DEVELOPMENT OF BOTTOM CAVITY OF 4 LITER BOTTLE

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ABSTRACT

Four liter plastic bottle always use in chemical industry. A good of mold will need to produce a high quality of four liter plastic bottle. Actually the mold for this bottle is dividing into three parts. They are top cavity of bottle, main cavity of bottle and bottom cavity of bottle. This project will show how and what are the processes that involve developing the bottom cavity of four liter bottle. These projects start with initially in design stages, material selection for bottom cavity mold and fabricate the mold. The latest technologies that use to fabricate the mold are Master Cam software and CNC milling machine. Another processes are use to ensure no defect and follow the characteristics from actual specification.

ABSTRAK

Botol plastic 4 liter sememangnya banyak digunakan dalam industri kimia. Acuan yang baik diperlukan dalam menghasilkan botol plastic 4 liter yang bermutu. Pada dasarnya acuan ini terbahagi kepada tiga iaitu acuan pada bahagian atas botol, bahagian tengah botol dan juga pada bahagian bawah botol. Di dalam projek ini akan ditunjukkan bagaimana dan apa proses yang terlibat dalam menghasilkan acuan bawah botol.Projek ini melibatkan proses reka bentuk, pemilihan bahan yang sesuai sehingga kepada pembentukan acuan menggunakan technology terkini iaitu perisian Master Cam dan CNC milling machine.Untuk menghasilkan produk yang bermutu, acuan tadi perlu melalui beberapa proses lain supaya produk yang dihasilkan tidak mengalami kecacatan dan menepati spesifikasi sebenar.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

A bottle is a small container with a neck that is narrower than the body and a "mouth." Bottles are often made of glass, plastic or aluminum, and typically used to store liquids. Plastic bottle is commonly use in our life. There have one liter, two liter, fourth liter of plastic bottle. Four liter bottle typically used to store liquid like cooking oil (for both cooking and as fuel), water and other chemical substances. . These bottles are produced from polyethylene using the blow molding process. Bottle labels consist of a printed, tight-fitted plastic sleeve. The color available for four liter bottle is white, natural, black, and custom colors available.

Every day the demands for this type of bottle from industry are increase. However the quantities of the product still not enough. Therefore in this project, I will develop bottle four liter which easy to handle and suitable to all liquid especially for chemical substances. The process that uses to make bottle is blow molding process.

In Malaysia, the number of individual that can develop mold for bottle is very small. The mold determines the shape of the end product with all its details. It helps provide the end product with essential physical properties and the desired appearance. Usually the mold maker builds the blow mold according to the molders or the customer's specifications.

1.2 Problem Statement

In this project, a 4 liter bottle based on bottom cavity is developed to overcome a few problems. The first problem is the design of the bottle now not suitable for the certain purpose. Some of the bottle is easy to pour but very difficult when to hold or carry it. In another word, it not agronomics to us. For the bottom part, the design must give high stability to the bottle.

The second problem is in our country, there only a little mold maker. Usually the mold of bottle will import from China. The price for each mold is very expensive and high cost invests if to buy a mold from the manufacture. Beside that it can localize the mold design in Malaysia for multi usage.

1.3 Objective

Project Objective

1). To design mold of bottom part for 4 liter bottle.

2) To assembly with a main cavity of 4 liter bottle.

1.4 Scope of Project

Project Scopes

- Design the concept of bottle.
- . Identify the suitable material properties according to the molds
- . Simulate the fabrication of the mold.

- . Fabricate blow mold (Bottom cavity).
- . Apply in to product fabrication and get the final product.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is discussing about the blow molding technique and extrusion blow mold. This to element is very important to know before the mold of the bottle can be produce. The other element that will include in this chapter is about the polymer material consideration. The main process to develop the mold also discuss in this chapter.

