HEAT CALCULATION OF THE CONSENTRATOR OF THE HELIOPYROLISIS DEVICE

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Abstract. *Reducing energy consumption in pyrolysis technology is one of the main problems. Because initially energy (heat) must be supplied to ensure the temperature regime of the reactor. Decomposition of biomass waste requires a lot of thermal energy, and additional heating of biomass requires excessive energy consumption. Usually, the processes carried out in a pyrolysis plant are carried out at the expense of coal, natural gas or electricity.*

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

Introduction

The problem of reducing energy consumption in biomass pyrolysis can be solved by using a heliothermic heating system. As a result of the research conducted in this field, a method of using solar concentrators in the biomass pyrolysis process, i.e. heliopyrolysis method, was proposed (Fig. 1)[1].

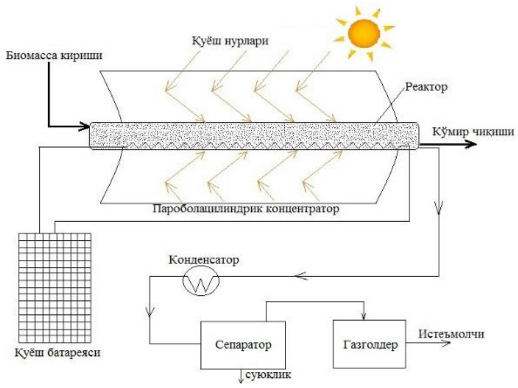

Figure 1. The principle scheme of the heliopyrolysis device.

A heliopyrolysis device based on a solar concentrator is environmentally friendly and reduces energy consumption for the process. The temperature required for the process is generated by parabolic cylindrical solar concentrators. The advantages of the proposed method are that the pyrolysis reactor can be continuously heated by solar energy using solar concentrators. The heat supplied to the reactor by the steam-cylinder solar concentrators is determined by the heat calculation of the existing device.

Materials and methods

A parabolic cylindrical concentrator has a reflecting surface, and a beam of length *l* is received along its axis the location of the reactor is narrow (Fig. 2) . The axis of the concentrator is located in the east-west direction , and the mirror is automatically directed to the sun . The screen installed on the collector serves to reduce heat loss [2,3,4] .

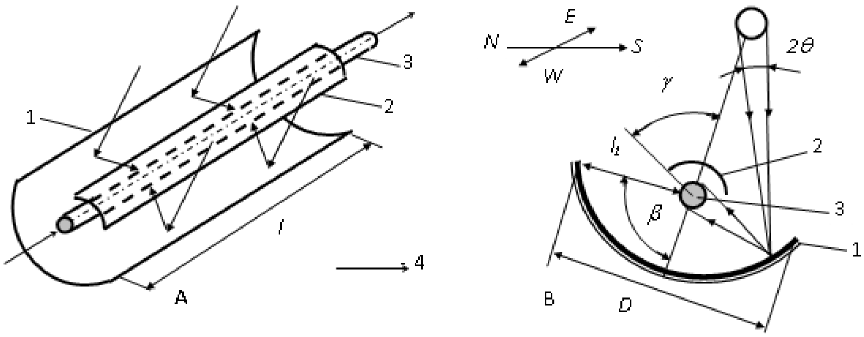

Figure 2. Scheme of a parabolic cylindrical concentrator.

A - overview; B - cross section; 1 – parabolic cylindrical mirror; 2 – screen; 3rd reactor; *NS* - north-south; *E* -*W* – east- west.

In the heliopyrolysis reactor [5-20]:

$$Q_{yut} = R\, kl\, DS_{\perp}; \tag{1}$$

where: *R* is the reflection coefficient of mirror; *k* - heat transfer coefficient; *l D* - radiation surface, m^2; $S_{\perp}$- unit of solar radiation falling on the surface, W/m ^{2}

If we do not take into account convective heat losses, the reactor loses energy in those parts that are not protected by the insulation layer. Heat losses by radiation are determined by the following equation [20-25]:

$$Q_{iq} = e\, s\, T_p^{\,4}\, 2\, p\, rl\, (1 - g\, /\, p\,)\,; \tag{2}$$

where: *e* – radiation capacity; $s = 5.67 \times 10^{-8}$ W/(m ^{2} K ^{4}) - Stefan-Bolsman constant; T_p – reactor temperature, K; *r* is the radius of reactor tube i, m.

In order to reduce heat losses , the radius *r* should be reduced, and in order to increase the energy *Q*, the size of the reactor pipe should match the size of the concentrator:

$$r = \lambda\, th\,;\ \theta = R_o / L_o\,; \tag{3}$$

where: R_o is the solar radius ; L_o - distance between the earth and the sun , km.
The heliopyrolysis reactor pipe is determined by the following formula:

$$T_n = \left[\frac{kR\tau_s S_{\perp}\cos\tau^{o}}{\varepsilon\sigma}\right]^{1/4}\left[\frac{D}{2\pi r(1-\gamma/\pi)}\right]^{1/4}; \tag{4}$$

where: t_k is the light absorption coefficient of the surface.

The temperature will be maximum. In this case, the second term in equation (4) tends to $1/\theta$. In this case, the maximum temperature of the reactor-tube is as follows [26-28]:

$$T_{n\max} = \left[\frac{kR\tau_k S_\perp \cos\tau^o}{\varepsilon\sigma\theta}\right]^{1/4}. \qquad (5)$$

inside the heliopyrolysis reactor is determined by the following equation:

$$T_p{}^4 k\, Q_{reak} = Q_{yut} - Q_f < Q_y ; \qquad (6)$$

where: Q_f is the useful heat obtained from the heat carrier , W.

Results and discussion

Usually, the heating temperature in such reactors is 300÷450 ^{o}C. Under favorable conditions, the heat carrier can heat up to 700 ^{o}C.

The surface of the concentrator surface is called the aperture $F_k = lD$. The concentration coefficient X is determined by the ratio of the aperture on the heat-receiving surface F_p to the surface:

$$X = F_k / F_p = S_p / S_\perp; \qquad (7)$$

where: S_p is the average radiation of the receiver surface.

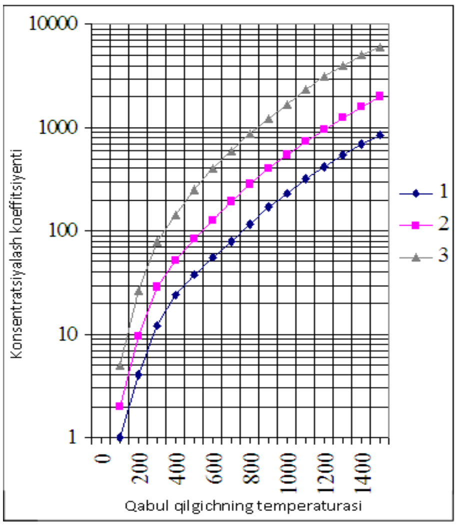

Figure 3. Concentration coefficient i *X* and heat sink temperature

The ratio between t_t (^{o}C).

1) Lower limit when $Q_{yut} = Q_{tp}$; 2) when η =40%; 3) when η =60%

Conclusion

In normal conditions $S_\perp$= 800 W/m^2; R=0.8; k_t=1; The maximum temperature T_{pmax}=750 K is reached when θ=4.6×10^{-3} rad. Therefore, it is possible to create a temperature in the reactor that ensures the pyrolysis mode through the calculation concentrator, and heat energy is saved for private needs.

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