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ACCOUNTING FOR THE TECHNOLOGICAL CLASSIFICATION OF THE DIAMERT OF CRUSHED COAL PIECES ACCELERATED ABSTRACT BOILING DRYING DRYING DEVICE

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Summary: The article determines the technological characteristics of the device depending on the diameter of the crushed coal pieces, the calculations are included in the excel program. This is mainly due to changes in heat consumption, the amount of energy used to drive the supplied air, and the efficiency. As a result, the change in the efficiency ratio ranged from 15% to 9% and was analyzed using graphs. The analysis showed what is the technically and economically optimal value of the equivalent diameter of coal seams. In addition, the value of other key parameters increases or decreases as the equivalent diameter of the coal segments increases. Hence the value of these parameters is directly proportional to the equivalent diameter of the coal seams. The results of the calculation were made for use in local heat supply systems where Angren brown coal is ignited.

Keywords: intensified fluidized bed, coal drying, coal moisture content, energy intensity, critical speed.

Introduction

Drying is the process of removing moisture from the material by evaporating it as a result of heat transfer to the material being dried. There are many types of drying and enrichment devices. Each has its own disadvantages and advantages.

Dryers are classified as:

According to the principle of action:

a) continuous; b) periodic.

Type of heat carrier used:

a) air; b) gas; c) steam.

According to the hydrodynamic regime:

a) boiling layer; b) mixed layer; c) boiling layer.

According to the mode of movement of the material to be dried in the devices:

a) abstract boiling layer dryers;

b) vibrating abstract boiling layer dryers;

c) pneumatic pipe dryers;

g) simple and combined air dryers;

d) simple and combined cyclone dryers;

e) single and multi-section sliding devices.

Problem statement

The coal preparation process used at the Angren TPP is very complex, which is disproportionate to the station's economy. In addition, additional energy is required for drying and enrichment due to the high ash and moisture content in terms of Angren B2 brown coal content. Therefore, the Angren TPP is designed to carry out coal enrichment and drying operations in a single unit, using the hot smoke gases released during fuel combustion as secondary energy. The main task of the article is to determine the technological parameters of the abstract boiling layer drying device, in which the periodically operating heat carrier is air, and on this basis to determine the rational value of the equivalent diameter of coal supplied to the device.

In this device it will be necessary to determine the technological parameters of the coal supplied for research. For this purpose, heat and mass-exchange calculations of the boiler of the local heating supply system, which burns high-ash Angren brown coal, were carried out. The boiler is designed to burn 100 kg/h of coal.

Table 1 shows the initial parameters and we only considered the change in technical parameters relative to the equivalent diameter.

The equivalent diameters of the coal segments were 0.003 m, 0.005 m, 0.006 m, and 0.01 m.

№	Parameter	Designation	Unit of measurement	Value
1.	Density of coal	ρ	kg/m^3	730
2.	Thermal conductivity of coal,	λ ,	m^2/hour	0.638*10^{-3}
3.	The maximum allowable temperature of the material,	t_1	^{0}C	170
4.	Heat capacity of air,	c_g,	kDJ/ kg*grad	1,01
5.	Atmospheric pressure,	P	mm.w.c	10^4
6.	Humidity of incoming air,	x_0	kg/kg	0,01
7.	The heat of vaporization of water	r,	kDJ/kg	2260 (540 kkal/kg)
8.	Heat capacity of dry coal,	C_m,	kDJ/kg*grad	1,3
9.	The temperature of the air entering the device,	t_2	^{0}C	170
10.	Relative humidity of air at the exit of the device	φ_2		0,8

The calculations are performed algorithmically using the following formulas:

Air speed. From the graph of the relationship between the Lyashenko criterion and the Archimedes criterion Ly = f (Ar), we find L_{kr} by the value of Ar determined from the following formula:

$$\text{Ar} = \frac{d_e^3 \cdot \rho_m \cdot g}{\nu^2 * \rho_g} \; ; \; (1)$$

where: d is the equivalent diameter of the coal, m; g - free fall acceleration, m/s^2 ; ν- kinematic viscosity m^2/s ; ρ_g- density of the gas, kg/m^3.

We determine the Archimedean criterion from the graph [1].

