Light weighting containers

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The need to lightweight glass containers is driven by competition from alternative packaging such as P.E.T., aluminum cans and paper products. If glass containers had no such competitive pressures, then it is possible that they would be heavier than they are today. In that case however, production speed increases would probably still drive light weighting efforts.

Today's glass container industry has progressed in technology and in its ability to produce quality containers at high speeds and efficiency. This is a far cry from the early days of mass production capable on the newly introduced Emhart I.S. machine. Then, production was single gob, the number of machine sections did not exceed five, containers were thick and heavy, and glass composition and refining quality were at standards that would be unacceptable today. Modern production lines may have up to 20 sections with multiple gobs (up to four gobs per section), and furnaces capable of producing 500 tons of glass. Sometimes these facilities employ oxygen firing and sophisticated refiners, forehearths and feeders that are capable of delivering gob weights within a tolerance of ±1 gm.

Given the current competitive market, the glass container industry must compete by producing the lightest-weight container, at the highest possible speed, with the highest possible (packed to melt) efficiency at the lowest possible operating cost.

WHY LIGHT-WEIGHT?

Glass in its pure state is extremely strong. However, strength can be reduced considerably as stresses and microscopic surface defects are introduced during the forming process. A container that has less glass is naturally less able to resist stress. However, since reducing the weight of a container reduces its cost and the costs associated with transportation (etc.), the majority of glass containers today are lighter than they were 10 years ago. Although decreasing the weight of a container increases its fragility, this is not necessarily the case with all containers. Some containers, because the weight-to-capacity ratio is so large, can have a considerable amount of glass weight removed without seriously affecting impact or burst pressure strength.

The shape of the container is often designed for market appeal, but the design should be analyzed to remove unwanted stress raising geometry. This analysis also helps the glass container manufacturer reduce the weight of the container whilst maintaining its strength. Of course, perfection is hardly ever achievable as design appeal and functionality inevitably must involve compromise. Another factor affecting the strength of the container is the distribution of glass within the container. The choice of forming process, the operation of the forming equipment and the operating of the process are key to achieving the desired glass distribution in a container.

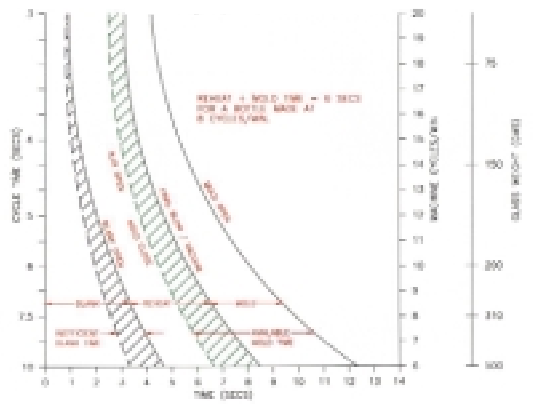


Figure 1: IS Machine Double Overlap Forming Cycle, Blow & blow

The glass works that pay attention to the details of the process inevitably will make the best quality containers using the least amount of glass.

TABLE 1: LIGHTWEIGHTING EXAMPLES

Type	Size	BB	LWBB	NNPB
Beer	750 ml	585 gms	490 gms	390 gms
	640 ml	525 gms	440 gms	365 gms
	500 ml	410 gms	330 gms	270 gms
	330 ml	300 gms	220 gms	175 gms
Spirits	1 litre	550 gms	460 gms	420 gms
	750 ml	510 gms	420 gms	385 gms

By light weighting, the glass manufacturer may also increase the output from his equipment. Since the weight of hot glass being delivered to a machine is a measure of the amount of heat that machine must remove to make the container, less weight equals shorter reheat and run times. Therefore, it is possible to construct a diagram as in Figure 1 to show this. Note the limit to cycle speed (besides the thermodynamics of the process) is also the mechanics of the process.

