

<sup>1</sup>. Slobodan STEFANOVIĆ, <sup>2</sup>. Vladeta JEVREMOVIĆ, <sup>3</sup>. Imre KISS, <sup>4</sup>. Damjan STANOJEVIĆ

## BASIC STRATEGY OF TIRE RECYCLING WITH THE EPMHISIS ON THE TIRE INDUSTRY

<sup>1,4</sup>. High School for Professional Applied Studies, Vranje, SERBIA

<sup>2</sup>. High Technical and Mechanical School for Professional Studies, Trstenik, SERBIA

<sup>3</sup>. University Politehnica Timisoara, Faculty of Engineering - Hunedoara, ROMANIA

**Abstract:** Considering the options for waste rubber - reduction, reuse, recycling, energy recovery and storage in landfills - there is a clear trend towards the renewing of energy. The use of waste tire as an alternative fuel reduces the amount of old tires, protect natural resources and increasing energy independence. In many cases, this is a reasonable option. There are lots of sustainable options, extensive use of old tire that exist today and that will grow (using rubber granules in retreaded asphalt mixed with caoutchouc to manufacture various rubber products, various applications in the construction industry). Based on the analysis method for recycling rubber products, there is a great diversity in the quality and quantity of recycled material. And it is of primary importance for use in new tires. Methodology production costs optimization, and quality control require further research and efforts to standardize these processes.

**Keywords:** rubber, tire, recycling, waste

### 1. INTRODUCTION – BASICS OD RUBBER THAT IS USED FOR MAKING TIRE

Population growth, rapid industrialization and improved living standards have resulted in an increase in the use of rubber and therefore increasing the amount of waste. Expressed by volume, auto tires are the leading single item of waste.

Around the world rubber consumption is around  $18\text{-}20\cdot 10^6$  tons through a variety of products. In industrialized countries for the development of the tire leaves 60 % of the total consumption of rubber. Tires are the most famous and the life of the tire is very noticeable. In addition there is a danger of fire from environmental contamination. With the increasing number of cars and bikes vast amounts of waste tires are piling up. On a modern car except tire it is possible to find more than 500 different pieces of rubber, with a total weight range of 30-45 kg. In the U.S., about  $242\cdot 10^6$  tires are discarded annually in Canada  $20\cdot 10^6$ , Germany  $60\cdot 10^6$ , France  $40\cdot 10^6$ , UK  $45\cdot 10^6$ , Italy  $39\cdot 10^6$  per year. (Figure 1). According to the calculations it is generated by the one tire per person per year. In most developed countries, scrap tires are 1-2 % of the total amount of municipal solid waste.

Estimates are that in Serbia is annually discarded about  $1\cdot 10^6$ , 400 cars and  $400\cdot 10^3$  truck tires, totaling about  $30\cdot 10^3$  tons of waste [1].

Apart from waste, tire rubber is usually composed of pipes, conveyor belts, the remains of the footwear industry. Other

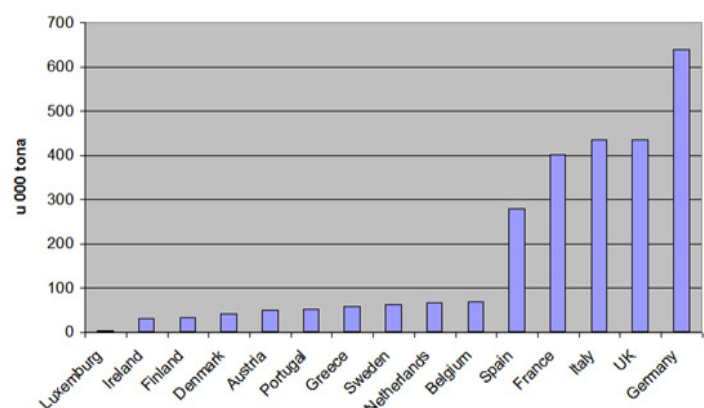


Figure 1. Amount of tire wasted in EU

waste rubber parts are made of rubber, washers, insulation material for electrical installations, packaging and others. All this makes smaller share of the total amount of waste.

Recycling is difficult for several reasons:

- ✓ rubber is a macromolecule which makes difficult degradable 3D network, which prevents the reprocessing,
- ✓ rubbers are mixed with incompatible materials and separation is difficult to perform,
- ✓ rubber is bio degradable, example- tires are not significantly degraded even after several decades in a landfill.

## 2. RUBBER PRODUCTS

Every year about 16 million tons of natural and synthetic rubber is consumed in the manufacture of products such as medical gloves, tires, bearings, bridges, etc. The lifespan ranges from a few minutes of medical gloves to more than a century, the bearing bridges.

