Improving the Energy Efficiency of the Auger Drum Pyrolysis Device

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Abstract: In the article, different biomass raw materials and hydrocarbon waste processing methods are studied. The authors proposed the principle thermal scheme of the auger drum pyrolysis device, and the prototype was installed at the “Alternative energy sources” training ground of the Karshi Engineering Economics Institute, and preliminary thermal and technical tests were conducted. According to the results of the conducted experimental research, as a result of pyrolysis processing of biomass raw materials and various hydrocarbon waste: from solid household waste (unsorted) up to 35-60%, from car tires and other rubber waste up to 45-60%, from medical waste 25-30%, 25-30% from wood and agricultural waste, 45-65% from all types of plastic are indicated.
Keywords: biomass raw materials, hydrocarbon waste, processing, heat-technical testing, alternative fuel.

Introduction.

In the innovative development of our country's economy, energy saving and increasing the efficiency of using alternative energy sources, introducing technologies working on the basis of renewable energy sources are defined as important tasks [1,2].

Biomass is one of the classic renewable energy sources, which can be processed into solid, gaseous, and liquid alternative fuels. Obtaining fuel and energy by processing biomass and various local organic wastes, firstly disposal of agricultural and local organic wastes, secondly obtaining cheap fuel, and thirdly reducing the amount of harmful waste released into the atmosphere. The possibility of using biomass for energy purposes provides energy, environmental, and economic benefits at the same time. The analysis of biomass energy devices shows that reducing the energy capacity of the raw material processing process, optimizing the energy balance of the device, and increasing its energy efficiency. Therefore, the thermal processing of biomass, obtaining fuel, heat, and electricity from it is highly effective in providing energy to consumers in areas far from centralized energy supply [3-5].

Using solid household waste for energy purposes, obtaining alternative liquid, gaseous, and solid fuels has been attracting more and more interest in our country in recent years, since liquefied petroleum gas is a source of cheap raw materials all over the world [6-8].

Methods and materials.

The authors analyzed the methods and methods of processing solid household waste, and one of the main tasks in the transition to practical use is the development and implementation of energy-efficient technologies and devices for obtaining high-quality and cheap energy [9].

A pyrolysis device can process any hydrocarbon waste - rubber, plastic waste, wood and waste, oil-contaminated soil, oil compounds, household waste, industrial waste, medical waste, etc. designed for thermal processing [10].

One of the most effective methods of thermal processing of MSW is the pyrolysis method, pyrolysis technology is an innovative solution for waste management and significantly reduces the area of landfills. The authors proposed a pyrolysis device for the thermal processing of MSWs (Fig. 1).

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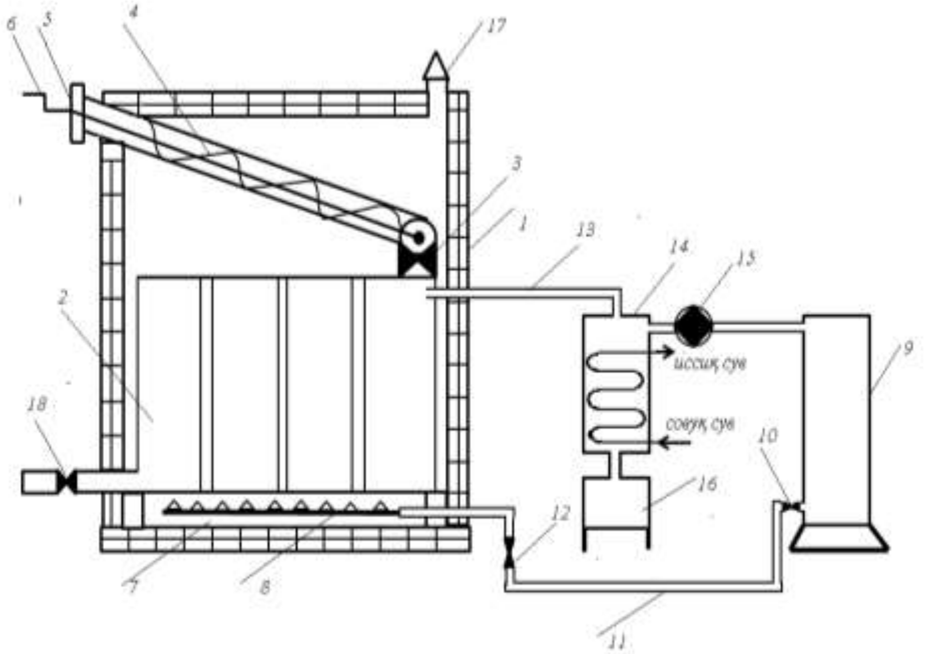

Figure 1. Scheme of the pyrolysis device.

The pyrolysis device for the thermal treatment of municipal solid waste consists of a shaft (1), a pyrolysis reactor with a "pipe cover" (2), a screw (3), a shaft-screw drum dryer (4), a cover (5), an auger (6), combustion chamber (7), burner (8), gas holder (9), valve (10,12,18), pipe (11,13), spiral heat exchanger (14), filter (15), liquid fuel tank (16), smoke chimney (17).

In a pyrolysis device, as a result of thermal processing of raw materials in closed reactor chambers at low and high temperatures without oxygen, they are separated into particles and alternative fuels [11-19].

