REDESIGN OF A STANDARD PACKAGING PEANUT

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Abstract

The design analyzed is a standard packaging peanut used as padding during shipping to ensure the safe delivery of goods. This product is validated by the ability of the extrusion blow molded packaging peanut to withstand a continuous load from an object that is on top of it. The redesigned packaging peanut is a more durable and less messy version of the current product making them reusable.

Introduction

The redesigned product will be a 1.27 cm long extrusion blow molded packaging peanut as shown in Figure 1. The product will have a 0.038 cm wall thickness and will be made out of a HDPE.

The goal in this redesign is to produce a reusable product. Currently the products are almost always immediately disposed of and the motivation for the design is to allow people to reuse the product. All current packaging peanuts are made of a foamed polymer and are very easily damaged. Often times when a consumer opens up a boxed delivery, it contains hundreds of broken packaging peanuts and many small pieces that have fallen off of the packing peanuts.

This design was created to allow consumers who receive boxed shipments with packaging peanuts will be able to reuse the product to send another shipment. The new design will also have less mess because of the sturdier material selection.

Statement of Theory and Definitions

Current Packaging Peanut Design

Currently packaging peanuts are made from a foamed polymer and are about 1.27 cm long as shown in Figure 2. The problem with the current design is the fragile nature of the material and the inability to easily reuse or recycle them. When a customer orders something to come in the mail or someone sends a package to another individual, the packaging peanuts that are currently used will break and fall apart during shipping. This causes the consumer to open a shipping box and pull out their ordered product and have many pieces fall out and create a mess. This in turn, makes the consumer want to discard the packing peanuts.

Proposed Design of Packaging Peanut

With a new design to allow less mess and reusability, consumers everywhere would be more likely to reuse or recycle the packing peanuts. This redesign will allow the same function of the original design, but it will allow a longer life. The new peanuts will be made out of a more durable material to allow longer use. They will also be made out of a material that can be easily recycled. This new design is a “U” shape and 1.27 cm long with a wall thickness of .038 cm.
Design Goals

First and foremost, the new design should be able to withstand the shipping process so they may be reused in another shipment. This will be achieved by a different material than what is currently used.

The new packing peanut must generate less mess. This is a problem with the current design, so this must be corrected by material choice.

The new packaging peanut will need to be recyclable as well in the case that the consumer does not want to reuse the product. This will be solved by material selection in the redesign of the new packing peanut.

This design must also be able to withstand the forces that it will experience in shipping. Any forces that the packing peanut will experience come mostly from the weight of the shipped object and any shifting that may occur. This will be tested using ANSYS software.

The new product needs to maintain its performance in a variety of temperatures. The product should perform the same in a temperature range of -40 to 60°C. This range will account for temperatures in the most drastic climate conditions where packages are shipped.

Life expectancy of the product should be at least 5 shipments. The longer the lifespan of the product, the more drastically the cost savings will increase compared to the current packaging peanuts. Long life expectancy will be a key attribute in the advantages of the new product.

Competitive Items

The competitive item for the proposed design is a foam polymer packaging peanut that is about the same dimensions of the redesigned product. The major disadvantage to the current design is the fragile nature of the material. This product is almost never reused because of this. Packing peanuts currently are also made assuming a one time use so they are commonly discarded. The current product is not often recycled as well.

Description of New Process

The process of creating the new product will be extrusion blow molding. Extrusion blow molding is a similar process to injection blow molding but there are several key differences. Figure 3 shows the formation of a part using extrusion blow molding. Extrusion blow molding is the most common method of producing hollow plastic parts.

The first stage of the extrusion blow molding process is the extrusion stage. Material is fed into the extruder from a hopper that allows gravity to force the material into the extruder. Once in the extruder the screw rotates to move the material as well as heat it through shear heating. Shear heating is heat created from friction between the polymer and the metal components of the screw [2]. The screw is responsible for conveying, melting, and pressurizing the material so it can be forced through the die and mandrel [3]. This process melts the material and allows it to be forced through the die and mandrel. The die and mandrel are responsible for creating the hollow parison that will eventually become a part. The die is the outer component and the mandrel is the inner component responsible for forming the parison shape. There are two main categories of die and mandrel, converging and diverging. Figure 4 shows examples of each die and mandrel design. The material is extruded for a set amount of time so the parison will extend past the bottom of the mold enabling it to be pinched shut when the mold closes. Processing parameters characterize the shape and thickness distribution of the parison.
The second stage of the process begins when the mold closes. The mold closes and pinches the parison at the top and bottom allowing the inside to be pressurized and allow the parison to stretch. A blow pin is inserted into the parison and air is blown to stretch the parison into the shape of the mold. The blow pin is typically inserted into the opening of the bottle. The material will begin to cool when it touches the mold wall. It is critical that the air pressure stays on until the part until it is completely cooled. This will allow the material to stay against the mold wall and cool completely and eliminate any warpage that may occur. After the part is entirely cooled, the mold will open and the part is ejected. Ejection systems, such as robots, sometimes can aid in quickly removing the part from the mold to lower cycle time.

