Plastic Tuba Mute

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A. Introduction

The field of music includes many accessories that are currently made of some type of metal or wood. One such accessory that is currently hand-made of wood as well as rolled sheet metals is a tuba mute. The current manufacturing processes make the reproducibility of these limited with high costs. The purpose of this mute is to deafen and alter the sound emitted from a tuba. This accessory can easily be converted to a type of plastic so that it is lighter and cheaper to manufacture, making it cheaper for the customer to purchase. Tuba mutes are a hollow cone with the pointed end cut off. A tuba mute could be produced from plastics using a variety of different processes. The most beneficial process to create the mute is blow molding. Blow molding can easily produce the large hollow parts with a higher reproducibility than the current production methods.

B. Application of Blow Molding

Blow molding itself is a plastic-forming process that works well for the manufacture of simple hollow parts, i.e. a tuba mute. Other processes such as rotational molding, injection blow molding, and injection molding do not lend themselves to manufacture the tuba mute as easily and inexpensive. Rotational molding can create large hollow parts, but the cycle times are long and part definition is not usually exact. Injection blow molding is used when tolerance is an issue on a part, such as the threads on a bottle. Injection molding has high tooling costs and large hollow parts are difficult to manufacture this way. The part needs to be inexpensive and due to the high cost with all three processes and the manufacturability difficulties of rotational molding and injection molding these processes are less adequate than extrusion blow molding.

Extrusion blow molding lends itself to be the best processing method to produce the blow molded tuba mutes. In extrusion blow molding the capability to create large, low tolerance, hollow parts are easily accomplished. The molding cycle will be shorter than the time to create the parison because of the size of the mute, allowing for a continuous process. Also, the size of the parison will lend itself to sag. This is used to an advantage.
The larger diameter of the mute is at the bottom of the mold, with the thicker area of the parison, when blown out this will help with the thickness variation of the mute. In the application of creating a tuba mute, a large blow pin would be necessary to create the hole in the end of the cone like structure.

C. Design Details

This product was designed so that it could be robustly made at a low cost and as easily as possible. The tuba mute only needs a few things for it to meet the standards of most tuba players. The standards established for this tuba mute were to be light weight, durable, and able to fit into the bell of most tubas. A corking set will be included with the mute when sold. This cork set is used to customize the fitting of the mute into the bell. There are many different size tuba bells and a cork set would be less costly then producing a mold for each sized bell.

The overall size of the tuba mute is 27 inches in height with a bottom-larger diameter of 15 inches and a top-smaller diameter of 4 inches. This size is an average size for most tuba mutes, therefore allowing it to be used and customized with any size tuba. This cone shape allows the part to be ejected from the mold easily without secondary ejection. The wall thickness is expected to be durable enough at .080 inches.

Temperature concerns that need to be kept in consideration are based on how a user is going to use the product. Most times, a tuba mute will be stored and used at room temperature. The mute does however need to be able to withstand colder and warmer temperatures than room temperature because of travel. When traveling, it may see temperatures as low as 10°F and as high as 120°F. These design considerations will be considered when choosing the material.

The parison is extruded through a diverging die head and have a diameter of 4 inches. This would allow the parison to mold with a blow ratio of 1:1 at the top and a blow ratio of 3:1 at the bottom. It is known that the wall thickness on the radii on the edges of the part will have a thinner wall thickness. Large radii are designed into the mute to minimize the thinning.
The mold should be designed with 1-3\% shrinkage in mind. This is not a major design concern because the part is very robust and does not need to be exact. A draft angle is not an issue due to the cone shape of the part. Also, texture is not a main concern considering the current materials a tuba mute is manufactured with, i.e. wood and sheet-metal. Therefore, texturing is not necessary.

With all of these design concerns in mind High Density Polyethylene is the most logical choice as the material. Properties that helped in the decision making were toughness, high melt-strength, ease of processing, cost, and its recyclability.

D. Mold Tooling Details

The type of mold would be a standard aluminum blow mold. There will be regions such as the pinch off at the bottom of the mold and the blow pin area that will experience higher wear from continuous cycling with such a large parison. These regions should be fitted with inserts so that the mold has a longer lifespan and can be easily repaired. The mold should also include vents so that the large amount of air in the mold will be able to escape. Due to the large size of the part, it may require many vents to extinguish all of the trapped air.

The cooling of the mold will not be a difficult process. Due to the nature of extrusion blow molding not requiring ejector pins, like injection molding, the cooling lines can be routed to maximize the heat removal. This is also going to be exemplified by the high thermal conductivity of aluminum as the mold material.

The mold will not require a high gloss surface finish. This is due to the standards for finish already established with tuba mutes. Currently, the surface finish on the tuba mutes is quite poor. The lack of a high polish on the mold will help reduce cost but is also not critical since once the mute has been blown to size it will shrink away from the mold and will not attain the quality of surface finish provided on the mold.
E. Manufacturing Details

Some possible problems that may occur are wall thickness variation, stretching and tearing of the parison due to its size, and not blowing the part out completely. The wall thickness variation will be greatest in the deepest draw areas. This variation was discussed earlier and avoided almost completely with the sagging of the parison. The stretching and tearing of the parison is from the size and weight. To help with the sagging and tearing parison programming can be implemented. Also, a low shear screw will help to not degrade the material, keeping the melt strength at its highest. To help insure the part is blown out completely a higher blow pressure may be used.

The size of this machine and its costs may limit the costs of the mute. To help keep costs down, a company with a machine large enough would be pursued to manufacture the tuba mutes. Also the production life is small with 5000 tuba mutes produced per year. A company may only produce the mutes when they are demanded. This will also help keep costs down.

F. Conclusion

This part is very simple and straight-forward. It does not require a complex process and will be easily produced with extrusion blow molding. The tuba mute is ideal for the extrusion blow molding because of its simplicity and is a hollow cone shape. The part, at most, may require the parison programming as mentioned earlier.

G. Design Drawings

i. Hand Sketch

ii. Detailed Drawing

iii. Photo Rendering
Plastic Blow-Molded Tuba Mute

Wall Thickness: 0.08"