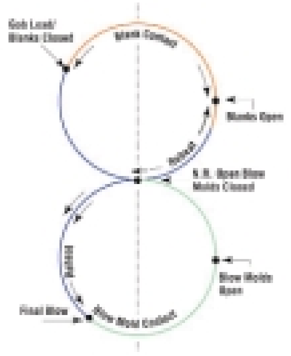


Figure 2

Glass is well known to be environmentally friendly since it is reusable many times over, chemically inert, impermeable and manufactured from readily available and abundant materials. Lightweight containers produce even less impact on the environment due to less waste and less energy consumption. These facts become important advantages when competing against PET, metal cans and paper cartons, so the glass container industry must continuously strive to produce lighter and lighter weight containers.

THE PROCESS FOR LIGHT WEIGHTING

For the purposes of this article, there are only two choices for forming methods that will be examined: Blow and Blow (BB), and Narrow Neck Press and Blow (NNPB). In this discussion, one should remember that the formation of a glass container requires a charge of hot glass (the gob), formation of a pre-form (the parison), reheating of the parison, and final forming of the reheated parison. Basically, it is a three stage process consisting of pre-forming, reheating and forming steps.

The I.S. machine takes this three-stage process and fits it into two mechanical cycles of the machine. This is referred to as the double overlap process, because the blank cycle and the blow mold cycle overlap at neck ring open. See Figure 2. This inevitably leads to some contradiction when comparing the two forming processes.

Thus, when looking at the two processes with respect to various criteria, the results look like this for the same container at the same weight. See Table 2.

TABLE 2 Criteria	BB	NNPB
Container Strength	Yes	No
Glass Distribution	No	Yes
Cost of Containers	Yes	No
Production Speed	Yes	No
Technical Difficulty	Yes	No

Container Strength

Contact between the plunger and the glass causes micro-checks and inclusions in the inner wall of the container, which weakens the container made by the NNPB process.

Glass Distribution

Control of glass distribution is best achieved by the NNPB process. Although light weighting in Blow and Blow has achieved significant results.

Cost of Containers

For the same container, at the same weight, a blow and blow container has least cost because it will produce faster, with less mold cost and less technical difficulty.

Production Speed

Although in NNPB, the speed of the blank cycle is faster. The limit to speed inevitably is the blow mold where the longer reheat, stretch required for NNPB parisons reduces available mold contact time.

Technical Difficulty

No one will argue that NNPB is a more difficult process to operate than Blow and Blow. However, the writer believes that as technology stands today, achieving the ultra light weights shown in T 3 (courtesy of Wiegand Glas), the process of preference is NNPB.

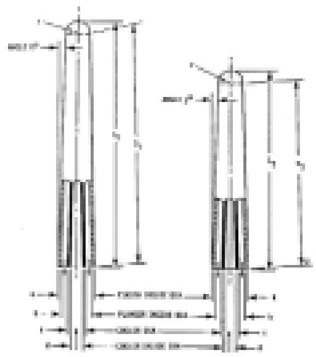
HOW TO LIGHT WEIGHT WITH NNPB

The process is the Emhart Glass 62 wide mouth press and blow process applied to narrow neck containers. This is essentially a process for non-pressure containers adapted to pressure containers. Using this process, it is possible to eliminate the settle wave inherent with Blow and Blow.

To operate NNPB, an understanding of the problems and limitations of the process is necessary.

The finish and pressing operation –almost without exception – determines the parameters of the process. For example, the inner diameter of the finish determines the largest diameter of the plunger (typically 18-20mm), that in turn determines the amount of cooling air entering and exhausting the plunger. (See Figure 3)

Figure 3



Ideally for the fastest production, a parison (which is long with little reheat/run) is desirable. However, the longer the parision, the longer the plunger, and therefore the shallower the angle of the plunger will become (to a minimum of 1°). The greater surface area of the plunger in contact with the glass increases the heat load on the

TABLE 3. THE WIEGAND PROCESS	Bordeaux bottle	Beer bottle	Beer bottle
Capacity	1.0 l	500 ml	330 ml
Weight	385 g	185 g	120 g
Colour	Dead leaf	Amber	Amber
Process	BB with vacuum assist on blank side	NNPB	NNPB
Coating		Polymer coated with PAS coating machine, avg. internal pressure = 30 bar	Polymer coated with PAS coating machine, avg. internal pressure = 28 bar

