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Analysis of Six Halocarbon Ethaene Series Nano Refrigerants Used in Automobile Air Conditioning

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ABSTRACT

This research work investigates the losses involved in process and overall cycle due to irreversibility in vapor compression refrigeration system with evaporator temperature as influential parameter by energy destruction and second law efficiency analysis. The present work analyzed the behavior of six halocarbon ethane series nano refrigerants R-123, R-124, R-125 R-134a, R-143a and R-152a with variation of evaporator temperature. From second law efficiency increases with evaporator temperature and for R-123 almost constant η with increases evaporation temperature and also same η at temperature 233K (-40^{O}C) comparison of R-134a

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

1. INTRODUCTION

Refrigeration and air conditioning is used to cool products or a building environment. The refrigeration or air conditioning system (R) transfers heat from a cooler low-energy reservoir to a warmer high-energy reservoir. The purpose of this thesis is to investigate whether or not CO_2 is a good alternative solution for supermarket refrigeration, to theoretically and experimentally evaluate its performance compared to a conventional/ alternative system solution. By identifying the strength and weakness points in CO_2 system solutions it is possible to apply and test modifications to optimize the system for its best possible performance. By combining the experimental and theoretical findings it is possible to point out potential improvements in the experimental rigs, and thereafter, conclude upon good CO_2 system solution/s for supermarket refrigeration. It is also important to investigate safety issues when CO_2 is applied in this application where a computer simulation model would give a good indication of the risks attached to using it. A further step in this analysis of CO_2 in supermarket refrigeration The work in this thesis started by surveying existing CO_2 supermarket installations in Sweden. Installed and possible solutions where CO_2 is used have been summarized as a basis for the theoretical and experimental analysis.

2. PROBLEM IDENTIFICATION

This thesis report is based on analysis of parameters of vapor compression refrigeration system uses halocarbon refrigerants. On the basis of energy analysis of refrigeration systems many studies are being carried out on the performance of alternative environment-friendly refrigerants. It was established that for a specific amount of desired exergy, more compression work is required for R123 and R134a than R11 and R12.Although the differences are not very significant at high evaporation temperatures and hence R123 and R134a should not be excluded as alternative coolants. During the analysis they obtained an optimum evaporation temperature for each condensation temperature, which yields the highest exegetic efficiency.

3. OBJECTIVES

The main objectives in this research work are

- To investigate the various parameters of vapour compression refrigeration systems e.g. pressure, temperature.
- Comparative analysis of R-123, R-124, R-125, R-134(a) R-143(a) and R-152(a) in a vapour compression refrigeration system with respect to various condensation temperature & pressure.

4. METHODOLOGY

A vapour compression refrigeration system is an improved type of air refrigeration system in which a suitable working substance, termed as refrigerant is used. It condenses and evaporates at temperatures and pressures close to the atmospheric conditions. The refrigerant used does not leave the system but is circulated throughout the system alternately condensing and evaporating. The vapour compression refrigeration cycle is indeed based on the factors you mentioned:

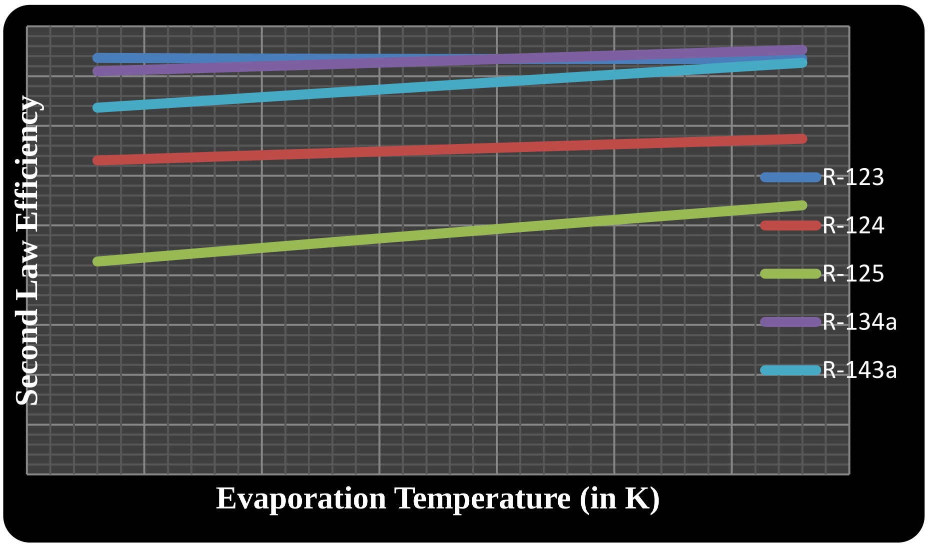
- Refrigerant flow rate: The rate at which the refrigerant circulates through the system affects the efficiency and cooling capacity of the system.
- Type of refrigerant used: Different refrigerants have different properties, such as boiling points, pressure-temperature characteristics, and environmental impact. The choice of refrigerant depends on factors such as efficiency, safety, cost, and environmental regulations.
- Kind of application: The specific application, whether it's air conditioning, refrigeration, dehumidification, or any other cooling process, influences the design and operating parameters of the refrigeration cycle.
- Operation design parameters: These include the temperature and pressure conditions at various points in the cycle, as well as the size and configuration of components like the compressor, condenser, evaporator, and expansion valve. These parameters are determined based on the desired cooling capacity, efficiency, and other system requirements.
- System equipment/components: The selection and design of the various components in the refrigeration system, such as the compressor, condenser, evaporator, and expansion valve, are critical for achieving the desired performance and efficiency of the cycle.

