UDC 620,952

BASIS OF BASIC PARAM
With the upper combustion

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The results of theoretical studies of air flow in boilers burning straw cereals. The basic parameters of boilers, providing minimize energy loss by burning biomass, by separating the work area to the area of education and region generator gas combustion.

The boiler, burning straw, biomass, fuel, air, gas generator.

Problem. In Ukraine produced heat generators, air-cooled for straw that can ahrehatuvaty dryer and used for heating greenhouses and industrial premises, water-heating boilers for heating industrial premises, social and cultural facilities, boilers, heat generators for burning wood waste [1, 2 3]. However, the combustion of biomass having some difficulties related to the heterogeneity of biomass as fuel; relatively high humidity, low specific enerhovmistom, low ash melting point.

Analysis of recent research. In the area of biomass burning need to create favorable conditions for the complete combustion of straw, without melting ash and maintaining a uniform process heat [4, 5, 6, 7].

Such conditions can be achieved by applying boilers with two workspaces: the formation of the first and second generator gas generator gas combustion [8] (Fig. 1). In these boilers is the ability to control the process of heat due to changes in the volume of air entering the working area of the boiler.

The purpose of research. Set the main parameters of combustion boilers upper division workspace furnace boiler formation region generator gas and combustion area.

Results. From structural considerations [9] for uniform air flow in the region of formation gas generator, take the lower section of the air diffuser is made of 4 tubular sections of constant cross section and the upper section for filing the required amount of air in

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region formed by burning gas - in the form of tapered duct (Fig. 2).

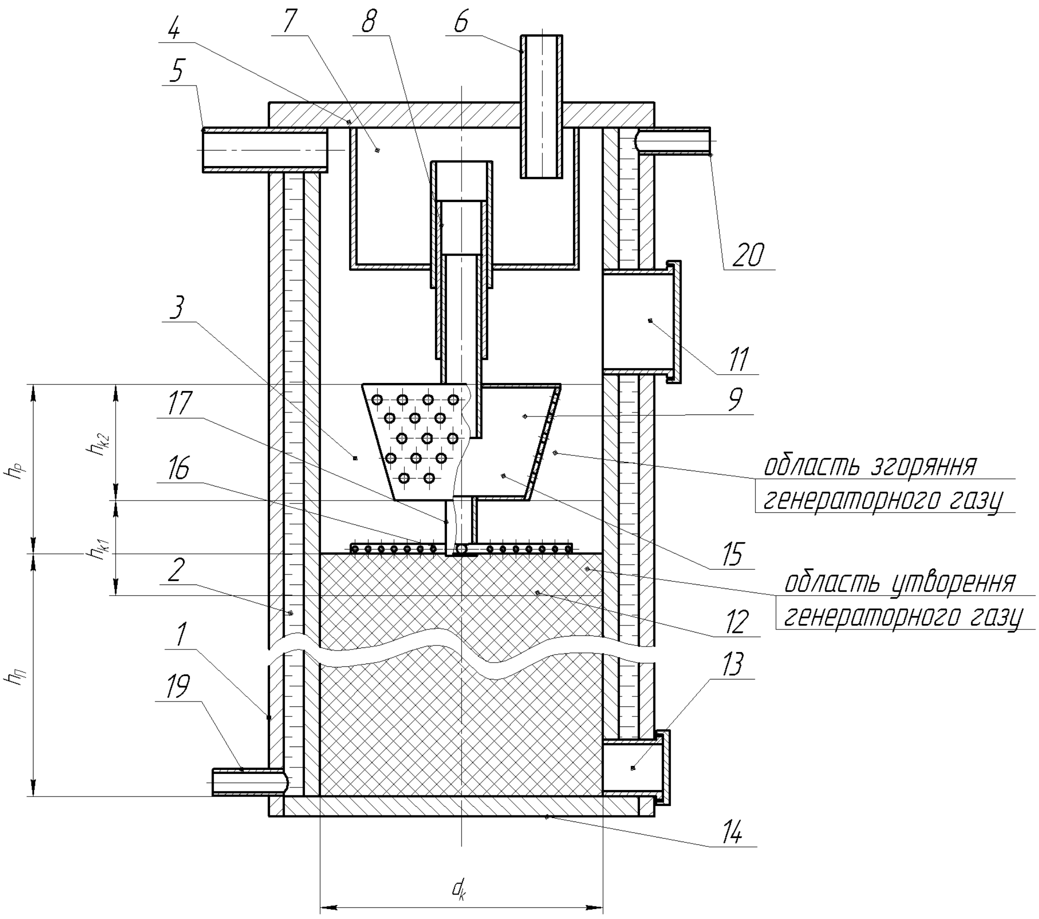


Fig. 1. General view of the straw-burning boiler: 1 - the case; 2 - cavity; 3 - combustion chamber; 4 - cover 5 - pipe to remove the products of combustion; 6 - pipe for air supply, 7 - intermediate capacity; 8 - guide; 9 diffuser air; 10 - hole, 11 - the door for fuel; 12 - fuel, 13 - the door to ashes; 14 - the bottom; 15 - upper section of the diffuser air; 16 - the lower section of the diffuser air; 17 - tubular, 18 - tubular members; 19 - pipe for cold water supply; 20 - pipe to drain hot water; dK - the diameter of the boiler;
hP - Height of the fuel; hr - height air spray; hK1 - height field generator gas formation; hK2 - height field generator gas combustion.

