

## Experimental Analysis of the Performance of a System for Freezing Fish Products Equipped with a Modulating Vapour Injection Scroll Compressor

**Authors :** Domenico Panno, Antonino D'amico, Hamed Jafarholi

**Abstract :** This paper presents an experimental analysis of the performance of a system for freezing fish products equipped with a modulating vapour injection scroll compressor operating with R448A refrigerant. Freezing is a critical process for the preservation of seafood products, as it influences quality, food safety, and environmental sustainability. The use of a modulating scroll compressor with vapour injection, associated with the R448A refrigerant, is proposed as a solution to optimize the performance of the system, reducing energy consumption and mitigating the environmental impact. The steam injection modulating scroll compressor represents an advanced technology that allows you to adjust the compressor capacity based on the actual cooling needs of the system. Vapour injection allows the optimization of the refrigeration cycle, reducing the evaporation temperature and improving the overall efficiency of the system. The use of R448A refrigerant, with a low global warming potential (GWP), is part of an environmental sustainability perspective, helping to reduce the climate impact of the system. The aim of this research was to evaluate the performance of the system through a series of experiments conducted on a pilot plant for the freezing of fish products. Several operational variables were monitored and recorded, including evaporation temperature, condensation temperature, energy consumption, and freezing time of seafood products. The results of the experimental analysis highlighted the benefits deriving from the use of the modulating vapour injection scroll compressor with the R448A refrigerant. In particular, a significant reduction in energy consumption was recorded compared to conventional systems. The modulating capacity of the compressor made it possible to adapt the cold production to variations in the thermal load, ensuring optimal operation of the system and reducing energy waste. Furthermore, the use of an electronic expansion valve highlighted greater precision in the control of the evaporation temperature, with minimal deviation from the desired set point. This helped ensure better quality of the final product, reducing the risk of damage due to temperature changes and ensuring uniform freezing of the fish products. The freezing time of seafood has been significantly reduced thanks to the configuration of the entire system, allowing for faster production and greater production capacity of the plant. In conclusion, the use of a modulating vapour injection scroll compressor operating with R448A refrigerant has proven effective in improving the performance of a system for freezing fish products. This technology offers an optimal balance between energy efficiency, temperature control, and environmental sustainability, making it an advantageous choice for food industries.

**Keywords :** freezing, scroll compressor, energy efficiency, vapour injection

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