The benefit of nanoparticles add to R600a in a vapor compression system

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Nanorefrigerants are a new class of refrigerants, resulted by adding nanoparticles in a conventional refrigerant.

This paper focuses on the performance of a vapor compression system in two cases: when the working fluid is a pure refrigerant (R600a) and when the working fluid is a nanorefrigerant (R600a/Al_2O_3). The nanorefigerant has resulted by adding Al_2O_3 nanoparticles the environmental friendly refrigerant.

- **1. INTRODUCTION**
- Refrigeration is a relatively new technology used for slowing of bacterial growth.
- Refrigeration plants operate on a series of consecutive thermodynamic processes, forming a cycle, the most common refrigeration cycle being the vapor compression one.

- Nanofluids are sein to be attractive for heat transfer applications, due to their improved thermo-physical properties; these fluids result from a base fluid in which are suspended nano-size particles.
- Nanorefrigerants are a new class of refrigerants, given by a mixture of nanoparticles and refrigerants; the use of nanorefrigerants in refrigeration systems shows a higher heat transfer rate, a better Coefficient of Performance, an improved refrigeration effect and a lower power input at the compressor.
- It is recognized the fact that a performant vapor compression refrigeration cycle ensures electrical energy saving. In the present time, when a better system performance and energy efficiency are important goals, this paper is discussing about the merit of a simple vapor compression refrigeration cycle working with a nanorefrigerant (R600a / Al_2O_3, nanoparticles of Al_2O_3 having a mass fraction of 0.06% and a density of 3690 kg/cm^3).

- In this paper, the selected pure refrigerant is R600a, meaning a HC (hydrocarbon). We will highlight in the following that this selection is based on its good environmental behavior, although its flammability might be an obstacle- aspect also discussed below.

2. ENVIRONMENTAL ASPECTS

- Refrigeration systems might have a significant environmental impact because of leakages and high electricity consumption.
- As a result, the main requirements applied to these technologies might be summarized as:
- adopting environmental friendly refrigerants,
- minimize or, if possible, high global warming potential refrigerants renouncement,
- minimize CO_2 release during operation.

- Refrigerants must comply not only thermo-physical and safety requirements, but also with environmental constraints. As a result, requirements for low Global Warming Potential (GWP) and Ozone Depletion Potential (ODP) refrigerants are consequences of Kyoto and Montreal Protocols.
- HFCs contribute to the global warming, although they do not affect the ozone layer.
- In this respect, suitable alternatives of HFCs are HCs (hydrocarbons) – which, besides their friendly behavior towards the ozone layer, show a very small GWP.

- **3. ABOUT THE SELECTED REFRIGERANT**

- The environmental issue has pushed the refrigeration industry to find solutions for in use and new equipment, from refrigerant use point of view. R600a (isobutane) is a refrigerant belonging to HC family.

4. PERFORMANCE ANALYSIS

- The merit of the vapor compression system is:

