Blow Molded Utility Pole Transformer

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Abstract

The growth of the blow molding industry is at the discretion of prospective applications that best utilize resources that provide value added engineering to a plastic part; one that can potentially be shaped most cost effectively through this particular process. The key to any product development is to take advantage of a particular process, in this case blow molding, in order to achieve the most desired result from the respective manufacturing system.

The potential for blow molding a utility pole transformer unit lies in the very advantages of plastics as a whole, as well as blow molding. The hollow housing of a transformer could potentially be molded utilizing keen cost initiative and function to better provide the necessary tools needed to transport electrical energy from one circuit to another through these inductively coupled conductors.

Despite not typically being thought of as a primary mode of entering the electrical industry, the blow molding of a transformer made of plastic could easily be made conductive or insulated given the very nature of plastics. Plastics are very much a large part of the electrical industry due to their extreme electrical insulation and ease of becoming conductive. The molding would boast high production volumes of transformers that are seen on every mile of every street. Molding a transformer from plastic would provide very desirable value added engineering by eliminating the need for welding and fabrication of minor features onto the unit by being able to add the features all in the same blow molding cycle.

The potential application could greatly increase the life of a transformer unit by efficient utilization of a material that is very highly resistant to the conditions. Impending design from recycled materials would also provide for a superior public perception and efficiency.

Introduction

The product to be molded presents a very robust, cost effective way of blow molding a utility pole transformer, namely the housing of the transformer. Essentially an electrical device, a transformer’s means is to transfer electrical energy from one circuit to another through inductively coupled conductors or the transformer’s coils. The purpose of the described blow molded plastic part would be to provide a more efficient way of protecting the electrical devices/ coils from the conditions of the environment by acting as a housing.

The part will be shaped in such a way as to reduce the accumulation of water and corrosive materials in a way unlike standard transformers. With the inherent capabilities of extrusion blow molding and plastics processing, the housing will have great opportunities to utilize a more forgiving and optimized design.

The way that current transformer models are manufactured, they require extensive bending and forming of the metal being used and do not allow for very complex shapes or integrated features. The utilization of blow molding will completely change the design and manufacturability of a very common product that most just take for granted that it will always be the same and never change. It is the scope of this blow molding implementation to change that.

Not only is blow molding perceived to be the best process for the proposed product, with careful consideration and planning, the product would likely become the more preferred and money saving method of replacing superseded designs.

Application of Blow Molding

The challenge for this particular application of blow molding is simply the justification of using the respective processing method. However, the satisfaction of persuading others to believe what is presented as true and the best way to do something is often the most rewarding aspect of an idea. As far as using blow molding to produce a more effective means of housing a transformer’s coils on a utility pole, it is very clear.

The application will utilize not only a better processing justification, but also a greatly improved material realm to choose from. The validity of the innovative widget starts with material and transpires along with the molding technique.

The first decision made was to use plastic as the workable substance. Plastic is not only one of the best commodities for outdoor performance, but also boasts a very simple means of formation to nearly any complex shape imaginable. It is the abilities of
plastics that make this replacement of metal even more desired.

The advantages of using plastic in this particular application are numerous. The potential for weight reduction, thermal and electrical insulation, corrosion and chemical resistance, high volume production, and energy savings are just a few of the unsurpassable characteristics of the materials nature.

With the decision to use plastic for any application comes the question of what processing technique to use. The benefits of each method change greatly from product to product and require a very keen skill set to contrast subtle differences in the systems. Based on the hollow nature and integrated capabilities of extrusion blow molding, it is the clear winner for the transformer.

The key to justifying the extrusion blow molding process is directly related to the value added engineering capabilities of the process. By extruding a parison wider than the width of the transformer during molding, the handles, connector joints, and other protrusion and features on the side of the part can all be molded as a whole. This greatly reduces the cost and complexity of secondary fabrication of the transformer in standard practices.

Potential to introduce the coils inside of the parison during molding would allow for a one time, simple approach to producing several finished products in a short amount of time. An advantage of extrusion blow molding is the ability to have continuous formation of the parts with systems such as parison transfer, multiple-mold, or rising mold. With these capabilities as well as inexpensive tooling and maintenance, this process is tough to beat.

Simply put, extrusion blow molding is the cheapest way of producing a large production volume of hollow parts with the biggest growth relating to integrated and replacement products.

