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ENVIROMENTAL APPROACH TO RECYCLING OF SHOE POLYURETHANES

ЭКОЛОГИЧЕСКИЙ ПОДХОД К УТИЛИЗАЦИИ ОБУВНЫХ ПОЛИУРЕТАНОВ

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ABSTRACT

FOOTWEAR INDUSTRY, REUSE, WASTE, RECYCLING, REACTIVE APPROACH, PROACTIVE APPROACH, POLYURETHANE

The article deals with reuse and recycling activities in the footwear. A waste management framework and model are described. Processing options of polyurethanes shoe are presented.

АННОТАЦИЯ

ОБУВНАЯ ПРОМЫШЛЕННОСТЬ, ПОВТОРНОЕ ИСПОЛЬЗОВАНИЕ, ОТХОДЫ, ПЕРЕРАБОТКА, РЕАКТИВНЫЙ ПОДХОД, ИНИЦИАТИВНЫЙ ПОДХОД, ПОЛИУРЕТАН

В статье рассмотрены мероприятия по повторному использованию и утилизации отходов в обувной отрасли, описаны структура и модель управления отходами, представлены варианты переработки обувных полиуретанов.

The footwear industry is a diverse manufacturing sector, which employs a wide variety of materials and processes to make products. Leather, synthetic materials, rubber and textile materials are amongst the basic materials most commonly used in shoe manufacture. Each material has its own specific characteristics. These materials differ not only in their appearance but also in their physical qualities, their service life, the different treatment needs as well as their recycling and recovery options at the end of their useful life. There are approximately 40 different materials used in the manufacturing of a shoe [1].

The footwear industry produces different types and styles of footwear. At the moment there are many different styles and categories of shoes. Most of them can be described as having a subset of parts and components. These are common to all types of shoes. The basic parts of a shoe can be grouped broadly into three categories:

- the Upper, which includes all parts of the shoe above the sole;

- the Lower, which refers to the whole bottom of a shoe;
- the Grindery, which includes items that incorporated into the shoe and do not belong either to the Upper or the Lower [2].

The largest share in the cost of shoes comprises leather for upper shoes and materials for the lower of shoes.

One of the main tasks of the footwear industry is improving raw, material and energy efficiency, as well as eliminating the use of hazardous materials during the production phase. The growth efficiency made in production is being overtaken by the considerable increase in the demand for footwear products. This results in a large flow of waste, most of which is disposed in landfills.

Effective management of waste is a rather complex issue made up of many components. The European Commission has set up a waste hierarchy framework [3]. It specifies the order in which waste management options should be based on environment impact. Based on this hierarchy, a waste management framework and model for footwear products was developed[4-6].

The model includes 5 (4) management scenarios: a reuse scenario, 2 disposal scenarios, a burning and use scenario to assess the real problems of shoe waste management.

For each variant, various environmental impacts, economic benefits, and technical requirements needs are to be considered. Disposal is considered the most undesirable option due to the obvious negative environment impact, depletion of resources, increased taxes and, in some countries, the limited availability of waste disposal sites. Burning is still considered a controversial technology, as it entails the emergence of an environmental problem associated with the release of pollutants. Reuse is not possible for all materials of shoe products, so recycling of materials is considered as the most suitable option.

Framework divides the waste management options for shoes into two major approaches: proactive and reactive. Proactive approach include all measures that are taken with the aim to reduce or minimise waste at the source. Reactive approach include all the other waste management options, which act in response to the waste problem.

The main idea of an initiative approach is that it is much more reasonable to reduce or even minimize losses than to develop an extensive treatment regimen and methodology to ensure that the waste does not pose any threat to the environment. In [7] notes that waste minimization activities can range from changes in products and materials to significant changes in processes and methods of operations.

A reactive approach is that the complete elimination of waste is not possible.

Proactive approach includes design improvements and material improvements. Reactive approach includes reuse, recycling, energy recovery and disposal.

However, not all of these methods can be applied when it comes to waste polyurethane foams.

Major ways of polyurethane foam recycling are by mechanical and chemical processes. The mechanical recycling processes for polyurethanes include the following [8-9]:

- Regrinding flexible polyurethane foam into powders to produce new foam;
- Re-bonding into a variety of padding products, including recovered pieces of flexible polyurethane;
- Adhesive pressing is a method, which involves coating the polyurethane granules with a binder and then curing them under elevated temperature and pressure;
- Compression moulding involves subjecting the polyurethane granules to heat and pressure to produce rigid and 3-D parts.

The chemical recycling processes include [9]:

- Glycolysis, which is the method, used to produce polyols from polyurethane waste by reacting polyurethanes with diols at high temperatures;
- Hydrolysis (a reaction of polyurethane with water) is used to produce polyols and amine, intermediates from polyurethane wastes. These intermediates can be re-used to produce other polyurethane components;
- Pyrolysis is the method, which utilizes relatively high temperatures in oxygen-free environment to break down polyurethane and plastics into gas and oil;
- Hydrogenation method is used to produce pure gases and oils through a combination of heat, pressure and hydrogen.

The main directions of the processing of shoe PPU waste are most related to their regeneration by the destruction method, by means of dispersion and by the thermomechanical method [10-12].

The best processing method is considered to be the use of the thermomechanical processing method, which allows solving the problem of waste and giving a tangible economic and environmental effect.

The main options for the production of materials and products for shoe bottoms using polyurethane wastes according to this method, based on numerous studies of VSTU researchers on this issue include the following:

- the technology for producing thermoplastic material from PPU waste suitable for casting processing;
- the technology for producing soles for slippers by preliminary extrusion on a screw extruder and subsequent final molding of the material in the roll gap;
- the technology of obtaining products' liner for the bottom of shoes by recycling waste polyurethane and upper leather raw material waste [10-11].

Currently, work is ongoing in the field of processing and modification of waste polyurethane foams. Received are two basic compositions of reduced density [13], with a fibrous filler. These compositions can be the basis for the production use of bottom parts of shoes: soles, and heels.

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