Improved and controlled motion during takeout

CONTROL OF THE MOTION DURING TAKEOUT PROCESSES IS AN IMPORTANT PART OF GLASS HANDLING IN IS MACHINES. IN FACT, POOR CONTAINER HANDLING DURING THE TAKEOUT MOTION NEGATIVELY IMPACTS CONTAINER QUALITY. THIS ARTICLE TAKES A LOOK AT HOW THE USE OF SPECIFIC MOTION PROFILES CAN CONTRIBUTE TO A REDUCTION OF INDUCED STRESS IN THE CONTAINER AND, CONSEQUENTLY, LEAD TO A GENERAL REDUCTION OF CRITICAL FINISH DEFECTS.

Smooth, jerk-free motion, high repeatability, consistency and speed are important demands on mechanisms directly handling glass in IS machines. Poor container handling during the takeout motion negatively impacts container quality. This article addresses the importance of controlling motion during the takeout process and compares the performance of pneumatic takeout mechanisms with servo-electric mechanisms. Furthermore, it shows how the use of specific motion profiles can contribute to a reduction of induced stress in the container and consequently lead to a general reduction of critical finish defects. The Emhart Glass 200 Series Servo Electric Takeout mechanism (SETO) provides the necessary motion control and offers many features that are unavailable in pneumatic models.

INTRODUCTION
The key to an optimum high-production glass container forming process is well controlled handling of the glass as it moves through the IS section. Avoiding the introduction of stress into the glass prevents the formation of defects - mainly critical defects of the finish. Glass handling by section mechanisms often is not as great a speed limiting factor as the necessary process time. The required
process time is determined by the thermal properties of the glass and the physical limitations of the forming process. In order to further increase the productivity of the IS machine, glass handling times need to be minimized. Consequently, speed, precision, controllability and repeatability of the section mechanisms must be improved. Within the scope of these growing demands, servo-electric drives are increasingly replacing the pneumatically driven mechanisms which still represent the standard in glass container forming machines.

SPECIFIC DEMANDS ON THE TAKEOUT MECHANISM

Although the takeout mechanism is not directly involved in the forming process, its contribution to container quality is significant. Unwanted bending and mechanical stress can be introduced to containers from inertial forces generated during the motion used to transport containers from open blow moulds to the dead plate.

The quality of the takeout motion is strongly related to the torque acting on the neck of the container. The force of this torque causes stress, which can lead to deformation in the neck area of the container.

Using a simple dynamic model as shown in Figure 2, neck torque can be expressed as function of the geometry (container characteristics / weight, distance center of container gravity to takeout tongs, etc.) and of the motion profile: $T_{neck} = f(\text{geometry, } q, \dot{q}, \ddot{q})$.

It is important to note that every takeout motion leads to neck torque as the container is being moved from the mould to the dead plate position. However, the resulting torque amplitudes, and, particularly, the resulting jerk (which is the first derivative of torque), are directly influenced by the motion profile (velocity, acceleration and motion time) and can be greatly minimized.

At start of the takeout “out” motion, a container is accelerated vertically with the whole of its weight being supported under the finish. Immediately after lift-off, the container starts to move in the horizontal direction, until it reaches the middle of the takeout motion, where the vertical motion component becomes zero. The horizontal acceleration and deceleration forces during the takeout motion induce bending in the container neck area. In other words, the vertical acceleration results in tension stress while the horizontal acceleration component is the culprit for container bending.

These observations underscore the sensitivity of this phase of the forming process to potential deformation and stress induced in the finish and neck area. It is evident that the takeout motion has a large potential for container quality improvement by reducing (or avoiding) physical stress.

SERVO-ELECTRIC VERSUS PNEUMATIC TAKEOUT MECHANISMS

Controllability, high repeatability and mechanism speed are three major advantages of servo-electric actuators over pneumatic actuators.

Controllability

The primary means to control the behaviour of a pneumatic mechanism is the adjustment of airflow and air pressure. Consequently, it is impossible to independently set timing and velocity at specific points during the mechanism’s motion. On the other hand, servo-electric mechanisms allow the user to define a wide range of motion profiles.

The superior performance of the SETO over the pneumatic mechanism is clearly shown when comparing measured velocity profiles of pneumatic and servo-electric takeout mechanisms at a typical motion time of about 700 milliseconds. In particular, the deceleration phase and the jerk induced by the end stop cushioner of the pneumatic mechanism do not meet the requirements of smooth glass handling.

