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# Evaluation of various CFD modelling strategies in predicting airflow and temperature in a naturally ventilated double skin façade

Wilmer Pasut [a,*], Michele De Carli [b]

[a] University of California at Berkeley, Center for the Built Environment 390 Wurster Hall #1839, Berkeley, CA 94720-1839, USA
[b] Dipartimento di Fisica Tecnica, Univesità degli Studi di Padova, Via Venezia 1, 35131 Padova, Italy

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ABSTRACT

Demands for energy savings, thermal and visual comfort and a high-tech image for new building envelopes can be met with a Double Skin Façade (DSF). These kinds of building envelopes are widely encouraged, proposed and increasingly designed by architects. Naturally ventilated DSFs seem very interesting from an energy point of view, but a good design is crucial to improve the energy savings and the proper operation of the system. Computational Fluid Dynamics (CFD) can play an important role in evaluating and improving the thermal behaviour of a DSF. This paper shows, through a sensitivity analysis, a good strategy for carrying out a CFD simulation of this special building envelope. In this work the validations of the results are based on experimental data from the literature.

The paper provides a discussion that highlights which factors are important in the simulation, and which increase model complexity without improving the prediction capacity. The results show that, for a DSF characterized by a prevalent bidirectional flow, the additional effort required to make a 3D model is not justified by a significant improvement of the results. This work shows also that the accuracy can be improved by modelling outdoor ambient. The performance of k-ε and k-ω, the two most commonly used turbulent models for simulating the naturally ventilated DSF is evaluated.



## 1. Introduction

In the last years, new building envelope systems have been developed in order to improve thermal insulation, to shade solar radiation and to provide suitable thermal and visual comfort conditions. One of these special types of envelopes is “Double Skin Façade” (DSF). DSF are made with two layers of glass separated by a significant amount of air space. The space between the glasses can be ventilated with three different strategies: mechanical ventilation, natural ventilation or hybrid. The ventilation of the air gap contributes to saving energy both during the summer and the winter time. In fact, during the winter time, the air between the glass is heated by the sun rays (greenhouse effect [1]), thus improving the thermal performance of the façade with a consequent reduction of heating costs. With hybrid ventilation systems, during the winter, the fresh air can be pre-heated in the DSF gap before entering in the HVAC system. During the summer, the air flow through the DSF (mechanical or natural) can help to decrease the temperature in the gap.

A blind for solar control is usually installed in the DSF gap. In addiction to reducing heat gain during the summer, this blind increases airflow through the gap with a strong buoyancy effect. In mild seasons, stack effect occurring in the intermediate space can be used as driving force to promote natural ventilation of the whole building [2].

The correct behaviour of a DSF is the key to increasing energy savings, but correct behaviour requires the structure to be designed correctly. One of the weakest spots of this kind of envelope is the design, especially for naturally ventilated façades, where the thermal process and the airflow mechanism influence each other. The magnitude and extent of this interaction depend on the geometric features of system, and the thermal and optical properties of various components.

Ventilated facades are already a common feature of architectural competitions in Europe; but there are still relatively few buildings in which they have actually been realized, and there is still too little experience of their behaviour in operation [1,3,4]. For this reason the CFD analysis could be one of the most important tools to predict the behaviour of DSF and help architects make decisions during the design process.

In the literature there are several examples of using CFD to study the behaviour, features and energy consumption of a DSF [5–7].

* Corresponding author. Tel.: +1 510 642 4950; fax: +1 510 643 5571.
*E-mail addresses:* wpasut@berkeley.edu, wilmer.pasut@gmail.com (W. Pasut).

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