Recyclability

Recyclability is the ability to process a material for reuse. Recycling is important in modern waste reduction and is beneficial to the environment. Plastics make up almost 13 percent of the municipal solid waste stream, a dramatic increase from 1960, when plastics were less than one percent of the waste stream [4]. The largest amount of plastics is found in containers and packaging. These reasons are why people are looking for recyclable products.

Material

ExxonMobile HDPE HD 9856B blow molding grade resin was chosen for the new product. HDPE has good durability, making it useful for packaging. HDPE is also easily recycled. HDPE is a commodity resin making it relatively inexpensive as well.

Design Validation

The teams’ proposed part design will be tested evaluated in many different ways. For the product to be considered successful, the product must function properly under all the testing conditions. In general, the product must withstand the applied load from any product that may be padded with the packing peanuts for shipping, it must keep the product safe and secure during shipping, and it must be reusable for a longer period of time than that of the current packaging peanuts. If all of these specifications are met, the product will be considered successful.

To prove that the product can meet the above specifications, several tests must be completed. The first test will be a virtual simulation using ANSYS to evaluate the loads that the products will undergo. The next several tests will be used to evaluate the durability and reusability of the product. An impact test will be completed to test for the impact resistance of the product. A chemical resistance test will be completed as well.

ANSYS will be used to evaluate the loads that the product will put under during normal use. The part will be evaluated using the maximum loads during normal use. This will be one of the parts on the bottom of the box receiving the most force from a product being shipped and the force of the other packing peanuts pushing down on it. This program will evaluate both crushing resistance and the ability of the packing peanuts to securely hold a product in place if it is to shift during transport.

Impact testing is important for the product because it will be a part of the reusability of the product. It must be able to withstand an impact for several reasons. Firstly, it must withstand the impact if a product is dropped on top of one of them. If it completely fails, then the contents of a package may not be safe during shipping. The test will be to simulate someone dropping a 2.26 kg product on a packing peanut from a height of 1.5 meters

The packaging peanuts need to have good chemical resistance on their own. This could come in the form once again of many household cleaners. A wide range of household cleaners must be able to be applied and the packaging peanut must not be compromised. This is important in the reuse of the product.

Design Procedure

The steps that were taken for the product design process procedure are as follows; preliminary design, material selection, detailed design and testing. These building blocks are essential for the creation of a successful plastic part. Each one of these blocks will be described below.

The preliminary design was created by examining the problems of current packaging peanuts. Current designs were critiqued for their reusability factor and performance. The longevity of the product was able to be improved by switching from the current foamed polymer to a HDPE material.

Since the packaging peanuts would be subject to many household cleaners, a semi-crystalline material was selected. This is due to the crystalline structure that allows the chains to fold into a denser matrix. Chemicals have difficulty impregnating the crystal structure. Semi-crystalline polymers can offer longer life to products coming in contact with chemicals.

The material that was chosen was an extrusion grade HDPE that had a melt index of 0.46 grams/ ten minutes. This low melt index value indicates that the material has high melt strength and can be extruded easily. The HDPE
fills the chemical resistance requirements as well as providing good processability.

The detailed design was created from reviewing the General Electric blow molding guidelines. The original design was modified to coincide with the General Electric guidelines. The final design was then analyzed using ANSYS software.

ANSYS provided feedback on how the packaging peanuts would withstand a load during shipping. The product was reviewed and modified to allow the parts to perform properly.

**Presentation of Design**

The design of the packing peanut is a simple easy to mold shape. This new shape can also efficiently support a load.

The design was validated using Finite Element Analysis on a program called ANSYS Workbench. This program allowed an estimated 2.26 kg force being applied to a packing peanut. The results analyzed within ANSYS were Von Mises Stress and deformation. Von Mises Stress shows the equivalent stress on the plastic from all forces. This is necessary to look at to ensure that the product will not fail from the applied load. Deformation shows how the load will deform the product and the magnitude of deformation.

The newly designed packing peanut will be able to be recycled more easily than the current design. The new design is HDPE and will be easily recyclable for the consumer and recycle plants as well. HDPE makes up most of the plastic being recycle already and creating the packing peanut from this material will be beneficial to the environment and recyclability of the product.

**Conclusion**

With the new design, the product will be easier to use and reuse, have a longer life, and be easily recyclable. This will easily be able to replace the current design and material of packaging peanuts.

