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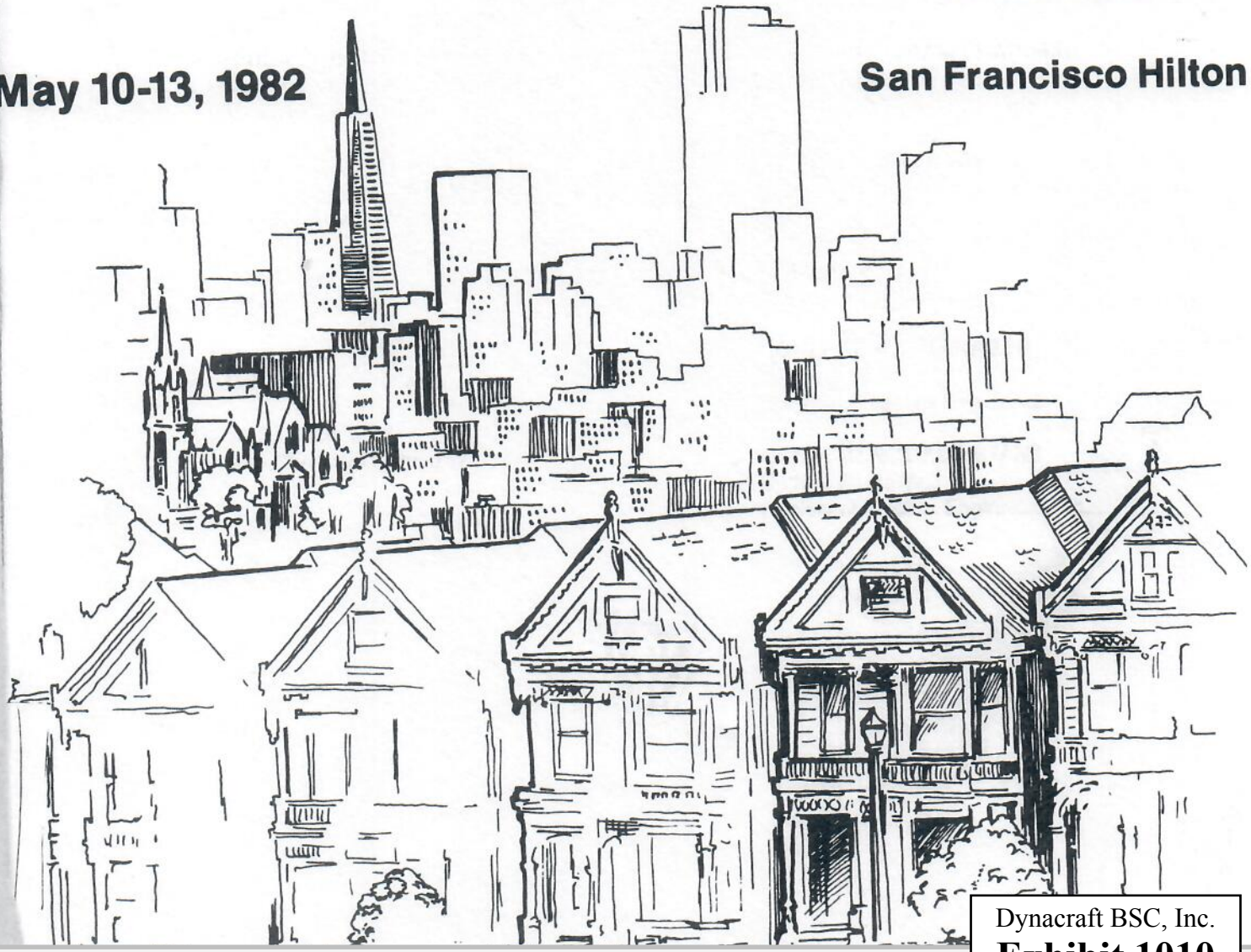

BLOW MOLDING HIGHLY IRREGULAR SHAPED PARTS WITH MOVING MOLD SECTIONS

D. L. Peters

Phillips Chemical Company
Plastics Technical Center
Bartlesville, OK

INTRODUCTION

Technology is presented disclosing methods of using moving mold sections to blow mold highly irregular part shapes in high density polyethylene. The significance of the technology is that it is the only known means to blow mold these parts in one piece. Although it is fairly common to move mold sections of a blow mold to release undercuts and permit part removal, molding techniques to affect or control wall thickness is used by relatively few molders. The ability of these new molders to blow mold uniquely shaped parts has paid dividends by eliminating or reducing costly secondary operations. Three of the more important moving mold section techniques as developed at the Plastics Technical Center of Phillips Chemical Company are discussed.

