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Enhancing the Performance of a Transportable Environmental Control Unit (ECU) Operated in High-Temperature Climates

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ABSTRACT

Numerous people live or venture into environments, such as the Middle East, where the temperatures can skyrocket as high as 54°C. This leaves many air conditioners unable to operate efficiently. Although much research has been conducted for incorporating vapor injection processes into refrigeration systems, such as ones used in supermarkets, little has been researched regarding the application in extreme heat environments. While most basic air conditioning units do not require the addition of a vapor injection process along with an economizer, this project requires the air conditioning (AC) unit to operate under extreme high temperature conditions. The project investigates the addition of a vapor injection process and an economizer on the performance of a transportable Environmental Control Unit (ECU), operating with refrigerant R-407C, running under ambient temperatures as high as 51.7°C (125°F) and an indoor temperature of 32.2°C (90°F), and using a single injection port scroll compressor. The retrofitted AC unit was compared to a baseline cycle without vapor injection. Results for fixed injection vapor superheat at 7°C show that the cooling capacity increased for all test conditions from 6.7% to 15%. Due to the high compression ratio, the compressor discharge temperature relatively increased for the extreme test conditions. In addition, the compressor power consumption increased by up to 18%, while the COP of the system increased by 1%. Furthermore, the second law of thermodynamics analysis showed that the compressor had the largest irreversibilities, with the condenser and evaporator showing significant irreversibilities as well. Future work includes optimizing each component to improve the system's COP.

KEYWORDS

Vapor Injection, Economizer, R-407C, Single Injection Port, Scroll Compressor