To determine the critical velocity of air entering the device, we use the following formula:

$$\omega_{cr} = \sqrt[3]{\frac{Ly_{cr} \cdot \nu \cdot \rho_m \cdot g}{\rho_g}}, \text{m/s}. (2)$$

here: Ly_{cr}- The critical value of the Lyashenko criterion

The number of abstract boiling layers is represented by the ratio of the values of the Lyashenko criterion depending on the porosity of the layer:

$$К_w = \sqrt[3]{\frac{Ly}{Ly_{cr}}};\ (3)$$

In this case, the air velocity (taking into account the full cross section of the apparatus) is calculated as follows:

$\omega = \omega_{cr} \cdot К_w$ m/s. (4)

here: ω_{cr}- critical velocity of air, m/s.

The diameter of the device. We determine the minimum diameter of the device from the minimum air flow L_{min}, which in turn is found from the material balance equation for heat and the heat balance equation:

$$L_{min} = \frac{rG(u_1 - u_2) + Gc_m(\theta_1 - \theta_2)}{c_g(t_2 - t_1)}\ \text{kg/hour.}\ (5)$$

here: u_1, u_2- initial and final moisture content of coal, %; θ_1, θ_2- inlet and outlet temperatures of the material to be dried, ^{0}C; [2].

We then determine the minimum diameter of the device from this formula:

$$D_{min} = \sqrt{\frac{V_{sek}}{0.785\omega}}\ ,\ m\ .(6)$$

here: V_{sek}- the size of the device, m^3.

Abstract boiling layer height. For the approximate calculation, we use the kinetic equation obtained with respect to the Fure criterion (Fo):

$$F_0 = \frac{0.35 \cdot 10^6}{\frac{E}{1-E}} \left(\frac{t_1 - \theta_1}{\theta_1}\right)^{-2.2} \left(\frac{c_м G}{c_г L}\right) К_0^{0.7} Ar^{-0.58}\ ;\ (7)$$

here : К - the initial value of the number of boiling layers

The average stability time of the material in the abstract boiling layer:

$$\tau_{ave} = F_0 \frac{d^2}{\lambda}, \text{hour.}\ (8)$$

The amount of material in the layer:

$$G_{sl} = \tau_{cp} G, \text{kg.}\ (9)$$

Abstract boiling layer size:

$$V_{sl} = \frac{\tau_{cp} G}{\rho_m (1 - \varepsilon)}, m^3.\ (10)$$

here: ε- porosity of the layer

$$h = \frac{V_{sl}}{S_{sl}}, \text{m}\ .\ (11)$$

here: S_{sl}- the surface of the abstract boiling layer, m^2 .

The diameter of the device:

$$D = \sqrt{\frac{\frac{BG}{\rho_m(1-\varepsilon)}}{0.785^2 \cdot h \cdot K_\omega}} \text{, m. (12)}$$

Output air parameter. In doing so, we calculate the amount of moisture that has evaporated:

$$W = G(u'_1 - u'_2) \text{, kg/hour. (13)}$$

The amount of air:

$$L = \omega p_g \text{ , kg/hour. (14)}$$

The amount of moisture:

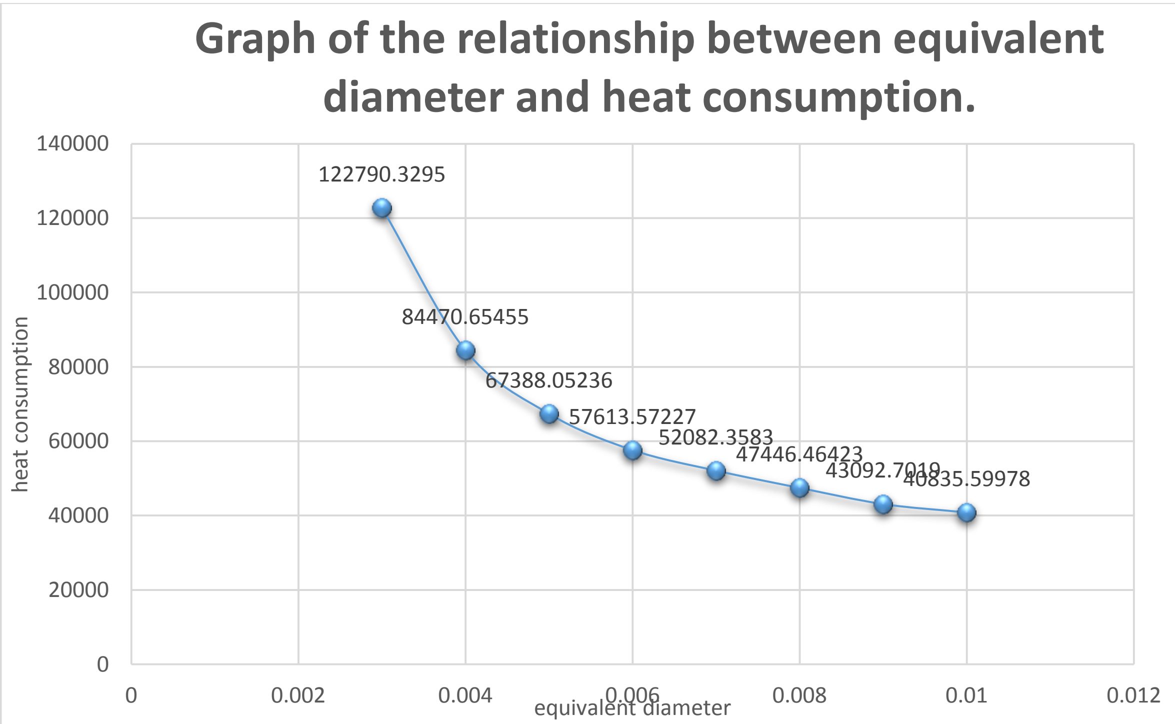
$$x_2 = x_0 + \frac{W(1+x_0)}{L}, \frac{\text{kg}}{\text{kg}}. \text{(15)}$$

