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MODELING AND CALCULATION OF THE HEAT BALANCE OF THE SOLAR CONCENTRATOR HELIOPYROLISIS PLANT

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Abstract. *The article analyzes alternative methods for extracting fuel from biomass. The physicochemical characteristics of various biomass were studied. A comparative analysis of the technical and energy parameters of bioenergy and pyrolysis devices used in practice was carried out. In this work, it was found that the energy intensity of biomass processing using bioenergy and pyrolysis devices is high, and the share of biomass energy in the total energy balance of devices is 40-60%.*

Key words: *solar radiation, light opening, radiation reflector, short-term heat accumulator, solar heating, insolation passive systems, thermal efficiency, heated room.*

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 great, and their practical use is highly effective in terms of energy, ecology and economy [1].

One of the effective methods of obtaining energy from biomass is the heliopyrolysis method, in which solid, gaseous and liquid alternative fuels can be obtained in a short time [1,2]. It is important to determine the amounts of heat supplied and lost to the heliopyrolysis process, thereby creating an opportunity to assess the energy balance of the process. In the article, the heat balance of an alternative fuel extraction device using the heliopyrolysis method is modeled and calculated [3-10].

Method

The heat given in the process of obtaining alternative fuel by the heliopyrolysis method is equal to the heat consumed:

$$Q_{int} = Q_{ab} \quad (1)$$

The energy supplied to the helipyrolysis reactor Q_{ber} is determined as follows [11-16]:

$$Q_{ab} = P \cdot tg(\frac{U_m}{2}) \cdot L \cdot R \cdot E_o \cdot 3{,}6 \cdot 10^3, J \quad (2)$$

here P– focal parameter , m ;U_m - the angle of sunlight; L– concentrator length, m; E_o- falling radiation value, W/m ^{2} ;R - the reflection coefficient of the surface.

The amount of heat consumed from the heliopyrolysis reactor is determined as follows:

$$Q_{sp} = Q_{biom} + Q_{env} \tag{3}$$

The amount of heat required to heat the loaded biomass to the temperature of the pyrolysis process $Q_b$is determined using the following expression:

$$Q_{biom} = \rho_b \cdot V_b \cdot s_b \cdot (t_p - t_a), J \tag{4}$$

In the process, the amount of heat spent in the environment through the reactor Q_{env} is determined as follows:

$$Q_{atrof} = \pi \cdot d_2 \cdot L \cdot k \cdot (t_p - t_a) \cdot \tau, J \tag{5}$$

where, $K$is the heat transfer coefficient, W/m ^{2} ·ºC; L- the length of the reactor, m; t_b– biomass temperature, ºC; t_a– ambient temperature, ºC; τ- time, sec.

The heat transfer coefficient for a cylindrical heliopyrolysis reactor is determined by the following equation:

$$k = \frac{1}{\frac{1}{\alpha_1 d_1} + \frac{1}{2\lambda_d} ln\frac{d_2}{d_1} + \frac{1}{2\lambda_{iz}} ln\frac{d_3}{d_2} + \frac{1}{\alpha_2 d_2}} \tag{6}$$

where, α_1, α_2- heat transfer coefficient, W/ m^2·ºC; λ_d- heat transfer coefficient of reactor wall material, W/m ·ºC; d_1- the inner diameter of the reactor, m; d_2- outer diameter of the reactor, m; d_3- the diameter of the insulation layer, m; λ_{iz} - thermal conductivity coefficient of insulation material, W/m·ºC.

By equating equations (2), (4) and (5), it is possible to construct the heat balance of the reactor as follows [17-29]:

$$R \cdot tg\left(\frac{U_m}{2}\right) \cdot L \cdot R \cdot E_o = \rho_b \cdot V_b \cdot s_b \cdot \left(t_p - t_a\right) \cdot \tau + \frac{2\pi \cdot d_2 \cdot (t_p - t_a) \cdot \tau}{\frac{1}{\alpha_1 d_1} + \frac{1}{2\lambda_d} ln\frac{d_2}{d_1} + \frac{1}{2\lambda_{iz}} ln\frac{d_3}{d_2} + \frac{1}{\alpha_2 d_2}} \tag{7}$$

Results

Results of study of variable parameters of biomass heliopyrolysis process

Table 1

Variables	Designation	Value
Biomass amount, kg …………	m	2.7
Biomass humidity , %..................	φ	15
Biomass heat capacity, J/ kg• º C	c_p	2000
Biomass in loading temperature, º C	t_b	30
Temperature of the pyrolysis process, º C	t_j	450
Process duration, min……......................	τ	180
The sun radiation magnitude, W /m ^{2}	E_o	900
The coefficient of reflection of the surface….	R	0.9
Focal parameter, m.......................................	P	4.4

Results of calculation of heat balance of heliopyrolysis reactor

Table 2.

No	m, kg	$t_{\delta 1}$, ^oC	$t_{\delta 2}$, ^oC	Q biomass , kJ	Q around, kJ	E_o, Vt/m^2	Q_{giv} KJ
1	4	30	450	3700	432	900	6415
2	4	30	450	3700	432	800	5700
3	4	30	450	3700	432	700	4900
4	4	30	450	3700	432	600	4200

Conclusion

As a result of using a solar concentrator in a heliopyrolysis device, it is possible to create a temperature regime of 400÷450 ^oC. Experiments show that a parabolic cylindrical solar concentrator with an aperture area of 1.2 m^2 generated 6415 kDJ of heat in the device in the conditions of the city of Karshi. According to the obtained results, it was proved that the device can generate the necessary heat for heliopyrolysis of biomass.

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