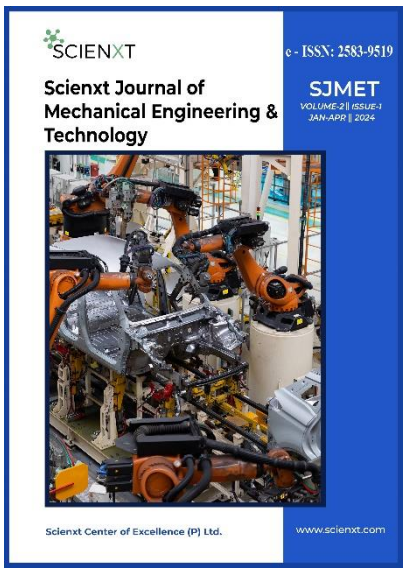

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Comparison of thermodynamic performance in cascade systems utilizing various refrigerant combinations

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Abstract:

In numerous industrial and medical settings, achieving very low temperatures poses a challenge for conventional refrigeration systems due to extremely low evaporator pressures. Consequently, cascading presents itself as a viable solution, wherein two distinct vapor compression plants, each operating with different refrigerants, are interconnected. This arrangement enables the condensation of vapor from the low-temperature stage by utilizing the evaporation of liquid from the high-temperature stage.

The primary objective of this study is to conduct a comparative thermodynamic performance analysis of cascade systems (CCS) tailored for both cooling and heating applications, focusing on various refrigerant pairs. The specific aims are to identify the most suitable refrigerant pair and to investigate the influence of operating parameters on the performance of cascade refrigeration systems (CRSs) across different refrigerant combinations.

Key findings indicate that the highest coefficient of performance (COP) for CCS in cooling applications is achieved with the CO_2-NH_3 refrigerant couple (COP = 1.934), while the lowest COP is observed with the CO_2-R1234yf refrigerant couple (COP = 1.777). Additionally, exergy efficiencies of CCS for cooling applications are reported as follows: 49.89% (CO_2-HFE7000), 49.72% (CO_2-R134a), 50.74% (CO_2-R152a), 49.17% (CO_2-R32), 48.56% (CO_2-R1234yf),

51.19% (CO_2-NH_3), 49.29% (CO_2-Propane), and 49.28% (CO_2-Propylene).

Keyword:

Cascade system, Refrigerant, Coefficient of Performance, and Couple of Refrigerant