Estimation of possibilities of making euro pallets from reclaimed polyolefin’s with tuff

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Summary

Possibilities of reusing and developing of waste plastics are one of the main problems of waste management for municipal government especially in the context of adapting Polish law to standards of EC [1]. During the last 10 years total amount of plastics waste increased twice, especially in communal agglomerations. Among communal waste plastics make up 7 to 14% of their mass and 30% of their volume [1,2]. Plastic products have been recycled to be used in a number of different products often different from their original use. Reclaimed plastics can’t be used as products which have contact with food or as high demands esthetic and hygienic products, they also shouldn’t be applied as short-time used products because they quickly come back to plastics store-place. Reclaimed plastics have lower properties than virgin plastics – mainly the strength falls with the simultaneous fall of modules and increase fragile especially for PP, PE, PS and PET [1]. One of the possibilities of reinforcement of polyolefines is adding diverse fillers like glass or carbon fibers (but they are rather expensive) and natural fillers like mineral, wood and others [3]. It’s especially important for wasted of low density polyethylene which has low modulus. For the tests it was used waste polyethylene (LDPE and HDPE) from industrial with 15% mineral fillers – tuff. For the tests it was prepared two kinds of composites materials with 15% of tuff powder. Besides for comparison it was tested recycled polyethylene (HDPE and LDPE) and next was tested specimens cut out from produced europallets (with 15% of tuff). It was tested mechanical properties all prepared composite materials like tensile strength, stress and bending e-modulus and processing properties like melt flow, Vicat point and photos on SEM microscope.

Keywords: mineral fillers, tuff, plastic pallets, mechanical properties

1. Introduction

During last decades, the great population increase worldwide together with the need of people to adopt improved conditions of living led to a dramatically increase of the consumption of polymers (mainly plastics). Materials that appears interwoven with the consuming society where we live. Current statistics for Western Europe estimate the annual total consumption of plastic products at 48.8 million tons for 2003 corresponding to 98 kg per capita. The same quantity a decade before, i.e. in 1993 was approximately 64 kg per capita (Plastics Europe Association, 2007, Association of Plastic Manufacturers, 2007). Over 78 wt% of this total corresponds to thermoplastics (mainly polyolefin’s, low density polyethylene, LDPE-17%, high density polyethylene, HDPE-11%, polypropylene, PP-16%) and the remaining to thermosets (mainly epoxy resins and polyurethans). Polyolefin’s (LDPE, HDPE, PP) are a major type of thermoplastic used throughout the world in such applications as bags, toys, containers, pipes (LDPE), industrial wrappings and film, gas pipes (HDPE), film, battery cases, automotive parts, electrical components (PP). Plastic takes up about 10% of our total waste stream, and it is composed mainly of the non-renewable resource petroleum. So the more petroleum we burn to make new plastic products, the more greenhouse gases we release into the air. Only 5% of all plastic is recycled, so we need to push for more plastic
recycling practices in our daily lives. When you recycle plastic you can create millions of useful new products [1,2].

One of the possibilities of reinforcement of recycled polyolefin’s is adding diverse fillers [4,5] like glass or carbon fibers (but they are rather expensive) and natural fillers like mineral, wood and others. Historically, mineral fillers are used in polymers for a variety of reasons: cost reduction, improved processing, density control, optical effects, thermal conductivity, control of thermal expansion, electrical properties, magnetic properties, flame retardant and improved mechanical properties, such as hardness and tear resistance. Today, specific minerals are frequently added to products to enhance their functionality and/or aesthetic qualities. The most popular mineral fillers used in thermoplastic compounds are: calcium carbonate, talc, wollastonite and kaolin. Filler market in plastic alone total over 100000 tones per year. Calcium carbonate is the least expensive and the largest mineral filler used in thermoplastic as well as thermoset compounds. PP and other polyolefin compounds are the largest users of calcium carbonate. Besides providing economy, it reduces shrinkage and offers good surface finish. Calcium carbonate can be incorporated at a very high level of more than 70%. Talc helps in enhancing the stiffness of thermoplastic compounds and raises the heat deflection temperature significantly. Talc also provides better dimensional stability. The particle size of talc determines the impact strength, as the finer particle size enhances or maintains impact, and increases stiffness at the same time. Talc also reduces coefficient of linear shrinkage of the plastic product. Wollastonite used alone or in combination with glass fiber mainly to balance the cost of glass reinforcement. Additionally, it helps to improve the surface finish of glass fiber reinforced thermoplastic products. Wollastonite requires surface treatment for easy dispersion. Finer particle size is essential better dispersion. Polyamide is the major thermoplastic polymer that uses wollastonite. Kaolin or clay or natural alumnisilicate provides good impact modification. It competes well with talc. Polyamide is one of the major thermoplastic that uses kaolin particularly for automotive applications. Clay also helps in providing cost economy. Clay also requires surface treatment for ease of dispersion. Clay also improves dimensional stability like talc. Clay provides better sound dampening effect compared to wollastonite and talc [5,6].

