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ASSESSMENTS OF THE IMPACT EXTRUSION DIE GAP ON THE QUALITY IN TECHNICAL BLOWING PRODUCT

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Abstract

Extrusion blow molding is the technological process of processing polymeric materials for the growing market popularity, resulting from the increase demand for container produced manufacturing by this technique for cosmetics, pharmaceuticals as well as technical product used in the automotive industry. Implementation of the extrusion blow molding process in the work polymer processing system is determined by many factors including technological parameters, which influence the quality of a manufacturing hollow product. Obtaining a product with the most uniform wall thickness distribution is made possible by the use in the extrusion heads control systems such as VWDS. The system can change the size of the opening die gap, resulting in thickening or thinning the extruded parison in the places where the parison is blown in a different blow ratio degree, so as to avoid excessive thinning final product. In the present study was shown the effect of opening die gap on the quality blowing parts (intake manifold airflow in a motor vehicle) in relation to the value of the product weight and wall thickness in critical areas required by the customer of the product.

Keywords: *extrusion blow molding, die gap, wall thickness, product weight*

1. Introduction

Extrusion blow molding (EBM) is one of the major technological processes used in blow plastic. In addition to its significance is injection blow molding (IBM) and injection stretch blow molding (ISBM). Extrusion blow molding is the biggest share among the three of these technologies. It is estimated that the total blow molding industry is growing every year in the number of 3 to 5% and this trend is maintained [1].

Extrusion blow-molding is a manufacturing process that in the great advantage as a base material using a high density polyethylene. European demand for PE-HD, to the wider plastics processing technology, in 2011 accounted for 12% of the total production of plastics [9].

This type of plastic is used for the production of blowing packaging for cosmetics, chemicals and all kinds of technical creations. Blow molding products can counted to the group of hollow products. They can be classified in this group if they meet the following geometrical requirements: have a relatively thin wall, which runs around a hollow space, and the holes present in these objects are much smaller than the inner surface such as: bottles, fuel tanks, road cones. Hollow plastic parts reach a volume of several milliliters to several hundred liters [2].

2. Description of blowing process

In a conventional extrusion blow molding process, in the extruder take place the preparation of melting polymer. Plasticized material is directed to the extrusion head, where the parison is placed in a blow mold, welded in a pinch off area and shut off. Welding and prepare to cut the parison is due to specially shaped elements on the surface of pinch-off section. Blowing process, usually by compressed air, followed until the contact of the parison with the cavity walls and mapping the surface [7]. Finally blown product, after cooling in the mold cavity, leaving the mold, followed by removal of the flash in the finishing station (or partially by hand in the case of complex structure of the technical products), where the product goes to the quality control station. If hollow product meet the requirements goes to the customer.

In the case of blowing technical products of larger sizes, or extruded weight of the parison (over 2 kg) apply discontinuous extrusion blow molding. This includes the periodic rapid extrusion of parison by accumulator head. Extrusion cycle is starting when the mold is ready to accept a parison. Blowing mold is placed just below the extrusion head. Fast discontinuous extrusion reduces the tendency to stretch the parison under its own weight, and is usually achieved by accumulating head. Also in the case of an extruded parison diameter exceeding 130 mm is used the divergent die head extrusion nozzle [4]. During extrusion blow molding should also take into account aspects of the energy resources management [8] due to that, in the case of some technical parts reaching up to 85% the technological flash. These flashes are selected to be recycled. A much more detailed description of the process of extrusion blow molding products can be found in Meyer Kutz [1].

3. Explanation of experiment

For research task of assessing the impact of the extrusion gap on the quality of a blowing part with respect to the values of the weight and wall thickness in critical areas required by the customer of the product, used blow molding machine type Batttenfeld VK3-200 with accumulator head, blow mold (Fig. 1) and partially automated waste disposal stations. Discussed produced part is airflow duct for one of the leading brands of cars, visible in the CAD form model in Figure 2 Investigations were realized in an industrial company Graform Bydgoszcz [3].

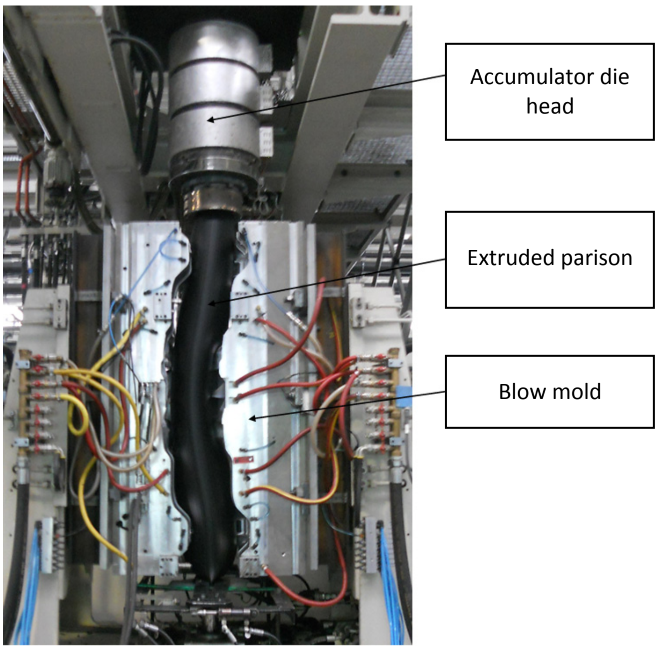


Fig. 1. Extrudate parison when locating in a blow mold [3]