Figure 4

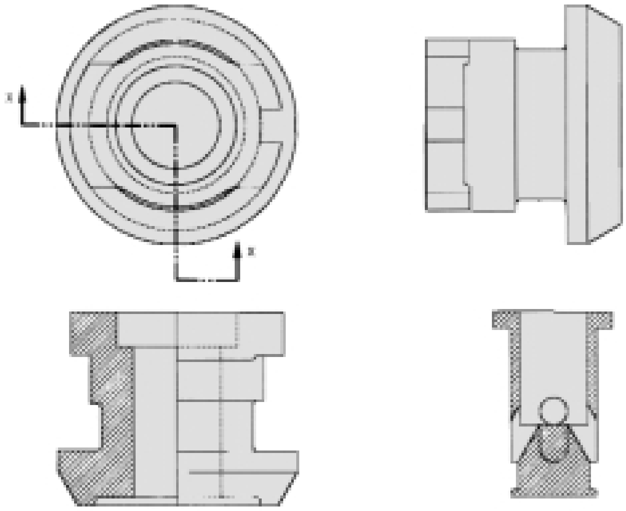
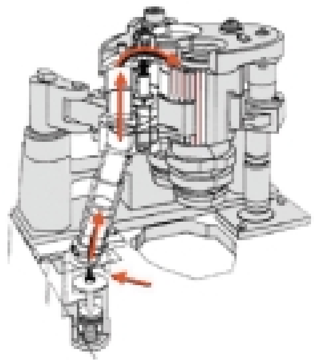


Figure 5



plunger, thereby increasing the cooling requirement as well as the risk of damage to the glass contact surface.

Note: The plunger is a very shallow angle cone - almost a cylinder. As an approximation, the percent increase in length is proportional to the percent increase in cooling.

CONCLUSION

The shorter the parison, the better the angle on the plunger for plunger withdrawal. This requires less plunger cooling and results in a stronger container with a faster pressing action.

However, this short parison requires more reheat time, which shortens mold contact time. Here part of the answer goes back to the gob. The glass conditioning is critical; a gob with a homogenous and elevated temperature is required to provide more stored heat in the parison to allow faster reheating.

The formation of the parison is fast so that the parison has only sufficient stiffness to survive inversion again, thus enabling a faster reheat. This also means that heat removal by blank mold cooling is much less than that for blow and blow parisons.

Now there is more heat to remove in the blow molds. Addressing the heat buildup could mean slowing the process. A more realistic solution would be extending mold contact to maximize dead plate cooling and installing the Emhart Glass Blow Mold Cooling System.

LIGHT WEIGHT BLOW AND BLOW (LWBB)

Fundamentally, the blow and blow process differs from NNPB as follows:

1) The finish is made first in blow and blow and last in NNPB;
2) The parison is blown in blow and blow and pressed in NNPB. The result in blow and blow is 'settle wave', eliminating this is vital to ensuring the glass distribution necessary to lightweight.

Essentially, the time between loading the blank and starting blowing (or pressing) the glass should be kept to a minimum in the parison forming process whether blow and blow or press and blow. Therefore, settling the glass into the finish and corkage reheat has to be minimized. This in effect minimizes the thermal difference in the parison caused by the different glass contact times of the settled glass to the counter blown glass.

Basically, this requires loading the blank mold without a funnel, and using a valve type baffle (Figure 4) or a later development from Emhart Glass called a "V. Baffle". Wiegand Glas is successfully using the V Baffle with or without vacuum settle, and with blank side top down Vertiflow. (Figure 5).

In effect, all the above helps to quicken the blank mold cycle and help to eliminate the settle wave. The specially shaped design of the parison is important, and it incorporates an over capacity close to that of NNPB, with a longer reheat/run than that normally required for blow and blow. This in turn requires a slightly high gob temperature.

As with NNPB, it is important to maintain blank mold cavity volumes in blow and blow, because as the cavity grows, the relationship of the parison design and over-capacity will change.

Finally, no matter what process is used, providing that the production machinery is new (or in like-new condition), light weighting is a means of lowering the material cost of the glass container while increasing the output of the IS machine. Lightweight production's high speeds and efficiency offer today's glass container manufacturers a quality product that can answer the competition from alternative packaging. ■

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