Modeling the Heat Exchange in Cavities of Building Constructions Using COMSOL Multiphysics®

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Abstract

In Europe a lot of dwellings are built with exterior cavity walls. These double walls provide stability to the structure and separate the controlled indoor climate from the outdoor fluctuating environment. In this study we want to receive more insight in the heat exchange between the walls through the cavity in between, by computer simulations and verifications. Simulations and calculations with several variants of the cavity wall should give information about the effects of influence factors to the different heat transfer mechanisms, named: radiation, convection and conduction. As we mentioned above, the heat exchange between the two walls through the air cavity occurs by radiation, convection and conduction. The parameters that have influence to these mechanisms are given in Figure 1.

The main problem here is the accuracy of the simulated airflow in the cavity and the accompanying heat exchange near the cavity surfaces. For example the airflow could be quite close to laminar flow but also quite close to turbulent flow. This causes different air velocity profiles for each case. Moreover, the heat exchange near the cavity surfaces is very dependent on the specific air velocity. So a relative small change in air velocity profile may have a big impact on the heat exchange near the surfaces and on the overall energy performance of the building construction. This is also shown in Figure 2 and 3. The 2D temperature distributions of the construction for both laminar airflow and as well as turbulent airflow in cavities are shown in Figure 2 and 3 respectively. Figure 4 presents the big difference between the temperature profiles at half height of the construction for both airflow modeling approaches.

In the paper we present a systematic approach and some guidelines for modeling the heat exchange in cavities of building constructions.

Reference

Schijndel, A.W.M. van (2011). Multiphysics modeling of building physical constructions. Building Simulation: An International Journal, 4(1), 49-60.

Figures used in the abstract

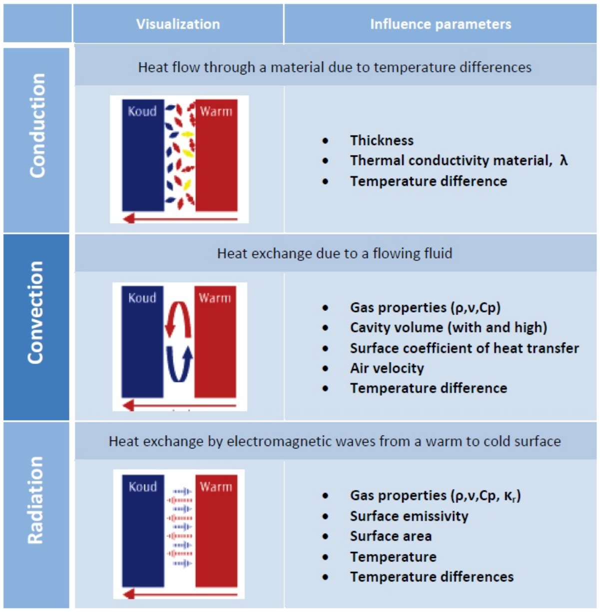

Figure 1: Heat exchange mechanisms in a cavity

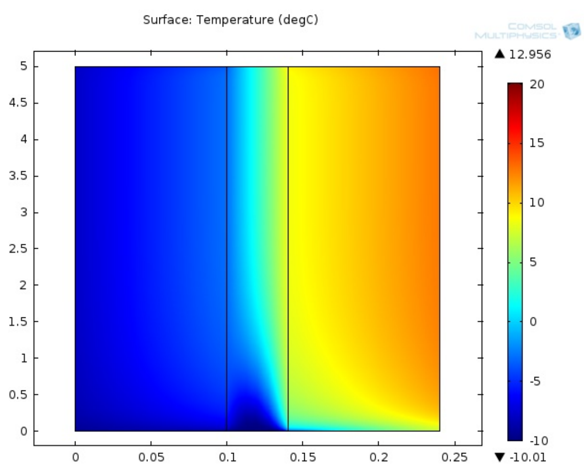

Figure 2: Simulated 2D temperature distribution in case of laminar flow

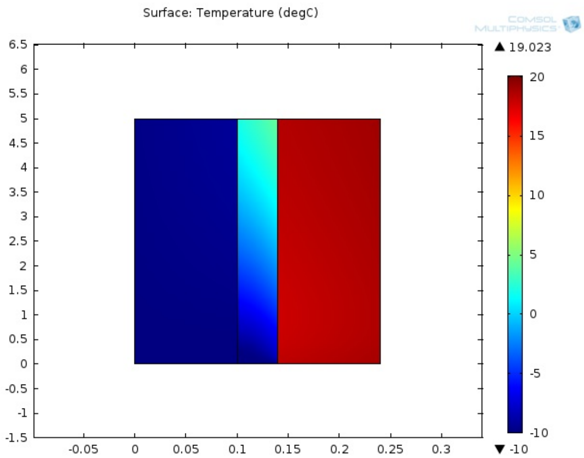

Figure 3: Simulated 2D temperature distribution in case of turbulent flow

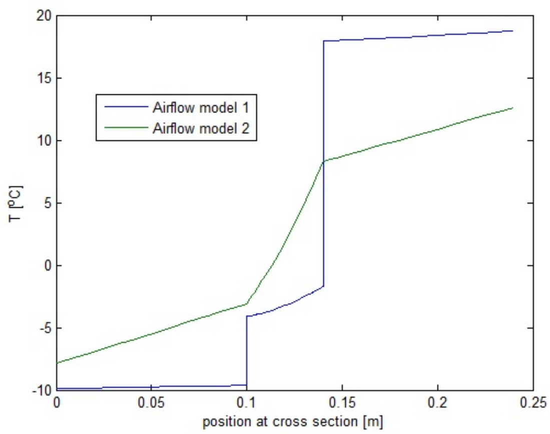

Figure 4: The different temperatures due to laminar and turbulent airflow