INTEGRAL HANDLE LID (1)

High density polyethylene water cooler lids with an integral handle have been blow molded commercially since 1965. Several million lids of three sizes have been produced using movable mold sections of blow molds to form handles. A lid on a five-gallon cooler is shown in Figure 1.

The mold consists of two basic mold halves - one half for the top of the lid and the other half for the bottom. The top half contains the movable "slides" to form the handles. The bottom half of the handle cavity is located in the movable slides and the top half in the stationary part of the mold. The horizontal slides are located under a face plate as shown schematically in the "open" position, Figure 2.

The molding sequence starts with a pre-pinched and slightly pre-blown parison between the two open mold halves. The handle slides are open at this time. The mold halves are then closed on the parison. The closing action of the mold compresses and forces part of the parison into the handle cavity. A horizontal cut through the mold showing the parison "bubble" during mold closing is illustrated in Figure 3. (A photograph of a production mold with the slides open is shown in Figure 4.) The slides are then closed almost simultaneously with the mold closing. The blow air is introduced through a needle into a flash "pocket" under the handle. The blow air forms the parison to the flash pocket shape, and then flows through two open pinch blade spots under the handle, resulting in the lid body being blown through the handle passage as illustrated in Figure 5. The handle slides open with the mold opening to release the undercut and allow the part to eject.

Processing efficiencies are excellent with precise control of the following variables: timing, distance of slides opening, and speed of slides movement. The amount of pre-blow air and blow air timing also must be regulated and synchronized accurately with respect to both mold closing and slides closing.

The resultant lid has flash which must be trimmed around the periphery and under the handle; otherwise the handle is completely finished as the slides and stationary mold cavity form the handle without flash. Good wall distribution is achieved as can be seen in the 3/4 part photograph of a commercially produced lid shown in Figure 6.

INTEGRAL HANDLE, DOUBLE WALL, INTERNALLY THREADED LID (2)

Further development work resulted in a second high density polyethylene one-piece water cooler lid also having an integral handle plus an internally threaded double wall skirt. Many millions of these water cooler lids shown in Figure 7 have been produced commercially since 1968.

Again there are two basic mold halves - one half to form the top and outside skirt and the other to form the internally threaded handle as shown in the upper part of the sectioned illustration, Figure 8. (This is in contrast to the first lid mold in which the slide sections only are movable.) The bottom half is also quite different in that double wall blow molding technique is utilized to form the double wall skirt, (lower illustration, Figure 8). A third distinction is the molding of the internal threads on the inside of the double wall. This necessitates an unscrewing core which releases the threaded lid off the core on mold opening. A photo of a commercial mold with quarter mold sections open is shown in Figure 9.

The molding sequence requires that a pre-pinched and pre-blown parison be dropped between the mold halves. The quarter molds of the upper half are open at the time the parison is extruded. The press closes and almost simultaneously the quarter molds are closed by air or hydraulic cylinders to pinch the parison sector which forms the handle. The closing of the mold halves compresses and "balloons" the pre-pinched parison over the threaded core, "flashing" the cavity periphery. Blow air is introduced, forming the part as shown in the horizontally sectioned illustration, Figure 10.

At about the same time the press opens, the threaded core rotates to unscrew the part off the core. After a short delay, the quarter mold sections open. The delay on the quarter mold opening "holds" the lid so that the threaded core can unscrew rather than rotate the entire lid. Splitting the handle section of the mold into quarter sections results in the advantage of being able to mold a complex, irregularly shaped part with excellent wall distribution, as shown in the sectioned lid of Figure 11. The disadvantage is "flash" in two planes (Figure 12) which requires more trimming and regrinding.

As the photo of the parts shows in Figure 13, the lid can also be molded with internal threads in a compression molded solid wall. This type of lid has excellent thread strength but it does not have the rigidity of a lid with a double wall skirt; it tends to warp, and the outside appearance is inferior to the blow molded double wall part because of "sink" and "drag" marks.

DRUM INTEGRAL HANDLING RING

A 30-gallon high density polyethylene drum with a handling ring integrally molded in the bottom chime area has been developed at the Plastics Technical Center in Bartlesville, OK. The handling ring allows metal drum lifting equipment to be used. A "double wall" relatively sharp radius chime was molded in the top (bung end) of the drum. The handling ring and sharp radius corner was located in their respective ends for mold building convenience and would be reversed in a production mold. A photo of the drum is shown in Figure 14.

