1- IN TUNE WITH CUSTOMER DEMANDS

More than ever, the glass container is the premier packaging choice of leading international brands. Glass containers convey the image of a high quality art form thereby driving the demand for a wide variety of shapes, sizes, and colors. This presents the challenge for glass producers and machinery suppliers to be able to produce a wider variety of containers at costs more typical of those mass-produced on dedicated lines.

Emhart Glass has pursued a program over the last four years to develop a forming machine that facilitates this “mass customization” by employing state of the art technology. Inherent in this new technology is stable steady state operation and the ability for further automation.

While building on the known forming methods of Blow and Blow, Press and Blow, Narrow Neck Press and Blow, etc., the new technological platform known as NIS addresses major areas of concerns of our customers.

1) Reduce variation in the forming process

2) Decrease the complexity of operation of the forming machine

These areas, as well as many others, are addressed by employing sophistication in the controls while reducing the mechanical complexity of the machine.

2 - INNOVATION IS KEY TO PRODUCTIVITY

The greatest productivity gains achieved due to technological advances during the past twenty years have targeted ease of use, increased repeatability and predictability.

Electronic timing and Verti-Flow® mold cooling are two examples of this. Verti-Flow alone allowed certain jobs on an IS machine to operate up to 20% faster than previous mold cooling systems (Fig 1).

By increasing the predictability and quality of mold cooling, container quality was increased and more emphasis was given to light-weighting techniques.

IS machines have still been plagued with process variation, most of which comes from lack of mechanism motion control. This is primarily due to the inherent instability of pneumatics and compressed air. Pneumatics rely on items such as valve timing and repeatability, air quality (temperature, particulate content, humidity, etc), and piping. Changes or problems in any of these areas result in poor performance or the need for frequent adjustment to maintain steady state operation. Since many of the adjustments are manual, further automation of the IS machine is not possible.

The NIS heralds a new technological era with a fully servo-electric machine, providing “closed loop”
control of Gob Feeding, IS mechanisms and Ware Handling.
With an advanced control system architecture, NIS allows for true steady state operation of the IS machine where environmental changes such as ambient temperature, frictional changes, and mold equipment wear are accommodated automatically. The need for frequent tuning and adjustment is virtually eliminated. Where pneumatics are used, piping is nearly or completely eliminated, thus increasing the repeatability and predictability of these particular functions. Because variables such as speed and cushioning are now controlled electronically, full job duplication and faster job change is achievable. As a result, the benefits of the Individual Section (IS) are maintained, but unlike the pneumatic machine, each section is able to run identically.

3 - SIMPLIFICATION OF MECHANISMS

It can be argued that by minimizing the complexity of a design, the path for malfunction is reduced. Considering the Plunger Mechanism as one of the IS machine’s most critical mechanisms, the current method for distribution and control of compressed air represents a level of complexity that is beyond the requirement for proper functionality. The quality of workmanship in pipefitting can ultimately influence the performance of the plunger mechanism and even each cavity within a plunger mechanism. It stands to reason then that elimination or reduction in the amount of piping would result in a more robust and better performing system.

The pictures in Fig. 2 give an appreciation of how much the current piping and related pneumatic controls have been simplified. With the NIS, virtually all plunger related piping has been eliminated and replaced with manifolds and distribution plates making up the PCM® (Pneumatic Control Module) which is “plugged in” without any sealing requirement. This design has proven to be less prone to variations and failures than conventional systems.

Another example to consider is the Mold Open and Close Mechanism, one of the most complicated mechanisms in the IS Machine. The basic design uses linkages and air cylinders to open and close molds and clamp them shut. It is necessary to have a mold holder bracket that carries much of the forces generated by the linkages. Unfortunately, the position and size of the brackets hinder access to the machine and plunger mechanism in particular. In addition, to provide adequate clamping forces for several machine configurations and center distances, it is necessary to have families of Mold Open and Close Mechanisms and Mold Holder Brackets to cover the full container range.

The patented NIS Mold Open and Close Mechanism provides better performance while also increasing the access and view to the center of the machine (Fig 3). In addition, the same basic mechanism is used for virtually any center distance.

4 - FULL MOTION CONTROL

The state of the art for IS Machine timing and control has been “electronic event timing”. Conventional systems have provided for a one-way communication to the machine. Motion instructions are not verified for “if” and/or “when” they happen. As motion controls (pneumatic and hydraulic) are individually tuned by section and by mechanism, timing accuracy and repeatability may not be the same from one section to another.

The NIS changes this and sets a new standard for the industry. In addition to machine timing, the NIS Control System is capable of controlling mechanism motions and forces while providing full feedback as to when events have occurred. The NIS electronics continuously monitor and verify that the positions of each mechanism are where they are commanded to be throughout their motion profiles. As a result, “slack time” can be reduced, cycle rates can be increased, and all sections can be set up to run identically across the machine.

Tab. 1 highlights many of the other performance benefits realized by the full closed loop control approach.
One major benefit is a 50% reduction of "work-out" or "dry-run" time. This is the time typically required while starting production for the fine-tuning and equalization of sections.

Another benefit is increased mold equipment life. By tailoring motion profiles and forces to the specific container size and forming process, the NIS software will minimize the wear and tear on mechanisms and mold equipment by employing optimization routines. For example, the Blank Mold Open and Close Mechanism can be programmed to close with only the force necessary to keep the blanks from opening under parison forming pressure. The motion profile also eliminates mold "slamming" that might occur with pneumatic systems. The result is less mold equipment wear, requiring less mold equipment exchange and therefore less damage. As mechanism end positions are also set electronically, job changes can be done faster and in a more repeatable fashion.

Advancements in controls and software have made possible automatic setup whereby mechanism end positions can be automatically determined for a particular job.

5 - ENERGY REDUCTIONS

Measurements and calculations of energy consumption for 10-section machines operating in Blow & Blow and NNP&B show that the electricity consumption required to operate the NIS machine is substantially reduced. This is accomplished by replacement of pneumatically actuated mechanisms with servo-electric mechanisms.

Tab. 2 highlights savings on operating energy, based on a European environment, mainly in Blow & Blow and monthly job changes.

Tab. 1-Highlights of NIS Performance.

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<td>% Pack:</td>
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<tr>
<td>Mold Maintenance Cost:</td>
<td>-20%</td>
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**6 - BENEFIT TO THE OPERATOR**

Noise presents a major work environment issue in our industry. Noise reduction was a goal for the NIS machine program. Actual measurements showed noise level reductions of up to 7 dB(A). Noise levels generated by a 10 section NIS machine were less than one fourth that of a conventional 10 section IS machine (Tab. 3).

**7 - CONCLUSION**

The Next generation IS machine, known as NIS, employs the latest Servo-electric and Controls technologies. The machine uses well proven and flexible IS forming processes combined with the most advanced automation available in glass container forming to date. The first NIS Machine has been in operation producing containers since April 1999. Its design allows customers to automate basic manual tasks and to free up labor making them available for more useful functions.

A good product development earns its reputation through field performance. We invite you to see the benefits of NIS for yourself by contacting your EMHART GLASS representatives. We look forward to hearing from you.