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## USAGE OF POST-CONSUMER TIRES AS RAW MATERIALS

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*This article is devoted to the problem of post-consumer tires accumulation and recycling both in Europe and Ukraine. It describes general tires properties, their structure and composite elements which are valuable secondary resources. Also there are analyzed the most known methods of used tires treatment and final product of tires utilizations.*

*Розглянуто проблему накопичення та утилізації відпрацьованих шин як в Європі, так і в Україні. Описано загальні властивості шин, їх структуру та складові компоненти, що викликають інтерес як цінний вторинний ресурс. Проаналізовано найбільш відомі методи переробки використаних покришок та кінцеві продукти переробки шин.*

### Introduction

During the Soviet Era the main focus of human activity was on production, therefore the waste generation was dealt simply by dumping excess and often dangerous material directly into the environment.

So in some parts of Ukraine large waste deposits of solid and liquid residues (including post-consumer tires) have accumulated.

Waste disposal as an issue has only been recognized in recent years when the responsibility for waste management moved to the government. A number of laws, resolutions and initiatives are underway now to improve waste management and reception facilities.

Dynamic growth of transport infrastructure in the whole world is a consequence of technological progress, which is appealed to simplify the human being. Main vocation of any transport facility is a comfortable and fast distance overcoming. With all this going on, the safety and speed of travel mainly depend on the tires, which provide a contact of a vehicle with the road surface.

Throughout its life, a tire is a relative culture-free consumer product which is allowed to travel freely. However, technically, under existing national and international laws and regulations, once a tire has been permanently removed from a vehicle, it is defined as waste. Consequently its movements can be, and often are, restricted or curtailed.

Although the tires was not defined as a hazardous waste in any legislation, the problem on used tires collection and recycling is an acute for all countries over the World, because of quick development of automobiles market leads to a continuous tires accumulation.

According to the data of European Association on the secondary tires treatment there are approximate 2,5 millions tons of post-consumer tires annually in the Europe, in USA – 2,8 millions tons, in Japan – 1,0 million tons, and in Russia – 1,0 million tons.

World practice shows, that only 10% of used tires are recycled by the method of shredding.

About 20 % of collected tires are used as an alternative fuel.

This problem is concerned Ukraine too. According to the statistical data annually there are about 100 thousands used passenger tires and 65 thousands – 70 thousands of truck tires. 60 % of this quantity is accumulated in Kiev and its region. Small part (2 %) of them is burned to get stove oil. Rests of them get out to the unapproved garbage, ravines and suburban forests that lead to aggravate a serious ecological situation in Ukraine. These figures do not include tires which remain uncounted for many reasons, including those which are illegally dumped or abandoned.

### Tires composite elements and their appropriation

As tires should keep up the extreme loadings, it is a complex of high-qualitative materials, which consists of 15 elements. While the material composition of tires can vary to some extent from continent to continent, those differences have a negligible effect on their use or wearability.

There are four principal groups of ingredients in any automotive tire: rubber, carbon black, steel, textiles, and also some additives. Rubber, which is the principal element of the tire, is a thermoses material whose individual chains have been chemically linked by covalent bonds during polymerization or by thermal treatment during fabrication.

Once the bonds are formed, these cross linked networks resist heat softening, creep and solvent attack, and cannot be thermally re-processed. Such properties of rubber make it possible to use tires under severe conditions.

Metals (steel cord) – primarily high grade steel, constitute the second large component. They provide rigidity and strength as well as flexibility to the casing.

The most common traditional textiles used in tire casings are nylon, rayon and polyesters.

By the way the textile cords don't apply for production of truck tires.

The other elements are chemically or physically bonded together.

The rubber compounds used in tires are complex mixes.

Compounding is the process by which a number of ingredients are added to modify and improve the physical properties of the rubber and to make it more readily useable for various applications.

Specifically, the function of the compounding process is to modify the hardness, strength and toughness of the rubber and to increase its resistance to abrasion, oil, oxygen, chemical solvents and heat. Different formulates are used to produce specific qualities.

Tires are non-toxic, non-bio-degradable, their shape, weight and elasticity make them candidates for a range of different applications.

In any form, tires retain their inherent characteristics including resistance to mold and mildew, heat and humidity, retarded bacteria development and resistance to sunlight or ultra-violet rays, oils, many solvents, acids, and other chemicals.

### **Tire life-cycle**

It is generally accepted that tires are a major world market. Although national regulations determine local standards, all tires are manufactured to meet a specific purpose – road use.

The question what to do with them once they have out-of-lived the function for which they were created has stimulated considerable discussions – by government, industry, support organizations and the public at large.

The tire life-span can be defined as a finite period of road use, consonant with the five-seven year period during which a tire can be retreated.

