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Ecological, Economic and Technologically Effective Method of Recycling of Old Tires

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ABSTRACT: Using a newly developed, highly efficient technology, the recycling of obsolete car tires, alternative fuels and hydrocarbon gases have been obtained to replace fuel oil and natural gas.

KEY WORDS: Thermal pyrolysis, pyrolysis furnace, reactor, boiler fuel, gas condensate.

I.INTRODUCTION

With the increasing population in the world today, the demand for the necessary products for the mankind is increasing. In the modern era of science, various products are produced for the needs of mankind, and the lifestyle of the population is improving. It is known that some of the products used for the needs of the population are released as waste. Today, in our country and in almost all countries of the world, solid household waste is growing at an annual rate of 1% per capita.

More than 800 types of waste have been recorded so far, and their number is expected to increase further in the future. Energy, transport, non-ferrous and ferrous metallurgy, chemical industry and construction industry are the main sources of waste generation and environmental pollution. According to the analysis, in recent years, the country has generated more than 100 million tons of industrial waste per year. 14-14.5% of them are toxic wastes, tires, batteries, used oils, packaging materials, mercury-containing and other wastes. In addition, about 35 million tons of household waste will be generated. Considering that about 2 billion tons of industrial, construction and household waste are stored in landfills and waste storage facilities of the country, and they occupy an area of 12,000 hectares, it is not difficult to imagine the negative impact of waste. [2]

80 percent of these wastes are organic, and their recycling can produce large amounts of energy and energy carriers. Experts say that household waste is a cheap raw material all over the world. The experience of developed countries shows that 85% of it can be recycled. In Northern European countries, separate collection of waste has been established, as a result of which most of the raw materials, such as rubber, paper, plastic, aluminum, are sent for recycling. The positive impact of this process on the environment is enormous. Waste recycling saves energy and raw materials significantly. According to statistics, in Japan, 34 percent of rubber and cable products, 43 percent of glass products, and 54 percent of paper and cardboard are recycled. In China, 33 percent of metal products such as aluminum, iron, copper, and 34 percent of wool, silk, leather, and rubber products are obtained from the recycling of various wastes.

The forecast for the annual volume of solid waste generation in the Republic of Uzbekistan is estimated at 14-14.5 million tons. Given the average population growth rate of 1.5%, this figure could reach 16-16.7 million tons by 2028. Urbanization also affects waste generation, the population of urban areas emits more waste than the rural population, such a growth rate of solid waste generation reflects the living conditions of the population and the growth of the republic's economy. However, the need for a systematic, programmatic approach to the modernization and improvement of the system of solid waste management is even more pressing. Because without such an approach, it is impossible to solve problems in the field. [1]

II. LITERATURE SURVEY

Makarevich E.A., et al. Proposed with their article explores the way recycling of used tires. Experimental data for improving the carbon balance Heavy-media methods of enrichment. Magnetic and vibroseparate, oil agglomeration, thermal processing [5].

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NovichkovYu.A. Proposed conducting comprehensive research to develop recommendations environmentally friendly application of low-temperature pyrolysis technology fordisposal of worn out and discarded tires, as well as methods of obtaininghigh-quality secondary raw materials with increased environmental safety [6].

Anikin E.V., et al. The purpose of this work is to obtain from rubber technical waste of secondary resources with their subsequent use.The tasks are laboratory tests, tests with detectionshortcomings with their subsequent elimination. After the pyrolysis process, such products are formed as:hydrocarbon, pyrolysis fuel, steel cord, pyrolysis gas. But in this article will focus on such resulting products ashydrocarbon and pyrolysis fuel [7] .

III. DEVICE CHARACTERISTICS

During the experiment, a low-temperature pyrolysis process was selected to decompose the rubber products. The main objectives of this study are to optimize the pyrolysis process and design semi-industrial pyrolysis devices to maximize the range of products in the liquid fuel. Pyrolysis of automobile tires in a laboratory pyrolysis reactor has been studied theoretically and experimentally. The main factors were studied and identified. In order to implement the process, a technological scheme of a semi-industrial device was developed. The pilot device was assembled using the developed technological scheme. (Figure 1).

