EBP 203

PLASTIC MATERIALS

GROUP ASSIGNMENT 1

PLASTIC COMPOUNDING REPORT

GROUP 4

FULL REPORT

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i) Polypropylene Plastic Bottle

The base plastic that our group had chosen is Polypropylene (PP). The product that we concerned to produce is the high durability polypropylene water bottle.

Polypropylene is one of the polymers that are frequently used in the plastic industries. We did choose the polypropylene due to its good mechanical properties and heat resistance. The most importantly, polypropylene's manufacturer could gain benefits through them because of the low cost and the ease of the plastic processing. Besides, polypropylene can help to reduce the pollution if we walk the 3R Campaign because it has the fully recyclability. Its main downside is the low impact strength, which it can be improved by some toughening modification. For a toughening modification or the upgrade of the quality and the properties of the plastic product, the thermoplastic or elastomers such as fillers, additives are used as modifiers to mix with our base plastic which is polypropylene.

Phthalate ester as the plasticizer

There are several types of fillers and additives/masterbatch that our group use to produce the polypropylene water bottle to enhance the durability and the quality of the product. One of the additives that we use is plasticizer. We did use the phthalate esters as the plasticizer. The presence of it are used to improve the toughness or the plasticity of the polypropylene water bottle and they are only used to promote or ease the production of the polymer. Besides, it improve the material's processibility in the mean time to make the polypropylene rigid and hard. So the water bottle could survive if it accidentally hits the floor or in the other rough situation.

Butylated Hydroxyanisole as the antioxidant

Antioxidant do presence in our polypropylene water bottle is to protect the polymer from environment to produce the high durability polypropylene water bottle. Besides, the antioxidant inhibit the atmospheric oxidation and degradation of the product when it is expose to the oxygen. When the polymers are exposed with oxygen, it will easily oxidized and degraded. Thus the polymer will produce severe chemical compound in our water. Those compound will affect the human's health

and will lead to the worst case. That is why antioxidant is used in this production to prevent the degradation of the base plastic.

Hindered amine light stabilizer (HALS)

Polymers in general and especially polypropylene are highly susceptible to the degradation processes when exposed to the oxidant and ultraviolet light or atmospheres. The industrial formulations therefore require the addition of the UV stabilizer to maintain the physical, mechanical and thermal properties for long periods of the plastics product exposure. Hindered amine light stabilizers (HALS) are one of the most important thermal or light stabilizing agents of polymeric material. They are broadly available with low toxicity and low cost. In the meantime, they are compatible with a wide variety of commercially relevant polymeric materials. Thus, the beverages in our product is safe to consume even if the polypropylene water bottle is exposed under the light.

Struktol TPW 113 as the lubricant

In order to improve the flow of the production of the polypropylene water bottle, the lubricant are added. Lubricant do help to reduce the heating and the shear between two surfaces while the polypropylene being manufactured. Even though that the polypropylene is a good heat resistance, the lubricant could help to prevent their response to the temperature or heat that generated by friction can affect the processing output. The Struktol TWP 113 is a functional lubricant package. The lubricant is designed to have the superior filler wetting and dispersion characteristic in a wide range of polymer systems. It provides major improvement in processing and increase the production rate for filled compounds.

Sulfoselenide and Cadmium yellow as the colourant

Colourant and pigments have been widely used for their attractive colour, high heat resistance and excellent fastness properties. Pigmentation is the most frequently used method for modifying the optical appearance of polypropylene (PP) for design, styling and functional purposes. To make the polypropylene marketed to the consumer and the buyers, the appearance or the looks of the product are the most important besides having the best durability to attract them to purchase this plastic product.

Calcium carbonate as the fillers

The aim of the presence of the calcium carbonate in to the polypropylene water bottle is to improve the performance of the plastic whether while being manufactured or being consume by the buyer. It helps the improvement in the heat deflection temperature, impact strength, and stiffness in the final product. In the meantime, fillers is used to reduce the manufacturing or production cost of the product. The displacement of the plastic in the product allows for significant raw material cost saving by replacing it with the lower cost fillers, calcium carbonate. Besides, the calcium carbonate can guaranteed the sustainability of the polypropylene water bottle its self.