2.2 The principal of Blow Molding

A simple explanation of the principle of blow molding is a balloon. If we blow air into a plastic tube that is closed on all side except the point which the air enters, the tube will expand and take the shape of the mold that is around the tube. The process begin with a plastic resin hot tube called a parison or pre-form. The parison is placed within a split mold with a hollow cavity. The mold sides are then clamped together, pinching and sealing the parison tube. Air is blown into the tube, which expands the hot resin wall into the shape of the part. Once cooled the part is ejected from the mold and trimmed. There are several methods of blow molding plastic parts. However they all have 5 stages in common. They are plasticizing or melting the resin, parison or pre-form production, inflation of the parison or pre-form in a mold to produce the end part, injection of the part and finishing of the part.

The first four steps take placé in sequence and the five step is performed while the other four steps are cycling. Exceptions occur when a number of pieces are produced on the same machine, simultaneously, then the four steps may overlap. Most of the cycle time is taken up by the blowing and cooling step. The speed of the machine that melts the resin and makes the parison must be configured to conform to the blowing/cooling time [1].

2.2.1 Parison Formation

The parison or pre-form is formed by either of two techniques for melting the resin, extrusion or injection molding. For small, high production clear parts, injection blow molding would be the process of choice. For larger industrial parts the accumulator method is the process of choice and higher volume detergent or oil bottles would most likely be produced on a wheel machine.

2.2.2 Parison Dimension

Usually the diameter of the parison is nearly the same as the diameter of the container finish, although this depends strongly on bottle design. Containers with an offset neck or a handle require a wider parison. It is generally recommended that the ratio of the container diameter to the parison diameter not exceed four to one. The parison dimensions are not identical to the die dimensions, since the stress relaxation and elastic memory characteristics of plastics cause the parison to shrink in length and swell in diameter and wall thickness as it is being produced.

2.2.3 Extrusion Blow Molding

In extrusion blowing, a hot tubular is extruded continuously. The mold halves close which seals off the open end of the parison .See in the Figure 2.1. Air is then injected and the hot parison expands against the mold walls. After cooling, the product is ejected. Extrusion blow molding can produce article large enough to hold 10000L of water. Blow extrusion offers strain free articles at high production rate but scrap reprocessing is required. Controlling wall thickness is the largest disadvantage of extrusion blow molding. By controlling (sometime called programming) the wall thickness of the extrude parison, thinning is reduced. For a part requiring an extremely large body yet needing strength at the corner, a parison could be produced with the corner area much thicker than the wall [8].

losing of mold halves.   B) Injection of air

Figure 2.1 : Injection of air in blow mold

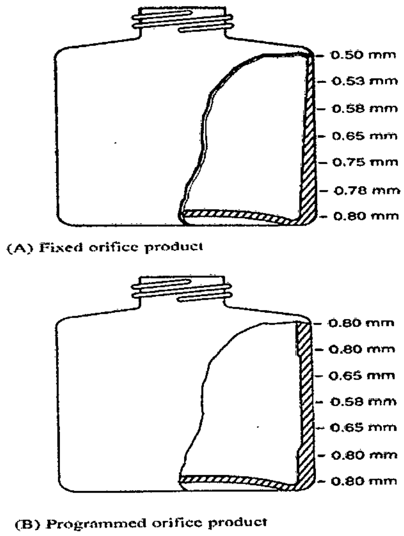

Figure 2.2 : Parison programming with die orifice

Hot plastic is fed into an accumulator and then forced through the die. A controlled length of parison is produced when the ram or plunger operates. The extruder fill the accumulator and the cycle begins again. The wall thickness of tube or parison will be controlled to suit the bottle configuration. This is done by using a die with a variable orifice as show in Figure 2.3. The advantage of extrusion blow molding are:

- Most thermoplastics and many termosets may be used.
- Die cost are lower than those of injection molding.
- Extruder compounds and blends materials well.
- Extruder plasticates material efficiently.
- Extruder is basic to many molding processes