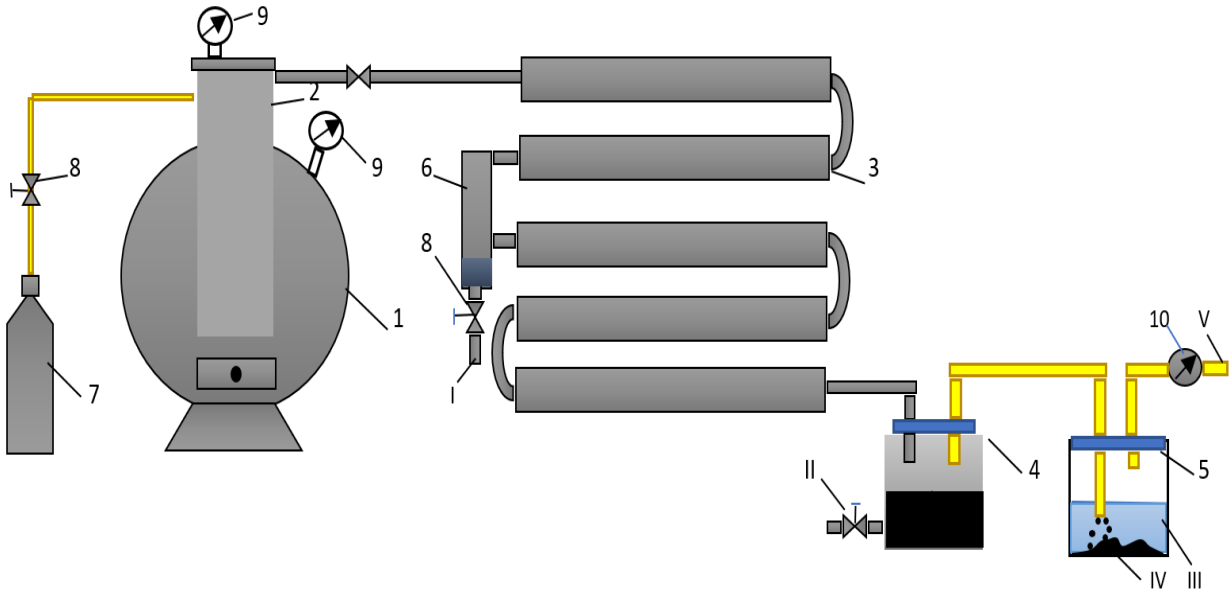

Figure 1. Experimental technological scheme of obtaining fuel from obsolete car tires on the basis of pyrolysis process.

1-Pyrolysis furnace; 2-pyrolysis reactor; 3 water coolers; 4.6 -collector; 5-absorber; 7- inert gas balance; 8-crane; 9-thermocouple; 10 gas meters;
I-light liquid product; II-heavy fuel product; III- alkali; IV-residual carbon; V-purified hydrocarbon gases.

The created pilot device has an additional part such as pyrolysis furnace, reactor, refrigerators, gas collector, liquid collector, thermometer, thermocouple, inert gas balloon. 3.2 kg of automobile tires weighed on an analytical balance were loaded into the pyrolysis reactor. Prior to the start of the process, the tightness of the device was checked by injecting an inert gas into the rector and expelling the oxygen inside the reactor. Another function of inert gas is to prevent the risk of explosion.

IV. METHOD OF EXPERIMENT

Scientific research has been conducted to ensure the implementation of the tasks set out in the above resolution. During the research, an economically and environmentally efficient recycling method was developed as a

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result of recycling used waste tires belonging to the category of toxic waste. The main thing in this method was scientifically justified the possibility of obtaining the necessary products from the waste for industry and the national economy.

Once the process began, the performance of the thermocouples was monitored continuously. The thermal pyrolysis process was carried out at temperatures up to 600ºC. Research on the pilot device has shown that the outlet temperature of the gas phase starts at 52oC and the outlet of the gas increases in the temperature range of 120-140 oC. The liquid fraction output started at 155oC. It was observed that the liquid collected in the collector (6) was light brown in color and formed in very small quantities. It was observed that the liquid collected in the collector (4) was dark brown in color. The released gas passes through the alkaline solution and the solid carbon residues are absorbed into the alkaline solution.

During the study, a black residual carbon and a volatile fraction were formed, which revealed that the volatile fraction could be converted into a condensable hydrocarbon liquid and a non-condensable gas. Studies on the production of hydrocarbon liquids from waste tires using low-temperature pyrolysis have been conducted in various modes. Solid car tire waste was studied in different technological modes, at different temperatures, at different times in a specially installed reactor. In pyrolysis, the decomposition temperature of car tires was observed in the range of 360 ºC to 600 ºC. The norm of the technological regime for the reaction temperature and heating rate of the pyrolysis process was determined. It has been proved that when the process is carried out according to the norms of the technological regime set for the thermal pyrolysis process, it is possible to achieve a significant increase in the formation of light hydrocarbon production.