The current emphasis on material recycling requires materials to contain additives which will allow the processing of complex mixtures of polymers through compatibilization, increased thermal resistance during reprocessing, allow for fillers recovery, and allow the use of ground waste as a fillers. All this technologies have high growth potential because of social, regulatory, and economic pressures. Product life cycle evaluation, an emerging development, will have a strong impact on the choice of future technologies and fillers associated with these technologies.

Plastic products have been recycled to be used in a number of different products often different from their original use. Plastic has to be divided into types because not all plastics will mix together during the recycling process. After plastic goes through sorting it is ground into smaller pieces to make the melting process easier. The chipping process often leaves small pieces of labels and glue mixed in with the plastic pieces. These small pieces of plastic undergo a cleaning process to remove the contaminants. Melting down the plastic and then forming it into small pellets to be used in future products. The recycling facility sells the recycled product to manufacturing companies, which can then use the recycled plastic stocks to make new products, instead of creating new plastic from fresh petroleum sources. This process tends to bring down manufacturing costs, and as a result, it makes recycling plastic much cheaper for the companies involved.

Plastic pallets are often made of new or recycled polyolefin’s (HDPE or LDPE). They are more widely used in Europe than in the rest of the world. Plastic pallets are often chosen over traditional wood pallets because they offer benefits which wood cannot. Some benefits over wood include the ability to easily sanitize plastic pallets, resistance to odor, longer service life span, and lighter weight, thus saving transportation and labor costs. They are usually extremely durable, lasting for a hundred trips or more and resist weathering, rot, chemicals and corrosion.

2. Results of tests

For the tests it was used waste polyethylene (HDPE and LDPE) from industrial and consumption films and as reinforcement it was used mineral fillers – tuff (fine grinding on particles 5-15 µm). The mineral particles were treated 1 mol HCl to modify the particle surface for enhanced bonding with the polyethylene.

To process production batch of europallet, produced by Becker GmbH, we proposed to make pallets of such composites: reclaimed LDPE + HDPE and reclaimed LDPE + HDPE with 15% of tuff powder. It was assumed that application of continuous loading was 10000N on the surface of pallets. It was analyzed two kinds of supports: first on the external skids of pallets and second on classical support of fork-lift truck.

Tests of mechanical properties during tension and bending show that properties connected with increasing of straight like e-modulus grow along with content of tuff. Example of it’s shown in Fig. 1. However properties like Charpy impact strength and melt flow index (MFR/220°C) shown at Fig. 2. low with increase of amount of fillers.

![Fig. 1. Comparison of E – modulus during tension and bending test for composites of recycled polyolefin’s with addition 15% tuff powder](image-url)

Comparison of deflections for two kinds of supports of pallets made of proposed composites was shown in Fig. 3A and Fig. 3B.
3. Conclusion

In this article it estimated possibilities reinforced reclaimed HDPE and LDPE by mineral fillers – tuff and possibilities its processing in using on large products (like europallets) on standard processing lines. Mechanical properties especially modulus of elasticity increase along with amount of fillers. The low-filler reclaimed polyethylene’s can be use on such products like boxes, flower pots, automotive parts and others building and
roading parts. Using the thermoplastic polymer waste for PWM production solves three problem at once:
1) preventing environment pollution by means of polymer waste recycling,
2) obtaining new materials suitable for goods production,
3) possibilities its utilization by the way of combustion.

First results of investigations of mechanical properties of recycled polyethylene composites with mineral tuff are very promising. The using the natural fillers (which have good properties) leads to increasing polyethylene application and reducing a price of the products. The low price of making tuff powder would enable us to use this filler in modification of such polymers as: polyethylene, polyamide, polyolefin’s and biopolymers in the future. In these materials tuff can replace glass marbles and other mineral fillers increasing stiffness.

Literature