Antimony trioxide as the flame retardant

Flame retardant is one of the additives that make plastics resistant to the flame and it is used to reduce the general risk to life besides limiting damage to property. The flame retardant will help to ease the manufacturing process so that the final product is not vanished by the heat. The antimony trioxide will help to protect the plastic product from degradation and decomposition when exposed to high temperature and heat to maintain its durability during the manufacturing or after used by the buyer. Besides, the flame retardant will surely ensure the polypropylene water bottle will remain its shape, strength, durability and safety while processing and producing the base polymer until we get the final product.

ii) Polypropylene Plastic Bottle's Formulation

Ingredient	Usage Level (parts per hundred)
Polypropylene	100.00 parts
Phthalate esters	2.5 phr
Butylated Hydroxyanisole (BHA)	1.0 phr
Hindered amine light stabilizer (HALS)	1.0 phr
Struktol TPW 113	1.5 phr
Sulfoselenide and Cadmium yellow	0.5 phr
Calcium carbonate	2.5 phr
Flame Retardant	2.5 phr

Compounding is defined as the process of incorporating additives, modifiers into PP for achieving uniformity on a scale appropriate to the quality of the articles subsequently made from the compound. It is also known as hot or melt blending.

Polypropylene (PP) sold for commercial consumption has some types of additive. We will define 'unmodified' PP as representing only those additives without which PP could not be viably processed in commercial extruders, moulding machines and the like. Accordingly, we will define 'modified' PP as that which has additives designed to provide special environmental, processing or physical properties.

We use antacids (calcium carbonate 2.5 phr) as fillers additives to unmodified PP. Calcium carbonate is required to neutralize catalyst residues that could otherwise form acids detrimental to the converter's equipment. The second basic additive to PP is antioxidant（Butylated Hydroxyanisole 1.0 phr）. This is required, as a minimum to protect the polymer from chain scission during processing and ageing.

In addition to process stabilizers, additional heat stabilizers are used to improve the long term heat ageing of PP. In this case, UV Stabiliser (Hindered amine light stabilizer HALS), flame retardants (Antimony Trioxide) are targeted to affect a certain class of properties. Antioxidant will afford improvements, with the choice dependant

on the environment requires. An important parameter is the continuous use temperature. Typical PP homopolymer with moderate stabilization has a continuous use temperature of 105 deg. c. Special stabilization can increase that temperature to 125 deg. C. Phthalate esters is used as plasticizers to be added to improve toughness of Polypropylene.

The UV resistance of unmodified PP is poor. However, stabilization can improve its performance significantly. Typically, hindered amines-can be used in combination with other appropriate additives to deliver service life or more than 5 years outdoors in both pigmented and non-pigmented products. This can be done without affecting the appearance of a component. In addition, if a black appearance is acceptable, special grades of carbon black at levels above 2% can provide a service life of more than 20 years.

In addition to the stabilized applications listed above, there are many specialized uses of PP that require low levels of stabilizers. Among the applications for these stabilizers are the protection of PP components in radiation sterilizing environments, the prevention of colour development in various environments and the stabilization of wire-coating resin against the effects of copper. Each of these unique applications requires specific additive packages. In this case, we add colourant like cadmium yellow and red pigments. Lubricants (Struktol TPW 113) is used during the process of injection molding.

Ingredient	Comment
Polypropylene	100.00 parts
Phthalate esters	2.5 phr used as plasticizer is added to improve toughness of polypropylene water bottle
Butylated Hydroxyanisole (BHA)	1.0 phr used as antioxidant is added to prevent the degradation of the product
Hindered amine light stabilizer (HALS)	1.0 phr used as UV stabilizer to withstand oxidant and ultraviolet light
Struktol TPW 113	1.5 phr used as lubricant to improve the flow of processing.
Sulfoselenide and Cadmium yellow	0.5 phr used as colourant to beautify the product
Calcium carbonate	2.5 phr used as fillers to improve performance of polymer
Antimony Trioxide	2.5 phr used as flame retardant to withstand high temperature.

iii) What are the issues that will encounter during process?

- Quality of mix

Maintaining a consistent quality of mix is very important to prevent various quality problems downstream. Controlling the total work history during mixing is very important to maintain low batch-to-batch variation. Also, the order of addition of ingredients, the mixing scheme, types of mixer, rotor design, rotor speed, even or friction rotor speeds, water temperatures, type of cooling system,tip clearance, and fill factor, all have significant effects on the state of mix.

