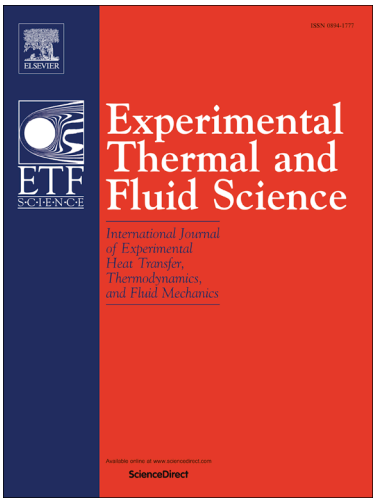

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Innovative use of fluorescein for the air path study within light-weight wall assemblies

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Abstract

The impact of air infiltration on the hygro-thermal performance of a wall is closely linked to the air dispersion inside it, but there is a lack of experimental studies and methods for the air path investigation within light-weight wall assemblies. A new technique has therefore been developed, consisting in an innovative use of fluorescein micro-particles as tracer inside the insulation material. It is a destructive method but it has the great advantage of not being intrusive unlike the use of any type of sensor. The experimental protocol is detailed in this paper.

This technique was tested on a number of preliminary tests which showed consistent results and a good repeatability of the measurement. A fluorescein transport model was developed to facilitate the comparison between the experimental fluorescein concentration mappings and the numerical velocity fields. This method was then applied to a specific configuration: an air channel in contact with porous media. A simple analysis of the resulting fluorescein concentration mappings enabled to draw conclusions on the impact of parameters such as the flow velocity or the insulation material on the air infiltration. It has also given evidences of phenomena such as the appearance of thin air gaps between the components of the wall assembly. The results were compared to a numerical study with the fluorescein transport model coupled to a CFD model.

1. Introduction

Air infiltrations through airtightness defects in building envelopes can have a significant impact on the thermal performances of a building. A number of experimental techniques have been developed to identify and quantify the air leakage degrading the building airtightness. Pressurization tests are carried out both in situ, mostly with a Blower Door ([1] and [2]), and in laboratories ([3] and [4]) to measure the leakage air flow of envelopes, walls or building components as a function of the pressure difference. Tracer gases are also used to estimate the air change rate under real pressure conditions ([5] and [6]).

A finer analysis with an identification of the movement of air through exterior wall assemblies is however sometimes required. This is especially the case when humid air is infiltrating the wall with a risk of condensation. The consequences on the structure's durability as well as on the additional thermal losses depend indeed on the air dispersion inside the wall and on which materials are in contact with the humid air. Experimentally it is possible to identify the air inlets and outlets by using infrared thermography ([7] and [8]) or smoke visualization [9], but the air path inside the wall is harder to investigate.