The material, which was performed technical product is high density polyethylene trade name Marlex HHM 5502 BN of 0.35 g/10 min melt flow index. Recommended processing temperature for this type of material are within 171÷204 °C. To the blowing process used this same recycled material added in the number of 70% of virgin material and added a black dye added to the material in an amount of 1%.

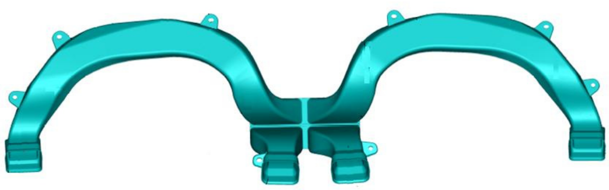


Fig. 2. Air duct geometry for motorization (technical product) [3]

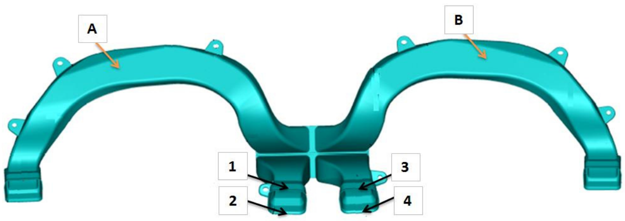


Fig. 3. The critical measurement points which should be saved referred dimensional tolerances

The research began with the adjustment the die gap in extrusion head of value 8.5 mm, after which in each case after the experimental trials for 12 blown products, these setting increased by 0.5 mm up to a value 13.5 mm. The aim is to determine at what value of the die land and programmed VWDS parison profile controlled at 62 points of its length are possible to meet the criteria the value of weight and wall thickness. Blow pressure was p = 8 bar, cycle time T = 68.2 s. The criterion of weight values according to the findings of the client must be 620 g ± 31 g while maintaining a wall thickness value criterion in mounting areas (1, 2 , 3, 4) should be $1{,}2^{+0{,}2}_{-0{,}4}$ mm and wall thickness of a product in the area A and B within $1{,}3^{+0{,}3}_{-0{,}3}$ mm. These points are shown in Figure 3.

As a result of the extrusion blow molding process was obtained products with flash – technological overmeasure (Fig. 4). The flash was removed by finishing station and directed to a recycling. Next, using a wall thickness device – Magna Mike 8500 GE Panametric, at designated locations wall thickness and the weight of a product were measured.

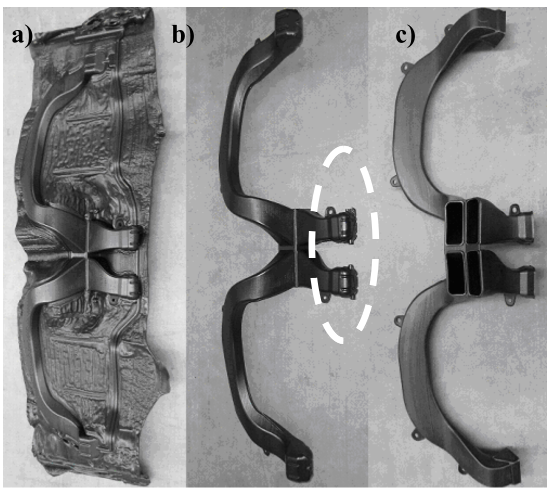
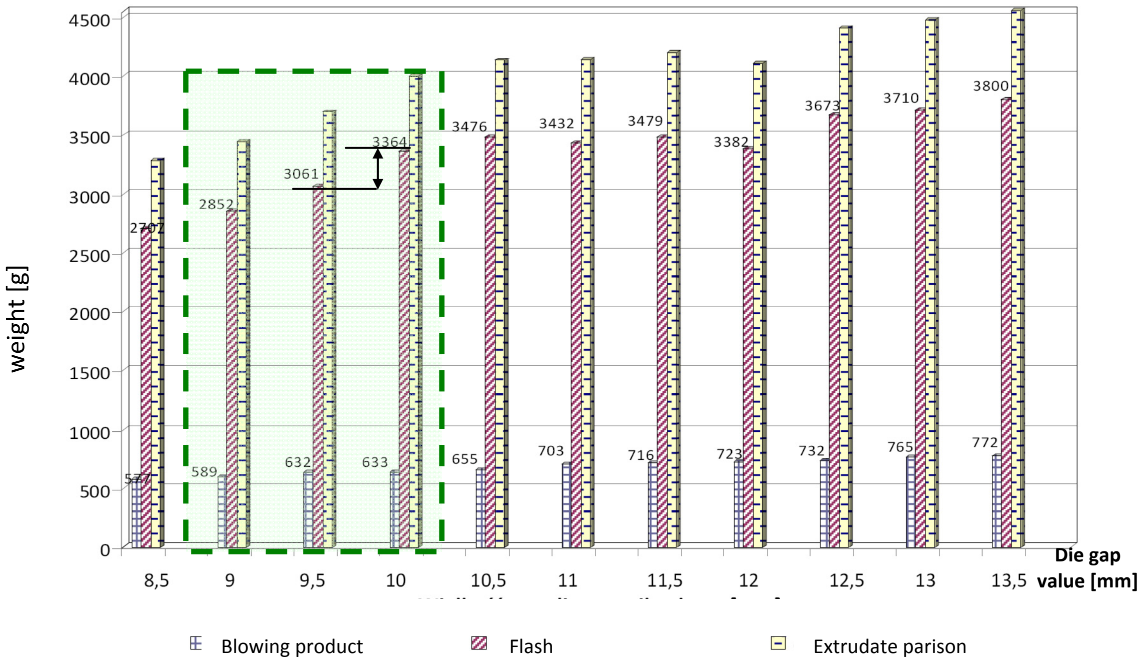


