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Reuse scenarios of tires textile fibers: an environmental evaluation

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Abstract

End of Life Tires (ELT) constitute a major portion of End of life Vehicles (ELV). The treatment process of ELTs is primarily aimed at recovering steel and rubber, which jointly represent the main portion of the ELT material and are currently applied in different sectors. During the treatment of ELTs, other sub-products are generated in significant quantities (about 10-15% in weight), as textile fibers that currently are landfilled or used for energy recovery. The aim of this study is a comparative evaluation of the environmental impacts related to three different end of life scenarios for the textile fibers. In addition to landfilling and incineration, this study considers the possibility to reuse textile fibers as reinforcement in bituminous conglomerates. Results obtained through the Life Cycle Assessment study confirms that the reuse scenario leads to a relevant reduction of impacts in terms of Global Warming Potential. However, by considering other environmental metrics the reuse scenario is not always the less impactful one.

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Keywords: End of life tires; second life application, fiber material, environmental impact.

1. Introduction

Nowadays, end of life vehicles (ELVs) constitute a massive waste source in Europe, even if ELV recycling is a priority of the European Union (EU) waste legislation, as underlined in the ELV Directive [1]. End-of-Life Tires (ELTs) constitute a relevant portion of ELV waste, more specifically “every year, about 3.4 million tons of old tires are disposed of in Europe, most being dumped or sent to landfill, in direct contravention of the EU rules banning landfilling of both whole and shredded tires.”[2,3,4]. Management of ELTs has become a critical problem worldwide

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due to the increasing number of vehicles circulating in the road network and to the crucial role that mobility has assumed in modern society development.

Since landfill disposal has been banned in most Countries, alternative final destinations have been sought, with the major effort dedicated in trying to exploit in the most efficient manner the high energy potential of ELTs [5]. The treatment and the recovery process of ELT is primarily aimed at recovering triturated rubber in various sizes and types, as well as steel fiber, which jointly represent the main portion of the ELT material [6,7,8]. Unlike rubber and steel that are currently being reused in various application fields, textiles represent a special waste (European Waste Catalogue – EWC code 19.12.08) to be disposed. Textile fiber represent about 10% by weight of the ELTs and every year, in Europe, about 320,000 tons per year of dirty fibrous material must be disposed as special waste. This results in negative impacts on the environment, economic losses and public costs. In Italy, in 2013, approximately 60% of dirty fibrous material collected by Ecopneus was sent to energy recovery in furnaces for the production of cement, 25% was used as fuel for electricity production while the remaining 15% is destined for disposal in landfills [9,10,11]. In this context, this study aims to investigate three different end of life scenarios of the textile fiber from an environmental point of view. In addition to the baseline scenarios (landfilling and energy recovery), commonly implemented in the Italian and European contexts, the use of the fiber in bituminous conglomerates is considered. The comparative evaluation is performed by using the standard Life Cycle Assessment (LCA)methodology [12], to demonstrate if and how much a reuse scenario for the textile fiber, positively influences on the reduction of environmental impacts related to ELTs[13].

After this introduction, the paper is structured as follows. Section 2 illustrates the characteristics of used tires, as well as the main state of the art researches related to reuse of ELTs and textile fiber. Section 3 details the three considered end of life scenarios with particular focus on the reuse of textile fiber in bituminous conglomerates. Section 4 presents the conducted LCA study and the discussion of the obtained results. Finally, Section 5 reports conclusions and future developments.

2. End of life tires characteristics and valorization

Tires are made up of four main parts: (i) the tread, designed for contact with the ground and to ensure the proper friction; (ii) the carcass, the structural part of the tire on which the tread is vulcanized; (iii) the shoulder, which minimizes the effects of irregularities of the terrain and transfers the load due to braking and oversteering under acceleration; and (iv) the heels, to fit the casing to the rim.

Regarding the constituent materials, tires have a mixed composition of carbon black, elastomer compounds, steel cord, fibers, in addition to several other organic and inorganic components. Table 1 shows a brief overview of this composition [3].

Table 1. Average composition of a tyre.

Ingredient	Rubber/Elastomers	Carbon Black	Metal	Textile	Zinc Oxide	Other
Passenger Car	47%	21.5%	16.5%	5.5%	1%	8.5%
Lorry	45%	22%	23%	3%	2%	5%
Off The Road	47%	22%	12%	10%	2%	7%

Each compound contributes to the particular characteristics of the tire, so as to promote longer life and a particular level of friction [14, 15]. The most common treatment for ELTs is the shredding in dedicated mills. The output of the treatment process is thus a shredded material of various sizes and types, depending on the intended uses: rubber chips or granules (about 70%), steel fiber (5-30%) and textile fiber (up to 10%).