The vapour compression refrigeration cycle works by using a refrigerant with special properties. The refrigerant vaporizes at temperatures lower than the ambient temperature, absorbing heat from the surroundings and causing cooling. This vapour is then compressed by the compressor, increasing its pressure and temperature. The high-pressure vapour then flows into the condenser, where it releases heat to the atmosphere or a cooling medium, causing the vapour to condense back into a liquid state. The high-pressure liquid is then expanded through an expansion valve, which reduces its pressure and temperature, preparing it to enter the evaporator again, starting the cycle anew.

By controlling the saturation temperature and pressure of the refrigerant at different points in the cycle, the vapour compression refrigeration system can effectively extract heat from a low-temperature source and reject it to a higher-temperature environment, providing cooling in the process.

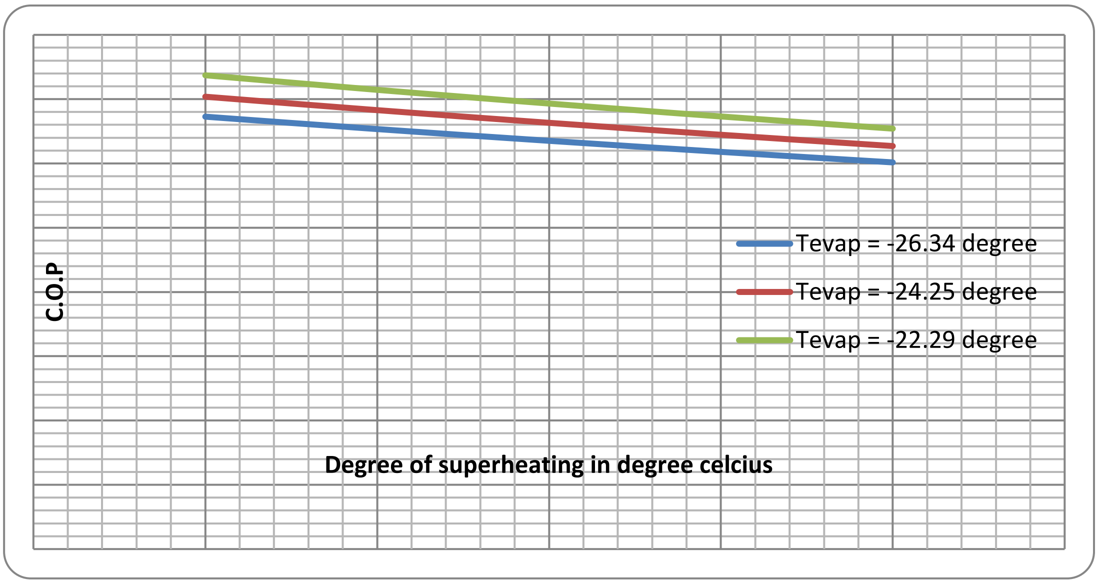
5. RESULT AND DISCUSSION

Second Law Efficiency (η)						
Refrigerant / Temperature range (Te→Tc) K	R-123	R-124	R-125	R-134a	R-143a	R-152a
243→313	0.8345	0.6741	0.5405	0.8529	0.8267	≥1
233→313	0.8344	0.6602	0.5039	0.8385	0.797	≥1
223→313	0.8349	0.6456	0.4664	0.824	0.7668	≥1
213→313	0.8366	0.6306	0.4276	0.8099	0.7366	≥1

