Automation Potential in the Production of Glass Bottles

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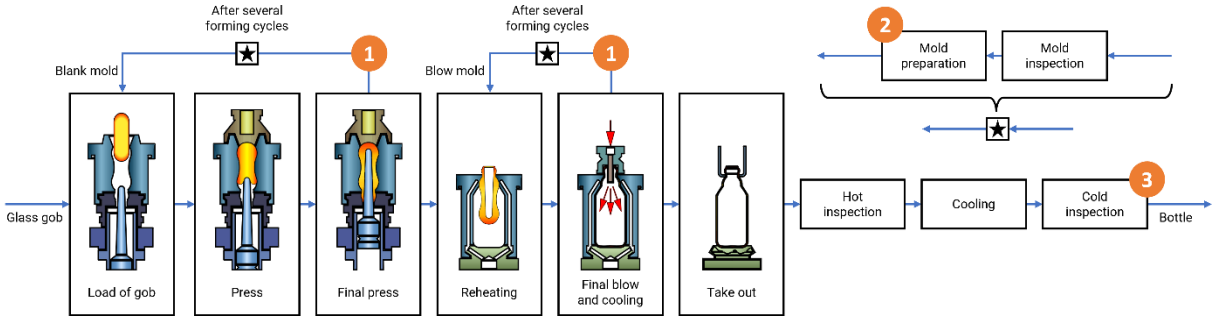
Glass bottles come in a variety of shapes and sizes, making it appropriate to use robots for automation. The process of manufacturing glass bottles is shown in Figure 1 [1]. In container glass production, particularly in the shaping process following the gob cut, automation can be a crucial measure to address the demanding working conditions. Although the shaping process already exhibits a high degree of automation, there is untapped potential for automation within the process.

Firstly, the IS machine is typically swabbed manually. Secondly, the exchange of heavy molds is done by hand by machine operators. In the IS machine, depending on the product, either the press-and-blow or blow-and-blow method is applied. After forming, the bottles are placed on a conveyor belt, pass through a cooling oven, and are finally checked for various quality criteria such as inclusions, stresses, burst pressure, dimensional accuracy, and wall thickness. Quality assurance can also be further automated, e.g. to fully capture the wall thickness distribution across the container.

Figure 1. Press-and-blow process inside an IS machine for manufacturing glass bottles including mold preparation



GHI, IPGR and IGMR are working together on several projects to unlock the described automation potential by combining process understanding and automation know-how. Projects already implemented are highlighted in Figure 1 and described below.

1) Automated mold change: Regularly changing molds in the process places an enormous physical burden on all employees, which cannot be sustained in the long term. Therefore, the goal of the project was to automate the mold changing process. To this end, the complex requirements of the environment were documented and evaluated. Automation using an industrial robot suspended from above on a linear axis in combination with a mobile robot was simulated and evaluated.

2) Automated coating of molds: The process of (re)coating molds is well suited for automation on an industrial scale. The molds are scanned with a laser line scanner attached to the tool center point of a serial robot. Sensor data combined with robot pose information is used to plan the coating trajectory, which depends on the shape of the mold and the geometry of the spray nozzle [2]. Once the trajectory is planned, the coating is applied. An industrial cell has been developed for this process, including concepts for automated mold feeding.

3) Automated wall thickness measurement: Wall thickness plays a crucial role in product quality. It is therefore particularly interesting to know the exact material distribution along the bottle contour and not just evaluate the wall thickness at critical points with inline sensors as is the industry standard. A complete capture of wall thickness distribution could contribute to the homogenization of wall thicknesses, which in turn could lead to thinner walls and improved product quality. In the project a confocal displacement sensor guided by an industrial robot is used to measure the thickness over height. The trajectory is calculated from the information in the technical drawing of the bottle. The

sensor is positioned perpendicular to the bottle wall at a specified distance and provides two readings: The distance to the inner and outer wall of the bottle. The difference between these values defines the wall thickness, which can be stored together with the vertical distance from the bottle bottom to the measuring point, which is known from the robot pose. Using a rotary table, the measurement can be repeated several times around the circumference of the bottle.

References

[1] B. Corves *Formgebung bei Hohlglas / Forming of hollow ware*, **2002**, GLASS, Edition II, p. 80.
[2] M. Schmitz *Automatische Formerkennung über Laserscanner und Trajektorienplanung für die Beschichtung*, **2022**, https://blog.rwth-aachen.de/robotik/automatische-formerkennung-ueber-laserscanner-und-trajektorienplanung-fuer-die-beschichtung/, last checked on 12.12.2023.