Polystyrene essay sample

Religion, Bible

Research Question

Polystyrene is a very commonly-used material in the food and consumer electronic packaging industries. This paper will revolve around the research question " can polystyrene have other uses aside from its common uses?" The HIPS will be of particular importance here because much of the paper will revolve around the use of HIPS, how it is used, and how it differs from typical polystyrene. HIPS, which stands for High Impact Polystyrene is used in the research and development and manufacture of mechanical prototypes and other tools that are often subjected to high impact environments, stress, and tension. It is one of the extraordinary types of polystyrene because it represents polystyrene and other plastic products in a whole new way. Usually, polystyrene materials are used in food and consumer electronic packaging. Common polystyrene can never be used in high-stress environments because it will easily break down. However, materials made out of HIPS can be very resistant to stress and can therefore be used as a primary material in developing machine prototypes. It may actually serve as a substitute material for steel, wood, concrete, etc.

Introduction

Polystyrene is the material that is otherwise known as Styrofoam. This material is a form of plastic although it does not look like a typical one when conventional definitions of such material are used. It is a strong type of plastic formed by combining injectable forms of benzene, erethylene, monomers, and other secondary materials altogether (Cowie, 1991). The objective of this paper is to discuss the different possible uses of polystyrene, particularly the HIPS or High Impact Polystyrene. The manufacturing processes involved in producing polystyrene, the different possible forms and derivatives of polystyrene, its advantages and disadvantages shall also be covered.

History of Polystyrene

Polystyrene had a lot of names before it was finally termed as such. The first use of polystyrene dates back to the discovery of a material called Storax, acquired from the resin of the Turkish Sweet Gum Tree in 1839 by a man named Eduard Simon, one of Berlin's most competitive apothecaries during his time (Baeurle et al., 2006). Chemistry and other complicated fields concerned with the production and development of existing drugs, and the research and development of new drugs were not that prioritized and narrowed back then. The Storax, especially the process of extracting such material and its possible uses, caused a lot of issues among other researchers. Other apothecaries tried to synthesize the same material, aiming to surpass the quality of the material that Edward Simon had synthesized. New methods of synthesis were discovered until an English Chemist named John Blyth and his partner who is also a Chemist but was from Germany, August Hofmann, successfully introduced a new and improved version of Simon's Styroloxyd (Styroloxyd is the oxidized and thickened form of the Storax) in 1845. They called the substance metastyrol. It definitely had a lot of similarities with the Styroloxyd; in fact, different lab analyses conducted during that time were able to prove that the two materials which were synthesized via two varying processes were chemically identical. What surprised chemists during that time was the fact that during the synthesis of Styroloxyd, the process of oxidation was very necessary. In the synthesis of Metastyrol on the other hand, the two chemists who pioneered the work were able to prove that it is not the oxidation process that lead to the synthesis of Styroloxyd or metastyrol but the polymerization process. Approximately 80 years passed and chemists and the public still thought that metastyrol is already a dead-end until a German organic chemist named Hermann Staudinger proved that the original styrol synthesized by relying on a technology that is more than eight decades old, could further be developed through the process of heating. Staudinger discovered that as styrol molecules become exposed to higher temperatures, the excited molecules due to the increase in temperature start to create a chain reaction which leads to the creation of a macromolecule. The resulting macromolecule is the polystyrene that we know of today (Dante et al., 2009).

After the valid process of synthesizing polystyrene has been finally discovered in 1931, for-profit organizations began the large scale production of polystyrene. Since then, polystyrene was manufactured in pellet or bubble form. This was made possible by the reactor vessel used in polystyrene production plants during that time (Mark, 2009). After heating and boiling the styrol, the polystyrene enters a chamber where it is cut precisely into pellets or beads. Other more specific manufacturing methods evidently followed. By 1985, the production of polystyrene beads already involved the use of molders so that the resulting polystyrene product can come in different shapes, based on the shape of the molder used which was predetermined based on the customers’ order requests.

