EFFICIENCY OF USING A SOLAR CONCENTRATOR FOR BIOMASS HELIOPYROLYSIS

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Abstract. *The article analyzes the efficiency of the solar concentrator for biomass heliopyrolysis and the saving of heat energy used for the specific needs of the device, as well as the thermal technical indicators of the device. The article also proposes a heliopyrolysis system with a solar concentrator to provide heat to the pyrolysis reactor. A temperature of 400-700 ℃ can be obtained as a result of the application of a solar concentrator to this type of pyrolysis device. As a result, it allows to reduce private energy consumption for the pyrolysis process by 30-35%. In this article, the goals of computational-theoretical research obtained in the process of heliopyrolysis are mainly directed to the approximate assessment of their thermal efficiency, taking into account the degree of optimization of thermal technical parameters.*

Key words: *heliopyrolysis, concentrator, pyrolysis reactor, biomass, amount of heat, solar radiation, thermal efficiency, alternative fuel, temperature, time.*

Introduction

Currently, rational use of natural fuel resources and ensuring energy efficiency are important tasks. Effective use of renewable energy sources is important in saving energy resources. The energy potential of solar and biomass energy from renewable energy sources is large, and their practical use is energetically, ecologically and economically effective. 3000 hours) radiation energy can be effectively used for various purposes [1]. The technical potential of solar energy in our country is three times more than the amount of energy obtained for current consumption from all energy sources. In world practice, it is established to use solar energy for lighting, heating, air cooling, ventilation, heat and electricity production of buildings. Currently, it is important to use solar concentrators to use solar energy in technological processes that require high temperatures. In recent years, in Uzbekistan, scientific studies on the use of solar energy in various technological processes have been conducted and practical results have been achieved [2,3,4].

Fuel and energy production from biomass using solar energy is primarily of interest to autonomous and long-distance energy consumers of centralized energy supply systems in the form of small rural settlements, farms and individual houses. Therefore, the processing of plant biomass for the production of fuel, heat and electricity is an important task, mainly to provide energy to the rural population, especially to energy-deficient areas.

In recent years, scientific researches on the use of pyrolysis devices for obtaining alternative fuels from biomass indicate that significant theoretical and practical results have been achieved in this field. Currently, foreign scientists are conducting research on the use of solar concentrators in the pyrolysis process. In particular, the Mexican scientist Morales studied the pyrolysis process using parabolic concentrators, but the practical possibilities related to the daily position of the sun and seasonal radiation levels were not fully explored in the studies [5]. In our republic, G.N. Uzokov, R.T. Rabbimov, KhaDavlonov, Sh.Imomov conducted scientific research on obtaining alternative fuel from local biomass by pyrolysis method [6-25].

However, despite the results of the conducted research, there are no sufficiently scientifically based results on the use of solar energy in increasing the energy efficiency of the pyrolysis device to obtain alternative fuel from biomass energy. Therefore, it is important to substantiate the effectiveness of using solar devices for obtaining alternative fuel from biomass in a pyrolysis device.

Materials and methods

One of the main problems is to reduce the energy consumption in pyrolysis devices. Because in order to ensure the required (350-700 ^{o}C) temperature regime of the reactor, energy (heat) must be supplied initially. It is usually done by using coal, natural gas or electricity as an energy source for the processes carried out in the pyrolysis unit. This is because biomass waste requires a lot of thermal energy to decompose, and additional heating of biomass requires excessive energy consumption.

Results and discussion

required for the process was determined and the dependence of the generated energy on the aperture of solar concentrators was analyzed. In this work, the first law of thermodynamics serves as the basis of a theoretical thermodynamic approach to calculating the energy required for the process. It was found that the required energy demand in biomass heliopyrolysis depends on the surface of the solar concentrators for heating biomass at a certain time, the useful work coefficient of the device, the coefficient of reflection of the surface, the amount of biomass and the temperature difference [26-28].

Calculation of Q_{PSK} solar energy density in the focal zone of a parabolic cylindrical concentrator [27,28] :

$$Q_{PSK} = 2 \cdot R \cdot tg(\frac{U_m}{2}) \cdot L \cdot R \cdot E_o, \boldsymbol{J} \quad (1)$$

Here R– focal parameter ; U_m - angle of incidence of light ; L- concentrator length , m; E_o-falling radiation value , W/m ^{2} ; R - reflection coefficient.

required to heat biomass is determined as follows:

$$Q_B = s_b \cdot m_b \cdot \Delta T, J \quad (2)$$

The FIK of a solar concentrator is determined as follows:

$$\eta = \frac{Q_{PSK}}{Q_B} \cdot 100\ \% \quad (3)$$

(1) , (2), (3), (4), the following equation is formed:

$$\eta = \frac{2 \cdot R \cdot tg(\frac{U_m}{2}) \cdot L \cdot R \cdot E_o}{s_b \cdot m_b \cdot \Delta T}$$

The designation, naming and units of the parameters for the equations are given in the table below

Designation	Naming	Unit of measure
η	FIK	%
Q	Amount of heat	J
m	mass	kg
T	temperature	K
c	Heat capacity	J/kg·K

Energy required for the heliopyrolysis process was modeled in different ratios and the results were determined . In this case, 1 kg of biomass with a heat value of 2000 J/K·kg was processed . Table 1 shows the values of the variables for the sample model , all these values can be changed in the model if we consider that biomass moisture content is 10% and solar radiation is 900 W/m. Table 2 shows the values of the variables in the modeled heliopyrolysis device. Biomass heat capacity values are taken from the literature and can be modified within the model.

Results of study of variable parameters of biomass heliopyrolysis process

Table 1

Variables	Value
Amount of biomass, kg…………………………….	1
Biomass moisture, %...	10
Biomass heat capacity, J/kg•°C……………..	2000
Biomass loading temperature, °C…………...	20
Procedure duration, min……………………	180
Amount of solar radiation, W/m²…………..	900
FIK……………………………………………	25

Results of experimental study of solar concentrators in biomass heliopyrolysis

Table 2

Process time	Ambient temperature, °C	Consentrator aperture, m²	Biomass heat capacity, J/kg °C	Solar radiation, W/m²	Temperature in the heliopyrolysis reactor, °C	FIK
12: 00	30,1	1.2	2000	650	40	0, 2 8
12:15	30.5	1.2	2000	680	65	0.34
12:30	30.7	1.2	2000	700	84	0.38
12:45	31.6	1.2	2000	750	156	0.47
13:00	31.5	1.2	2000	780	180	0.60
13:15	31.8	1.2	2000	790	230	0.58
13:30	33,3	1.2	2000	840	290	0.62
13:45	34,6	1.2	2000	880	360	0.65
14:00	36,2	1.2	2000	900	380	0.64
14:15	38,3	1.2	2000	870	400	0, 63
14:30	38,2	1.2	2000	850	350	0.62
14:45	37.5	1.2	2000	840	300	0.61
15:00	37.0	1.2	2000	820	270	0.119

Conclusion

As a result of using a solar concentrator in a heliopyrolysis device, it is possible, firstly, to create a temperature regime of 450÷500 ºC and secondly, to reduce private energy consumption in the process of pyrolysis up to 30%. The conducted experiments show that the parabolic cylindrical solar concentrator with an aperture of 1.2 m2 in the conditions of the city of Karshi, when the solar radiation energy was 900 W, the FIK of the device was 60÷65 %. Thus, the creation of a heliopyrolysis device with a solar concentrator, research and development of scientific and technical solutions for biomass heliopyrolysis, as well as its implementation, is a promising direction in alternative energy.

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