It is comprised of three principal periods: new, continued use (continue chain of utility) and consignment to a waste treatment system. Definitions of the tires covered by the life-cycle are:

**New tire:** a newly manufactured product which meets industry specifications, standards and requirements for its intended purpose and national criteria for road use in the country of service as it is entered into service. **Part-worn tire:** a post-consumer tire which retains a minimum of 1,6 mm of visible tread depth in its most worn groove and which when subjected to inspection of the structural soundness of the casing and/or proper repair can be safely returned to its originally intended purpose.

**Retread able casing:** the structural part of a post-consumer tire which may or may not have residual tread depth sufficient for further road use and which when subjected to internal and external inspection of the structural soundness of the casing can be reprocessed by vulcanizing new tread to the body and the tire can be safely returned to its originally intended purpose.

**Retreated tire:** a post-consumer casing which has been subjected to internal and external inspection to determine its structural soundness and which has been reprocessed whereby new tread has been vulcanized to the body and it can be safely returned to its originally intended purpose as a retreated tire.

**Non-road-worthy used tire:** a post-consumer tire which can no longer be used for its originally intended purpose, due to wear and/or damage and/or age, which no longer meets national road requirements, but which can be recovered in whole or in part with-out transformation.

**End-of-life tire:** a post-consumer tire which may or may not have a structurally sound casing or residual tread depth suitable for further road use, which has been discarded and/or consigned to another use (namely storing up and accumulation).

### **Economical and ecological essence of tires recycling. Model "4R's"**

The problem on used tires recycling has a great economical and ecological essence for all advanced World countries. The irreplaceable natural crude oil is forced to use secondary resources with the maximum effectiveness.

Key to the successful attainment of sustainable economic growth is the diminution of principal waste stream, among which post-consumer tires figure importantly and the creation of recycling and recovery systems which will re-utilize these post-consumer tires waste products to recover material or energy source.

While landfilling was recently banned in EU as an option for the disposal of post-consumer tires, taking full effect in 2003 for whole tires and in 2006 for size reduced tire materials, it remains an option in more than 90 % of countries, worldwide.

However, that is beginning to change for a variety of reasons including the imposition of new landfill tax and increasing gate-fees.

As the use of landfills decreases, the development of viable solutions alternatives has gained critical importance.

The generally accepted model is informally referred to as the 4Rs:

- reduce the amount of potential wastes;
- reuse products and materials whenever possible;
- recycle products at their end-of-life as raw materials for a new generation of products;
- recover the energy from post-consumer materials or products to replace fossil fuels.

This model is currently applied in a majority of industrialized countries and is being adapted and adopted by many developing countries. Nevertheless the patterns of reuse and recycling vary from region to region, country to country or state to state, according to local goals, needs, and cultures, available resources and technologies as well as potential markets.

In conformity with the notions of sustainable development strategy the waste recycling with the receiving of raw materials has both the economics and ecological effectiveness. That's why the tire recycling resulting in the getting of rubber crumb, steel and textile (mechanical treatment) and alternative liquid fuel, additives and solvents, solid residues with the high carbon concentration, gas, steel (chemical treatment) thus would solve a complex of ecological and economical problems.

#### **Widely used methods on tires treatment**

A passenger car or lorry tire is 100 % recyclable. It is not a hazardous waste and consequently does not appear on any list of dangerous materials. The chemical and physical properties of post-consumer tires make them a valuable resource – whether for their material and energy content. Therefore application include the use of the materials, as well as whole tires, in such application as civil engineering, construction and road applications, in the manufacture of industrial and consumer products, and as feedstock for energy recovery.

Material recycling encompasses two distinct components: the production of material and the use of those materials in a board array of products and applications. Material production is the size reduction of post-consumer tires in four principal categories: cuts, shred, granulate and powder and production of oil substitutes: stove oil, mazut.

Three broad classes of treatment have been selected for inclusion to provide a non-technical overview of the predominant environmentally sound economically feasible and sustainable technologies that form the core of post-consumer tire markets: retreating, size reduction, energy recovery. As tires are permanently removed from a vehicle, they are inspected and those which meet the necessary criteria are selected for one of the reuse alternatives. Those which are not suitable for retreating are consigned to a recycling or recovery process. Production wastes from retreating, recycling and energy systems are disposed of as final residues.

Tires recycling include the production of size reduced materials as well as the use of whole tire and size reduced materials in numerous applications. Six treatments will be presented: baling, shredding, granulating (both mechanical and cryogenic), rubber reclaim, and pyrolysis each of which produces one or more materials for use in later applications.

#### **Conclusions**

It is obviously that post-consumer tires have long been negative influence on environment and economics support of recycling and energy recovery is beneficial components of a scrap tire management program. Using recycled tire rubber can be less expensive than making new rubber for some products. Using recycled rubber to make products like asphalt and mulch groundcover can increase safety and reduce maintenance costs compared to using some traditional materials.

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