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EXPERIMENTAL SOLAR INSTALLATION FOR THE PROCESSING OF MUNICIPAL SOLID WASTE

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ABSTRACT
A solar installation for the processing of municipal solid waste in order to obtain landfill gas and organic fertilizers is proposed. The parameters of thermal and anaerobic fermentation of the processes occurring in this installation are considered. A substantiated analysis of the formation of energy efficiency and improvement of the sanitary and environmental situation in solid waste processing systems is shown.
KEYWORDS: *Municipal Solid Waste; Solar Energy, Solar Installation, Alternative Fuels, Waste Management.*

INTRODUCTION

Currently, one of the ways to reduce the consumption of expensive traditional energy resources in industrial production and in the energy sector is to use renewable energy sources.

With the constant increase in fossil energy prices, as well as the depletion of oil and gas reserves, an increasing number of countries are using alternative (renewable) energy sources. One of these types of renewable fuel resources is biogas, which is obtained from waste of various origins.

Municipal solid waste (MSW) - organic and inorganic waste, massively and continuously produced by the urban and rural population, consists mainly of hydrocarbon raw materials, which allows them to be considered as one of the types of renewable fuel resources. "Solid household waste" is a product of human activity generated in residential buildings, public, medical, institutions, waste of restaurants, trade enterprises, various institutions, municipal services and subject to removal from the territory of cities and rural settlements [1].

SIGNIFICANCE OF THE SYSTEM

A wide range of waste can be a source of renewable fuel resources. Such municipal solid waste includes wood, paper, various combined packaging, textiles, food and vegetable products, etc., which are generally not suitable for further processing.

If you use solid waste for the generation of thermal energy, you will not get the cleanest fuel. Sulfur-containing and chlorine-containing compounds are

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present in small amounts in it (less than 0.5%), heavy metals, etc. can be found (table 1) [2,3].

Table 1.

element	dimension	concentration less
S	%	0,5
Cl	%	0,5
F	%	0,1
Cd	mg/kg	10
Tl	mg/kg	1
Hg	mg/kg	0,5
Sb	mg/kg	75
As	mg/kg	10
Pb	mg/kg	100
Cr	mg/kg	100
Co	mg/kg	20
Cu	mg/kg	400
Mn	mg/kg	100
Ni	mg/kg	100
PCP	mg/kg	100
PCB	mg/kg	50
V	mg/kg	25
Zn	mg/kg	75

The table shows that the level of toxic elements in the fuel from solid waste in many positions is significantly lower than that of coal, and these indicators are true.
Currently, there are enough developments that are widely used to control and divert landfill gas abroad. Gas is usually removed by suction and sent for burning in an open flare or in significant quantities and disposed of in an appropriate quality. Landfill gas is collected from vertical wells drilled on the site of already filled storage facilities, or from horizontal collector wells constructed during waste storage.

LITERATURE SURVEY

In 1985, there were more than 30 plants in the United States that used biogas from waste landfills. In Germany, in private commercial operation there are a number of small-capacity plants that generate electricity by burning biogas from waste storage facilities [2].

In the UK there are cement and brick kilns using biogas from waste storage facilities [3].

In China, heat and electricity generated from biomass or MSW are bought by the government almost 2 times more expensive than those generated from conventional fossil fuels. A number of resolutions have been adopted in this country, in which investment is encouraged specifically in the field of incineration, which is considered promising in the framework of the development of the sanitary cleaning industry in large cities [2,4].

Thus, to date, considerable practical experience has been accumulated on the use of biogas from solid waste storage facilities.

Currently, such facilities are not used in Uzbekistan, which, in addition to missing economic benefits, leads to environmental gas pollution.

The problem of the use and disposal of solid waste is currently one of the important and at the same time far from a final solution problem. One reason is that a relatively small change in the composition of solid waste often requires a significant change in treatment technology. The main reason is that the processing and disposal of solid waste is a special case of the sanitary and environmental situation, which in the Republic of Uzbekistan leaves much to be desired. The amount of waste is growing, and their recycling is too small.

At the same time, the organization of the export of solid household waste from the population in the cities and regions of the Republic of Uzbekistan is in poor condition, almost all cities do not systematically remove solid household waste from the population, the material and technical base of specialized sanitation organizations is not equipped with special equipment in the required quantity, existing landfills do not meet sanitary rules and norms; in a number of places spontaneously formed landfills are used.

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The problem of utilization of municipal solid waste is not only a technical problem, but also a sanitary and environmental one.