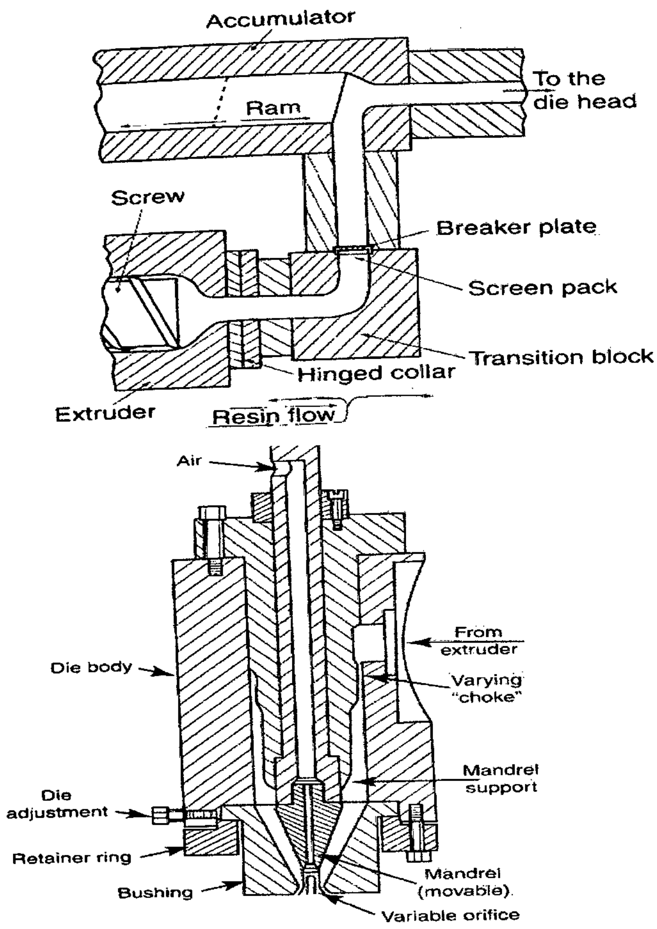

Figure 2.3: Die with variable orifice

Many different way of forming blow molded product have been developed .Each product may have an advantage in molding a given product. On manufacture both forms and fills the container in a single operation. Rather than compressed air, the product is forced into the parison.

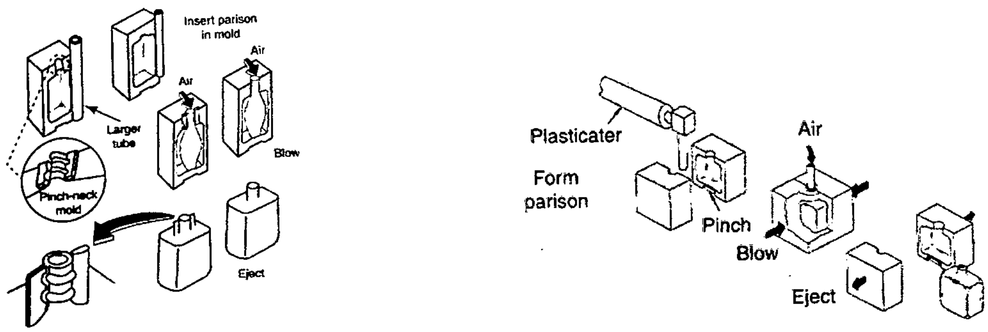

Figure 2.4 : Various blow molding proses

The flash (Excess material) is trimmed from the bottle neck and bottom, as well as from other areas that are pinched off, for instances to form handles or offsett necks the marks left from the removal of the flash serve as an easy means for identification of extrusion blow molded bottle. It typically appears as a rough area along the mold parting line, centered in the middle of the bottom and running half or so of the distances to the heel of the bottle.It is also possible on careful examination, to identify the roughness at the top of the finish, or on other areas where flash was trimmed. The flash, after being trimmed, usually is immediately ground up and feed back into the extruder at the controlled rate, mixed with the virgin resin [1].