V. EXPERIMENTAL RESULTS

During the study, the types, composition and methods of recycling of used tires were studied. The number and types of tires will vary depending on the type of vehicle, the area of use. Tires that can be used as raw materials also vary in mass. During the study, the number of tires used to use 1 ton of waste as a raw material is determined based on the type of vehicle and the number of tires. (Table 1).

Table 1. Mass values of different types of tires for cars and trucks

Vehicle type	Tire mass, kg	The number of tires required for 1 ton
Passenger car	6,5-9	154-110
Buses and minibuses	15-30	67-34
Truck	50	20
Agricultural machinery	40-100	25-10
Special vehicles	30-200	33-5

Depending on the type of vehicle and the area of use, the composition of the tires will also vary. We compared the used tire tires of cars and trucks in terms of content for use as raw material. (Table 2)

Table 2. Comparison of the composition of tires of cars and trucks

Material	Composition of tires, %	
	For cars	For trucks
Rubber	47	45
Technical carbon	21,5	22
Metal	16,5	25
Synthetic yarn	5,5	-

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Zinc oxide	1	2
Sulfur	1	1
Additives, resins, oils	7,5	5
Note: In some types of tires, some of the technical carbon can be replaced with silicon oxide.		

Its chemical composition was studied to process the car tire. The composition of the tire consists of the following basic chemicals.

1.Rubber is the basis of all tires. Originally, natural rubber was used, and now synthetic rubbers derived from petroleum products and other means are used in various sectors of the economy and industry.

2.Technical carbon is an industrial technical carbon that turns tires black. When vulcanized, technical carbon forms a perfect molecular compound, which increases the durability and strength of the tire. The rubber mixture with technical carbon is vulcanized using sulfur.

3.Silicic acid. It has been replaced by carbon in gas-restricted areas. The strength of the tire is related to the technical carbon, but is slower when using the tire obtained using silicic acid.

4.Resins and oils. These are auxiliary materials that are added to rubber compounds. The softness and hardness of the tires depend on the amount of resin and oil.

5.Sulfur. This is an additive that improves the vulcanization properties of the tire. With its help, molecules of rubber, technical carbon and other additives bind together to form strongly branched molecules. Thus, the rubber compound becomes a soft, elastic rubber.

6.Vulcanization activators. These are stearic acids, zinc oxide and various accelerators. Their function is to improve the properties of the tire when used in hot conditions and under pressure.

This means that a variety of hydrocarbon products can be obtained by recycling hydrocarbons, synthetic rubber, resins, oils, and technical carbon-containing tires. [4]

The number of tires in cars made in different countries of the world also varies depending on the areas of use, speed, load capacity and other characteristics. The period of replacement of a car tire with a new one depends on their area of use, the roughness or unevenness of the moving roads, the type of pavement and other factors. For example, passenger cars, trucks, and special vehicles used in industries such as oil and gas, geology, and mining have a much shorter service life than tires used in other industries. We examined the overall service life of the tires and how many tires were equipped according to the type of vehicle. (Table 3)

Table 3. Number of car tires and service life

Vehicle type	Number of tires, (pcs)	Tires use Period, (years)
Passanger car	4-6	1-2
Buses and minibuses	4-12	1-2
Truck	4-32	1-1.5
From agricultural machinery	4-14	1-2
Special vehicles	4-36	0.5-2

As can be seen from Table 3, the tire life is at most 2 years, regardless of the type of vehicle. This means that after 1-2 years of using the tire, it can no longer be used according to the standard. From this it can be seen that the split tire used turns into waste.

VI.CONCLUSION AND FUTURE WORK

In order to as a result of the research, we used the pyrolysis method to obtain fuel during the recycling of used car tires. This method is a process that involves the decomposition of organic compounds in tires in the absence of

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oxygen. Tire pyrolysis today is an economical and environmentally friendly way to dispose of them, as it not only solves the problem of recycling, but also allows the extraction of fuel from waste. Low temperature pyrolysis allows tires to be disassembled, each of the products obtained can be used for specific purposes.

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