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THERMOSET PLASTICS PRODUCT RECYCLING

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Abstract

Recycling thermoset products is economically sensible as it reduces wastage of precious resources and re-claims valuable energy. The aim of this paper is therefore to briefly review some of the alternatives possible for the recycling of thermoset products.

Introduction

Plastic recycling is in the growth phase as the whole industry is still relatively young. A further development in recycling, which is also being focused at FKKKSA, is the recovery of the individual chemical components of plastics for re-use as chemicals, or for the manufacture of new plastics. In Japan and USA, much progress has been made into recycling the polymeric waste back to the basic, i.e. the oil - the feed stock for making polymers (1, 2).

It has been recognized for a long time that plastics waste must be recycled to protect the environment and also to conserve raw material resources that will become scarce if not used efficiently. So far, the progress in plastic waste recycling is limited to only thermoplastics, particularly packaging materials, i.e. the most obvious plastic waste. There is a need to extend the attention to thermosets to confirm their recyclability and to communicate to the automotive and other industries the inherently environmentally-friendly nature of these materials.

Properties Of Thermosets

Thermosets resist heat and chemical attack, have good rigidity, surface hardness, dimensional stability and low flammability. Their lightness reduces the fuel and hence the costs necessary for transportation. Their properties vary according to type and formulation but a constant factor is that they will not soften or melt on heating as thermoplastics do. This is due to irreversible crosslinking of the polymer during processing. Thermosets are very durable and it is this

characteristic that has led to their widespread use in many high performance applications. Even durable products have finite lives, and indeed thermosets have potential for recycling.

Practical Recycling Options

The majority of the thermoset products (and even thermoplastics) waste is still used as landfill. This is due to the very high cost of facilities and labor needed for sorting, separating and recycling of the waste. For example, recycling of tires. Radial tires are typically made of several types of natural and synthetic rubber, fabric, steel and carbon black - each of these must be recycled separately, unlike the simple recycling of an aluminum can. There are several options available once a product has reached the end of its useful primary life. This starts with conventional re-use of the item, through energy, material and chemical recovery to ultimately and, as a last resort, landfill.

Energy Recovery

Energy recovery can be an attractive recycling technique for thermoset composites. It is particularly suitable for treating post-consumer waste products which are contaminated or where the composition of the plastic waste is not confirmed.This technique recovers the material's thermal content, providing an alternative source of energy. See also Figure 1. Studies at Nottingham University (3) have demonstrated that thermoset composites based on unsaturated polyester, epoxy and phenolic resins can be burned cleanly without producing harmful pollutant gases.The glass fiber reinforcement and mineral fillers - typically used to give bulk to composites - remain after combustion as they are incombustible. It is important to re-use these materials to make a viable recovery process.

Several ways are possible: the ash remaining for instance, has potential use in agriculture where it can help in controlling the pH of the soil. Composites can also be used in the manufacture of cement; the polymer burns to provide energy for the cement kiln and the incombustible materials and leftover ash can combine usefully with the cement (1).

Particulation

Ground thermoset scrap can be used for landfill with safety. The mineral-filled fully reacted resins can be used as fillers in major thermoset compounds - polyester, phenolic, amino and epoxy - and as filler/reinforcements in thermoplastics such as polypropylene, with property enhancement as the goal rather than the simple re-use of waste. Granulated thermoset scrap, if suitably processed, could be a marketable particulate material with applications both in the plastic industry and in other non-plastic industries.

Chemical Recovery

Plastics materials can be chemically broken down into smaller molecules which can then be used as the building blocks for new materials. Whilst the main emphasis in recycling of plastics has been focused upon material recycling, much R&D work is into chemical recycling. By this technique, the long molecular chains in the polymers are broken down into their component parts, ready for re-generation into new polymers or other chemical products. Chemical recycling methods available include pyrolysis, methanolysis, glycolysis, hydrolysis and thermal cracking, with pyrolysis being the most popular.

This method decomposes thermosets at high temperatures in the absence of oxygen. The gaseous organic compounds produced during decomposition can be used either as fuel or fresh feed stock to the chemical industry in place of oil.

Conclusion

The aim for both the community and the thermoset industries would therefore be to maximize the effective use of resources and to conserve the environment. Whilst it would be desirable to eliminate excess consumption and to recycle as much plastics as possible, the overall economic and energy balances must also be taken into consideration, i.e. the viability of thermoset recycling. Theoretically, by recycling, significant amount of useful energy which is currently lost during burning of waste can be recovered and put to good use. Another added benefit would be a significant reduction in the volume and weight of material that must eventually be sent to landfill.

Reference

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Figure 1 (from Ref 1)