The proposed design will offer a less mess and will be able to be more easily reused. Many people immediately throw current packing peanuts away to go to the landfill. The new design will allow for many to reuse the packaging peanut because of the sturdier design. Also, this allows for better recycling because of the widely recycled HDPE material choice. This creates a significant advantage over the current design.

The packaging peanuts are to encounter a estimated 2.26 kg during their use. They are designed with a thick enough wall to endure this load with minimal deformation. The bottom most packing peanuts are the ones that will see the most weight, therefore the 2.26 kg estimate was derived from this situation. This 2.26 kg force was simulated in ANSYS and resulted in minimal deformation and relatively low stress results.

The total deformation from the load applied on the packing peanut was 0.131 cm. This minimal amount of deformation shows that the design is sturdy enough to withstand the loads the part will encounter during shipping. Figure 5 below shows the deformation results of the loading simulation from the ANSYS software.

![Figure 5 – Total Deformation](image)

The Von Mises stress results acquired from ANSYS show that the packaging peanut can withstand the stress that comes from the applied load. The part will experience a maximum of .1034 Mpa of stress when the load is applied. This can be seen in Figure 6 below. At .1034 Mpa, the part will still be able to return to its original shape once the load is removed.

![Figure 6 – Von Mises Stress](image)

**Future Work**
There are many steps that need to be completed before the product will be ready for market. The first and most important is to create a working prototype to see if the product will be able to function properly. Secondly the manufacturing of the mold to create the product needs to be completed. Only the design was completed, but not the actual machining of the mold. All of the testing to ensure the product will function properly once on the market will need to be completed. These include, impact testing and chemical resistance testing both to be completed at a range of temperatures.

Acknowledgements

Mr. David Johnson was a valued asset in understanding and implementing the ANSYS software. Mr. Jon Meckley played an important role in understanding what information should be included in the report.

References

Appendix

“Optimizing parison thickness for extrusion blow molding by hybrid method” is a journal article published that goes through the whole extrusion blow molding process. It is a good source for the basic understanding of the process.

The source was used in the report to allow the audience to have a basic understanding of the extrusion blow molding process. It is key that the audience understands how the process functions to understand any of the results that were presented.

“The Definitive Processing Handbook” is a handbook that goes in depth into every major and some minor plastics processing methods. It is a good source for everything about the extrusion blow molding process and what is happening during.

The source was used to explain shear and shear heating in plastics as they are processed. This is important for the audience to understand to allow a better understanding of the results. It allows the reader to gain background knowledge and to know that this phenomenon exists when processing plastic materials.

“Practical Guide to Blow Moulding” is a document that is good to reference when knowledge about all common types of blow molding is needed. This book contains a lot of in depth knowledge about extrusion blow molding that pertains to the study.

The source was used to explain how the material travels through the extrusion blow molding machine. It is important for the reader to understand this to help grasp the basics of the molding process. This, in turn, allows the reader to have a better understanding of what is happening in the machine during processing and in the results of the study.

"Plastics" is an excellent source for knowledge on all things plastic. This includes the process of extrusion blow molding. It goes in depth about everything material related as well.

The source was used to explain recyclability of plastics. It is important to inform the audience about how plastics are recycled and how the recycling stream works. This is important to the audience for easier understanding about what the team means by recyclability.

“Polyethylene” is a good source for information about polyethylene. It discusses not only material but explains, in depth, the common forms of polyethylene.

Among these are many extrusion blow molded polyethylene parts.

The source was used for its knowledge of polyethylene materials. It gives the reader good background information on the material and why it is being used for this product. It also showcases the flexibility of the material to the reader.
**ExxonMobil™ HDPE HD 9856B**

High Density Polyethylene Resin

**Product Description**

HD-9856B is a HDPE blow molding resin designed for high performance packaging applications. Containers made from HD-9856B exhibit a unique combination of stiffness and environmental stress cracking resistance. These properties, coupled with excellent processability on both continuous and intermittent equipment, afford significant lightweighting and/or fast-cycling potential in many applications. HD-9856B does not contain any antistatic.

**General**

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**Revision Date**

March 2019

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**Resin Properties**

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**Molded Properties**

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**Legal Statement**

Contact your ExxonMobil Chemical Customer Service Representative for potential food contact application compliance (e.g. FDA, HFPB).

This product is not intended for use in medical applications and should not be used in any such applications.

**Processing Statement**

1. Values are typical and should not be interpreted as specifications. Values may change with future development.
2. All molded properties were measured on compression molded plaques.
3. Bulk Density: 585 Kgm/m³ (35.6 Ibs/ft³)
4. Flexural modulus tested using Procedure A (1”x2”x0.125”), tangent calculation.
5. ESCR tested using Condition B, 100 % Igepal.
6. HD9856B has NSF recognition. Contact your ExxonMobil Chemical Representative for details.

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