Although similar to the European "L Ring" drum in appearance and function, the Plastics Technical Center drum mold was designed and built independently. This drum mold has been used to develop molding techniques, to mold drums for testing (including handling), and for the evaluation of resins.

Each end of each mold half has a movable section referred to as a "plug". The movable plug in the end of each mold half is semi-circular, as shown in Figure 15. The open and closed positions of the plugs during molding are shown by the "dry cycle" photographs of one mold half (Figures 15 and 16, respectively). The mating plugs of two closed mold halves form the head and bottom of the drum mold. The plugs are moved by means of hydraulic cylinders on each end and both sides of each mold half (Figure 17). The 3 1/2" diameter hydraulic cylinders are securely mounted to the mold body and plug assemblies. Large cylinder rods (2 1/2" diameter) are used to assure smooth plug movement with no "cocking" caused by possible variations of hydraulic flow or pressure in the cylinders. Good wear plates are required between the plugs and mold body to allow plug movement under ma-

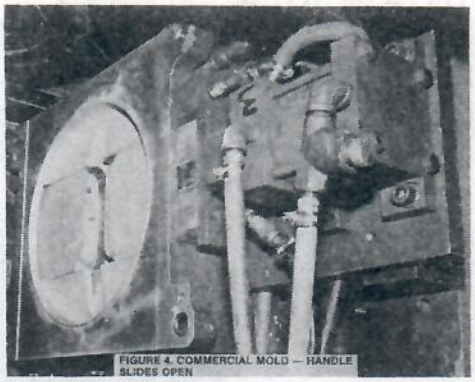

