Numerical and Experimental Study of the Glass Behaviour in the Blow & Blow Forming Process

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The design of the mold cavities and the definition of machine operation times and process temperatures are key issues to develop and mass produce optimal containers.

Glass forming to produce perfume bottles with specific thickness distribution profiles is based on trial and error and requires several tests in production line. These tests are expensive and time-consuming, which increases time to market. The use of a numerical model aims to reduce the number of prototypes by performing virtual tests of the mold equipment and the process conditions.

The blow and blow glass forming process takes place inside two different molds, the industrial process is carried out by blowing the glass against the walls of the mold cavity.

Temperature profiles on the glass skin in the different stages of the forming process where glass is visible can be obtained measuring with an infrared thermal camera. These data is used to verify the numerical results (see Figure 2).

Temperature of glass decreases from 1,030°C to around 650°C in few seconds.

Figure 2. Infrared thermal captures of the glass forming stages were glass can be seen: (A) and (B) gob forming, (C) gob loading, (D) blank mold open, (E) parison reheating, (F) blow mold open, (G) and (H) take out.

The blow and blow glass forming is a complex process and a full understanding has not yet been reached:

(a) It is not possible to see the glass flow within the molds during the blowing stages.

(b) Accurate values of glass and forming tools properties are very difficult to obtain due to high temperatures, corrosive environment and fast-paced forming process.

Figure 3. Left: numerical results of the evolution of the glass domain and its temperature throughout the forming process of the SIERRA 60 bottle. Right: Numerical results of the initial step, parison and final blow compared with a cross section profile of the bottle ALFA 200. Results of the initial blank mold (top) and optimized blank mold (bottom).

Numerical simulations of the blow and blow glass forming process have been performed using axisymmetric glass containers representative of the wide range of Ramon Clemente's most common perfume bottles. The comparison of the cross sectioned produced bottles with the predicted results of the numerical model shows a good agreement for the glass thickness distribution.

The numerical model predicts consistent results in the glass thickness distribution. This example demonstrates the capability of the blow and blow numerical model to predict the influence of the blank mold cavity in the thickness distributions of perfume bottles.

The implementation of the presented numerical model will be a very useful simulation tool for Ramon Clemente.

With this research project, results have been obtained in:

(a) Numerical simulations of the blow and blow forming process to predict glass thickness distribution.

(b) Correlation of the simulation results of the glass temperature with experimental infrared measurements on the glass skin.

(c) Experimental validation of glass forming simulations and influence of the blank mold cavity in the thickness distributions of perfume bottles.

(d) Validation of the results of axisymmetrical and three-dimensional models for axisymmetric bottles.

Figure 4. Initial (left) and optimized (right) glass thickness distribution from the container base.