Polystyrene, Characteristics of

Polystyrene, contrary to what people usually say, is an organic substance. One common question about the structure of polystyrene is whether it is an organic or an inorganic substance. An individual who does not know a lot about chemistry usually differentiates an organic from an inorganic substance through memorization and whether it can be found in an organism's systems (because of the myth that all substances that are present in an organism's system is classified as organic). Unfortunately, using that as the sole basis in identifying the classification of s substance could be misleading. The more accurate and at the same time, fool-proof way to classify polystyrene's nature would be to know its molecular formula and the elements that predominantly build it. Polystyrene can be expressed by the molecular formula C8H8. Meaning, in a single polystyrene macromolecule, there should be a total of 16 electrons; 8 hydrogen electrons and another 8 carbon electrons (Norton, 2008). Knowing that a polystyrene molecule is predominantly composed of carbon (plus hydrogen), it can therefore be classified as a hydrocarbon. In fact, it is, in the most basic sense, a hydrocarbon. Hydrocarbons and other molecules that have a significant amount of carbon electrons are generally considered as organic substances. However, it should not be mistaken that all molecules and substances that can be found in a particular organism's system is automatically organic. There is a bunch of molecules that are inorganic but are classified as naturally-occurring and even absorbed substance in the human body.

Polymerization is a very essential process in the production of polystyrene

(Mihai et al., 2007). Basically, polymerization is a process which involves numerous monomer molecules, reacting altogether to create a chemical chain reaction resulting to the production of polymer chains which can be expressed by three-dimensional molecular networks. The best example in this case would be the alkene polymerization process involved in the production of polystyrene. Polystyrene is composed of numerous styrene monomer units. These styrene monomer units are originally double-bonded. Now, these double bonds reform into single bonds and as a result of the bond reformation, different connections are formed between nearby styrene monomers via the single bonds, thus the name polystyrene (Clayden & Greeves, 2000).

Polystyrene, in its economical form is usually described as lightweight, and in pellet form. These two characteristics can be best explained by the expansion phase involved in the production of expanded polystyrene. Polystyrene foam, when fully expanded is 98 percent air, and only 2 percent solid polystyrene. Sometimes, these numbers could change depending on different factors such as the intended-purpose of the polystyrene to be manufactured. If for example, the factory is budget-restricted, the manufacturer could further decrease the percentage of the solid polystyrene and increase the percentage of air by allowing the polystyrene to expand further. Throughout the whole process of manufacturing polystyrene, the base polystyrene material expands to over 40 or even more times. So the exact answer to the question why polystyrene materials tend to be so light is the truth that it is 98 to 99 percent air and 1-2 percent solid polystyrene (Clayden & Greeves, 2000).

Thermoset and Thermo-softening Plastic Polystyrene

There are generally two types of polystyrene material that can be found in the huge market dominated by plastic and probably polystyrene-derived products today: the thermoset and thermoplastic (also known as thermo-softening plastic) polystyrene. One good thing to remember about these two is that they are both polystyrene and can actually be manufactured in a single manufacturing line because of their genuine similarities, although most factory operators prefer to dedicate a single manufacturing line in the production of a particular type of polystyrene only (Mark, 2009).

Thermosetting polystyrene, otherwise known as thermoset, is a type of polystyrene that irreversibly cures. Meaning, the form that it assumes after it has been cured and cooled would be its final form. Heating at temperatures well above 200 degrees C or 392 degrees F is by far the most common method used to cure thermosetting polystyrene (Mark, 2009). To be able to make use of its permanent and irreversible property, manufacturers use specifically designed molders. They pour the boiled solid polystyrene (while it is still in its liquid form) into that molder. The liquid polystyrene will then be left on the molder for quite some time for it to cure and cool. It will gradually assume the shape of the molder. After it has cured and assumed its solid form, the molder is removed and that's how thermoset polystyrene is usually manufactured. Because their shapes are irreversible, they are often manufactured in a pre-order basis.