FIGURE 4. COMMERCIAL MOLD — HANDLE SLIDES OPEN

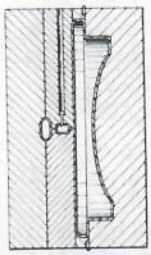

FIGURE 5
INTEGRAL HANDLE MOLD CROSS-SECTION SLIDES CLOSED

FIGURE 6. 3/4 SECTION OF LID

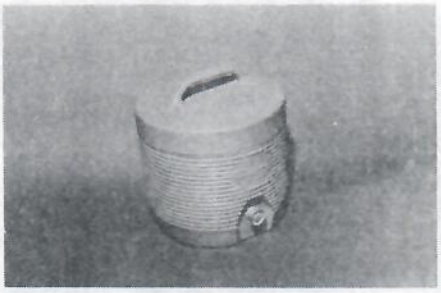

FIGURE 7. INTEGRAL HANDLE DOUBLE WALL INTERNALLY THREADED LID ON COOLER

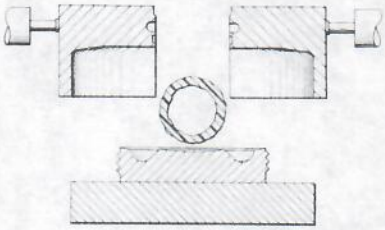

FIGURE 8
OPEN QUARTER MOLD SECTIONS AND THREAD FORMING CORE

FIGURE 9. COMMERCIAL MOLD — SPLIT QUARTER MOLD SECTIONS

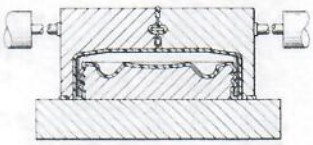

FIGURE 10
QUARTER MOLD SECTIONS CLOSED ON THREAD FORMING CORE HALF

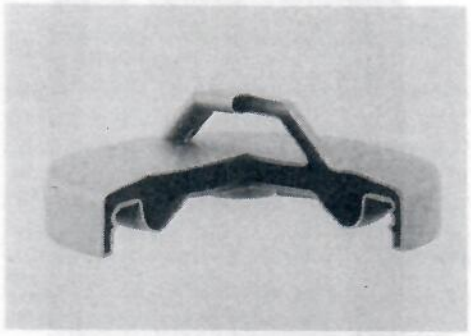

FIGURE 11. 3/4 SECTION DOUBLE WALL LID

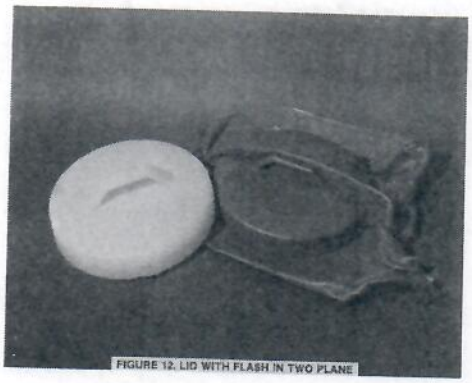

FIGURE 12. LID WITH FLASH IN TWO PLANE

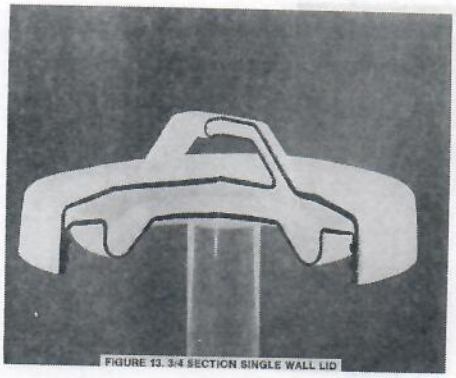

FIGURE 13. 3/4 SECTION SINGLE WALL LID

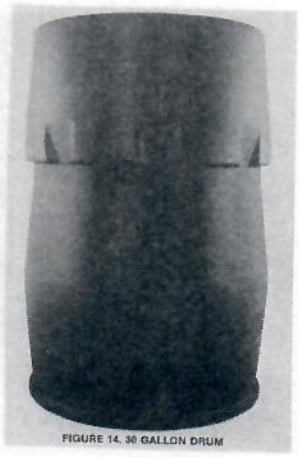

FIGURE 14. 30 GALLON DRUM

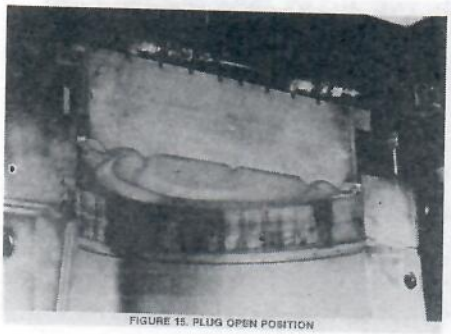

FIGURE 15. PLUG OPEN POSITION

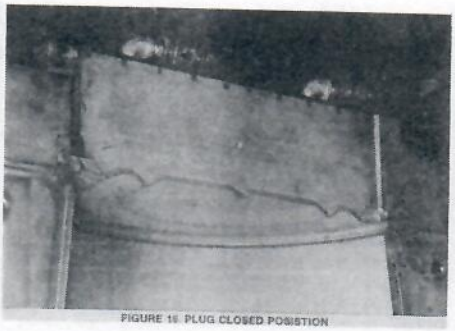

FIGURE 16. PLUG CLOSED POSISTION

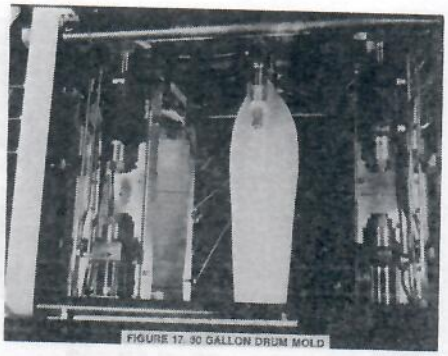

FIGURE 17. 30 GALLON DRUM MOLD

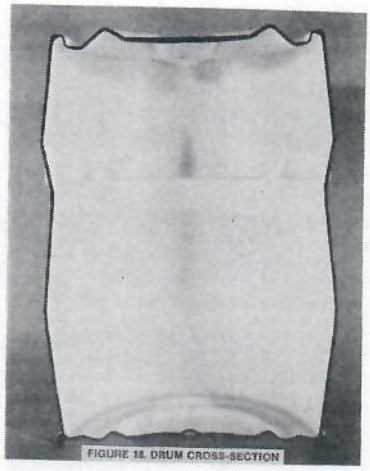

FIGURE 18. DRUM CROSS-SECTION

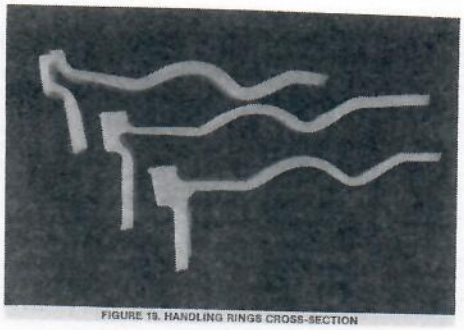

FIGURE 19. HANDLING RINGS CROSS-SECTION