Heat and mass transfer model of a wet brick simulant during energy test of a domestic electric oven

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**Abstract.** Baking and roasting are generalized cooking methods consisting in heating the food inside an oven at a uniform temperature. In these processes, heat is transferred to the food mainly by means of radiation and convection. Electric kitchen ovens require a great amount of energy and only less than 20% is employed for cooking. The oven energy class (ranging from A+++ to D) is certified by several test regulated by the European standard EN 60350. Such test prescribes to measure the energy requirement to increase the core temperature of a standard wet brick of 55 K, using different oven functions. For manufacturers, performing the tests for different oven models and the trial-and-error approaches employed to design oven control strategies demand a vast amount of time and resources, thus making the use of simulation tools highly desirable. The overall process sustainability would increase, because of a significant reduction of experimental tests and energy.

The aim of this work was to develop a parametric numerical model able to describe heat and mass transfer between oven environment and the brick simulant prescribed by the test standard. Experimental tests were carried out to define thermal and diffusivity properties of the brick as a function of moisture content and temperature. Simulations and experiments have been carried out for different cooking methods (forced air, conventional and ECO) and oven temperatures. Water loss, thermal profiles, and the subsequent energy consumption (load heating and evaporation), were compared.

Comparing model and experimental energy test results, a ratio between the brick energy absorption and the whole oven energy consumption ranging from 20 to 27%, was observed. This depends on the cooking method, but not on the oven temperature. The lower brick energy consumption was obtained with the ECO function, and it is mainly due to the lower water evaporation. Linear relations between oven temperature and brick energy consumption were found all the cooking methods. Furthermore, strong linear relations were achieved between the energies calculated for conventional and forced air methods at different oven temperatures.