Plastic Component Performance Role In A Consumer Product Fire

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Background

In most US households there are all types of consumer products used every day that add value to people's lives. The product performs a chore or household task more efficiently, adds entertainment value to their lives, or delivers a basic necessity such as heat. Most of these products use some form of energy to produce the desired function. Electrical energy allows the user to manipulate a product’s functions through a control system. Electricity is also used to operate electrical devices such as motors, or, produce heat. Combustion of a fuel, such as natural gas, can also be used as a heat source. In some cases, the combination of electricity and a fuel source are used to produce a function. Water heaters, clothes dryers, and furnaces are examples of dual energy appliances.

Independent of the energy source used to run a product, when energy is used, a risk exists that this energy produces unintended outcomes. One, but not all, of those unintended consequences is the risk of the product catching fire. If a fire does occur within a product, from a **product safety** standpoint, the role of the product's enclosure must be to contain the fire. This enclosure strategy is required to prevent the product fire from propagating to the adjacent area and eventually evolving into a house fire, which has potential life threatening consequences as well as significant property damage. Not all consumer product producers are necessarily aligned with the need for this enclosure strategy.

Clearly the product is expected to perform the necessary functions to add value to the consumer, but must also satisfy other requirements the user typically demands. Some of those demands include styling, which makes the product aesthetically pleasing, cost, and the often unrecognized user requirement, the product is safe.

From a manufacturer standpoint, styling and cost can be managed most effectively through the use of plastic materials for either part or all of the product enclosure design. However, plastic can have performance limitations when it comes to containing a fire.

There are two unique classes of plastic materials, thermosets and thermoplastics, each of which has its advantages and limitations

Thermosets

If plastics are used, thermoset plastics offer the greatest potential for containing a fire. During the manufacturing process to make components out of this material type, a chemical reaction creates cross linked bonds in the material. This chemical bond cannot be reversed, which produces high temperature resistance, no true melting of the material, and the inability of a thermoset to ignite if exposed to a sustained flame. All excellent properties for an enclosure component to contain an internal product fire. Unfortunately, thermosets are not recyclable and components made from this material type tend to be more expensive than a thermoplastic equivalent. This material type can restrict styling options, and are typically very brittle, which make thermosets susceptible to cracking and breakage but still need to meet other product requirements such as unintentionally dropping the product or shipment of the product to the store.

Thermoplastics

Thermoplastic materials do not create an irreversible chemical bond during the manufacturing process nor can one be added by a post operation. Thermoplastics therefore produce performance properties significantly different than thermosets, including fire performance. Thermoplastics will melt, exhibit permanent deflection when exposed to elevated temperatures below their melting point, and continue to burn after igniting. All of these thermoplastic properties vary depending on the base material type such as polypropylene, polyester, nylon, acetal, etc.

To aid the design engineer in selecting the proper thermoplastic for an enclosure component, in the US, the typical measure of a thermoplastic's resistance to burning is Underwriters Laboratory (UL) 94 standard. This standard determines a thermoplastic's propensity to ignite due to flame contact and the material burn rate once ignited. These characteristics can be measured in either a horizontal or vertical orientation, with the vertical orientation being the most severe test case.

The base material used for a thermoplastic is an important factor for burn performance. In addition, elements found in the halogen group of the periodic table, such a bromine, can be added to plastics to significantly improve their burn performance rating. With the addition of a halogen, the plastic compound is referred to as a "fire retardant" or "FR" grade. Unfortunately, many people, including design engineers, mistaken the meaning of fire retardant as indicating the thermoplastic will no longer burn, which is not the case at all. Any fire retardant thermoplastic will burn as long as exposed to a flame, and if the plastic is exposed to temperatures above the material's auto ignition temperature, the plastic will burn even when no flame contact is present.

This misunderstanding of FR plastic performance during a fire often misleads people into thinking a change to an FR grade is all that is needed to obtain the fire performance required for the part, but that assumption is often inaccurate. In addition to burn rate, other properties are needed to make a FR plastic component contain a fire, including heat deflection temperature and melting point. The flame retardant plastic can't contain a fire if the part has melted out of the way before the fire reaches the original boundaries of the component. Another factor to consider when using an FR thermoplastic material is their release of unburned chemical compounds during a fire. Europe has been the leader in slowly banning the use of FR additives due to the toxicity of these compounds to occupants of the house, the fire personnel putting out the fire, and the environment.

Conclusion

A product has many requirements which must be met to satisfy the consumer who uses it, the manufacturer who makes it, the stores who sell it, and of course, government agencies such as the Department of Energy (DOE) and the Consumer Product Safety Commission (CPSC). Some of those requirements directly compete against one another, which makes the job of the design engineer challenging. In the end, plastics have their place in the design of consumer products to support meeting those requirements, but as usual, nothing is as easy as it might first appear, including the use of plastic components for a product enclosure which must contain an internal fire within its boundaries.

Robert C. Hoffman Jr, PE, CFEI is a licensed **Professional Engineer** certified as a **Fire and Explosion Investigator**. With 30 years of experience, the primary focus of his knowledge is a deep understanding and application of all aspects of **Product Safety** for the **Consumer Goods Industry**. Mr. Hoffman works as an expert witness with clients needing to understand if a product in the field has some type of design or manufacturing defect, as well as clients needing support to defend their product against a potential field hazard allegation. His background in statistics and presentation of data allows him to take complex situations and break the information down into simple, yet accurate assessments of the situation.

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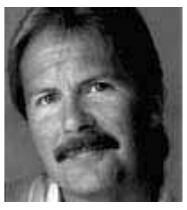

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