- Uncured elasticity

Uncured compound elasticity typically decreases with increased work history during mixing. In compound development, different elastomer bases will impart different degrees of nerve to a given compound. Different elastomer bases may also break down at different rates during the mix. If the compound breaks downfaster during the process, it may ultimately possess less nerve.

What are the issues that will encounter after the process?

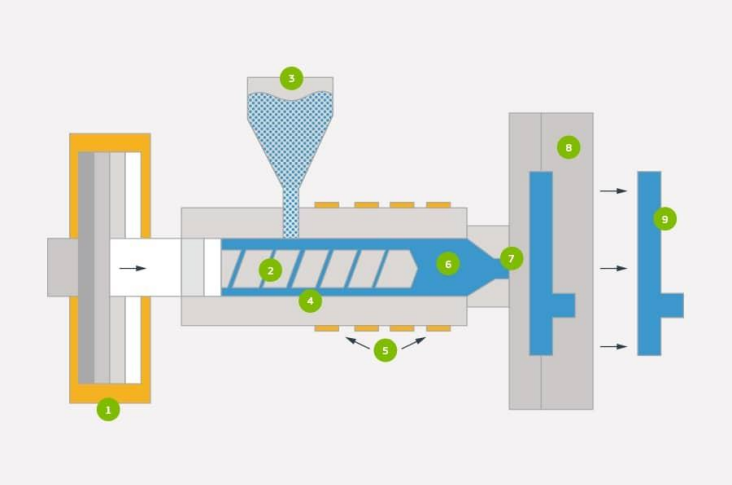
- Discoloration

A common cause of discoloration is leftover pellets in the hopper or residual resin in the nozzle or mold from a previous production run. This defect typically affects the appearance of the part without reducing its strength. Poor thermal stability of the coloring agent or improper mixing of the masterbatch are other potential causes.

- Warping

Plastic can warp during the cooling process when uneven shrinkage puts undur stress on different areas of the molded part. This undue stress results in bending or twisting of the finished part as it cools. One of the main causes for warping in injection-molded plastic similar materials is that cooling happens too quickly. Often excessive temperature or low thermal conductivity of the molten material can worsen the problem.

iv) Processing method : injection molding



Polypropylene resin is commonly a low-density, opaque polymer with superior thermoforming and injection molding properties. The polymer also have high flexibility make it can be molded into variety of shapes, making it useful for plastic injection. Injection molding is a method to obtain molded products by injecting plastic materials molten by heat into mold, and then cooling and solidifying them. This method is suitable in the making of this type of polypropylene bottle because of a few reasons.

- Fast production and highly efficient: Injection molding can produce an incredible amount of part in an hour. It depends on the size and complexity of the mould, many industries also use this method.

- Flexibility in design: Exceptionally high pressure is added to the moulds themselves. As a result, the plastic inside the molds is pressed harder and

allows the component to be imprinted with a huge amount of detail and to create complicated or delicate forms.

- Low scrap rates: Injection moulding produces very little post-production scrap relative to traditional manufacturing processes. Any unused or waste plastic, however, can be reground and recycle for future use.

- Good colour control: Plastics parts can be manufactured in any required colours with the use of masterbatches or compounding without losing it colour needed for the product production.

- Reduced finishing requirements: There is often very little post-production work required as parts usually have a good finished look upon ejection, thus also reduce time taken for the process of the product.

- Enchanced Strength: When plastic injection moulding material, it is possible to use fillers in the moulding material. These fillers reduce the density of the plastic whilst it is being moulded, and can help add greater strength to the completed part.

v) Conclusion

The high quality of the polypropylene water bottle is based on the chosen polymer, fillers and the additive or the masterbatch itself. Those substances and compounds do help the final product achieve its best condition and the best quality. Other than that, adding the correct amount of additives and fillers also will make the formulation to become perfect and will help to lower the defects that will occur. Actually formulation was very important in the making of a product to achieve their needed characteristics and properties. Furthermore, the issues that may be occurred in the making of the product were also needed to be listed, Thus precaution will be make in order to prevent it. Lastly, the processing method were choosen to be injection molding because it was the best processing method to process a product with such characteristics and properties.

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Discussion