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PERFORMANCE EVALUATION OF A MULTI-SOURCE DIRECT-EXPANSION CO_2 HEAT PUMP

Marco Azzolin[1], Mohammad Mozafarivanani[1], Emanuele Zanetti[2], Riccardo Conte[1], Marco Tancon[1], Davide Del Col[1]
[1] Department of Industrial Engineering, University of Padova, Via Venezia 1, 35131 - Padova, Italy
[2] Department of Process and Energy, Delft University of Technology, Leeghwaterstraat 39, 2628 CB Delft, the Netherlands

The reliance of traditional heat pumps on a single energy source may limit operational stability and flexibility, prompting the exploration of multi-source energy integration for improved performance. Air-source heat pumps struggle with weather conditions, solar systems depend on solar irradiance, and ground systems require costly installations. To address these limitations, a three-source heat pump that combines air, solar, and ground energy, utilizing CO_2 as the refrigerant, is presented in this paper. Unlike conventional designs, this system uses two flexible operating modes: one that pairs solar and air sources, and another that combines ground and air sources. The innovation lies in the simultaneous use of renewable sources in direct expansion configuration. This approach enables CO_2 to absorb heat more efficiently under varying environmental and operational conditions by operating in flooded mode within solar collectors or the boreholes, and dry expansion mode in the air evaporator. Through a validated numerical model, the behavior of the system is simulated to analyze how air temperature, solar irradiance, and soil temperature affect the performance. A key finding is that combining two energy sources effectively enhances performance, even with minimal solar panels or ground components. In addition, compared to standard air-source heat pumps, dual-source modes can increase heating performance by up to 22%, providing both space heating and domestic hot water.

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HIGH TEMPERATURE HEAT PUMPS WITH NATURAL REFRIGERANTS

Aleksandra Milic,
Technical and R&D Engineer TEON

The presentation will introduce a model of a high-temperature heat pump capable of producing water up to 95°C, addressing the need for efficient and sustainable heating solutions.
This high output temperature allows for the seamless replacement of old boilers in existing heating systems with radiators, eliminating the need for costly renovations. Radiators, typically most efficient at 70-80°C, can operate efficiently without modification when using this heat pump.
The heat pump utilizes natural refrigerants like isobutane, which has a low Global Warming Potential (GWP) and is environmentally friendly. Isobutane's critical temperature of 134°C enables reliable operation at temperatures up to 95°C. Additionally, it operates at much lower pressure than traditional PFAS-based refrigerants, ensuring greater system reliability and an extended lifespan.
The high enthalpy of condensation at 80°C means that less refrigerant is required to generate more energy, enhancing the overall efficiency of the system.

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THE TRANSITION TO LOW-CARBON HEATING SYSTEMS: OVERCOMING CHALLENGES WITH NATURAL REFRIGERANTS

Maurizio Mastrapasqua,
Product manager
Frascold S.p.a.

The decarbonization of the heating sector is a key milestone in the global effort to achieve net-zero emissions and combat climate change. Buildings account for a significant share of greenhouse gas emissions, making the transition to low-carbon heating solutions essential. Among the most promising technologies for residential and commercial applications are heat pumps capable of producing hot water up to 80°C without requiring modifications to existing heating systems, making them a viable alternative to traditional gas boilers.

However, this transition presents both technical and regulatory challenges, particularly concerning refrigerants. The European Union is introducing stricter regulations to phase out HFCs due to their high global warming potential, while discussions on further restrictions for HFOs are ongoing. This highlights the urgent need to adopt natural refrigerants, such as propane, which offer a sustainable and future-proof solution.

Despite propane's advantages, one of the main technical barriers has always been the lack of high-temperature compressors capable of operating efficiently in these new applications while preserving the reliability of the system. To overcome this challenge, Frascold has invested in research and development, launching a new high-temperature series specifically designed to enable temperatures of up to 165°C. With this innovation, Frascold is unlocking the full potential of heat pumps in the heating sector, driving a more sustainable and efficient energy transition.

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DIGITAL SOLUTIONS FOR INDUSTRIAL REFRIGERATION

Gianmarco Gottardo,
Application Engineering and After Sales BITZER Italia

Eugen Bonelis, Digital Solution Manager BITZER GmbH

Pietro Trevisan, General Manager BITZER Italia

IQ modules turn compressors into intelligent devices, enhancing operations with availability, efficiency, and communication capabilities. The BITZER Digital Network (BDN) offers IoT-based services, providing essential data analyses and compressor operation reports. This helps optimize cooling systems through specific KPIs.

