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# Air-conditioning in residential buildings through absorption systems powered by solar collectors.

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**Abstract**

Over the past years, the scientific community has been exploring alternative solutions to the fossil fuels used for indoor air-conditioning. The solution here suggested is formed by absorption machines powered by solar panels used to air-condition small residential buildings. The study examined a small residential building and evaluated energy savings, reduction of $CO_2$ and the return on investment compared to a traditional solution. The results obtained might be considered as valid since the heat used was provided by a free energy source with a low environmental impact, devoid of $CO_2$ emissions.



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*Keywords:* absorption heat pumps; absorption chillers; solar collectors; air conditioning; Nearly Zero Energy Building; reducing emissions.

## 1. Introduction

Over the past few years the demand of air-conditioning in residential buildings has been increasing, in particular in the developed countries [1]. Traditional air-conditioning systems are usually powered by electrical energy [2-4], this is why the energy demand is higher. 50% of the energy consumptions in the residential sector [5,6] depends on air-conditioning systems and affects 12% of the total energy consumptions of the Country [7-9]. This growth might

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be controlled if we had a decrease in the electrical energy with a corresponding increase in the exertion of renewable sources [10-12].

In the summer, it is necessary to cool the environment because of the presence, during the day, of a high solar radiation, hence it might be useful to plan a system able to cool houses without any expenses, by using a renewable energy, as the sun. Nowadays the decision to power air-conditioning systems [13,14] through the energy generated using photovoltaics panels is too expensive, due to high installation costs [15,16].

The solution here suggested needs a system formed by absorption machines requiring a thermal energy source to function, in this case solar collectors. The system presents one machine with a heat transformer and an absorption refrigeration machine [17-19] powered by solar collectors. The heat transformer allows to increase the temperature of the heat taken from the collectors to improve the efficiency of the refrigeration machine (Fig.1).

Such combination might be a valid solution because it exploits the heat generated through a free energy source, that is the sun, with a low environmental impact devoid of any $CO_2$ emissions.

**Nomenclature**

| | |
|---|---|
| A | absorber; |
| AR | absorption refrigerator; |
| C | condenser; |
| E | evaporator; |
| G | generator; |
| HT | heat transformer; |
| R | refrigerator fluid (H2O); |
| S | solution = refrigerator fluid (H2O) + absorbent salt (LiBr). |
| $T_A$ | temperature absorber; |
| $T_C$ | temperature condenser; |
| $T_E$ | temperature evaporator; |
| $T_G$ | temperature generator; |
| P | pressure; |
| x | concentration of fluid; |
| g | mass flow; |
| $r(T)$ | refrigerator transformation heat; |
| $s(x,T)$ | differential heat of solution; |
| m | $g_s/g_r$; |
| $c_{PS}$ | specific heat of the solution; |
| $c_{PR}$ | specific heat of the refrigerator; |
| $L_{Ps}$ | solution pump work; |
| $L_{Pr}$ | refrigerator pump work; |
| v | vapor |
| l | liquid |

## 2. The system suggested

The solution here suggested is formed by evacuated tube solar collectors powering a heat transformer and an absorption refrigeration machine. The heat transformer, powered by solar collectors, while increasing the temperature of the fluid, improves the efficiency of the absorption refrigeration machine which in turn powers the air-conditioning system. The evacuated tube solar collectors allow to have higher temperatures than traditional glass panels. The temperature of the fluid in output was set to 75°C.

Fig. 1 and Fig. 2 report the diagram of the system suggested and the functioning conditions of each component of the machine. The absorption systems work with water and lithium bromide.