A Toy Challenges the Engineers

Improving Quality and Reducing Weight with Uniform Wall Thicknesses

In conventional extrusion blow molding, complex geometries result in severe fluctuations in wall thickness distribution. With the use of a novel die system, the wall thickness of the BIG Bobby Car trailer can be realized within narrow tolerances.

Body of the BIG Bobby Car trailer (figure: Gross)

Like the Bobby Car, the HDPE trailer is manufactured by extrusion blow molding (**Title figure**). The conventional method is to extrude a plastic parison (preform) and inflate it in a mold with compressed air to produce the defined part. Due to the strong variations in the degree of stretching in the part, which deviate extremely from one another both axially and around the circumference, the walls are thinner at some places and thicker at others. Achieving low-resource production together with high quality specifications is thus more difficult due to the process conditions.

In particular in the region of the loading platform of the trailer, the degree of stretching changes extremely abruptly in both directions. During closing of the mold, the wall of the base of the loading platform freezes first without stretching due to contact with the cold mold surface, corresponding to the unchanged wall thickness of the parison. In the region of the side walls, which surround the loading platform, on the other hand, the parison is severely stretched so as to reach the outer regions of the blow mold. In addition, the already severely stretched preform wall must be additionally pushed inward at the rear end of the edge in the corner regions. As a result, the lowest wall thicknesses in the part are found in the corners of the side wall (**Fig. 1**). To ensure the necessary stiffness in these regions in the past, the parison had to be extruded from the die far thicker than desired.

The design of the trailer underside is similarly critical, since this differs greatly from the geometry of the top side. In the base regions, the wall is required to be as thick as possible at the points where the axle is pushed through. However, due to the process, the parison is stretched especially strongly at these points, so that there is inevitably a low wall thickness. Wall thickness differences in the part occur because of very large differences in the degree of stretching in the circumferential direction, and for various reasons, are not easily influenced by static profiling. Neither a dynamic deformable Flex Ring, nor a PWDS system (partial wall-thickness distribution system) can achieve significant improvements. As a result, the trailer in the past was manufactured by means of a simple conventional conical die, without a specially profiled flow channel. »

Fig. 1. The weight and wall-thickness distribution (thickness values in mm) of the top side of the trailer manufactured with a conventional conical die (figure: Gross)

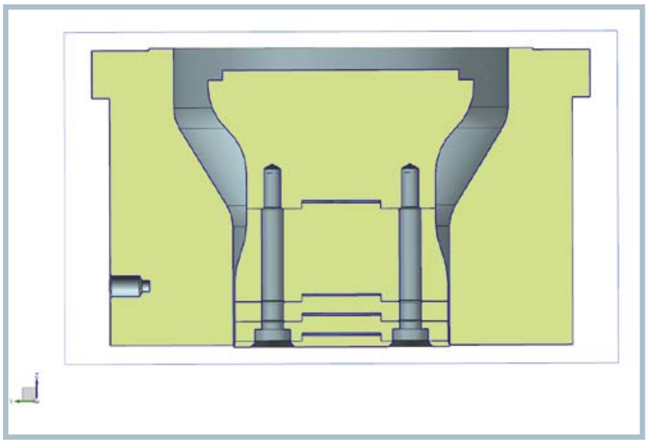

Fig. 2. Section through the conversion unit for the existing die head, consisting of the GWDS die and the GWDS mandrel, which is constructed of individual disks at the end (figure: Gross)

Fig. 3. GWDS mandrel, which has been manually profiled in the end region in an extreme manner in order to improve the wall thickness distribution in the region of the trailer loading platform (figure: BIG)

Fig. 4. Mandrel situation in which the melt-flow distribution of the parison is not influenced by the extreme profiling at the mandrel end, since the profiling is outside the flow channel (figure: BIG)

Cylindrical Die and Disk-Shaped Mandrel

A new approach to optimizing material-conserving production of the BIG Bobby Car trailer, while simultaneously improving quality, lay in the use of a cylindrical GWDS die (Gross wall-thickness distribution system), which opens up completely new processing possibilities [1–3]. This allowed a significant improvement in the wall-thickness distribution. It only required replacing the conical die and the mandrel of the existing blow molding head on a machine that had previously been supplied by Fischer – W. Müller Blasformtechnik GmbH, Troisdorf, Germany, with a newly designed cylindrical die and a mandrel with different profiles in the radial and axial directions.