Raw materials (used tires, medical, plastic, electronic waste, oil refining waste, etc.) are loaded into a device (reactor) made of heat-resistant material. The raw material is heated due to heat conduction through the walls of the reactor, and as a result of thermal decomposition (pyrolysis), a steam-gas mixture and a carbonaceous residue - polycoke - are formed. The steam-gas mixture is removed from the reactor through the pipeline and cooled, the steam is condensed and separated from the gas mixture. The liquid products are collected in the liquid collection tank, and the released gases are used as fuel to continue the process in the device. After the end of the pyrolysis process, the residual semi-coke products are removed from the retort, and the retort is again loaded with raw materials and installed in the furnace.

The reactor is installed vertically, and the mine furnace is surrounded by high-temperature heat insulation material based on refractory concrete and ceramic fiber. In the lower part of the mine furnace, a garelka and colonic brazier are installed for burning solid fuel and hot gases. Increasing the intensity of the combustion process and mixing the combustion products is carried out by air pressure. The reactor with raw materials is introduced into the mine shaft from the top of the mine furnace. The reactor is a cylindrical vessel made of heat-resistant steel with a lid. The paired surfaces of the reactor and the furnace are sealed with a special hermetic material along the perimeter.

A condenser is a cooler designed to convert vapors of liquid pyrolysis products into condensate. The steam-gas mixture is supplied from the retort to the condenser-cooler through a quick-disconnecting pipe and a deformation compensator. Condensate and non-condensable gases are discharged to the collector-separator through the pipeline.

Collector-separator-cylindrical container designed to collect liquid pyrolysis products and partially retain the liquid part from the flow of gaseous mixtures.

The final gas mixture is cleaned in a gas-liquid separator.

Combustible gases are transferred through the burner to the combustion chamber of the furnace or to another consumer.

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Raw materials are loaded into the reactor horizontally or vertically outside the furnace and the reactor lid is closed and secured.

The reactor is installed in the furnace and connected to the condenser-cooler through a quick disconnect connection.

The reactor can be installed both when the furnace is hot and when it is cold.

To light the oven, the door of the oven (firewood, coal, polycoke) is loaded onto the colonic grill and lit.

An increase in the intensity of the combustion process is ensured by supplying air from under the colonic grill.

Pyrolysis gas enters the bunker and burns. As the gas flow increases, the air pressure under the grill decreases.

The end of the pyrolysis process is determined by the decrease in gas flow. To obtain high-quality semi-coke, the process is carried out until gas evolution stops. After the process is completed, the fuel supply is cut off for 30 minutes to allow the retort temperature and the furnace temperature to decrease slightly before removing the retort. After the temperature drops, the retort is disconnected from the condenser-cooler pipeline (using a quick-disconnect connection) and removed from the furnace, and the reactor loaded with raw materials is installed back into the furnace. The discharged hot reactor is cooled in air the reactor lid is opened and the polycoke is removed.

Results and discussions.

It is more efficient to operate a large number of pyrolysis furnaces at the same time because the excess gas from the first furnace can be used to heat the second one. In each period, the furnaces are operated at different stages of the process. The distance between the 2 furnaces of the process is chosen in such a way that the second furnace goes through the maximum gas phase when the first furnace covers the fuel demand. Thus, there is no need for additional solid fuel, the amount of exhaust gases released into the atmosphere is significantly reduced, and there is no need to install a gasholder for temporary storage of pyrolysis gas.

The output of trace products

№	**Type of raw material**	**Amount of product to be obtained %**
1	**Rubber tire products** Liquid fuel Gas Mistallokord Technical carbon	 35 - 45 10 - 12 8 - 10 40
2	**Coal** Liquid fuel Gas Polococcus Water	 14 12 64 10
3	**Fuel oil** Liquid fuel Gas Polococcus	 85 – 90 7 5 - 7
4	**Plastic waste** Liquid fuel Gas Carbon	 60 - 85 10 5
5	**Medical waste** Liquid fuel Gas	 65 – 70 10 - 30

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	Carbon	5 - 15
6	**Wood products** Liquid fuel Gas Charcoal	 4 - 5 18 - 24 20 – 25
7	**Oil residue** Liquid fuel Polococcus Gas	 75 - 80 10 – 15 10 – 15
8	**Used car oil** Liquid fuel Gas Polococcus	 85 - 90 5 – 7 5 – 7

According to the results of the experiment carried out in the pyrolysis device installed in the “Alternative Energy Sources” training ground of the Karshi Engineering Economics Institute, it was determined that the amount of alternative pyrolysis fuel obtained from waste depends on the type of waste being processed, the specified temperature regime, the moisture content of the waste and the degree of grinding.

Conclusions

According to the results of the experiment, the following alternative fuels were obtained from waste.

35-60% from municipal solid waste (unsorted), 45-60% from car tires and other rubber waste, 25-30% from medical waste, 25-30% from wood and agricultural waste, 45-30% from all types of plastic up to 65%.

Pyrolysis technologies allow the processing of almost all types of waste, except for building materials, and obtaining alternative-pyrolysis fuel, and provide solutions to the following problems:

1. Reduces the impact of waste on environmental sustainability and human health.
2. Disposal of waste without waste (processing of waste without sorting).
3. Production of fuel (synthetic oil, pyrolysis fuel, diesel fuel, etc.) that meets the requirements of the “green tariff” for the production of heat and electricity.

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