Fig. 4. Real production of air duct product: a) product with technological flash, b) the blowing prodact with of waste technological flash in assembly area, c) the final product

4. The results of blowing process

As a result of measures both the thickness and weight of the air ducts was obtained results with a average value (weight of a product, technological waste weight – flash and the total mass of the extruded product) is given in Figure 5. According to the criterion of weight air duct, it is noted that the weight of a blow product is accepted for die gap range 9.5÷10 mm.



Rys. 5. The weight change of a blowing product depending on the die gap value

Table 1 illustrated measurements of the wall thickness in the areas designated by the client of final product. It is noted that these values are not met in all these places. In the case of assembly place the assurance of the wall thickness is met, the adopted set acceptable tolerance zone to the die gap set by the following values: 9.5, 10, 10.5 and 11 mm. In other analyzing points: A and B, only at the point A, we have got acceptable value. However, at the point B is a range of values beyond the upper value of the tolerance field.

Tab. 1. The range of the wall thickness in consideration point of blowing technical products

Die gap value [mm]	Thickness value in the assembly area [mm]				The wall thickness in the specific points [mm]	
	1	2	2	4	A	B
8,5	**0,85**	0,55	**0,95**	**0,80**	**1,22**	**1,44**
9	**0,95**	0,75	**0,95**	**1,00**	**1,39**	1,67
9,5	**0,95**	0,75	**1,00**	**1,00**	**1,42**	1,72
10	**1,00**	**0,80**	**0,95**	**1,20**	**1,48**	1,77
10,5	**1,05**	**0,83**	**1,05**	**0,93**	**1,42**	1,78
11	**1,00**	**0,85**	**1,05**	**1,10**	**1,56**	2,08
11,5	**1,20**	**0,85**	**1,05**	**1,00**	1,73	2,07
12	**1,10**	**0,90**	**1,05**	**1,25**	1,74	2,08
12,5	**1,00**	**0,85**	**1,10**	**1,25**	**1,52**	2,07
13	**1,05**	**0,85**	**1,20**	**1,15**	1,79	2,01
13,5	**1,15**	**1,00**	**1,22**	**1,30**	1,75	2,14

Taking into account the performance two criteria: product weight and value of the wall thickness, it is estimated that only case in which the value of the die gap is 9.5 and 10 mm can be considered as appropriate to the potential customer acceptance.

5. Final consideration and summary

Extrusion blow molding process enables molding technical hollow products of varying geometric complexity as a result of parison extrusion and then blow in the mold cavity. However, for the fulfillment of assumptions certain related to the assurance of a product weight and thickness distribution, it is important immense selection of appropriate technological parameters of processing, which in this case means the specified die gap value. Seen from the point of energy view, the process should be extruded parison profile VWDS system, while maintaining the value of the output die gap 9.5 mm. This means that in the present case the production material savings in the number of about 300 g for each product in relation to the setting 10. Almost total value of the material weight is contained in the technological flash. The weight difference products of to setting the die gap 9.5 mm and 10 mm is only 1 g. Also lower the overall flash weight helps to minimize the energy input on the line for recycling, during flash recycling.

From the viewpoint of giving of the new guidelines for the implementation of the extrusion blow-molding should be considered necessary to have to carry out the optimization procedure the thickness distribution in the extruded parison VWDS. Whereas that during the extrusion stretch parison follows its own weight in the area to produce at point A is in the space of tolerance, in turn, point B in due to the lack of any gravitational tension is too thick. Indication could be to attempt to reduce the range of the thickness of the extruded parison at the bottom, due to the fact that there is no practical stretched. The task significantly may be easier to use the calculation algorithm (optimization) available in the software Ansys-Polyflow often presented in some papers [5, 6]. By using this tool you can get guidelines for even greater savings in materials and energy.

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