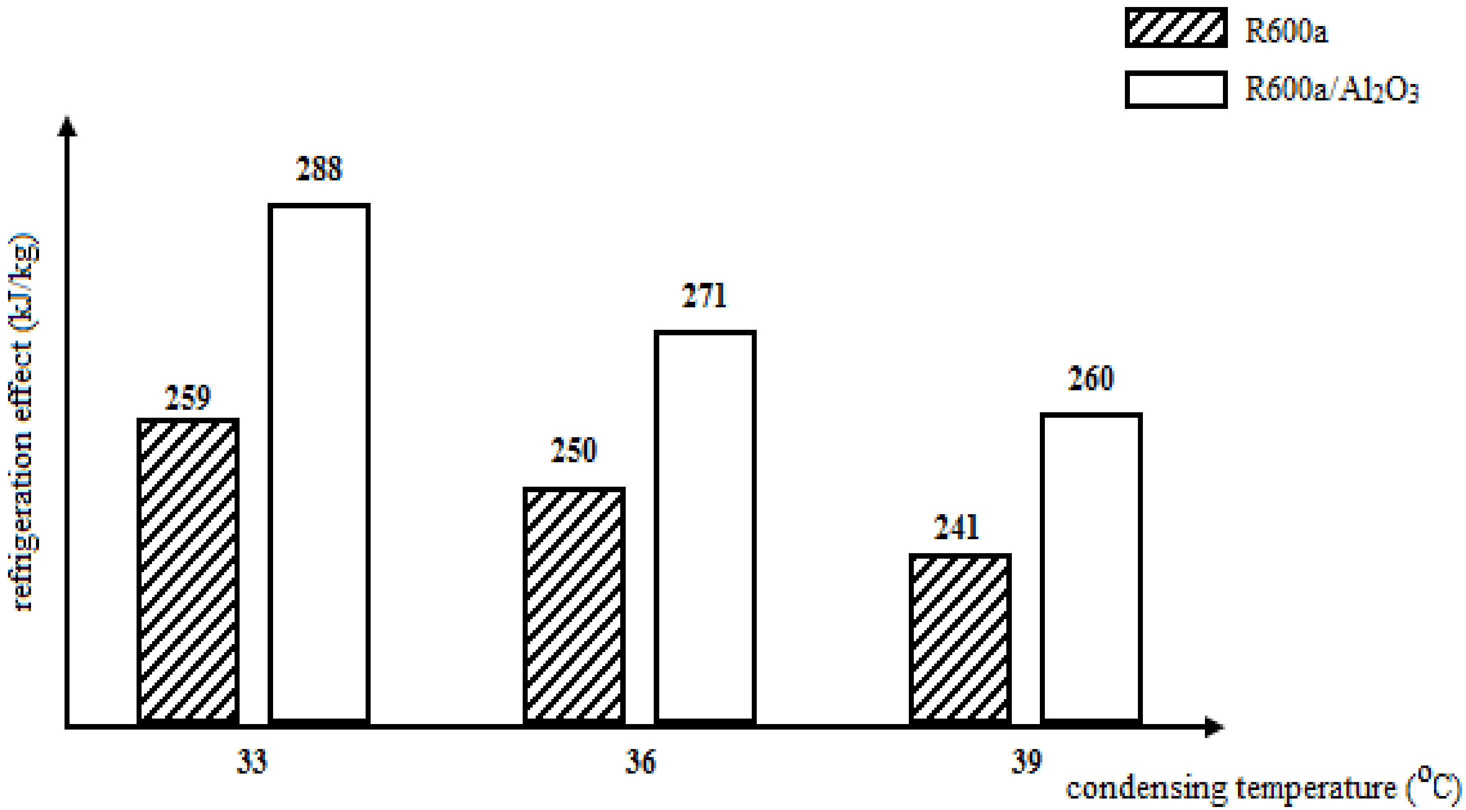
the Coefficient of Performance:

COP= q_0/w_c, where: q_0- the refrigeration effect, q_0- work input

- The evaporation temperature is kept constant (0°C), while the condensation temperature will take three different values (33, 36, 39°C).

In Figures 2, 3, 4, 5 are given the variation of the refrigeration effect, condenser duty, work input and Coefficient of Performance with condensing temperature.

