Journal of POLISH CIMAC
Faculty of Ocean Engineering & Ship Technology
GDAŃSK UNIVERSITY OF TECHNOLOGY

POLYFLOW SOFTWARE USE TO OPTIMIZE THE PARISON THICKNESS IN BLOWING EXTRUSION

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Abstract

The blowing extrusion is one of the most widely used techniques for the production of hollow plastic products. In order to improve the efficiency of designing plastics processing the blow products from thermoplastic materials used in Computer Aided Engineering software. This paper presents the blowing container simulation with high-density polyethylene (Borealis, BS 2541), using Polyflow software. In the present work was showed the impact of the initial parison geometry distribution onto final wall thickness in the sample container. Two cases of blowing parison were considered. In the first, pre-approved on the basis of a constant parison thickness (g = 2 mm) examined the distribution of the container wall thickness. There has been excessive thinning (between 0,2÷0,3 mm) in the container corners after blowing. On this basis, was made optimization of the parison profile thickness to remove excessive thinning. Noted was a significant effect of the initial extruded parison geometry on the final wall thickness distribution in the considered container. Optimizing the parison profile thickness allowed to eliminate excessive thinning in the corners of container walls. The minimum wall thickness was only 0,9 mm, assuming the final wall thickness of the container to obtain the order of 1mm.

Keywords: *blowing extrusion, optimization of the parison profile thickness, Polyflow simulation, container, HDPE*

1. Introduction

Predominant increase in the use of packaging primarily from polymer materials in terms of beverages, cosmetics, chemical products, pharmaceuticals, etc. are related, on the one hand, to the replacement of traditional materials (metal, paper, glass), and on the other hand, creating new applications such as multilayer containers, significant primarily for these materials. Already in 2000, the number of blow molding bottles for beverages in the world has exceeded 10 billion units. Nowadays, this number is much higher [2,5,10]. In 2007, Western Europe processed 52,5 million tones of plastics, including up to 37% in the production of packaging [16]. This justifies the expansion of the claim that the manufacturing of packaging technology, especially the extrusion blow molding process, is an important trend in plastics processing.

There are higher and higher requirements for blowing plastics processors to comply with the import of expensive processing tools, and they tend to increase the intensive use of computer-aided manufacturing techniques in order to minimize financial losses resulting from incorrectly designed tools such as blow molds. This be connected inter alia with complex processing properties of polymers in blowing extrusion which hinder the development of accurate prediction of material shape in blow molds and produced final geometry [10,13]. In this direction were taken numerous experimental studies in the world [1,3,11]. There is, however, a small number of Polish publications dedicated to blow molding simulation of plastics [4,6,7,8,9,12,14], such an important point of view of making good use values such as packaging. One measure to be applied is Polyflow simulation software [15] which can effectively prevent possible errors and optimize the structure of the initial parison geometry. Obtaining a uniform thickness of the wall container at the final stage of designing, the processor does not compromise on the additional costs and shorter design time while improving the properties and provides utility package.

2. Research aims

On the basis of the information contained in the literature [1,10] shows that it is not possible to obtain blowing products with a homogeneous distribution of wall thickness on the basis of parison with constant thickness, especially for products with a more complex structure. In this case, the wall thickness distribution was to be the most equitable form, one should pre-determine differential parison thickness. It is difficult to do it intuitively. This can be done with available simulation programs such as Polyflow.

The aim of this work is to evaluate the distribution of wall thickness in the sample bottle, adopted on the basis of pre-extruded parison, and determine the geometry of parison, which will improve the distribution of container wall thickness. This task has been achieved through the use of Polyflow software 3.12.2.

3. Assumptions

The simulations in the environment of Polyflow 3.12.2 are intended to facilitate the complex process of extrusion blow molding process and selection of optimal thickness blowing parison, in order to obtain a uniform wall thickness distribution of the final blow product. Properly designed geometry features, including the parison thickness, allow to specify the minimum plastic demand for the implementation of plastic container.

The purpose of the simulation are axially symmetric products whose shape and dimensions are presented in Figure 1. Due to the complex structure of blow modeling process in Polyflow environment, the methodology of the case was briefly mentioned in order to focus on the results of the simulation.

