Proceedings of the 11th World Congress on Mechanical, Chemical, and Material Engineering (MCM'25)
Barcelona, Spain –Paris, France - August, 2025
Paper No. HTFF 123
DOI: 10.11159/htff25.123

Simulation of Parison Control and Weight Optimization in HDPE Bottle Production Using PolyFlow

Hukumran Selim Erturk[1], Mert Patkavak[2], Canan Cimsit[3]
[1,2]Hayat Kimya
Sepetlipinar, Hayat st. No:2, Kocaeli, Turkey
hukumran.erturk@hayat.com.tr; mert.patkavak@hayat.com.tr; ccimsit@kocaeli.edu.tr
[3]Kocaeli University
Kabaoglu, Baki Komsuoglu st. No:515, Kocaeli, Turkey

Extended Abstract

This study focuses on the weight reduction of a 1440 ml HDPE bottle, produced by Hayat Kimya for filling detergent or fabric softener, based on top load and drop test results as well as simulation analyses. Using the PolyFlow software, the regions of the bottle that could be lightened were identified, and the process of achieving this weight reduction was detailed. The materials, testing facilities, and simulation software used in this study were entirely provided through internal resources. To validate the simulation results, samples were collected from the production line, and the necessary tests were conducted.

A review of the literature reveals studies where the parison control of HDPE bottles has been conducted in simulation environments. Peplinski and Mozer compare the bottle wall thickness distribution obtained from real production conditions with Ansys PolyFlow simulations and propose an optimized initial parison thickness distribution to achieve improved packaging quality for nail polish remover bottles. [1] Shubham Gupta and colleagues analyzed 2D axisymmetric bottle blow molding with ANSYS Polyflow, focusing on time-dependent flow, structuring, and solidification for accurate thickness profiles. [2] Amit V. Kadam et al. analyzed the blow molding process using ANSYS Polyflow, focusing on how parison diameter affects the final wall thickness distribution and stress contours in polyethylene bottles. [3] S. Suraya et al. examined the deformation behavior of polymeric materials during the blow molding process, using ANSYS Polyflow to perform transient computations on a 2D model of a polypropylene (PP) bottle and predict wall thickness distribution for various parison diameters. [4] Michał Modławski and Tomasz Jaruga conducted ANSYS Polyflow simulations of a thermoforming process to evaluate wall thickness distribution in a U-shaped product formed with a positive mold. The results were validated using a 3D-printed mold (FDM) and a poly(ethylene terephthalate) sheet, showcasing that simulation and rapid tooling technologies effectively predict thin-walled areas and enhance thermoformed part quality. [5]

As a result of the tests and parison control simulations, a 2% weight reduction was achieved in the products. There was no loss in the expected top load test performance of the bottles prior to the weight reduction, and no additional damage was observed in the drop simulations. Assuming an annual production of 100 million units, with each bottle weighing 100 grams, a total of 200 tons of HDPE material was saved, accomplished solely using the PolyFlow software. In the next phase, the data obtained from the simulations will be validated through field testing, and top load and drop tests will be applied to the samples. It is anticipated that any material savings achieved throughout the year will contribute to reducing carbon emissions. Additionally, improvements in extrusion time and energy consumption are expected to enhance production speed, reduce the cycle time of the blow molding process, and increase personnel efficiency.

References

[1] Karol Peplinski and Arkadiusz Mozer, “Comparison of bottle wall thickness distribution obtain in real manufacturing conditions and in ANSYS Polyflow simulation environment,” in Journal of Polish CIMAC, Bydgoszcz, PL, 2012, vol. 7, pp. 225-230,

[2] Shubham Gupta et al. “Simulation of blow molding using ANSYS Polyflow,” in ICESD, Dubai, UAE, 2013, pp. 168-473

[3] Amit V. Kadam et al. “Simulation of blow molding of polyethylene bottle using ANSYS Polyflow,” in IRHET, Mumbai, IO, 2019, vol. 6i pp. 1238-1240,

[4] S Suraya et al. “Simulation on the effect of bottle wall thickness distribution using blow molding technique,” in IOP Conference Series Materials Acience and Engineering, 114, Article ID:012004
[5] Michal Modlawski and Tomasz Jaruga, “Computer simulation of thermoforming process and its verification using a rapid tooling mould,” in *MATEC Web of Conferences,* 2018, vol 187, 157:02032