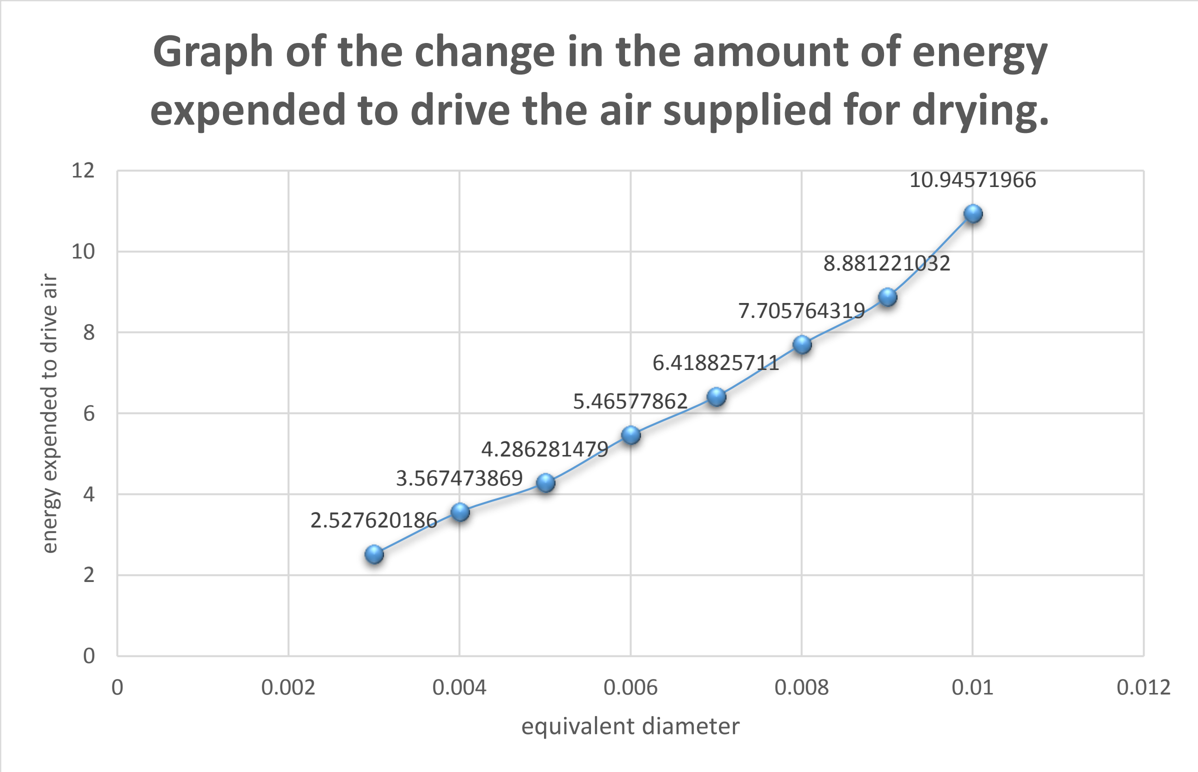
1-table

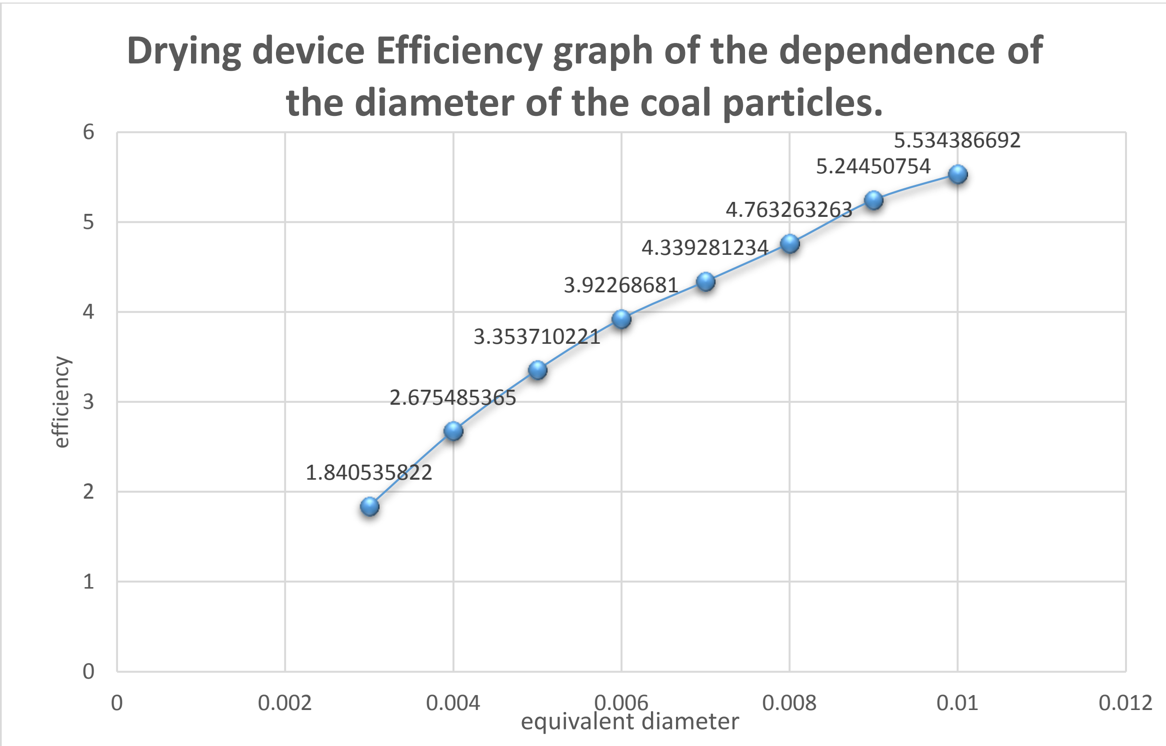
d	N	Q	E	q	η	l	Av
0,003	2,52762	64,80601	67,33363	122790,3	1,840536	1552,892	2,467458
0,004	3,567474	98,07982	101,6473	84470,65	2,675485	920,0694	1,883377
0,005	4,286281	128,0373	132,3236	67388,05	3,35371	660,6024	2,861029
0,006	5,465779	158,1172	163,583	57613,57	3,922687	513,4396	4,07512
0,007	6,418826	192,4154	198,8342	52082,36	4,339281	425,4678	5,558464
0,008	7,705764	225,3707	233,0765	47446,46	4,763263	357,7814	7,341085
0,009	8,881221	254,7257	263,607	43092,7	5,244508	301,74	9,452089
0,01	10,94572	293,1089	304,0546	40835,6	5,534387	266,8732	11,92023

The calculations were performed in excel, using the above equations, and the results were analyzed graphically.

The graphs show the relationship between the equivalent diameter and heat consumption, the change in the amount of energy expended to drive the supplied air, the change in the efficiency of the apparatus.







Conclusion

From the graphs above, we have seen that as the diameter of the coal seams increases, the heat consumption, energy losses increase, and the Efficiency decreases. By analyzing the changes in other parameters, it was clearly concluded that it was possible to use pieces of coal with an equivalent diameter of a certain rational size. That is, the maximum Efficiency value of the device among the selected diameters was obtained as 0.003 m.

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