Types of rubber depending on the application - Figure 2 shows the proportion of certain types of rubber in industrialized countries:

- ✓ Two types of rubber, NR and SBR prevalent
- ✓ Six frequently used ( BR, IR, IIR, NBR, CR, EPDM),
- ✓ Other special types such as CSM, CPE, FKM, FFKM, silicones, CO, ECO, ACM, etc) have a very specific application.

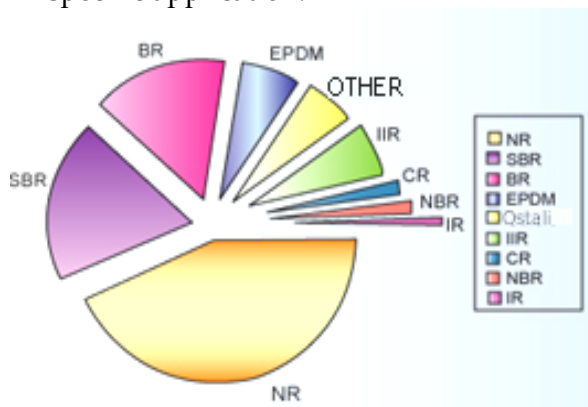


Figure 2. The different types of rubber [2]

Rubber itself is not suitable for industrial use.

Tires - are a complex composite material. They consist of (Figure 3): natural rubber (17% weight), synthetic rubber (about 31%), black (22%), steel cord (15%), textile cord (about 5 %) and different additive (about 10%) .

Rubber goods can be divided into two categories:

- ✓ Tires: manufactured about  $250 \cdot 10^6$  pieces in Europe every year , and that is more than  $2,6 \cdot 10^6$  with century exploitation of several years,
- ✓ Industrial products: various sizes and total weight of discarded industrial rubber products is greater than  $3 \cdot 10^6$  tons. Industrial rubber products are difficult or impossible to collect. Rubber products are very heterogeneous :
  - According to the dimensions, weighing less than a gram to the tone , the length of a millimeter up to hundreds of meters or even kilometers in endless belts,
  - A variable life span, from a few minutes up to more than a century.

## 3. BARIERS TO RECYCLING TIRES

### 3.1. Perturbation for recycling tires: immutable three-dimensional network

Rubber elasticity is the result of a 3D network, during vulcanization occurs connecting of the macromolecules of the original rubber. Chemical bonds between linear macromolecules also prevent relative movement.