With the use of the GWDS die, the change of mandrel position with respect to the die does not, as in the conventional process, vary the die gap but transports the mandrel, which is differently profiled from region to region, to the respective working position. **Figure 2** shows a cross-section through the point-symmetrical initial geometry of the mandrel before profiling. For a better display of the differently machined regions of the mandrel and to permit rapid adaptation and rapid exchange, the mandrel was made of several different disks.

Manual Profiling of the Flow Channel

The lowermost mandrel disk was intended specifically to allow the flow channel to be sealed for filling the melt accumulator. However, in preliminary tests it was found that it was not necessary to close the gap. The conical terminating disk of the mandrel was therefore removed. The mandrel length could thus be increased, so the extra length could additionally be utilized for the stroke of the mandrel, so that an even greater mandrel length was available for variable profiling of the mandrel. The different mandrel regions are then manually profiled in order to take into account the different degrees of stretching in the different respective regions of the trailer. **Figure 3** shows the mandrel geometry that was generated manually for the optimized production of the trailer. **Figure 4** shows the retrofitted blow-molding die with the profiled mandrel extending out of the die.

The wall thickness in the center of the trailer underside was thicker than necessary over the entire length. Therefore, the flow-channel gap in the die was reduced overall in this region and the flow resistance in the die was adapted in the outlet direction in order that, despite the reduced gap at the die end, the outlet velocity was approximately the same around the entire circumference. The thickness profiling of the parison for the top side, on the other hand, was very much more difficult, since, here, there are considerable differences in the degree of stretching in the melt outlet direction. For the rear loading platform edge, the wall thickness had to be significantly increased and reduced again shortly after that in order to reduce the wall thickness considerably again in the base of the loading platform. The wall thickness had to be increased again for the adjacent loading platform edge in the front region of the trailer, and then reduced yet again for the tow bar region, which is already inherently stiffened. Neither the complicated dynamic Flex Ring nor PWDS technology are capable of solving this complex problem satisfactorily, since, in particular, the loading platform is limited by the trailer wall on both sides, which logically each require a large parison wall thickness.

The comparison of wall-thickness distributions in **Figure 5** between the cylindrical GWDS die and the conventional conical die shows that the GWDS die achieved a considerable improvement in the wall-thickness distribution in the BIG Bobby Car trailer. Although the thickness could even be increased in regions that were previously critically thin, the weight, as well as the cycle time, could be reduced considerably. Since, in the interest of weight reduction, the thickness was reduced particularly at regions in which unnecessarily large wall thicknesses were present, the cooling time and therefore also the cycle time could be significantly reduced.

Summary

The example shows that for optimizing the BIG Bobby Car trailer using GWDS technology, using a cylindrical instead of a conical die, new technical possibilities for extrusion blow molding have been created. For example, very much greater thickness gradients in the parison could be achieved than had been possible in the past. Nevertheless, with simple adaptations by means of »

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References & Digital Version

- You can find the list of references and a PDF file of the article at ***www.kunststoffe-international.com/893465***

