# Advance in Technologies of Aviation Scrap Tires Disposal and Recycling

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***Abstract* – The analysis of the state of scrap transport tires accumulation and tecnologies for its disposal is done. The negative impact of tires accumulation and storage is considered. The perspective methods of scrap tires utilization are presented. Advantages and disadvantages of the technologies are discussed. Technological, economical, and environmental issues of technologies of tires recycling are analyzed. The most feasible ways for tires disposal are proposed.**

Keywords – scrap tires, chemical processing, physical processing, energy extraction, pyrolysis.

## Introduction

Motor transport as well as its infrastructure rapidly grow. Its lead to the accumulation of scrap tires, which volumes will also increase in near future. Consequently, this will lead to environmental pollution. Modern manufacturers produce virtually indestructible tyres, which cause a significant environmental problem with an estimated 1.5 billion scrap tires around the world, many of which finish up being dumped in forests and streams, as well as landfill (Boichenko, et al., 2019). Only in United States more than 3 million tons of scrap tires are produced annually, and up to 2.5 million tons in Europe. The disposal of scrap tires occupies large amounts of valuable landfill space, poses fire and environmental hazards (Yakovlieva, et al, 2021).

Naturally, the decomposition of waste rubber exceeds 100 years accompanied by soil poisoning and chemical releasing. This environmental impact could be minimized by viable alternative for the recycling of scrap tires by implementation of waste tire conversion technologies. Today in the waste management world a broad range of technologies are recognized that could be used to divert a portion of waste rubber materials currently being landfilled as well as other hydrocarbon materials (Boichenko, et al., 2019). Thus, the aim of this study was to analyze and compare existing technologies of scrap tires utilization and consider the most appropriate in terms of energy efficiency and environmental safety.

## Composition of tyres

Tires vary in size and design according to their purpose and manufacturer. Engineers are challenged with designing tires with cool running, heat-resistant materials while simultaneously exceeding tire service requirements. Generally, there are 8 types of ties, however, only two of them are used in aircraft applications – bias-ply tires, and radial tires. Although both types of tires share some similarities in design, some differences need to be noted. Bias-ply tires are popular choices for aircraft tyres because of their durability and retreadability. A typical radial tire with rigid belt provide increased landings and reduced rolling resistance. They have fewer components in their construction and are lighter than similarly sized bias-ply tires (Yakovlieva, et al, 2021).

The rubber is the tire main component; five types of rubber are used: natural rubber, StyreneButadiene Rubber, Polybutadiene Rubber, Isobutylene-isoprene Rubber, and Isobutylene-isoprene Halogenated Rubber. Textiles and metals are also part of the tire. Currently, steel cords are used to reinforce the rubber compound and provide strength. Among the materials suitable for use are cotton, rayon, polyester, and steel. The type and the percentages of minor components depend on manufacturer. These components are additives, sulphur compounds, and other toxic compounds such as heavy metals. Furthermore, the tires are produced using oils that may contain significant levels of Polycyclic Aromatic Hydrocarbons (PAHs) (Yakovlieva, et al, 2021).

## Review of technologies for scrap tires recycling

Scrap tires are considered to be a special type of waste with environmental, economic, and social issues. The problem of scrap tires disposal is that tires do not decay if buried, they resurface as they are of lower density than surrounding soil. If they are stored at landfills, they give an unstable surface to any landfill and the ground can't be used for building. If tires are accumulated on the surface, they pose a fire danger. Except making an environmental problem, scrap tires creates a health hazards in tropical regions as they keep water inside that provides the perfect habitat for microorganisms development (Ucar et. al, 2005). In addition, the tires are a high-energy material that justifies the efforts in the advancement of technology, innovation, and research and development.

The technologies for scrap tires disposal and recycling are classified as follows for *physical technologies* (mechanical recycling, low temperature processing, destruction and compression recycling), *chemical technologies* (ozone recycling, pyrolysis) and *energy extraction*.

Scrap tires is used in crumb rubber applications. In term of paving the rubberized asphalt concrete is a viable end use for tires. In term of molded rubber products millions of waste tires are used for crumb rubber products production. Also, a crumb rubber can be used as an soil additive which increase its permeability as well as airstream (Rouse et. Al, 2005). Tire-derived fuel can be used in cogeneration facilities or cement kilns, pulp and paper mills or industrial boilers; carbon black can be burned on site for alternative energy recovery or be sold for the needs in various applications. The value of the end products depends on the input materials composition type of tires used as a feedstock and the specific process requirements**.**The scrap tires recycling process begins with inspection, which aimed on deciding what can be reused, recovered, or transformed into a new product or energy (Boichenko, et al., 2019). Then, the tires are transported to recovery facilities, where they are processed by the shredder and/or grinder (Phale, 2005).

*Mechanical recycling*

Mechanical recycling is based on tires shredding, cord separation, and next rubber crumb gridding to powder. Disadvantages of this technology are high-energy consumption, rapid wearing of equipment and low quality of final product due to number of contaminating impurity in crumbs.

*Low-temperature processing*

Low-temperature (cryogenic) processing of scrap tires performs at temperatures from -60 °C to -90 °C, when the rubber is in crack-sensitive state. The benefits presented by this technology are metal and textile separation improvement and the yield of rubber product. Disadvantages of this technology are high cost of coolant (liquid nitrogen), power consumption, and delivery complexity.

*Destruction and compression recycling*

The scrap tires are fed through the holes to the chamber, where under the high pressure are separated on steel cord, textile and crumb rubber. Among the disadvantages of this technology are rapid wearing of the equipment, high energy consumption and multistage crumb rubber system.

*Ozone recycling technology*

The technology is based on scrap tire oxidation to crumb rubber. During the ozone processing steel and textile cords are completely separated. The high speed facilitates the gridding.

Minimal energy involvement. Disadvantages of this technology are expensive equipment, high explosive risk, the highest hazard class of ozone.

*Pyrolysis technology*

As a thermal decomposition process, the pyrolysis can be used to convert scrap tires as well as other hydrocarbon materials into useable products such as oil, syngas and carbon black. The technology is based on cracking under the high temperatures and without addition of air or oxygen. As lower the temperature as more pyrolysis oil is produced. As higher the temperature as more syngas is produced (Kryshtopa, et al, 2021). The oil derived from pyrolysis process can be used as low grade fuel in boilers or separated on fractions, such as diesel, gasoline and heavy oil. Pyrolysis gas usually satisfies systems energy needs by heating up the process. Pyrolysis technology is one of the most environmentally friendly, energy and cost efficient solution for treating a wide variety of rubber products in the international waste management stream, implemented in the most developed countries such as the USA, Japan, Germany, Switzerland and others (Yakovlieva, et al, 2021).

## Conclusion

The modern state of technologies of scrap tires processing is shown. Due to the rapid global growth of transport sector, we may observe increasing demand in tires production. Consequently, there is a tendency to increase in volumes of waste tires. This substantiates the necessity to develop environmentally friendly and energy efficient methods for waste tires processing. Analysing the existing and promising processing methods, we may conclude that waste tires may be efficiently use as a raw material in such industries as cement production, road construction and fuel production and other application. Fuel production in a result of waste tires processing is relevant direction in technologies of waste tires processing. It may have significant potential as well as energy and financial benefit. Thus, development and implementation of system of waste tires processing may provide its long-term use as well as efficient processing and secondary use with minimal negative impact on environment.

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