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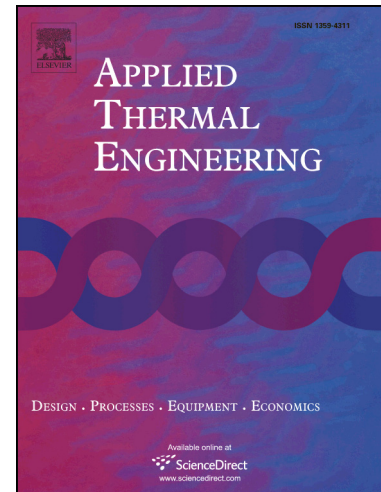
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Thermal and fluid dynamic analysis of an air-forced convection rotary bread-baking oven by means of an experimental and numerical approach

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ABSTRACT

In this paper experimental and CFD numerical analyses of an air-forced convection rotary bread-baking oven are presented. A particular experimental methodology for the thermo-fluid dynamic characterization of the rotary oven has been adopted. The purpose-designed on-board experimental apparatus represents a useful industrial test bench and, at the same time, can be used to collect data for the final user. The experimental apparatus can operate in stand-alone mode and under the actual cavity conditions in terms of temperature and humidity.

A fully 3D numerical CFD model of the rotary bread-baking oven is proposed. By using the numerical model, validated by the experimental results, it is possible to highlight the airflow pattern inside the oven cavity and understand how the loaves change the airflow pattern inside the cooking chamber. Through the data collected using the experimental tests and CFD numerical simulations, some improvements in terms of airflow management inside the cooking chamber can be made. Through these improvements, the final user (as for instance bakers, either industrial or artisanal) can exploit several advantages in terms of energy saving and reduction of non-conformal baked products in relation with the localization of the recirculation zones and zones with higher velocity inside the oven cavity.

Keywords: air-forced convection oven, CFD, bread baking, thermal analysis, energy saving

INTRODUCTION

Baking is the process of converting relatively unpalatable ingredients (starch, gluten, etc) into aerated, open cell structure bread, which involves simultaneous heat and mass transfer. The energy is transferred from the food to the air that surrounds it and then removed from the oven. The most widespread baking process is that of bread baking. Bread production is relevant from a commercial point of view but the ovens usually operate in an empirical way (trial and error method) which determines a non-adequate use of energy and in some cases, substandard bread quality.

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