German Version

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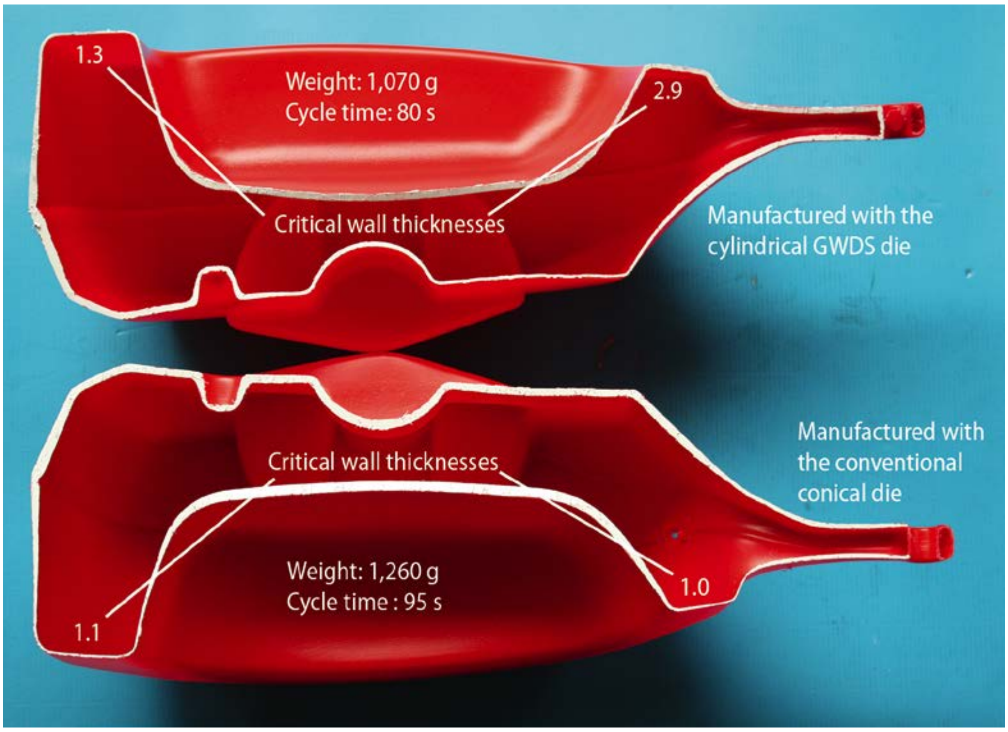

Fig. 5. The comparison of two trailer halves that are cut open in the machine direction shows impressively to what extent the wall-thickness differences have been reduced by the GWDS technique and the considerable weight saving that can be thereby achieved (figure: Gross)

local flow-channel profiling, the outlet velocity around the die circumference can be kept constant to a first approximation, so that problems with negative influencing of the parison extrusion could also be eliminated.

In general, GWDS technology allows any die head to be retooled for this novel process without problems. There is neither an upper nor a lower limit to the die diameter. Any head design can also be generally used with this die. It can be retrofitted to both continuously or discontinuously operating coextrusion blow heads, as well as multi manifold heads. It is unimportant how many parisons are extruded simultaneously and how small the clearance is between the individual dies. Consequently, the wall-thickness distribution of any blow-molded part that is currently produced by blow molding can be further improved by means of GWDS technology. In particular, with many technical blow-molded parts, which – in a similar way to the BIG Bobby Car trailer – often have extreme stretching gradients, not only can considerable quality improvements be obtained but at the same time also considerable weight savings with reduced cycle times. ■

Zwick Roell

Sitting until Fatigue Sets in

Automobile seats are tested thoroughly before being released for production to ensure that they retain their shape over the entire life expectancy of the vehicle. **Zwick GmbH & Co KG**, Ulm, Germany, has developed a test stand for such tests. In addition to the durability of the seat and seat frame, it also tests the hardness and fatigue of the foam used through cyclical trials. For this purpose, the seats and seat backs are tested at various positions. The typical quality attribute in these tests is the stiffness of the seats. Using a servo cylinder, the stiffness is tested in cyclical trials until fatigue occurs.

To make the servoelectric testing cylinder easily adjustable, Zwick installs it in a special portal. The testing cylinder is adjustable electrically in the X- and Y-directions; in addition, the height of the cross beam can be adjusted. As an option, the cylinder can also be positioned at a defined angle. Standardized test plungers for testing the foam and a protective enclosure complete the testing machine. The testing cylinder is available in six sizes: 1, 2, 5, 10, 20 and 30 kN.

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To the manufacturer's product presentation:
www.kunststoffe-international.com/904267

A new test stand is ideal for fatigue testing of foams (figure: Zwick)