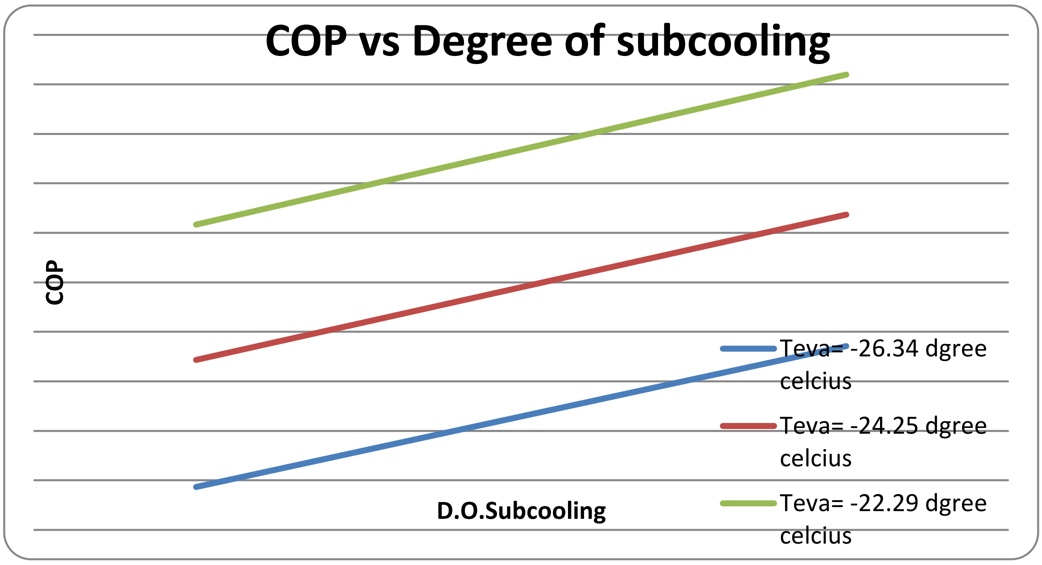


CASE-I

i) 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.

6. CONCLUSION

Based on the presented comparative analysis of the refrigerant impact on the operation and performance of a one-stage vapor compression refrigeration system, several conclusions can be drawn:

Effects of temperature and pressure: The study examined the effects of temperature and pressure variations at different points in the system, including the evaporator, condenser, superheating, and sub-cooling. These variations were found to have an impact on the system's operation and performance.

Comparison of refrigerants: The analysis compared the performance of five different refrigerants: R-123, R-124, R-125, R-143a, R-152a, and R-134a. The comparison likely considered factors such as thermodynamic properties, efficiency, and environmental impact.

COP variation with evaporating temperature and pressure: The coefficient of performance (COP), which is a measure of the system's efficiency, was found to be influenced by changes in the evaporating temperature and pressure. Specifically, if the evaporating temperature or pressure changes with 5-degree Celsius superheating and sub-cooling while keeping the condenser temperature or pressure constant, the COP increases with higher evaporating temperature and pressure.

Overall, the analysis provides insights into the relationship between refrigerant choice, system parameters, and system performance in a one-stage vapor compression refrigeration system. It highlights the importance of considering factors such as evaporating temperature, pressure, superheating, and sub-cooling in optimizing the system's efficiency (COP) and longevity.

7. REFERENCES

[1] L. F. S. Larsen, “Model based control of refrigeration systems,” Ph.D. dissertation, Aalborg University, Department of Control Engineering,2015, PhD. Thesis.

[2] T. Hovgaard, “Active sensor configuration validation for refrigeration’ systems,” Automation and Control, Technical University of Denmark, Tech. Rep., 2019, master’s Thesis. [Online]. Available: http://orbit.dtu.dk

[3] L. Larsen, R. Izadi-Zamanabadi, and R. Wisniewski, “Supermarket refrigeration system - benchmark for hybrid system control.” Proc. European Control Conference, pp. 113–120., 2017.

[4] L. F. S. Larsen, C. Thybo, and H. Rasmussen, “Potential energy savings optimizing the daily operation of refrigeration systems,” Proc.European Control Conference, Kos, Greece, pp. pp. 4759–4764., 2017.

[5] H. Rasmussen and L. Larsen, “Nonlinear superheat and capacity control of a refrigeration plant,” 2009 17th Mediterranean Conference on Control and Automation, pp. 1072–1077, 2019.

[6] M. Willatzen, N. Pettit, and L. Ploug-Sørensen, “A general dynamic simulation model for evaporators and condensers in refrigeration. Part I: moving-boundary formulation of two-phase flows with heat exchange,” International Journal of Refrigeration, vol. 21, no. 5, pp. 398–403, 1998.[7] J. Maciejowski, Predictive control: with constraints. Pearson education, 2002.

[8] J. B. Rawlings and D. Q. Mayne, Model Predictive Control: Theory and Design. Nob Hill Publishing, 2019.

[9] D. Sarabia, F. Capraro, L. Larsen, and C. de Prada, “Hybrid nmpc of supermarket display cases,” Control Engineering Practice, vol. 17, no. 4, pp. 428–441, 2018.

[10] T. Hovgaard, K. Edlund, and J. Jørgensen, “The potential of economic for power management.” Proc. Conference on Decision and Control, p. accepted, 2020.

[11] J. Rawlings, D. Bonne, J. Jorgensen, A. Venkat, and S. Jorgensen, “Unreachable set points in model predictive control,” IEEE Transactions on Automatic Control, vol. 53, no. 9, pp. 2209–2215, 2018.