INDUSTRIALIZATION AND PATH TO COMMERCIALIZATION OF THE ENERGY EFFICIENCY KIT: "COLD ENERGY"

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COLD ENERGY: INDUSTRIALIZATION AND PATH TO COMMERCIALIZATION OF THE ENERGY EFFICIENCY KIT

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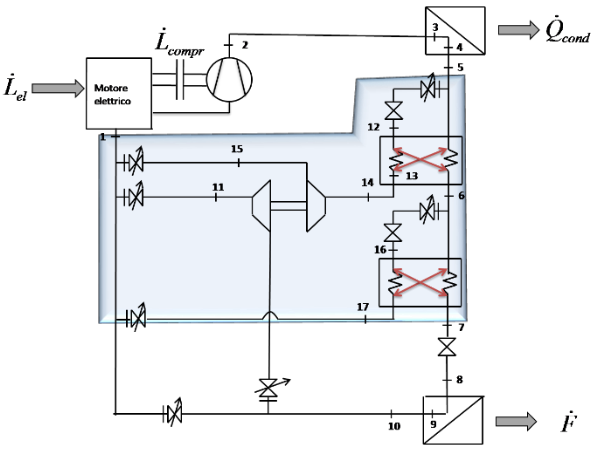
Abstract

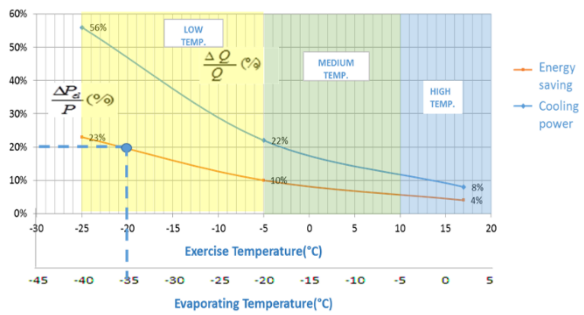
Cold Energy project aims to make available to the market an important tool to increase refrigeration plants energy efficiency. The experimental research has been completed and Turboalgor, a newco of Angelantoni Industrie group, has started activities for industrialization and commercialization of the product. The article describes the objectives achieved, the main stages of the activities to be carried out, the expectations and the potential impact on the market of **COLD ENERGY KITS** that, gradually, will be available for many applications in a wide power range.

1. Introduction



Cold Energy project, originated in 2013 with experimental research, based on a patent that contemplates the introduction of a turbocharger derived from the automotive industry and two energy recovery heat exchangers within a vapour compression refrigeration cycle.

Fig 1: A simplified scheme of a refrigerating plant where innovative components are highlighted with blue colour



Experimental phase of Cold Energy project demonstrated that in a vapour compression refrigerating cycle the introduction of a turbocharger powered by vapour produced through internal heat exchangers increases significantly both performances and energy efficiency of plant itself.

Fig 2: Theoretical graph of the energy saving and cooling power increasing vs exercise temperature and evaporation temperature

Fig 3: A photo of the whole Cold Energy test bench

The results achieved have decreed the opportunity to begin a new phase of the project focused on the development of a product and its commercialization; for this purpose, Turboalgor was born within Angelantoni Industrie group.

2. Characterization of Market Scenarios

The beginning and development of industrialization and marketing processes require the necessary definition of a context in which numerous parameters have been identified and evaluated with direct impact on the project and its potential success. The observation of fig.2 allows to highlight how the proposed innovation from Cold Energy offers benefits that depend heavily from use area of the refrigeration system: the advantage is maximum in the low temperature range and gradually decreases as we move towards air conditioning.

A further element of variability to consider is the type of refrigerant used; it is known that in recent decades there has been an important activity focusing on the detection of refrigerants that meet these requirements: low environmental impact, no danger for users and high-energy efficiency. The current context has not yet identified the "winning" refrigerant fluid, but there are many fluids with equivalent potentiality but characterized by the presence, for each of them, of at least one critical point. It cannot be overlooked that refrigeration systems are applied in many technological sectors and as result they are used in a power range from few watts like in domestic refrigerator to dozens of megawatts as in some industrial plants.