Thermoplastic polystyrene, also known as thermo-softening plastic, is another form of polystyrene that can still be remodeled even after the curing and cooling process. The processes involved in manufacturing this polystyrene product are somewhat identical with that of thermoset polystyrenes. The only difference is that there is a different material that is used here. In manufacturing a thermoset polystyrene, a thermoset monomer is used while a thermoplastic monomer is used in manufacturing thermoplastic polystyrenes, hence their names. The state (liquid or solid) of a material made from thermoplastic polystyrene is very much dependent on the temperature because thermoplastic polystyrene is made to be once again malleable or rigid upon reaching a certain temperature. Reactively, reaching the high temperature threshold will result to the thermoplastic polystyrene material turning into its malleable form and the opposite happens when the low temperature threshold is reached. This is the property that makes thermoplastic materials very economical. Because of their temperature-dependent malleability, they can easily be reused and recycled. However, it has been proven that materials made from thermoset polystyrene are more durable and resistant to heat compared to materials made from thermoplastic polystyrene.

Processes Involved in the Production of Polystyrene

Knowing that polystyrene is considered as a form of plastic, chances are it is made from oil or other petroleum products. Polystyrene is composed of thousands of monomers joined together by single bonds after the original double bond reacts to form a single bond. Upon the formation of the single bond, the monomers become joined by those single bonds creating a larger molecule called a macromolecule which in this case is polystyrene. Polystyrene is first exposed to a potent expanding agent. A typical polystyrene bead measures about half up to one and a half mm in diameter before the expansion process. After the application of the expanding agent and the expansion phase, the polystyrene beads will have expanded 40 times its original volume or even more. The expanding agent used typically comes in the form of pure hydrocarbon which may explain why polystyrene materials, despite having properties that are identical to plastic materials are still considered organic. The steam used during the heating process serves as the catalyst that will strengthen the effect of the expanding agent. As the temperature increases because of the steam, the expanding agent's temperature rises up to the point that it already boils. The boiling of the hydrocarbon is what causes the polystyrene beads to expand over 40 times its original volume. The heating process is usually repeated until such time that the polystyrene beads already have a closed cellular foam structure (Norton, 2008). During the final reheating process, they are either placed in a mold for molding or are reheated again until they mature.

High Impact Polystyrene

High impact polystyrene is another form of polystyrene that is specifically designed and crafted to withstand a particular amount of resistance, tension, or impact. In theory, it should be significantly more stable and sturdy than typical polystyrene materials because of the adjustments made during the manufacturing stage and in some cases, different materials that were added aside from the ones being used to produce polystyrene beads (The Open University, 2000). The monomer used in the production of High Impact Polystyrene (HIPS) is usually a thermoset monomer because it has been proven that the resulting polystyrene product made from this material can be more sturdy and rigid, which is why a high impact polystyrene will be created, than if a thermoplastic monomer is used. Again, the process of manufacturing HIPS materials can almost be as similar as manufacturing a simple polystyrene material. However, certain minor modifications may have to be necessary in order to achieve the sturdiness and rigidity of HIPS. For example, the manufacturers could have used a different hydrocarbon as the expanding agent. They want a more stable end-product and so they will try to reduce the rate of expansion. Meaning, the ratio between the air and solid polystyrene will also have to be changed. Ideally, to build a HIPS material, the material’s gas composition has to be minimized and its solid composition maximized because a more solid material will definitely be able to withstand more stress than a gaseous one.

