

B&R software meets all the automation requirements of a complete blow molding system with numerous function blocks which can be connected any way the user needs. This includes functions for controlling all movements, motors, air compression, heating zones, or linearization of the hydraulics. The connection to the project core (automatic sequence, manual control, etc.) is already integrated in the FBK, and programming in the Ladder Diagram editor guarantees easy maintenance and modifications.

The definition of wall thickness was created in the Visual Components editor. As a result, there is no limit to the number of coordinates which can be entered by the operator. The resolution of the calculated curve (number of points) can also be defined in the project. The operator can even choose between several methods of interpolation (sine / polynomial / spline) to achieve an optimal curve. As a further aide to the operator, any changes which have been made can be compared in the background with the current active curve. The new curve is accepted only after the changes have been confirmed. Using the profile, multiple event outputs can be controlled on the wall thickness control function block. Navigation and visualization are handled intuitively using touch screens.

The actual position controller runs in a high-speed task class and ensures accurate control of the wall thickness using speed input control and prediction time, similar to ACOPOS servo drives. Additional standard elements include temperature and wall thickness(es) trends, statistic process control of all parameters, alarm handling, user logbook, heating calendar, and recipe management in the form of portable .csv files.

# Hollow-Bodied Production Using Extrusion Blow Molding



Extrusion blow molding makes it possible to produce a wide variety of hollow-bodied products. The spectrum ranges from ampoules in medical technology to heating oil tanks with 10,000 liter capacity. The photo shows a compact machine for making small to mid-size hollow-bodied products. The funnel for plastic granules can be easily recognized on the top of the machine.

Extrusion blow molding is the most well-known process for producing hollow-bodied plastic parts. This process entails shaping a plastic tube and inflating it by blowing in compressed air. The thick-walled plastic molding blank is stretched by this process and pressed to the contours of the tool. The plastic cools off in this blow mold and the resulting product can then be removed.

This plastic tube for extrusion blow molding is made directly from plastic granules. The granules are first transported to the extruder via a worm gear, where they are mixed and melted. The plastic can then be shaped in the tube forming tool to guarantee constant wall thickness for the end product (wall thickness control).

### Weighted Quality

Next to the cycle time of the process, the weight of the end product is a decisive quality characteristic for machines and control. A high demand is placed on a uniform wall thickness, constant torque in the extruder worm gear and equal material conveyance.

### Software Demands

Software controls the extruder in terms of temperature of the heating zones and the speed of the worm gear. Depending on the machine type, it also controls post-processes like punching or cutting for single-sided (only one blow mold) or double-sided machines (left and right machine cycle, two blow molds). Modular software simplifies the programming

of additional components. A sophisticated option is provided in the definition of wall thickness for shaping the plastic tube. The quality of the controller is the central challenge faced during development. This concerns a closed loop positioning controller, even for asymmetrical profiles with x and y axes).

### Wall Thickness Control

The wall thickness of the plastic tube is entered by the operator during production. Using a graphics editor makes it possible to input any desired contour. However, the contour must proceed without any corners or edges in order so that the result can be controlled. The operator presets any number of coordinates, and the software connects them together using interpolation. This can be done with sine/cosine, polynomial, or spline algorithms. Furthermore, the operator can adjust the weight of the end product by stretching or compressing the tube profile and can control events from the profile such as switching inflation-air on/off in order to prevent the tube from collapsing. The job of the position controller is a precise and reproducible process of traversing the interpolated curve and controlling the default events. 