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TEZĂ DE DOCTORAT

FAȚADE INTELIGENTE: SOLUŢII PENTRU CREŞTEREA EFICIENŢEI ENERGETICE A CLĂDIRILOR

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Abstract

In the current energy context of increasing energy consumption, continuous global development and significant CO_2 emissions, it is becoming increasingly important to implement high-performance solutions (systems) that uses renewable energy sources and energy-efficient systems in the construction sector, to achieve indoor thermal comfort with optimal energy consumption.

This paper highlights the opportunity to implement glazed solar collectors in buildings, a solution that has the potential to reduce energy consumption for space heating, as well as energy consumption for heating the fresh air required by the building's inhabitants.

The first chapter is a bibliographic research that covers topics such as the current energy context, types of facades, solar facades, constructive types of solar collectors with air, plus experimental and numerical studies on the installation of glazed solar collectors in buildings.

The second chapter deals with the experimental analysis of perforated glazed solar collectors in order to improve their efficiency. The comparative studies revealed that for the configuration with a distance of 30 mm between the absorber and the glass, much better results are obtained than in the case of the glazed solar collector with the distance of 50 mm. Thus, the heat exchange efficiency for the solar collector, in the case of the 30 mm configuration, is superior by more than 8% for all air flows considered, as well as the thermal capacity which is higher by 13% - 51% compared to the 50 mm configuration mm, and also the average thermal energy delivered in an hour is 35% higher for the 30 mm configuration The overall efficiency of the solar collector was shown to be higher with a narrower distance between the absorber plate and the glass layer, with values increasing by 20% - 42% depending on the air flow rate utilized.

In the second part of this chapter, the glazed solar collector was studied from an experimental point of view, by integrating it into a container to analyze its implementation in a real building. The data reveals that the efficiency of the glazed solar collector with a distance of 30 mm between the glass and the absorber was in the range of 16-19% for air flows up to 200 m^3/h and for flows over 300 m^3/h its efficiency doubled, but the input temperature has decreased. Short- and long-term experimental results revealed that buildings with glazed solar collectors consumed less energy for heating and ventilation of indoor spaces than structures without glazed solar collectors.

The third chapter details the numerical analysis of perforated glazed solar collectors as well as the improvement of solar collector efficiency by studying different solar collector configurations. After completing the numerical studies, it was discovered that by using the glazed solar collector with a distance of 30 mm between the absorber and the glass, results in a higher efficiency than the 50 mm configuration, thus this confirms the measurements and experimental studies The 30 mm configuration has a 10% higher heat exchange efficiency than the 50 mm configuration. Regarding the overall efficiency of the collector

with the smaller distance between the absorber and the glass it turned out to be higher similar with that of the heat exchange efficiency.

The numerical studies carried out an analysis over a much longer period than the experimental study, more precisely over a period of one year. For the spring and autumn transition periods, the glazed solar collector with an absorber surface of 2 m^2 achieved a reduction in energy consumption by 13.6 kWh/m^2, proving once again to be extremely efficient as part of the necessary air preheating solutions ventilation of interior spaces. Following the studies, it was discovered that this type of glazed solar collector is especially effective during transitional periods when temperatures are low and solar radiation has values greater than 200W/m^2, this being the value from which the solar collector allows significant reductions in energy consumption.

The last chapter of this paper presents an LCA (Life Cycle Assessment) analysis regarding the environmental impact of the glazed solar collector. The study's goal was to analyze a glazed solar collector integrated into a building (a container). It was observed that the greatest impact on the environment for this type of building (reduced thermal massif) is represented by energy consumption, both to cover the necessary heat as well as the need for fresh air. The glazed solar collector helps to reduce energy consumption throughout the life of the building and implicitly the impact on the environment due to it.

By using the glazed solar collector to preheat the fresh air, a reduction of approximately 6.5% in CO_2 emissions was observed compared to a building that does not use any air preheating system. Thus, the glazed solar collector managed to reduce CO2 emissions by approximately 6.85 kg CO_2 m^2/year, representing a particularly interesting long-term solution in terms of reducing consumption and CO_2 emissions throughout the life of the building.