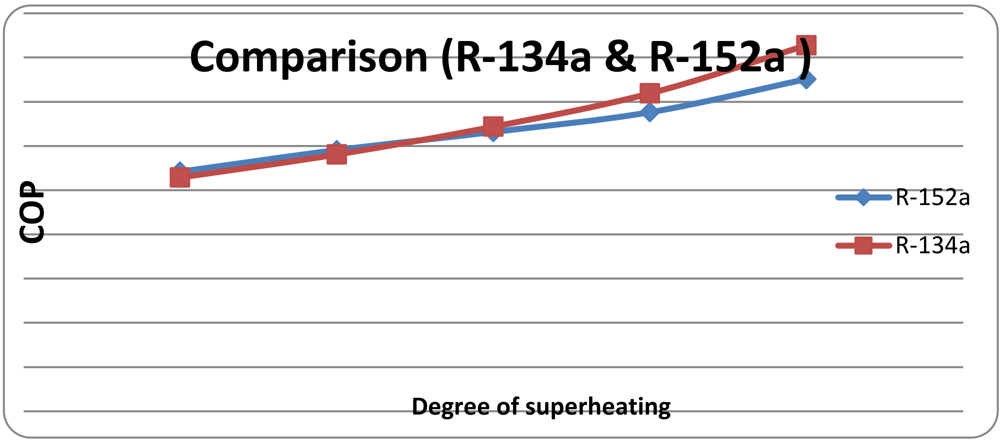

Fig 4.1 Comparison between R-134 a & R-152 a

SUPERCOOLING

Table-4.2 (Comparison of R-152a & R-134a)

Pc= 1200Kpa

Pe=100Kpa

	R-134a	R-152a
DOS	COP	COP
0	2.2396	2.3873
1	2.2694	2.411
2	2.299	2.434
3	2.3288	2.457
4	2.3585	2.481
5	2.38832	2.5044

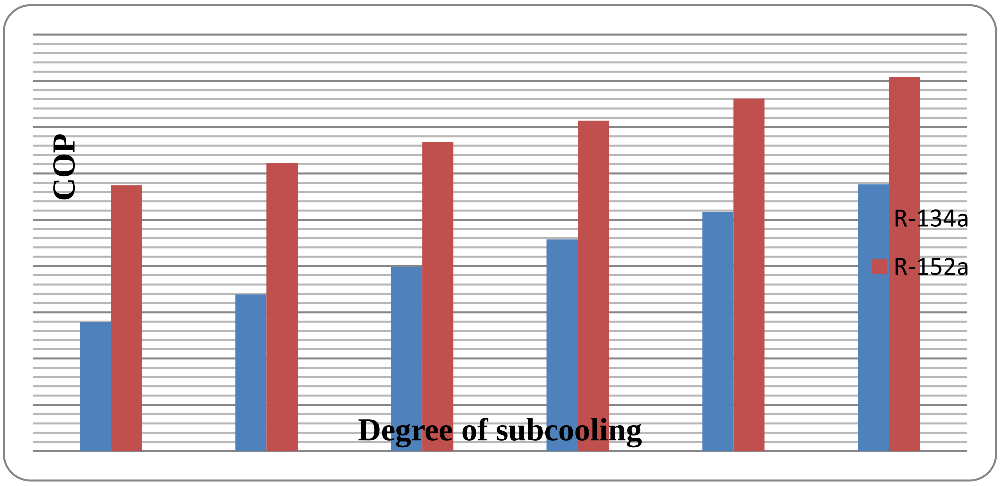

Fig 4.2 Comparison between COP & Degree of subcooling

Pc= 1100Kpa

Pe=100Kpa

	R-134a	R-152a
DOS	COP	COP
0	2.429	2.596
1	2.459	2.62
2	2.489	2.645
3	2.52	2.669
4	2.55	2.693
5	2.58	2.72

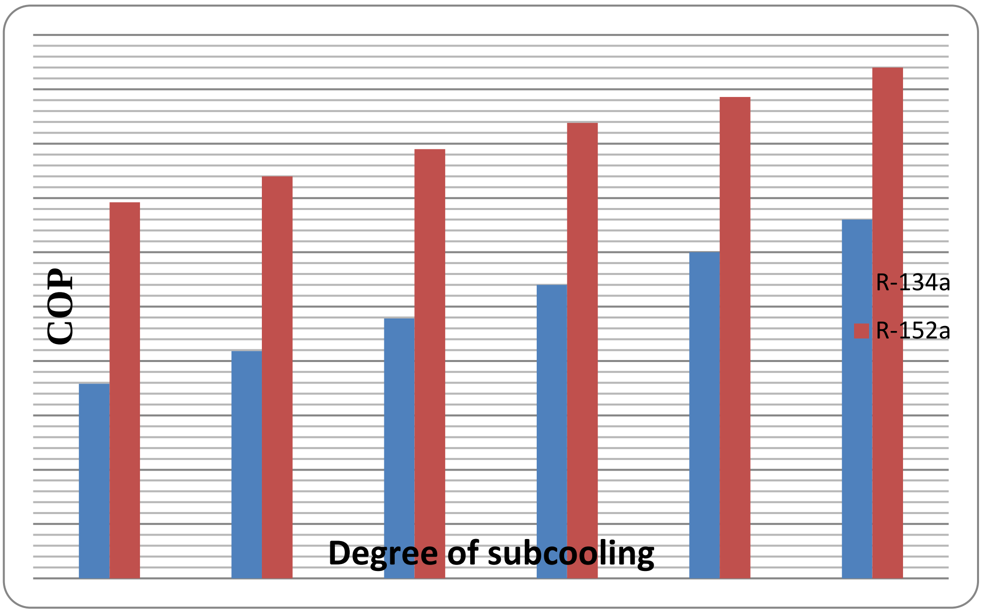

Fig 4.3 Comparison between COP & Degree of subcooling

5. CONCLUSION

A comparative analysis of the refrigerant impact on the operation and performances of a one stage vapor compression refrigeration system was presented. The effects of temperature and pressure of evaporator, condenser, superheating and sub-cooling were studied on the system operation and performances. Based on the theoretical analysis destruction rates were estimated for each component of the system in a comparative manner for five refrigerants R-123, R-124, R-125, R-143(a), (R152(a) and R134(a). If evaporating temperature or pressure changes with 5-degree Celsius superheating and sub cooling but does not changes condenser temperature or pressure, then COP increases with evaporating temperature and pressure. If evaporating temperature or pressure changes with 5-degree Celsius superheating but does not changes condenser temperature or pressure, then COP decreases with evaporating temperature and pressure. The COP of the refrigerator decreases with degree of superheating. If evaporating temperature or pressure changes with 5-degree Celsius sub cooling but does not changes condenser temperature or pressure, then COP decreases with evaporating temperature and pressure. The COP of the refrigerator increases with degree of sub cooling.

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