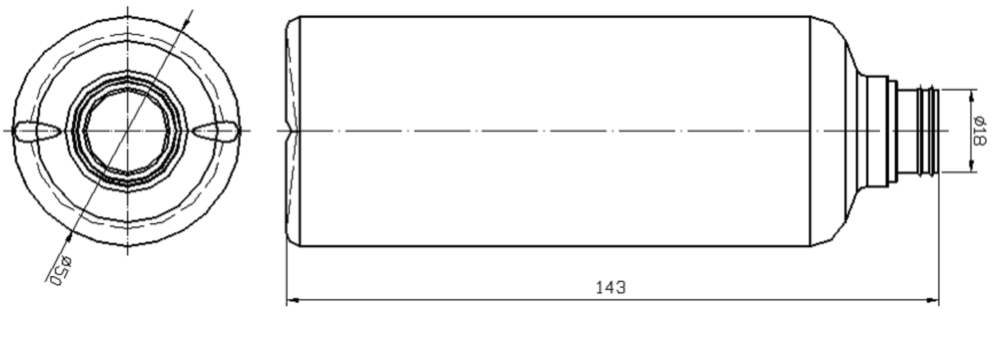

Fig. 1. The shape and dimensions of axially symmetric bottle

The simulation was carried out for a parison-shaped circular cross section: parison diameter d = 14 mm, thickness g = 2 mm. In order to carry out blowing simulation of the object, with the parison was separated geometry quarter, which significantly reduced the time of calculation. In order to determine the parting lines form in a later stage of modeling, for each of the objects has been added the reference plane. This plane in the longitudinal direction of the bottle is equal to the parison length. The final bottle geometry model is shown in Figure 2.

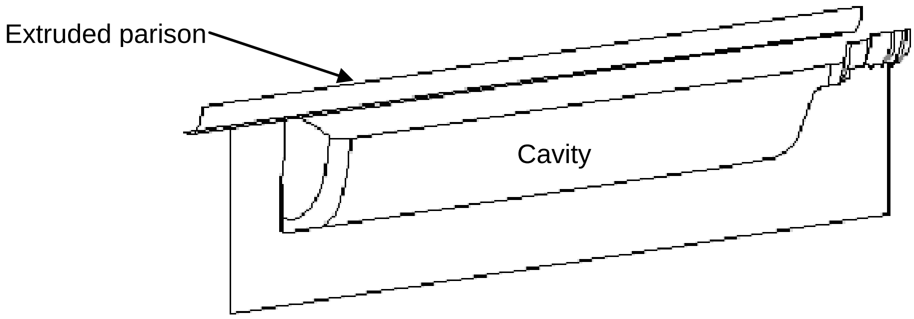

Fig. 2. The model of cavity with parison

4. Stages and results of blowing extrusion in Polyflow simulation

At a pre-arranged geometrical object were imposed grid finite elements in Gambit module. After the imposition of FEM, the mesh object is divided into separate sub domains for the parison and the cavity. The division is necessary to continue the modeling phase of the flow. Defining the problem was implemented in the module Polydata, which establishes the data: a physical model of parison and cavity, parison blowing range, the relative movement of the mold (cavity), the flow boundary conditions, and type of calculations. Adopted material for extruded parison is PE-HD, density ρ=0.96 g/cm³ and the viscosity μ = 92140 Pa•s for the temperature T = 190 ºC. The adopted initial thickness of the parison was g = 2 mm. Blowing pressure p = 0,9 MPa. Simulations were also put down the distribution of wall thickness of blowing bottles, and optimize a uniform distribution of wall thickness. The criterion of the optimization was the wall final thickness g = 1 mm. The obtained results allowed the simulation module Fieldview to create models depicting the spatial distribution of container wall thickness before (Fig. 3) and after the blow optimization of the initial thickness of extruded parison (Fig. 4). On the charts we can see that in the case of constant parison