The outlined aspects, coupled with the awareness of a strong geographic-dependent variability, led us to make a market analysis that, although approximate, allowed us to outline and decree significant decisions on the development of activities.

Depending on the collected information there was a work organization based on different time priority levels; the first target, that is today's work, is related to commercialization of energy efficiency kits to be used in low temperature applications, with a power between about 40 kW and 200 kW and using synthetic refrigerants with physical properties similar to those of R404a; at this stage the reference market will be limited to the European Community countries. Subsequently, a wider power range is expected to meet the main refrigerator market requirements and specific components for natural refrigerants will be developed with the aim to exclude only supercritical CO_2 system, which requires substantial evolution of the turbocharger due to high operating pressures.

It isn't unnecessary to emphasize that the choice of R404a as reference fluid for the initial marketing phase isn't the effect of a decision resulting from the observation of market trends, since the R404a and at least some of its substitutes will be used for a short time; the choice of R404a and similar is due to the fact that our experimental research was focused on such fluid, because of its diffusion in existing plants, wide availability of technical data and amount of collected data. However, we cannot forget that the energy saving kit is also applicable to existing systems and, in this case, R404a is one of the most used fluids.

3. Technical and Design Aspects

At the same time of commercial-marketing activities, technical activity is going to define the characteristics of Cold Energy Kit. We are working on turbocharger so that, by exploiting the experimental information obtained from the first prototype, we can improve performance that will have a direct impact on the achievable energy savings; meantime we are working in defining the path to industrial product. In fig. 4-5 you can appreciate turbocharger evolution to an industrial product.

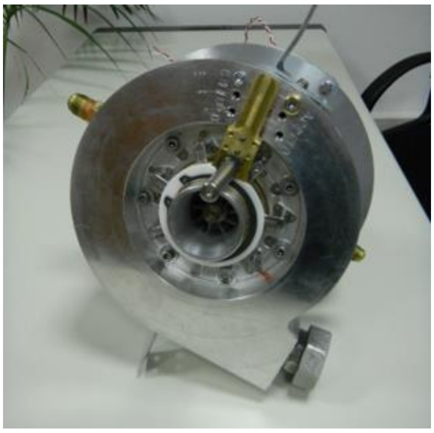


Fig. 4: Image of turbocharger prototype used in test bench

Fig. 5: Image of the new industrial turbocharger

Particularly important is the condition that Cold Energy is a kit applicable to both new and existing installations, it is therefore essential to accomplish a simple and fast integration; two complementary paths have been identified in this perspective: the first provides that main and auxiliary components are contained in a chassis, the second provides that the turbocharger is installed in the main compressor, properly modified to allow for integration, and heat exchangers become an integral part of the refrigerator circuit. In the first case you get a kit that appears as shown in fig.6; it contains all the main components previously described including turbo lubrication and electrical system. The interfaces are limited to four tubes that must be connected to the conventional refrigeration system; the only required utility is electricity.

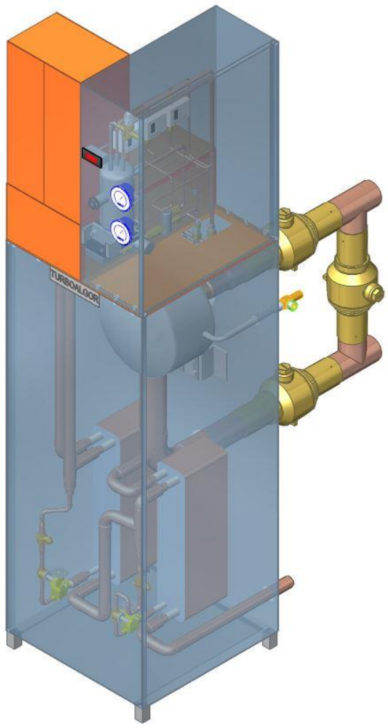


Fig. 6 (left): Cold Energy kit. In the order to improve the interiors visualization in the following representation, the walls of the enclosure have been made transparent

The kit can be equipped with an accessory s/w which, in addition to measuring the actual energy savings achieved, allows remote monitoring of device correct operation. The kit has a very small footprint compared to a classic refrigerator; fig. 7 provides an indication of this.

