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ScienceDirect

Energy Procedia 134 (2017) 588–597

Procedia Engineering

www.elsevier.com/locate/procedia

9th International Conference on Sustainability in Energy and Buildings, SEB-17, 5-7 July 2017, Chania, Crete, Greece

# Preliminary study of the hybrid solar DEC "NAC wall" system integration in building façades in urban context

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**Abstract**

A new concept of hybrid/natural air conditioning system, "NAC (Natural Air Conditioning) wall", with a high level of architectural integration is presented. NAC wall concept is that of a solar DEC (Desiccant Evaporative Cooling) open cycle with very low pressure drops, thus drastically reducing, or even avoiding, the electricity consumption for driving fans. The supply air is dehumidified by an adsorption bed and is cooled indirectly by an evaporative cooler, through a low pressure drop heat exchanger. Adsorption bed is a finned coil heat exchanger coated with a SAPO-34 zeolite layer realizing both heat and mass transfer in a unique component. The assembling of NAC wall components is analysed in order to optimize architectural integration and performances. Experimental data carried out in different operation mode offered promising optimization suggestions to increase the specific cooling power for a better building integration. The integration at a building level would represent an architectural innovation, and the NAC wall production would not impact the supply chain with disruptive changes.


Peer-review under responsibility of KES International.

*Keywords:* Solar cooling, Building integration, Barriers to innovation

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1876-6102 
Peer-review under responsibility of KES International.
10.1016/j.egypro.2017.09.570

## 1. Introduction

This paper reports the current development of the NAC wall system, by resuming the main measured performance, and focusing on the integration with building façades.
The NAC wall project aims to integrate a solar DEC system in building facades with a vertical disposition of a dehumidification module and the evaporative module. The NAC wall configuration can exploit natural buoyancy of air, as well as all the components have been optimized for low air velocity operative conditions, which implies very low pressure drops.
Open desiccant cooling cycles, thermally driven by solar collectors, have the potential to become likely low energy cooling systems [1]. Moreover, Henning et al. [2] stated that these systems allow saving up to 50% of primary energy, compared with conventional vapor compression technologies, involving low operating costs and moderate environmental impact. However, dehumidification phase and control system need to be optimized, in order to improve the efficiency of these processes [3].
In the past years, many researchers studied energy and economic benefits of the use of desiccant cooling cycle, based on dehumidification wheel with silica gel coating [4] [5] [6].
However, these systems are very difficult to integrate in a building due to the large size of the dehumidification component.
The goal of the project is to develop an effective, affordable and easy-to-integrate cooling system, consuming the lowest possible amount of electricity [7].
In the first section are reported last experimental results of dehumidification performance of desiccant heat exchanger in hybrid ventilation. Further on a discussion of the integration possibility of the NAC wall in the building façade have been carried out by authors.

## 2. NAC wall adsorption unit

The NAC wall includes a dehumidification component based on an air/water heat exchanger. This is realized by applying a coating of SAPO34 zeolite material on a coil, Figure 1,2. With this configuration, simultaneous heat and mass transfer happens in the dehumidification component, taking advantage both in desorption and in adsorption phase. The improvement on mass transport phenomena increase the total cooling power of a DEC system, and a reduction of global dimensions can be achieved. The reduction of system encumbrance is an important key point to achieve a better integration of DEC systems in buildings and façade. The finned coil has been sized in order to reduce as much as possible the air side pressure drops, and, consequently, the electric consumptions. In Table(1) information about coil heat exchanger are reported.

Table 1 . Finned heat exchange characteristics

| | |
|---|---|
| Pipe specs | Copper ϕ16 mm × 0.35 mm |
| Fin specs | Aluminum 0.23 mm |
| Fin dimensions | 480x150 mm |
| Fin spacing | 8 mm |
| Surface | 6.4 $m^2$ |

Figure 1.Coated Finned coil for heat and mass transfer

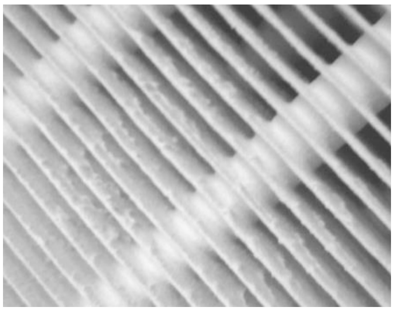

Figure 2 Zoom of the SAPO 34 coating

In order to exploit a solid adsorption bed without interruption it is necessary to use a batch configuration. Two dehumidification components work in parallel, switching between adsorption and regeneration phase, as shown in Figure (3). When one adsorption bed is in dehumidification mode, it adsorbs water vapor from the outdoor air flow; this transformation follows the line A-B in the psychrometric chart of Figure(4). Heat of adsorption increases air temperature up to 50-60 °C. In a DEC system, after the dehumidification stage, air is cooled down by an Indirect