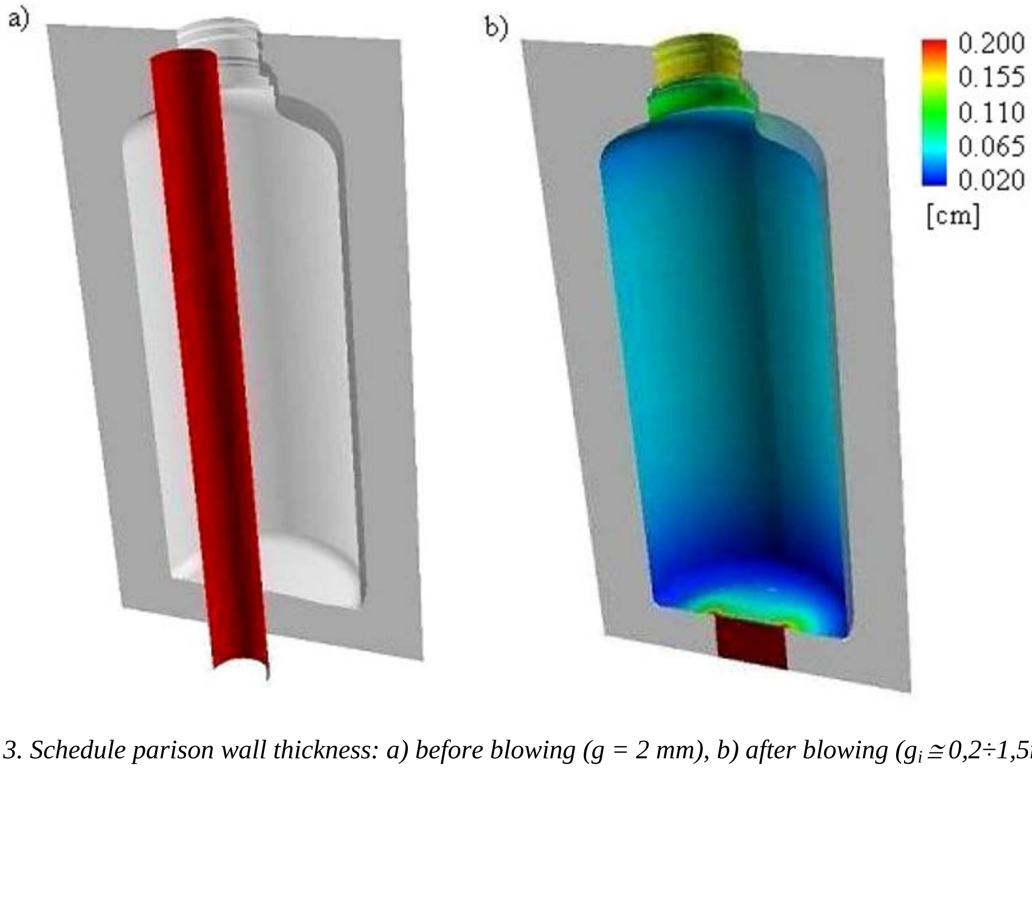

Fig. 3. Schedule parison wall thickness: a) before blowing (g = 2 mm), b) after blowing ($g_i \cong 0,2 \div 1,5$mm)

thickness g = 2mm, occurs an excessive wall thickness reduction in the corners $g_i \cong 0{,}2 \div 0{,}3$mm. This is an unacceptable value in terms of packaging design, as it can lead to corner deformation for its use. An alternative to this was a generation of such extruded parison which prevents the emergence of such thickness reduction during blowing. The result of this approach is to obtain a significant thickness improvement in the wall corners ($g_o \cong 0{,}9 \div 1{,}1$mm). Also in the rest of the container wall thickness was similar to the value of 1 mm, only the bottom of the bottle in the area increased to 1,8 mm.

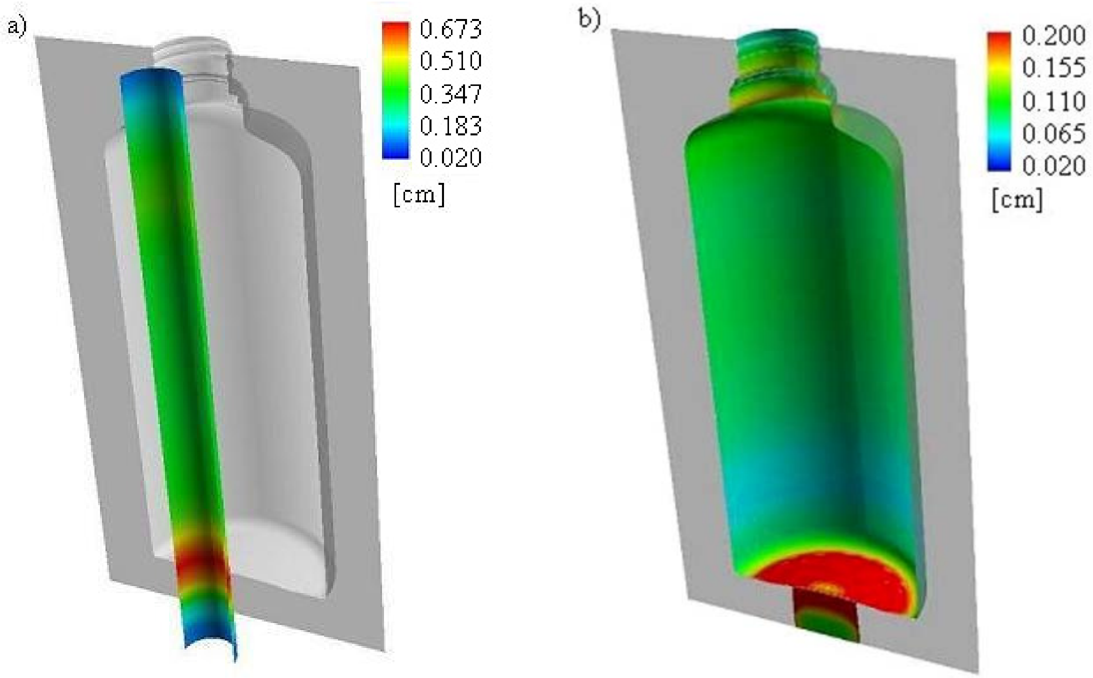

Fig. 4. Optimizing the parison wall thickness: a) before blowing ($g_o \cong 6{,}7 \div 1$mm), b) after blowing ($g_o \cong 0{,}9 \div 1{,}8$mm)

5. Summary

The blowing container simulations in Polyflow environment offer an opportunity to predict the shape and geometrical characteristics (thickness of the wall) of the intended form, thanks to the optimization of the profile thickness extruded parison. Using a simulation can be assessed at the design stage of the packaging, or its geometry form will not rise to unacceptable wall thickness, or even to tears at the stage of production. Using the Polyflow software at the initial stage of the design process, it is possible to propose an alternative form of parison profile geometry.

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Article was developed under the research BW-4/2006 titled: 'Unit Process for processing and recycling of plastic materials' provided in the Department of Plastics Processing – project manager: associate professor PhD. eng. Marek BIELINSKI.