Advanced Engineering Days

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A concept study of the recycling of end-of-life tires for use in the construction of buildings

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Cite this study: Çağan, Ç., & Özkul, İ. (2021). A concept study of the recycling of end-of-life tires for use in the construction of buildings. 1st Advanced Engineering Days, 96-99

Keywords
Rubber
Car Tire
Recycling
Sustainability
Composite brick

ABSTRACT

In this study, it has been tried to dispose of rubber-based tires that have completed their useful life in terms of environment and economy and to bring them back to the economy. Tires, which contain synthetic, natural rubber, carbon black, steel, textile and many binding chemicals, come to the fore as a threat to environmental pollution day by day due to the increase in the number of vehicles. Tire dumps have already formed in most countries around the world and their numbers continue to increase. At the point of disposal and recycling of tires to the environment, it is considered to add a mixture of grinded and processed granular rubber and steel to the bricks used in the construction of residential walls. It is thought that examining this solution in terms of economy, human health and applicability in the long term will contribute positively to sustainable environment and climate change.

Introduction

According to the report published by GoldStein [1], 1.6 billion new tires are produced globally every year. Apart from the tires produced, nearly 1 billion tires are released into the environment as waste every year. Only 100 million of these tires are recycled. Many countries, especially Arabic countries and the Middle East, have problems in the disposal of these tires. In deserts and cities, tire dumps reach gigantic proportions.

Complex processes applied to increase the durability and service life of tires make it very difficult to recycle them in nature. In a research conducted by [2], when a tire content of P205/55/R16 size (width/profile/diameter) is examined in the light of the information given by the manufacturer; precipitated silica (9.65), carbon black (19%), coated steel wires (11.4%), oil (6.12%), textiles (4.7%), sulfur (1.28%), stearic acid (0.96%), recycled rubber (0.5) %) and synthetic (24.17%) and natural (18.21%) rubber [3]. The vulcanization process (reinforcement of carbon bonds with sulfur), especially for natural rubber to be more elastic and to increase its service life, serves the purpose of use of tires, but makes recycling difficult.

The images of the tire dump above were obtained from Kuwait [4]. One of the largest tire dumps in the world is located in Kuwait, and tire fires occur in certain regions at certain times of the year. The table below shows how much other substances are used quantitatively in the production of 1 vehicle tire.

Figure 1. Used tire storage area in Kuwait [4]

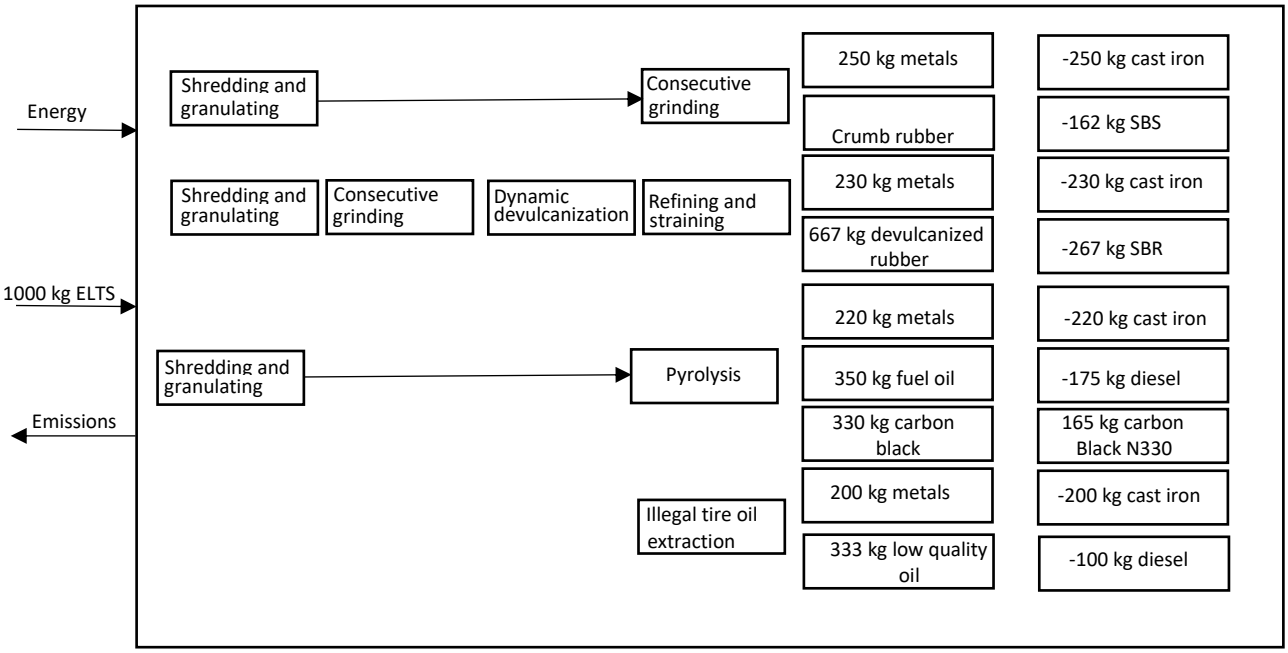
Table 1. Total consumption per one tire manufactured [2]