- Figure 2 Refrigeration effect versus condensing temperature



- Figure 3 Condenser duty versus condensing temperature

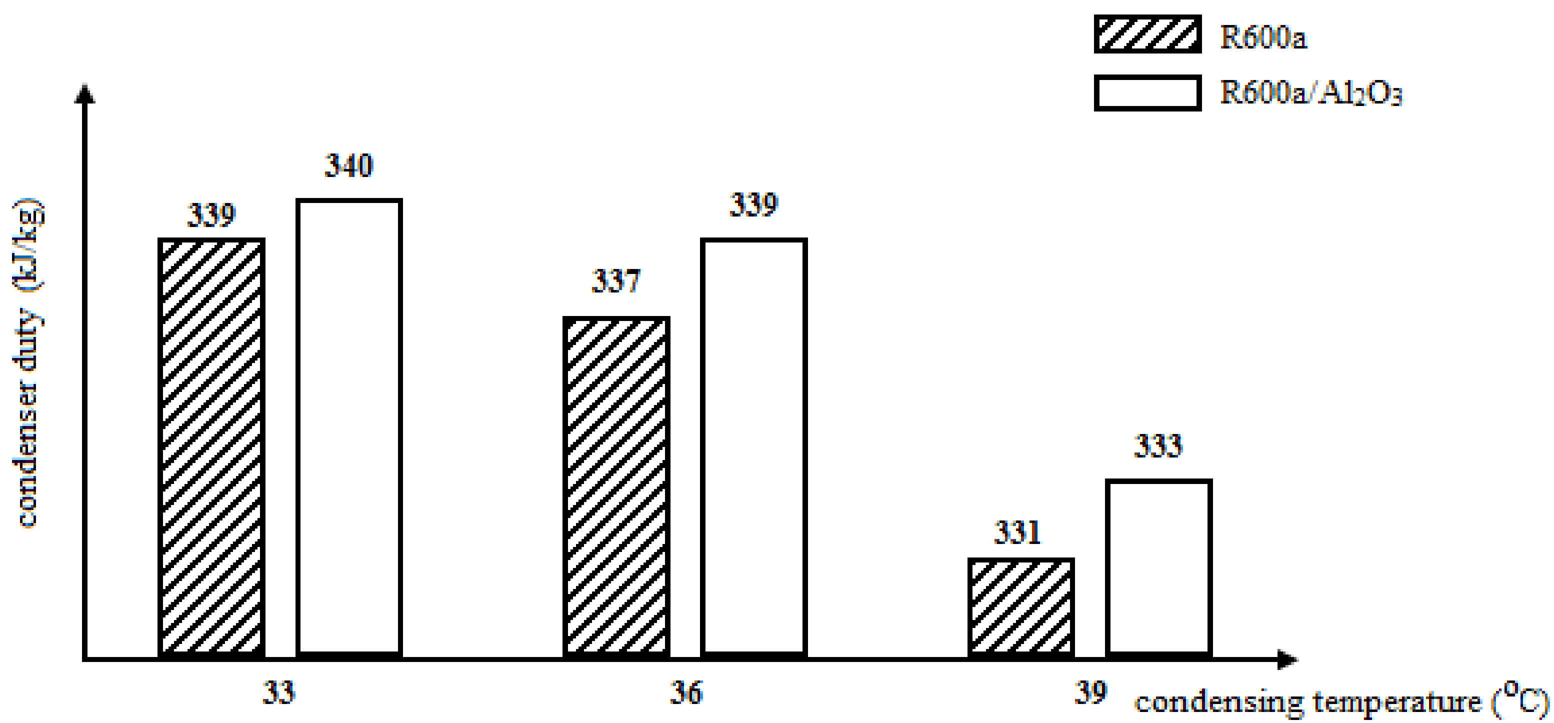
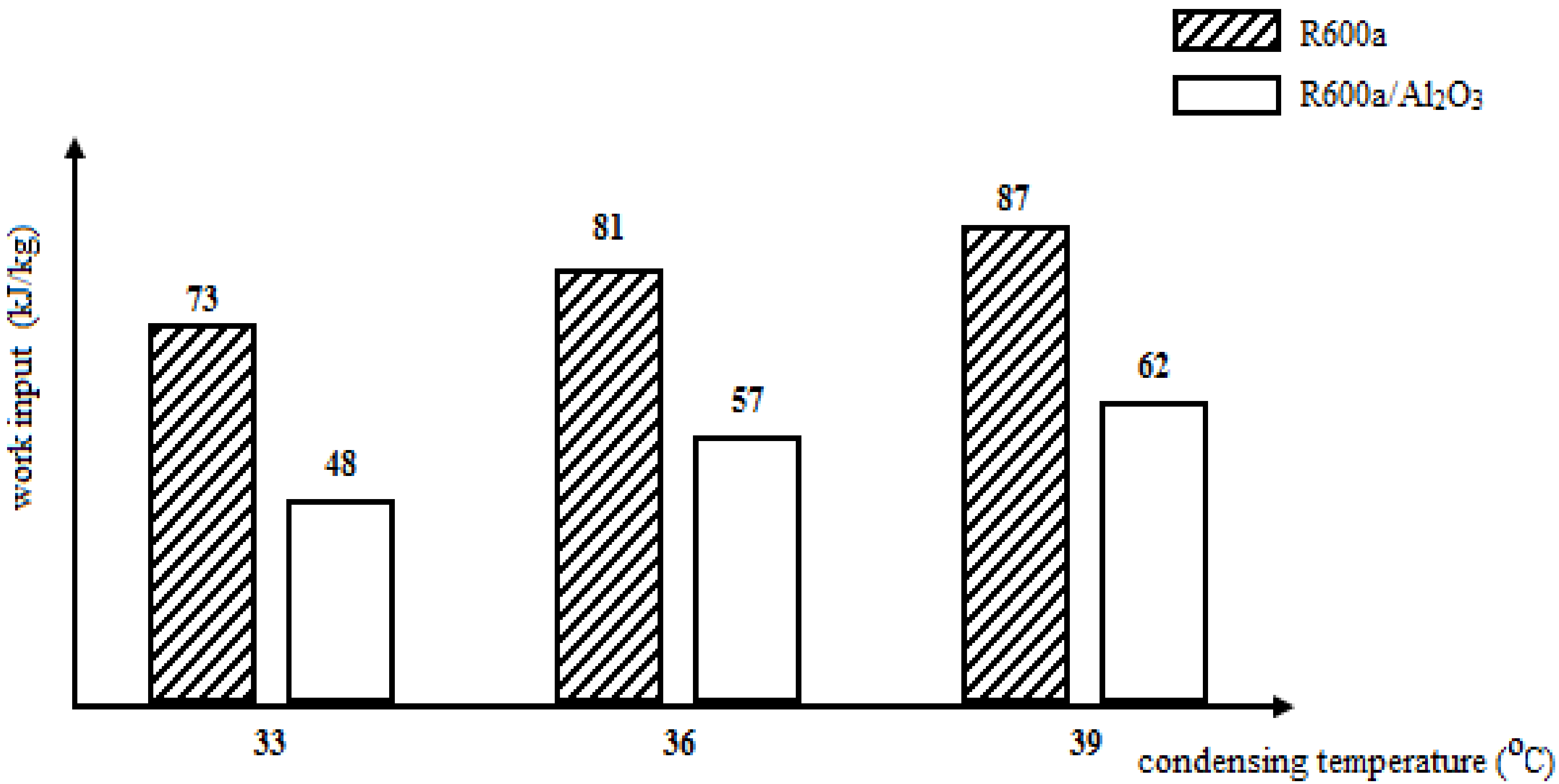
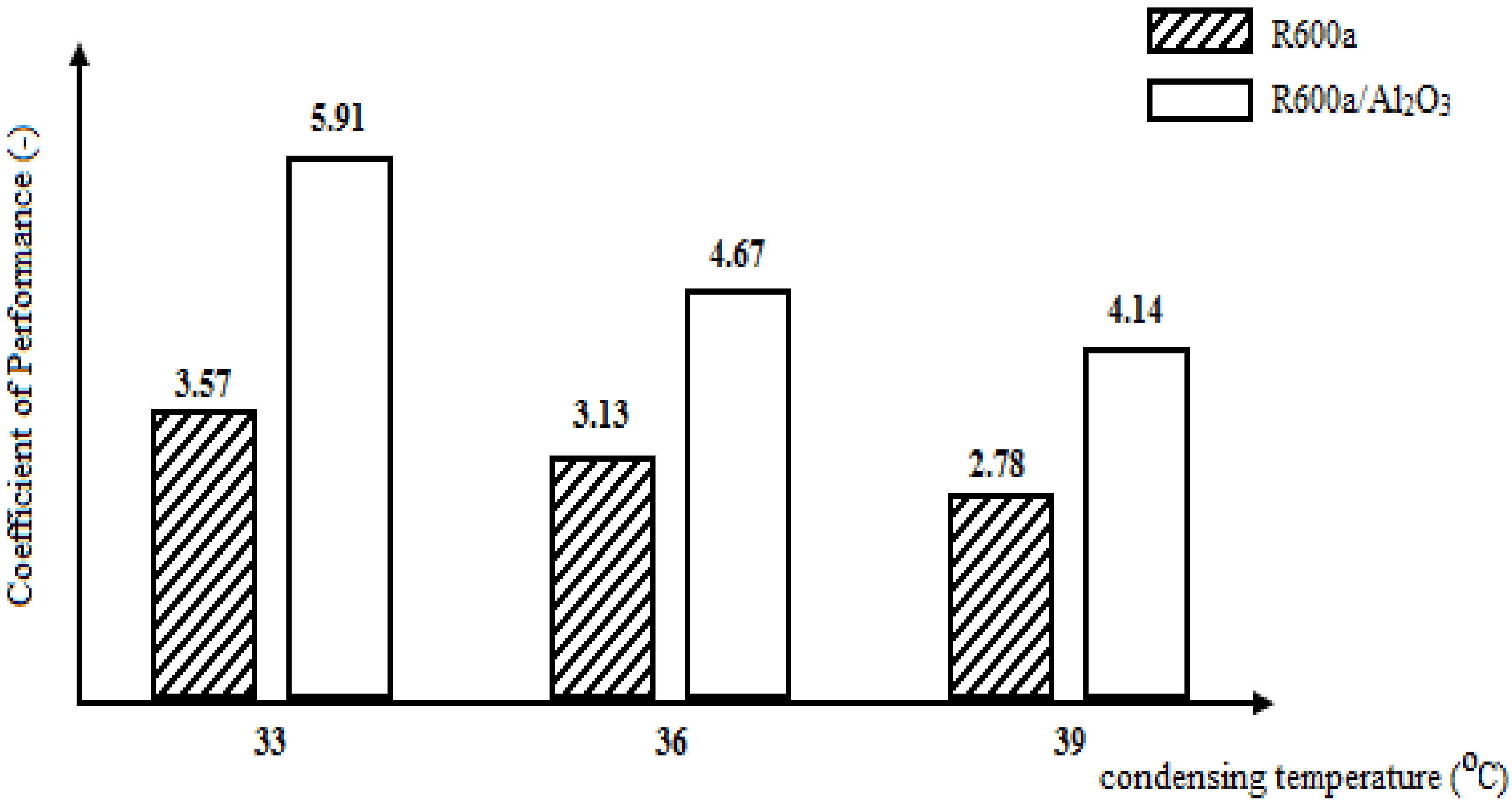


Figure 4 Working input versus condensing temperature



- Figure 5 Coefficient of Performance versus condensing temperature



- **5. CONCLUSIONS**

- The environmental concern imposes R600a among the attractive refrigerants for vapor compression applications. The fact that safety measures are now available is a reason for its adoption in vapor compression refrigerating cycles, instead in avoiding it. The environmental issue is not the only challenge refrigeration is facing: increasing awareness for energy savings and performance enhancement are of great interest.
- In this paper, the benefit of adding Al_2O_3 nanoparticles to R600a was evaluated by means of refrigeration effect, condenser duty, work input and Coefficient of Performance.

- Comparative analysis reveals better results for the case in which the nanorefrigerant it is used.
- When adopting the nanorefrigerant, the heat transfer in the evaporator and in the condenser is improved and the power input is diminished. COP improvement is obvious, therefore the use of nanorefrigerants results to be highly recommended.