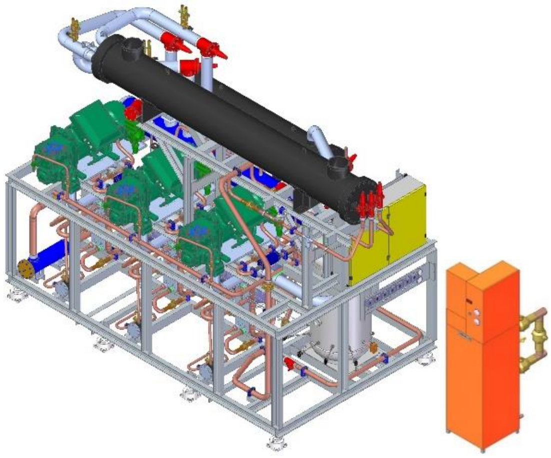


Fig. 7: Indicative representation of the footprint between kit and classic refrigeration system

In the second path, the turbocharger is housed in the main compressor casing adjacent to the electric motor; this imply a change in current geometry because the required space is not available.

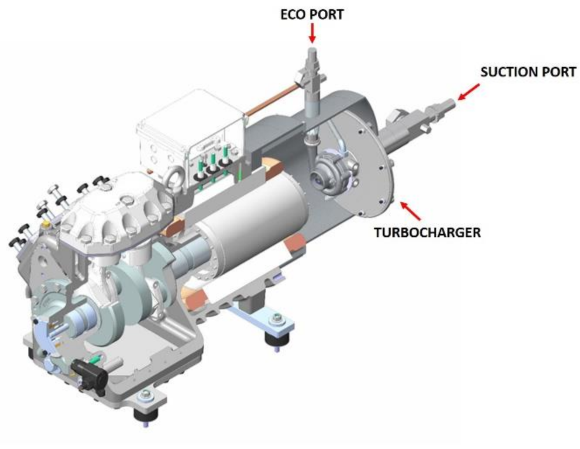


Fig. 8: Image of turbocharger integration in the main compressor housing

This solution is particularly advantageous in the case of alternative compressors where the oil used is compatible with the turbocharger lubrication system; this implies that the main compressor lubrication system can be used to lubricate the turbocharger, generating a production economy and increasing overall system reliability. The two heat exchangers are mounted on the refrigerating system in the same identical modes as the economizers are currently installed.

We conclude by saying that with the installation of the turbocharger in the main compressor a dream has been achieved: **make available ecoport in a reciprocating compressor** as well in scroll and screw compressors to achieve the benefits coming from the installation of economizer.

Bibliography

[01] Taras MF, Lifson A, Dobmeier TJ. *"Refrigerant Cycle with Tandem Economized and Conventional Compressors"* United States Patent; Patent No.: Us 6.955.058 B2; Date of Patent: Oct.18, 2005.

[02] Andres MJ. *"Expendable Turbine Driven Compression Cycle Cooling System"* United States; Patent Application Publication; Pub. No.: Us 2007/0193301 A1; Pub. Date: Aug.23, 2007.

[03] Lifson A, Taras MF. "*Refrigerant System with Variable Capacity Expander*" United States; Patent Application Publication; Pub. No.: Us 2010/0031677 A1; Pub. Date: Feb.11, 2010.

[04] Bush JW, Beagle WP, Mitra B. *"Refrigerating System with Parallel Staged Economizer Circuits Using Multistage Compression"* United States; Patent Application Publication; Pub. No.: Us 2010/0223938 A1; Pub. Date: Sep.9, 2010.

[05] Mitra B, Beagle WP, Bush JW. *"Refrigerating System with Parallel Staged Economizer Circuits Discharging to Interstage Pressures of a Main Compressor"* United States; Patent Application Publication; Pub. No.: Us 2010/0223939 A1; Pub. Date: Sep.9, 2010.

TEMPER – THE HIGH-ENERGY EFFICIENCY FLUID FOR SECONDARY REFRIGERATION SYSTEM