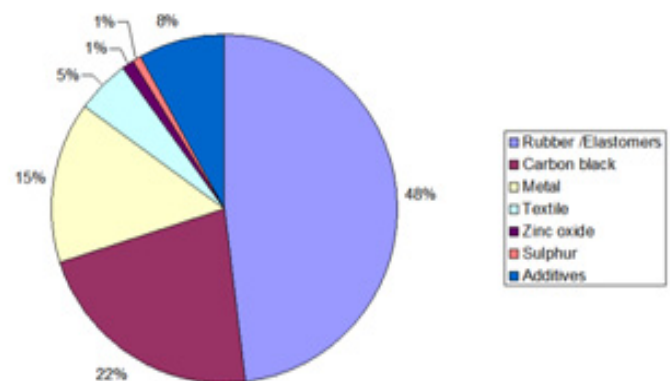


Figure 3. The composition of tire

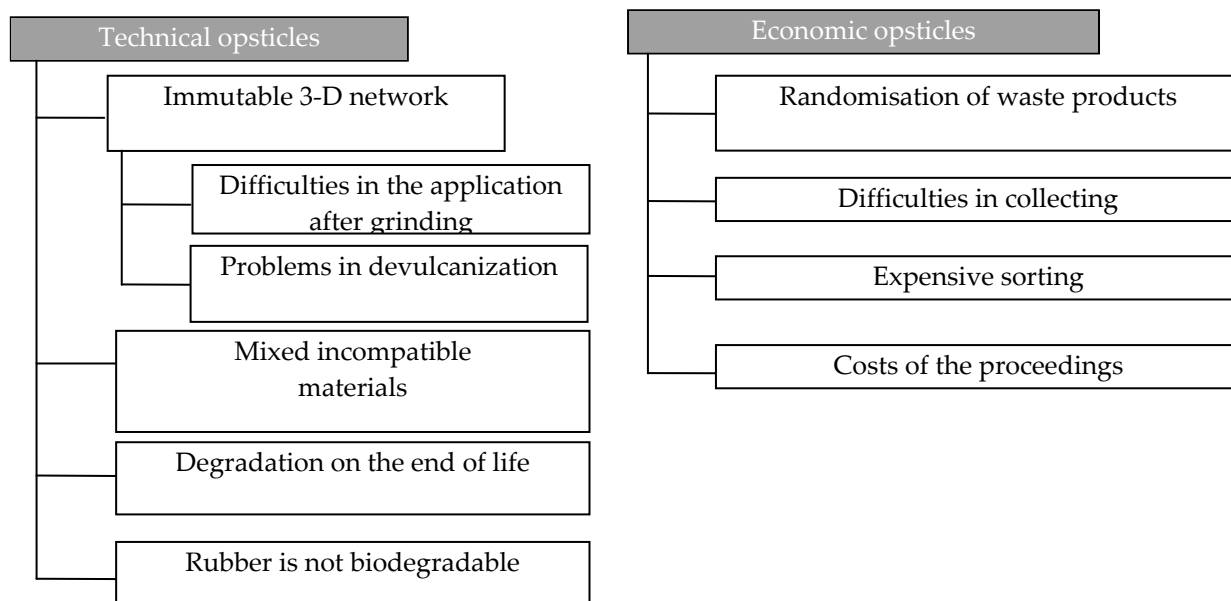


Figure 4. Difficulties in recycling tires [2]

### 3.2. Rubber is biodegradable

Rubbers are not subject to the degradation of nature and the tires do not decompose after burying in landfills after a few decades. Other ways of degradation, photolysis or hydrolysis, they too slow and limited to the surface layers.

Tires are manufactured so that they are sturdy and long-lasting. Rubber is spatially cross-linked elastomeric. Networking covers all the reactive centers of the polymer chains. Cross linked structure is a major problem for the recycling of tires.

### 3.2. Mixing of incompatible materials

Products such as steel / rubber parts, belts, reinforced hose, wrap the rolls, coated materials, adhesive insulating tape, systematically include gain or other incompatible materials such as steel, thread, cloth, plastic coating and the like. Joining is strong and separation is difficult and expensive. There are industrial processes for the separation of tires and other rubber material but generally is mechanically destroyed and can be re-used in the vulcanization or a powder.

## 4. RECYCLING AND RECOVERY TIRE – ALTERNATIVE

Over the last ten years in the world is growing interest in recycling tires. When it comes to tires, the term "recycling" is misused. The exact definition of recycling is reuse of material in its original purpose. The term recycling tires include the operations of comminuting and grinding waste with adoration metals, textiles and other impurities present in order to obtain the rubber granules.

Table 1. The main ways in recycling tire process

Certain species recovery	Methods	Technology renewal
Reuse of products	Regeneration	<ul style="list-style-type: none"> <li>✓ tire with a new tread (5-12% of waste tires and truck tires 50%)</li> <li>✓ grooving profile</li> </ul>
	Physical reuse	<ul style="list-style-type: none"> <li>✓ used as a weight</li> <li>✓ used as a form of</li> <li>✓ use the properties</li> <li>✓ use the volume</li> </ul>
Reuse of materials	Physical	<ul style="list-style-type: none"> <li>✓ tear</li> <li>✓ cutting</li> <li>✓ crushing the crumbs</li> </ul>
	Chemical	<ul style="list-style-type: none"> <li>✓ reclamation</li> </ul>
	Thermal	<ul style="list-style-type: none"> <li>✓ pyrolysis</li> <li>✓ combustion</li> </ul>
Getting energy		<ul style="list-style-type: none"> <li>✓ incineration</li> </ul>

## 5. USE OF RECYCLED MATERIAL FOR NEW TIRES

At the beginning of the 80s of XX century, there is certain technological and commercial success in the use of recycled rubber products. However, the use of recycled rubber in new tires were slow due to a number of technological and economic constraints that results from differences between the chemical and manufacturing methods used in the manufacture of tires .

Get recycled rubber from waste tire is pretty hard, tires contain more than one compound of rubber, then steel wire , textile cord , fiberglass , and plastic fibers . The process of recycling involves separating the steel cord and textile fibers, rubber through the multi-step process and the use of expensive equipment.

## 6. CONCLUSION

Million tons of tire recycling of end of life as well as industrial tires is a big problem.

Today in Europe, the total amount of rubber waste:

- ✓ One-third of the waste tire is located in warehouses, and the tire is not subject to biodegradation,
- ✓ Reuse and retreading is used by 20-25%
- ✓ Recycling of various materials use is about 20%,
- ✓ Recovery of energy use is about 22% ,
- ✓ Recycling of industrial rubber products is unknown, but very poorly.

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