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Innovative Method for Improving Energy Performance of Buildings with Glazed Façades

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Abstract

This study presents an original method for improving the energy performance of buildings with glazed façades.
For the proposed paper we analyzed using Ansys CFD software a study case for an office building with integrated heat pipes into the glazed façades.
For the complete analysis of our proposed system we realized a financial study using the RETScreen 4 Software Suite.

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Keywords: Heat Pipe; Glazed Façade; Nearly Zero Energy Building (nZEB); Energy Performance of Building; CFD Analysis.

1. Introduction

Increasing the energy efficiency and use of renewable energy in the residential sector is a priority area.

Energy use in residential buildings today totals about 42% of final energy consumption in the European Union, with great potential for energy recovery of 22% in the short term. European Directive on energy performance of buildings adopted (Directive 2010/31/EU), is an attempt to unify the different national regulations, to define common minimum standards for energy performance of buildings and to provide certification and inspection rules

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for heating systems and cooling. The new Directive requires that by 2020 all new buildings in the EU will have to be nearly zero-energy buildings (nZEB).

Romania also adopted in 2010, the Directive 2010/31/EU of the European Parliament and the Council on the Energy Performance of Buildings and recently the European legislation on nearly zero energy consumption (NZEB), Government Ordinance No. 13/2016 of 27.01.2016 amending and supplementing the Law no. 372/2005 on the energy performance of buildings which states that over four years will not receive a building authorization than nearly zero energy buildings: "New buildings for which reception on completion shall be based on the building authorization issued from 31 December 2020 will be buildings whose energy consumption is almost zero."

For public buildings these provisions shall apply earlier, from December 31, 2018.

Most importantly, it also set out minimum energy performance requirements for buildings renovations and for components when they need to be changed. This is very important considering that renovating the existing building stock is Europe's primary challenge if it is to achieve ambitious levels of energy savings.

The directive set out a more ambitious European framework for the Member States to follow.

Based on the previous results on glazed façades, we proposed a very accessible and low-cost solution to improve the energy performance of glazed façade buildings, by using heat pipes. [1,2,7,8,9,10,13].

Heat pipes are essentially a mean of transferring high rates of heat across small temperature gradients, and as such may be considered thermal “superconductors”[3,4].

A heat pipe can quickly transfer heat from one end to the other one. One of the advantages is the heat loss which is less than other materials [3,4].

The simplicity of the gravity return heat pipe makes this the preferred solution for a wide range of heat pipe applications [11,12].

Nomenclature

GF	Glazed façades
HPGF	Glazed façades with integrated heat pipes
T	Temperature, [^{o}C]
T_{op}	Operating temperature, [^{o}C]
L	Latent heat of vaporisation [kJ/kg]
Cp	Specific heat of vapour, constant pressure [kJ/kg· ^{o}C]
P_v	Vapour pressure [bar]
ρ_v	Vapour density [kg/m^3]
ρ_l	Liquid density [kg/m^3]
λ	Thermal conductivity, [W/(m· ^{o}C)]
l_{hp}	Length of the heat pipe, [m]
d_{hp}	Diameter of the heat pipe, [m]
I_d	Direct solar radiation intensity, [W/m^2].

1.1. Building with Glazed Façade (GF)

The demand for natural ventilation in commercial buildings is increasing due to growing environmental consciousness while at the same time energy consumption for buildings has to be reduced [1,5,6,10]. An advanced façade should allow for a comfortable indoor climate, sound protection and good lighting, while minimizing the demand for auxiliary energy input. Glazed façades (GF) have become an important and increasing architectural element in office buildings over the last 15 years. They can provide a thermal buffer zone, solar preheating of ventilation air, energy saving, sound, wind and pollutant protection with open windows, night cooling, protection of shading devices, space for energy gaining devices like PV cells and – which is often the main argument – aesthetics [1].