Advantages of HIPS

1. Good resistance to impact, pressure, stress.
2. Excellent Dimensional Stability
3. Low Cost
4. FDA Compliant
5. No side-effects to health
6. Good Aesthetic Qualities
7. Practically unlimited design options

General Uses of HIPS

Because of the sturdiness and stability it can offer, HIPS can be used in building household appliances and other structures. In fact, HIPS may be a good reasonable alternative for conventional household materials such as wood and concrete. It may be important to know however that some states do not allow the use of materials derived from plastic in building a structure or any part of a building that bears weight. A good example would be a building column that will hold some of the weight from the floor directly above it. In some countries, HIPS are used in combination with concrete. This combination is possible and is actually practical. The polystyrene covered in concrete may even serve as a good building insulator (Mihai et al., 2007). HIPS may also be used as a raw material for machine prototypes because it can definitely withstand the stress and impact involved in the dynamic functions of a machine. The excellent aesthetic qualities and the design-ability of polystyrene may also be a good point to consider whenever household owners have to choose between wood, steel or plastic materials in buying household appliances and other accessories.

Polystyrene and its effect on the Environment

Polystyrene is a form of plastic. It can be transparent and it can also come in different colors. Plastics constitute a significant percentage of the total amount of garbage we see in landfills and at the sea. It has been proven by studies that plastic debris is harmful and can even be lethal to marine life. One good example would be the sea turtles. Jellyfishes are part of the sea turtle's diet. Jelly fishes appear bright and transparent underwater. And it is not surprising to know that there are reported cases wherein a sea turtle ingested a polystyrene material floating in the water. The marine zoology experts' explanation is that the sea turtles think that what they are seeing in front of them are preys (jelly fishes) and not plastics. There have been numerous cases of sea turtles intentionally ingesting sea debris and died.

Polystyrene is also a non-biodegradable material. Up to this day, scientists do not know of any microorganisms that are capable of phagocytizing or breaking down polystyrene into a biodegradable form. Polystyrene is also resistant to photolysis. Therefore, there is really no way that materials made from such can be biodegraded.

This is why in the past years, local government agencies in some states have placed a relative ban on the use of polystyrene materials in food and other types of packaging because of the serious environmental threat that may arise if the current level of polystyrene production and disposal continues. As of now, there is no other way to protect the environment from the possible serious threats associated with the use of polystyrene but to recycle (Rathje & Murphy, 2001). Used polystyrene materials could be collected and dropped in recycling centers where they are then sent to polystyrene melting plants where they can be melted and be, once again, used to build a new polystyrene product. That way, landfill personnel would not have to wait for hundreds of years before they biodegrade.

Because of the serious possible consequences of concerning the expanded use of polystyrene products, some local government agencies have also started to require organizations that produce or use polystyrene materials in any of their products, may it be in the form of packaging, etc., to contribute to the local government’s efforts in disposing and recycling polystyrene (Hofer, 2008).

Conclusion

The discovery of polystyrene which was over a century ago led can be considered one of the greatest advancements in the history of consumer manufacturing. A lot of items and merchandises come in the form of polystyrene today. There are even buildings today whose walls are made up of a combination of concrete and polystyrene. But noticeably, the greatest contribution of polystyrene to the society is its use in the packaging of food and other consumer products. It has an inherent ability to insulate heat and to minimize shock at the same time. Nevertheless, there are other polystyrene-derived materials such as the HIPS which have an extraordinary function in the development of machine prototypes. Given the fact that it is impact-resistant and has low manufacturing costs, it can be a great alternative to conventional materials such as wood and steel. Polystyrene is a non-biodegradable, photolysis-resistant plastic product and can therefore pose a serious threat to the environment. Hence, Proper use and disposal should definitely be regulated.

Can Polystyrene have other purposes (e. g. mosquito and other insects killer)?

There are very few to no literature that could support the notion about the other possible uses of polystyrene. However, there is no doubt that for-profit and non-for-profit organizations who make revenues through polystyrene invest in research and development programs which most likely involve the other new possible uses of polystyrene. Another factor that should be considered here is the current perception of environmentalist groups and government environmental agencies regarding the use and manufacture of polystyrene. Different states have actually already imposed relative bans prohibiting the use of polystyrene-derived products because of the already-proven serious environmental issue associated with the production and use of polystyrene and polystyrene-derived products. Therefore, it is very likely that polystyrene would not be used for other purposes aside from its conventional purposes.

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