2.2.3.1 Wall Thickness

The pin in the die may be activated by a timing mechanism called an automatic timing device, which raises or lowers the pin while the parison is being formed. This allow the resin to be extruded to form a parison that will have a more uniform wall thickness, matching the sagging which would otherwise be thin in the top area of the tube. When the mold closes the pin returns to its original position. It can be seen by moving the mandrel up and down during the extrusion of the parison. Additional resin (and increase of wall thickness) can compensate for irregular part configurations. A further method of controlling wall thickness of the parison is varying the extrusion pressure through a fixed die opening. Higher pressure causes an increase in output while lower pressure will causes less resin to be extruded [7].

2.2.3.2 Blow Up Ratio

Blow-up ratio is defined as the ratio of the average diameter of the parison. The maximum recommended blow-up ratio for the most application is 5:1 but 3:1 is preferable and the optimum result also depends on wall thickness. With conventional tooling the mold closing around the parison at the pinch off causes the parison to changes in cross sectional shape [3].

2.2.3.3 Wall Thickness and Melt Temperature

The melt temperature becomes critical when extruding a parison with varying wall thickness. Should the melt temperature be too low, the thick areas may end up as thin areas? This can occur because of the differences in stretch ability and heat retention in the thicker area [8].

2.3 Main Characteristic of Bottom Bottle Design

The bottom of a bottle typically only has one primary function (besides helping hold the bottle together) and that is to provide a flat surface for the bottle to stand upright.Bottle bottoms aren't flat because they need an arched structure to allow them to be stable on a flat surface. The bottom of a bottle is usually the thickest part, retaining more temperature throughout the production line. Because the bottom is hotter, it is also more fluid and has a tendency to sag, forming a shape like a spinning top which makes it unstable on flat surfaces. Giving a bottle an arched shape at the bottom means that if it does sag, it can do so without touching the bottom.

2.3.1 Main Characteristic of The Bottom Cavity (mold)

The blow mold may have a number of parts, counting its various insert, but it usually consists of two halves. When closed, these halves will form one or more cavities which will enclose one or more parisons for blowing. The two mold halves are usually alike. There are usually no male and female sections. Pinch off edges are generally provided at both ends of the mold halves. A blowing pin may have the additional function of shaping and finishing the neck inside.Both mold halves must have built in channel for the cooling water. Set of guide pins and bushings or side plates in both mold halves ensure perfect cavity alignment and mold closing. Accurate guiding devices in both mold halve reduce setup

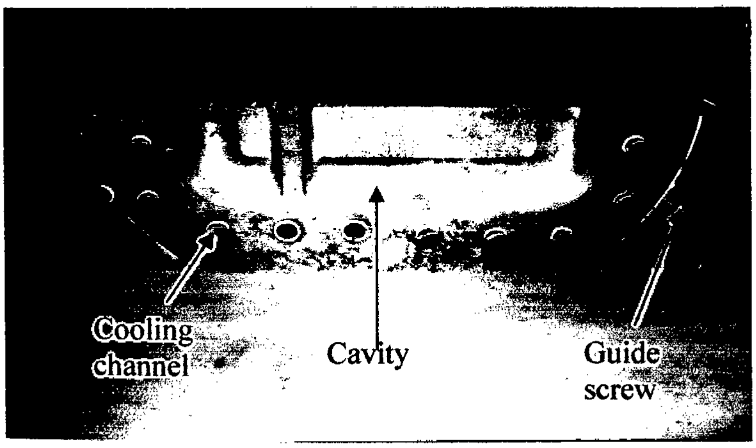

Figure 2.5 : Bottom cavity mold

2.3.2 Mold Materials

Because of the comparatively low clamping and blow pressures, the blowing mold need not be made of a high tensile strength material, with a possible exception of molds for very long production runs, say, hundreds of thousands or millions, which are sometimes made of steel. The predominant raw materials for blow molds are machined from aluminum billet, cast aluminum alloys, zinc alloys such as Kirk site, and occasionally, bronze. Beryllium copper because of its expense and difficulty in machining, is usually reserved for pinch inserts or cores where rapid heat transfer is needed. All these alloys are excellent material for blow molds.