The advantages of applying this technology in industrial refrigeration are illustrated thanks to the experiences gained with an important customer operating in this sector. The use of BDN has simplified the start-up procedures, allowing remote diagnostics to optimally manage maintenance and ensure the maximum operation of the system.

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PLUG-IN UNITS IN COMMERCIAL REFRIGERATION: COMPARISON OF DIFFERENT VARIABLE SPEED COMPRESSOR MODULATION METHODS FOR GREATER ENERGY SAVINGS

Luca Milani,
Application Specialist - Marketing Unit Refrigeration Food Service
Carel Industries

This speech presents the energy benefits enabled by variable speed compressor (VCC – Variable Capacitive Compressor) technologies. We will compare different compressor modulation technologies for propane plug-in units in commercial refrigeration. The analysis will be based on real-case data, demonstrating how control logics embedded in the electronic thermostat allow for greater energy savings compared to other technologies, such as fixed-speed compressors or modulating compressors controlled in a Drop-In configuration. In this context, new European regulations are playing a key role in encouraging manufacturers of refrigerated units to explore new technologies aimed at reducing energy consumption. The goal is to share how direct control of variable speed compressor modulation via the electronic thermostat can ensure greater energy efficiency.

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ECOLOGICAL AND ECONOMICAL SUSTAINABILITY MAXIMIZATION OF COMMERCIAL REFRIGERATION SELF-CONTAINED CABINETS

Marino Bassi,
Key Account Advisor
Nidec GA–Embraco

Peter Buksar - Nidec GA (Embraco) - EMEA Application Engineering Manager
Giovan Battista Donato - Nidec GA (Embraco) - EMEA Trade Marketing

The migration to R290 on self-contained cabinets is now a given. R290 (GWP=0.02) practically cancels direct CO_2 emissions and the development efforts are focused on the indirect CO_2 emissions due to the energy use.

Variable speed compressors (VCC) provide significant energy savings, however their potentiality are not entirely found on the cabinets due to energy erosion from other components running for longer periods when the VCCs work at low speed. It is necessary to adopt, in addition to high efficiency components a smart control able to coordinate all the functionalities of the cabinets.

The case studies here presented on three typical commercial cabinets, show the maximization of energy savings achieved by the Nidec GA-Embraco "Sinc it All" package, consisting of VCC compressors, inverters, ECM fan motors and intelligent control which synchronizes all the energy consuming components (VCC, defrost, glass heaters, fan motors…).

The tests, carried out according to EN 23593, evidence relevant energy savings of the “Sync it All” solutions vs the high efficiency R290 on-off or VCC compressors base lines.

Considering the production scale of the self-contained cabinets, these results represent an important ecological and economical contribution to the sustainability of the Commercial Refrigeration.

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MOBILE AIR CONDITIONING IN EUROPE
RESULTS OF R&D, POLICY, ALTERNATIVE TECHNOLOGY, BEST PRACTICES

Carloandrea Malvicino,
Head of CO_2 Emission Reduction Strategies
Enlarged Europe - Stellantis Italia

RTOC leading author of mobile air conditioning chapter

The Mobile Air Conditioning (MAC) industry has undergone several evolutions in recent years due to the environmental impact of the refrigerants used. The next evolution involves redesigning the MAC system to meet the needs of road transport electrification, which requires new functions such as heat pumps and thermal management for batteries and electronics.

Due to the risk that PFAS (per- and polyfluoroalkyl substances), a by-product of HCFC refrigerants (e.g., R1234yf), could be harmful to the environment, a new phase is approaching. The automotive industry is now reassessing the viability of natural refrigerants such as CO_2 (R744) and propane (R290) to proactively protect the environment and prepare for any regulatory limitations on the use of HCFCs.

The paper summarizes the latest MAC evolutions and the main regulations that are in force and that are expected to become in force in Europe.

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FUTURE VEHICLE THERMAL MANAGEMENT SYSTEMS

Max Vanderhenst,
Senior Technical Trainer
Nissens A/S

The article illustrates the transition from a conventional Automotive air conditioning system to the "Thermal management system", mostly used on modern day vehicles with an increased level of electrification of the hybrid or Battery electric type.

Other than performing than standard task of removing heat and humidity, these new generation Thermal management systems will also function as a heat pump system in winter periods for increased autonomy (driving range) as well as managing the Battery and other electric or electronic component's ideal temperature range for optimum performance

Covering topics like system design, components and refrigerants, it provides an interesting insight to the ever developing future of the AC or thermal management systems that will become one of the most crucial systems in the cars of the future.

Use the QR code to read the full article.

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