Repeatability

Measurements have shown that the acceleration of pneumatic mechanisms is not very repeatable, and this leads to cycle time variations at different positions of up to 50 milliseconds, or angular variations at a specific time of up to 25 degrees. These variations become even worse with changing conditions such as wear of mechanisms and cushioner cartridges, changes in cushioner oil temperature and operating air pressure, mechanism friction etc. It is self-evident that all these variations require a large “safety” timing gap and that this will limit machine speed.

Speed

Motion analysis indicates that the takeout’s “in” movement (from the kickback position until the pick up of a container) is process time critical. A servo-based takeout mechanism gives operators the ability to programme an optimal kick back position for a job. Accurate kick back positioning leads to shorter motion distances and process times for container pick up. In addition, the greater ability to control motion eliminates the shakiness commonly seen in pneumatic mechanisms - which can prevent precise positioning of the tongs immediately above the container finish.
IMPROVING PERFORMANCE THROUGH SETO MECHANISM

The simplified dynamic model suggests that the physical impact to containers is dramatically reduced with servo-electrical mechanisms. The ability to control sensitive parameters such as motion time, acceleration, and deceleration will result in minimized physical impact to the containers during takeout motion.

CHOICE OF MOTION PROFILE

In addition to the uncontrolled jerkiness caused by the constant cushioners, an important parameter that can negatively influence container quality is takeout out acceleration. Very abrupt or uneven acceleration can result in excessive bending.

Servo-electric mechanisms allow the specification of motion profiles. Coupled with controls, these profiles enable the mechanism to complete the motion in a defined time frame and within defined maximum velocities. Figure 3 shows how various takeout profiles with maximum normalized velocities between 1.3 and 2.0 can have identical motion times. This allows the user to optimize the velocity of the motion profile without potentially influencing the process time.

Similarly, takeout motions can have different motion times but identical maximum velocities (see Figure 4).

This flexibility has great practical significance. Today, pneumatic mechanisms are usually adjusted so that the bending and stretching of the container during the takeout motion is within acceptable limits. The motion time, then, is a result of these settings. A servo-electric takeout mechanism allows motion time and velocity to be set independently. In other words, with comparable velocities, it is possible to achieve faster controlled takeout times than with a pneumatic mechanism.

The available cam’s contains a number of asymmetric kinematics profiles (Figure 5) to optimize the container handling.
FEATURES OF THE 200 SERIES SETO MECHANISM

It is almost intuitive to understand that smooth container handling will result in fewer critical defects. The highly controlled takeout motion afforded by the use of servo-motion components minimizes variances in takeout kinematics by providing identical motion on each section and cycle. The controls for the 200 Series SETO allows the configuration of many different profiles from the different symmetrical and asymmetrical velocity and acceleration settings stored in the system’s database library. Job specific profiles that allow motion optimization for each container type can be loaded to (or retrieved from) the control system’s library. In addition to providing a fast and consistent takeout motion that preserves your ware integrity, the 200 Series has been designed with integrated servo motor cooling to preserve its mechanisms. Moreover, the inclusion of a safety device protects the health of operators when performing tong arm exchanges or other work on the blow side. Tong arm exchanges are not only safer, but are greatly simplified with the screw and clamping device. For a takeout arm exchange, the neighbour section need not be stopped. (Figure 6)

Simple conversion kits allow technicians to fit the 200 Series SETO onto existing sections without the need for any external piping. The gear box alignment with the SETO height adjustment support gives three degrees of freedom to align the takeout tongs over the container. Another innovation in the wide belt takeout arm transmits the torque with two keys. The two mechanical end stops are simply assessable from the outside. Integrated oil gages also are provided for operator convenience. A height adjustment scale, for easy and repeatable set-ups on job changes has been integrated into the SETO height adjustable column. (Figure 7)

CONCLUSION

Transporting containers from the blow mould to the dead plate is a critical phase in the container forming cycle. It has been shown that uncontrolled takeout motion profiles can lead to high neck torque and stress, which can ultimately cause critical defects of the finish. Servo electric takeout mechanisms meet the requirements of smooth glass handling and therefore represent an important alternative to conventional pneumatic takeout mechanisms. Besides the advantage of improved glass handling, the 200 Series SETO provide user-friendliness and retro-compatibility features that will facilitate the decision to switch to servo technology.


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