Total Consumption per one Tire Manufactured	
Input	**Quantity**
Production Stage	
Synthetic rubber (kg)	1.928
Natural rubber (kg)	1.456
Carbon black (kg)	1.496
Precipitated silica(kg)	0.768
Sulfur compounds (kg)	0.096
Zinc oxide (kg)	0.128
Mineral and plant oils (kg)	0.472
Stearic acid (kg)	0.08
Rubber from recycling (kg)	0.04
Steel wires (kg)	0.888
Textiles (kg)	0.368
Polymer substances-polyuretanes (kg)	0.192
Ethyl acetate (kg)	0.024
Substance facilitating rubber gluing butadiene adhesives (kg)	0.024
Remanining solvents (kg)	0.016
Water (L)	36.112
Electricity (MJ)	828.896
Others (kg)	0.096
Use Stage	
Furnace oil for power generation(L)	5.12
High-speed diesel for power consumption(L)	0.2716
Recycling Stage	
Used tire (kg)	40
Water (L)	36.112
Electricity (MJ)	828.896
Mineral and plant oils (kg)	0.472

Material and Method

According to a study conducted in China by [5], tires are recycled in 4 stages. These stages are detailed in the table below. When the cost benefit calculation is made according to this table, it is seen that the most effective way to dispose of tires is pyrolysis. However, considering that there is a constant demand for rubber in the industry, devulcanization is an important application method for the disposal of tires.

Table 2. Recycling methods of waste tires [5]



Crumb Rubber, tire derived fuel (TDF), rubberized asphalt, stall mats (Pet and Horse), playground material, automotive parts bonded rubber/molded products, upholstery products are currently obtained in the disposal of end-of-life tires. There is still a great contribution to be made to the added value by recycling these tires. With the study we will do, it is planned to add granular waste rubber pieces (3%-7%) to the iso bricks that will be used as insulation and wall material. In this way, insulation will be provided with the rubber material contained in the tire. With the steel wires in the tire content, the strength of the brick mortar will be increased.

The solution we have proposed is a method that we think will cause the least harm to nature in order to ensure the disposal of tires in a controlled manner. In this method, the used tire, which has been made into particles or fibers, will be stacked in the building material in a controlled manner. While the fibrous structures increase the strength value of the material, the granular structures will create pores in the building element. Although the porous rubber particles (~0.13 W/mK) are less efficient than the heat transmission coefficient of the air (~0.026 W/mK), it has a positive effect on the event heat transmission since it is lower than the heat transmission coefficient of the brick (~0.33 W/mK). In addition, considering that both sides of the plaster brick will be covered, it is ensured that the interface of the brick is closed to interaction.

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