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# Numerical simulation and performance assessment of an absorption solar air-conditioning system coupled with an office building

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## Abstract

To minimize environmental impact and $CO_2$ production associated with air-conditioning, it is reasonable to evaluate the prospects of a clean energy source. Solar energy, via thermal collectors can provide a part of the heating needs. Moreover, it can drive absorption chiller in order to satisfy the cooling needs of buildings. The objective of the work is to evaluate accurately the energy consumption of an air-conditioning system including a solar driven absorption chiller. The complete simulation environment includes the absorption chiller itself, the cooling tower, the solar collectors field, heater, storage devices, pumps, heating-cooling distribution, emission system and building. A decrease of primary energy consumption of 22% for heating and cooling is reached when using a solar air-conditioning system instead of classical heating and cooling devices. The modelling of each subsystem is detailed. TRNSYS software modular approach provides the possibility to model and simulate this complete system.

## Keywords

TRNSYS,
solar cooling,
absorption

## Article History

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## 1 Introduction

Solar air-conditioning is a good way to use renewable energy instead of fossil fuels to meet heating and cooling needs of buildings. It implies a decrease in energy consumption and $CO_2$ rejection. There were in year 2010 around 600 identified systems in operation all over the world while around 500 were located in Europe (Jakob 2011). A lack of awareness of such technologies is still encountered. The development of solar air-conditioning (SAC) technology is closely linked to its economical profitability. To check what the real benefits of SAC installation are, it is important to compute the energy savings as well as their essentials parameters (Casals 2006).

Previous work (Barbosa and Mendes 2008) about analysis of heating and cooling consumption suggests considering an integral approach to evaluate energy savings. Moreover, performance is greatly depending on external conditions and on cooling load dynamics in SAC systems (Bujedo et al. 2008). It is thus important to think about the whole system (Mugnier 2002; Eicker and Pietruschka 2009).

This study concerns a common solar air-conditioning system. A solar collector field provides hot water to a storage tank. Hot water then can be used for heating the building or feeding an absorption machine. This last device is used to produce cold water (Herold et al. 1996). As solar energy is not enough to heat and cool the whole building through the year, back up systems are used. To heat, a conventional gas boiler is used. To cool, two choices of back up can be assessed: heating water to feed the absorption chiller or use of a classical vapour compression chiller (electricity driven). A previous work (Thomas and André 2009a) has pointed out that the second choice is the best one from a primary energy point of view; it will be implemented in this study. The two choices mentioned here above can be roughly summarized as follows. The gas boiler back up namely "hot back up" produces generally 0.63 $kWh_{cold}$ with 1 $kWh_{prim}$ (boiler yield 0.9 multiplied by absorption chiller thermal COP 0.7) while the vapour compression chiller "cold back up" produces commonly 1.12 $kWh_{cold}$ with 1 $kWh_{prim}$ (primary energy factor for electricity 1/2.5 multiplied by the vapour compression chiller electrical COP 2.8).

A complete simulation environment is presented in this paper, it is implemented in TRNSYS (2006 ). Generally, the analysis is focused on the basic heating and cooling load of the building. Here, numerous other devices and effects are

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