The accumulation of rotting solid waste in surface storages inevitably leads to the formation of biogas in the sun, which is a product of the anaerobic decomposition process that occurs inside the mass of collected waste. Biogas must be diverted in order to prevent its migration from the landfill, as it is toxic and explosive. Its danger extends not only to the territory of the landfill, but also beyond its boundaries due to the significant volume of education.

As a result of anaerobic decomposition of the organic fraction of waste from the total amount of methane that enters the atmosphere annually, 40-70% is formed as a result of anthropogenic activities, more than 20% of which are landfills for solid waste. It is estimated that about 150-200 m^3 of landfill gas is formed from one ton of MSW [5,6,7,8].

METHODOLOGY

One of the main methods for the removal of solid waste throughout the world remains burial in a subsurface geological environment. Under these conditions, the waste is subjected to intensive biochemical decomposition with the formation of landfill gas. The main components of landfill gas include not only greenhouse gases (methane and carbon dioxide), but also such toxic compounds as carbon monoxide, nitrogen oxides, hydrogen sulfide, sulfur dioxide.

Methane contained in landfill gas generated during the decomposition of municipal solid waste is carefully collected, after which it enters the water filter - a special gas purifier that is used in various chemical and technological processes to clean gases from impurities. Here, the gas is cleaned of dust particles and unnecessary impurities (for example, sulfur and water mixture) and sent to consumers. After that, the gas becomes ready for further use.

Recently, interest in the development of new designs of power plants for processing solid household waste under conditions of anaerobic digestion, for obtaining alternative fuels and organic fertilizers in the process of methane fermentation of industrial waste and comparing favorably with other methods [1, 4,6, 7.8].
Usually, a solar installation (SI) means a complex of engineering structures consisting of devices:

- Mass preparation of solid waste;
- Production of landfill gas and fertilizers;
- Cleaning and storage of landfill gas;
- Production of alternative energy and heat:
- Automated control system SI, (SI must be airtight).

The optimal temperature of methanogenesis depends on the type of solid waste processed by the installation.

Installed control and measuring devices should provide control of the MSW mass level in the reactor, temperature and pressure inside it.

Active metabolism and a high rate of biochemical metabolic processes in the reactor are achieved due to the maximum maintenance and continuous updating of the values of the boundary surfaces between the solid and liquid phases. Therefore, solid materials, especially those of plant origin, must be pre-prepared using cutting, tearing or flattening devices in order to obtain particles as small as possible as a result of effective mechanical action. The proportion of solid particles suspended in a liquid largely depends on the technical means that are used to obtain thorough mixing, hydraulic transportation of the MSW mass and separation of landfill gas.

In the reactor, it is necessary to organize periodic mixing of the MSW mass, which ensures the effective and stable operation of the control system. The purpose of mixing is to release the generated landfill gas. Too frequent or prolonged mixing is harmful. Therefore, it is recommended to slowly mix the mass of solid waste every 4-6 hours.

By optimizing the operation of the installation and the composition of the waste, it is possible to speed up the processing even up to 3-4 days.

The most relevant heating system for solid waste mass is solar energy, i.e. solar installation equipped with a solar air heater.

SYSTEM DESIGN

The installation we developed (Fig. 1) can be used in small settlements and mainly for the processing of municipal solid waste.

The developed scheme for the decomposition of organic matter of solid household waste in the installation: the movement of water, as well as the diffusion of oxygen into the thickness of the installation, determines the nature of biochemical processes. Sufficient humidity contributes to the accessibility of organic substances, and especially volatile fatty acids (VFA) as a mass of solid waste for microorganisms, and their distribution in space.