Aluminum is the softest of the mold material in use and is most easily damaged in the shop. Furthermore, aluminum molds wear easily. On the other hand, they are easiest to machine. Aluminum and beryllium copper cast molds may be slightly porous, and occasionally, blow molders have experienced some permeability of such molds to the viscous resin. This may affect the appearance of the blow part. The remedy for this problem is coating the inside of the mold halves with a sealer .This will not affect the heat transfer between the resin blown against the mold and the mold walls.

Steel molds are heavier, more expensive, and more difficult to machine than those made of nonferrous alloys. Higher weight will mean more setup time in the molding shop. Moreover, the heat conductivity of steel is inferior to that of the three nonferrous mold materials. This results in a slower cooling rate and a correspondingly longer cooling cycle and consequently, a lower production rate for steel molds [6].

2.3.3 Important of Fast Mold Cooling

Different materials with consequently different heat conductivity at various point of the mold will result in no uniform cooling. This in turn might set up areas of stress in the finished piece, which would be susceptible to splitting in use. The blow mold halves must always be adequately cooled to solidify the part quickly, immediately after the parison has been blown out against the mold walls.

The cooling water may be tap water. If it has a high content of minerals which may settle in the narrow cooling channels, a closed system for circulating purified water should be used. Usually, the cooling water is recirculated, that is, reused time and again for along period. Sometimes it is partly recirculated and mixed with fresh tap water to maintain the desired temperature and to economize.

Cooling channel should also be as close to the (lengthwise or other) parting lines caused by the separation line of the two halves or by inserts. Parting lines will practically always show along mold separation lines. Cooling these areas will result in better finish of the piece along the parting line.

Larger molds may be equipped with several- up to three or more – Independent cooling zones. Generally, in the top or bottom areas, that is, around a bottleneck or the bottom pinch-off, or both, greater masses of resin are required than along the other areas. Such areas as well as thicker wall sections, therefore, often required additional cooling. Otherwise this section would still be viscous while the thinner wall sections have solidified when the piece is ejected. Cooling time is strongly affected by the extrusion melt temperature of the blow molding cycle. It has been experienced that an increase, or decrease, of 5°C in melt temperature can extend, or shorten, the cooling cycle by as much as one second [7].

2.3.4 The Pinch Off

Because of the comparatively high pressure and mechanical stress exerted on the mold bottom when (in the closing step) it pinches one end off the parison together, the pinch off in a nonferrous metal mold is frequently an insert made of hard, tough steel. The effect on the blown part always shows in the so-called weld line. The pinch off section does not cut off the excess parison tail.Its protruding edges cut nearly through, creating an airtight closure by pinching the parison along a straight line which make it easy later to break off or otherwise remove the excess tail piece. A high quality pinch-off of a thick walled parison is more difficult to obtain than that of a thin- walled parison .However much depends on the construction of the pinch off insert. The pinch off should not be knife edge, but according to some molders, should be formed by lands about 0.1 to 0.5mm. The total angle outward from the pinch off should be acute, up to 15° [6].

2.3.5 High Quality Undamaged Mold Cavity Finish

A high quality mold cavity finish and undamaged inside surface are essential in polyethylene blow molding to avoid surface imperfections in the end product. If the highest possible gloss of the end product is desired, the mold cavity should be vacuum assists for the removal of entrapped air. If other end product finishes are desired, the mold cavity should be finished accordingly [4].

2.4 CNC Milling machine

Milling machines have three feed axes: *X*, *Y* and *Z*. Two of these are generally activated by traversing the work table while the third axis is represented