**Design Details**

With the use of extrusion blow molding comes several critical design parameters that must be addressed. Careful considerations of the part design as well as the material are essential to a successful molding process.

Prior to design, the part requirements as well as the preferences should be considered. Most of the decisions take place after the data collection and product specifications are mapped out. The material selection is a foundation that the design and process exemplify as one of utmost importance.

The premiere material for such an application is a polyolefin. A high density polyethylene would likely demonstrate the exact necessities for the blow molded transformer. The resistance to corrosion and chemical attack along with maximum opportunity for recyclability make this resin the one of choice. Melt strength and a wide molecular weight distribution are also factors to consider in blow molding, and HDPE possesses both as well.

The key to the devise is to design for robust manufacturability. Requirements for a part molded of a polyolefin may entail special consideration with surface finish, draft, shrinkage, and blow ratio.

Normally polyolefins require a rougher surface finish in order to allow proper venting and ejection from the blow molded tool. Additionally, the shrinkage of HDPE is considerable compared to other types of plastics and may need special attention when applying a shrink factor to the molded part in order to keep the desired size. Interior corners of the model should have large radii to reduce the risk of filling problems as well as proper design as to not create deep draws and undercuts in the tool.

A product with multiple or co-extruded layers may prove to be desired as many properties can be added to the resin through this implementation. Barrier properties and recycled materials can easily be added as layers to an extruded parison to prevent water penetration and reduce cost respectively.

Keeping a uniform wall thickness in a blow molded part is easily the most challenging aspect of the process due to parison sag, but with careful concern can be corrected effectively. Blow ratios should also be limited to 3:1 to decrease potential of damaging the polymer chains during molding; however, increased ratios can be used if pre-blow air is introduced to the parison rather than blowing it out all at once.

Lastly, design for success means maintaining a structural design that is not prone to warpage and
By designing in ribs and crowning in surfaces, as well as tack-off regions for support, a more robust design can be achieved with very minimal effort.

The moral is that each product presents different degrees of challenge. A judgment must be made as to what level of up front engineering should be applied vs. risk. One has to be careful of diminishing return.

**Mold and Tooling Details**

As previously described, many parameters can be introduced or anticipated before the actual mold is produced. For the purposes of the transformer, an extrusion blow mold would be used. An aluminum tool would allow for great thermal extraction/conductivity and quick cycle times since a strong mold material like steel is not required with the lower clamp tonnages used in this process. Low pressures to form the plastic result in this low clamp tonnage.

The mold would likely consist of a cast aluminum that may or may not have some sort of steel or beryllium-copper plating at high stress regions like the pinch land. Also, cast aluminum is highly regarded as the premiere tooling material used with large blow molded parts which would include the transformer.

Cooling lines in an aluminum cast mold for a transformer would undoubtedly include copper tubing that had been bent into the respective shape of the part. This will minimize and allow for a more robust cycle.

Surface finish for PE requires a sand-blasting, and potentially may need venting to capture all the details of the transformer. The venting for this tool would likely exist as parting line and cavity pin vents in small features. The most critical dimension of the tool for weld strength at the parting line would be the flash pocket depth. Since the integrity of the transformer lies in the hands of the housing being able to prevent and leaks, this dimension could make or break it.

**Manufacturing Details**

Molding requirements for a transformer could potentially be very difficult and would possibly be the deciding factor of the application. To be able to mold all of the necessary features needed for a utility pole transformer is an advantage of the process but also a very difficult thing to do from a manufacturing standpoint. With proper technique, a very innovative method could be established for such a product.

The over-molding of some of the metal connectors and blowing around the coils would likely be a complex but rewarding exercise. If the model was unable to be molded around the electrical devices that the housing protects, a secondary lid action could always be introduced to the design, which would also allow for access to the inside of the housing.

**Conclusion**

Pole mounted transformers are built to take the harsh climate conditions they are exposed to. These tanks are shaped in such a way to reduce accumulation of water and corrosive materials. By blow molding the transformer unit out of HDPE, the design will only become more reliable and robust. Protective coatings are generally applied to the tanks to reduce corrosion, and in the coastal regions tanks are zinc sprayed or are made from steel. The implementation of a blow molded plastic housing would eliminate several underlying issues of current models seen every day. New efficiency standards could easily be set for the millions electric transformers on utility poles around the nation.