# Simulation and Design of a Oven for PET Blow Moulding Machines

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## Abstract

PET blow moulding machines are the most popular technology employed to produce bottles. The process starts with the production of the PET which is then used to make preforms that will be finally transformed into bottles. This paper will focus on the heating process of the preforms which is controlled through the thermal energy, produced by the IR lamps, and the cooling air flow. In fact one of the main issues in this transformation process is the temperature distribution along the preform length and the radial thickness, which should ideally vary according to the shape of the preform and the mechanical stresses introduced by the stretching action. Consequently the main objective of this development was to design a oven which gives the possibility of a fine regulation of the temperature in the PET section with a particular attention for the critical regions. The deep level of knowledge reached with this simulation work will lead to the production of better quality bottles, thanks to a higher level of reliability of the process, with also savings on production waste. This study has been led as a joint venture between SMILAB and POLIBRIXIA srl.

COMSOL has been used in the first part of the study to simulate all the boundary effects and disturbs present in the traditional systems, in order to understand their grade of influence on the results of the process. The study subsequently focused on the definition of the ideal thermal and fluid-dynamic process to implement in the project. This phase has been realized in an iterative way using COMSOL to simulate the thermal power absorption of the heat generated by the infrared lamps and the loss of thermal energy introduced by the air flow. This simulation represented the core stage of the project because it led to the definition of the main influent variables affecting the process to take into account for the definition of the final design. Finally COMSOL has been used also to define the geometry of the oven cavity and the fluiddynamic behavior needed to optimize quality and reliability of this production technique, aiming to obtain an air flow as uniform as possible in the oven chamber.

This study led to a deep understanding of the thermal absorption, conduction in the PET thickness and convention phenomena. In fact it has been possible to define the oven cycle times, the needed thermal power in the different heating phases, velocity and temperature of the air flow.

The definition of the main variables has optimized the power absorption, in particular an efficiency increment about the 14% in the optical-thermal system has been achieved with respect to traditional machines, reducing the number and power of the IR lamps needed. Also the improved air flow led

to better performances in terms of uniformity and reliability of the heating process and giving also the possibility to use the heat in excess to stabilize the oven temperature. Finally a broader implication of this study is the documentation of the thermal exchanges in the PET.