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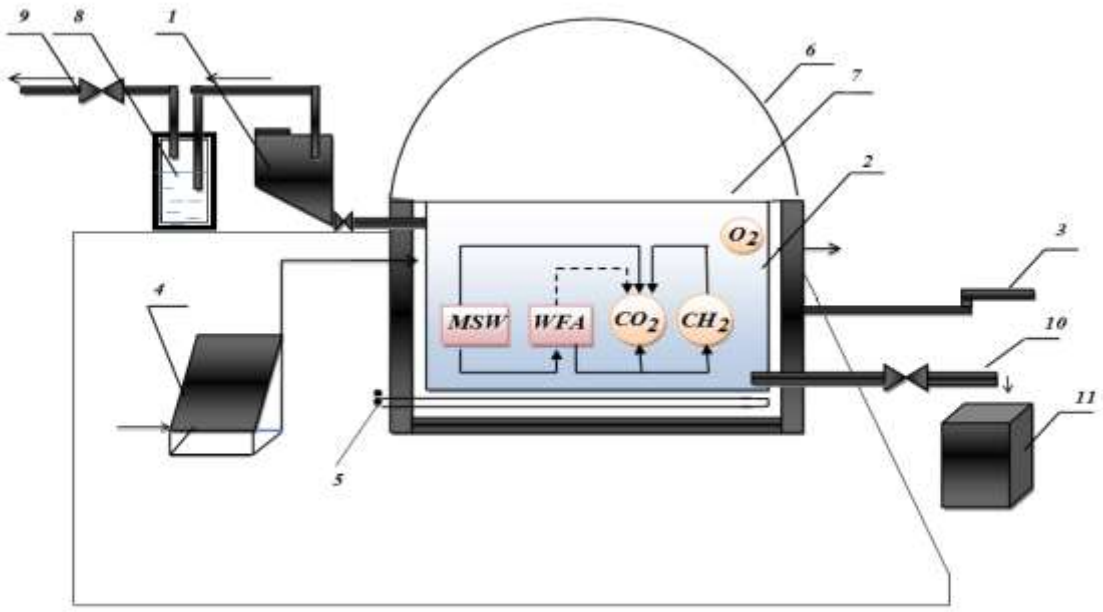

Fig. 1. Developed solar installation for the thermal processing of municipal solid waste

Receiving hopper (1), landfill reactor (2), mechanical mixer (3), solar air heater (4), electric heater (5), polycarbonate coating (6), metal sheet, i.e. an absorber (7) and a water filter (8). To increase energy efficiency, an electric heater is additionally installed on the device, which is a backup heater (5), a valve (9), an exhaust pipe (10), an exhaust hopper (11)

The energy of solar radiation can be used to heat the mass of solid waste and for large solar installations. Maintaining the required fermentation temperature in the reactor is due to the use of solar energy. After heating the MSW mass to the required temperature, water is drained. As a result, the intensity of heat from the solar air heater mass of solid waste rises to 55-60 ^{0}C.

Further maintenance of the temperature of the MSW mass within the required limits can be ensured by an electric heater.

DATASET DESCRIPTION

In the day mode, the loaded solid waste in the reactor is heated by a solar air heater (SAH) to a temperature of 50-55 ^{0}C. The electric heater is a backup heater and supports the creation of a stable temperature regime of anaerobic solid waste fermentation in the reactor on cloudy days and at night. This installation is characterized in that the reactor on top is covered with a translucent polycarbonate coating, which also serves as a passive solar installation, which provides the required temperature regime. Thus, the sun's rays passing through the polycarbonate glass flow into the installation and heat the metal sheet, i.e. absorber and due to thermal conductivity, heat is transferred to the internal volume of the reactor.

In addition, the heated air through the active SAH system to a temperature of 50-60 ^{0}C through the air channel heats the lateral and lower parts of the reactor surface.

EXPERIMENTAL RESULT

Analysis of the test data for the control system shows that the time of heating the MSW mass to a temperature of 55-60 ^{0}C is - 12 hours. The output of landfill gas in the optimal mode is 12-15 m^3/day [6,7,8].

The landfill gas productivity is 150-200 m^3/t, the working volume of the SI is 3.75 m^3, the temperature of the MSW mass in the reactor corresponds to the thermophiles mode: 55-60 ^{0}C.

Preliminary calculations and tests show that the developed installation will provide a stable temperature regime for solid waste fermentation and save heat energy consumption by 30-40%.

CONCLUSION AND FUTURE WORK

- In densely populated points (places) with a large number of municipal solid waste generated and the absence of landfills, there is a high possibility of processing solid waste. Demand for this kind of renewable fuel resources will grow over time and there will be an opportunity to save traditional fuel and energy resources.

- The developed solar installation for the processing of municipal solid waste can provide, without

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energy consumption, the production of landfill gas for its own technological needs.

- The use of landfill gas in technological production at the expense of solar energy makes it possible to ensure its summer and autumn production with the greatest efficiency, which is especially important in areas cut off from large energy centers due to river spills, impassability (in mountain villages distant from the center) and etc.

- The output of landfill gas when using solar energy to heat the mass of solid waste in the reactor in summer and autumn will increase.

- Modernization of the installation using solar energy will reduce the weight of specific capital costs and increase the profitability of solar installations.

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