Air flow can be rearranged as a system:

$$\begin{cases} V_{заг} = V_{пуг} + V_{сд}; \\ V_{пуг} = k_{рн} V_{заг}; \\ V_{сд} = k_{рв} V_{заг}; \end{cases} \qquad (1)$$

where Vzah - total costs of air in the spray boiler m3 / s;
Vpuh - The cost of air spray bottom section, m3 / s;
Vsd - The cost of air sprayer upper section, m3 / s;
krn - Air flow rate lower section dispenser;
krv - Air flow rate of the upper section of a spray.

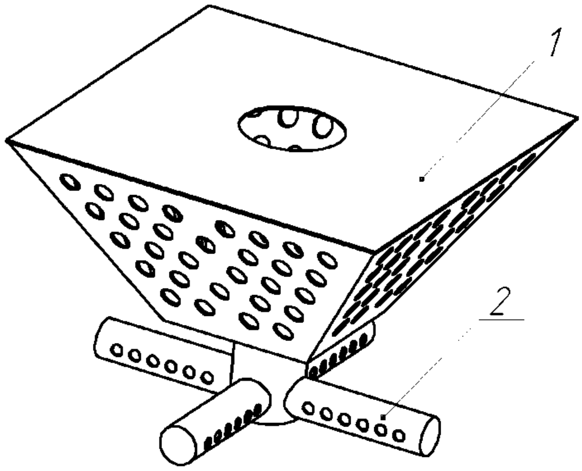


Fig. 2. Scheme of construction distributor Air 1 - upper section 2 - bottom section.

Consider air flow [9, 10, 11, 12] tubular section of the lower section dispenser (Fig. 3). In light of the fact that the tubular section should provide uniform air flow in the region of formation gas generator, it must be regarded as Air holes of various sizes. Numbering, holes used against air movement and holding cross-sections 1-1, 2-2, 3-3, ..., kk, ..., and, and, ..., nn, before each hole obtained formula to calculate the working diameter and the second hole for round tubular segment (given that $D_{He} = 4R_{\Gamma} = D_H$ [11]):

$$d_{Hi} = \frac{\sqrt{2}}{\sqrt[4]{\frac{4}{d_{Hi-1}^4} - \frac{16\mu^2}{D_H^4}\left[i^2 - (i-1)^2 - \lambda \frac{l_H}{n_H D_H}(i-1)^2 - \eta\right]}}; \tag{2}$$

where dNi - diameter hole and the second tubular section, m; dNi 1 - diameter and 1 st hole tubular section, m; NH - combined number of pairs of holes; DH - inner diameter of the tubular section, m; lN - the length of the tubular section, m; λ - coefficient of Darcy; η - loss coefficient at the air passage aperture (amortization).

Established with the following equation, the diameter of the 1st hole, which will be the maximum:

$$d_{Hn\max} = \sqrt{\frac{V_{пуг}}{2\pi n_H \upsilon_{\max}}}, \tag{3}$$

where dNnmax - maximum diameter of the 1st hole tubular section, m; umax - maximum air velocity at the outlet openings of the tubular section, m / s; Vpuh - air flow bottom of the sprayer, m3 / s; NH - combined number of pairs of holes; and using the formula (2) can be set diameters steam holes in the pipe sections that provide uniform air flow to the area gas.

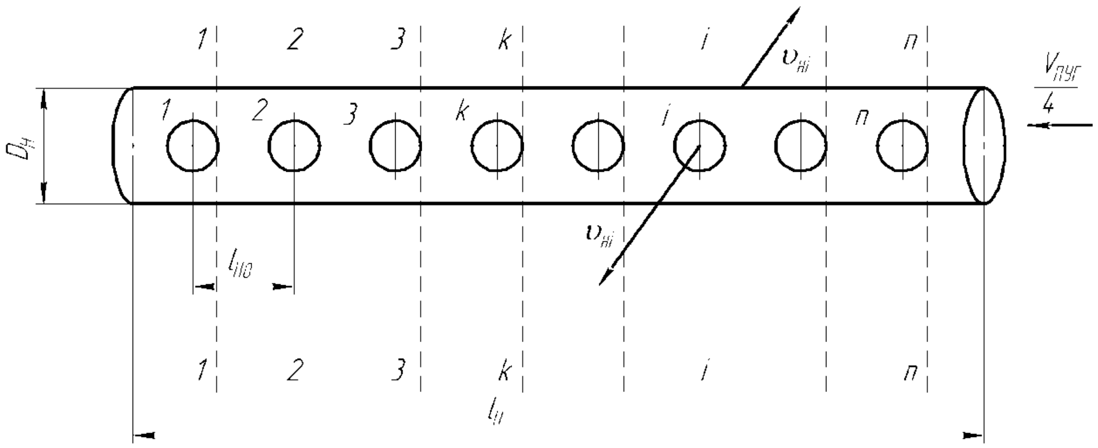


Fig. 3. Diagram of the tubular section distributor (air supply to the area of formation gas generator): DH - inner diameter of the tubular section, m; lN - the length of the tubular section, m; lNO - the distance between the holes, m; υNi- air velocity at the output of the i-th hole, m / s; Vpuh - air flow bottom of the dispenser, m3 / s.

Resistance section tubular distributor will equal the full overpressure at the beginning [9, 11]:

$$\Delta p_{НП} = n_c \xi_{нвх} \xi_{тс} \frac{\rho_{пов} V^2_{пуг}}{2\pi^2 D^4_H} = \frac{\rho_{пов} V^2_{пуг}}{2\pi^2} \left(\frac{1}{\mu^2 n^2_H d^4_{Hn}} + \frac{1}{D^4_H} \right), \quad (4)$$

where ΔrNP - resistance lower distributor, Pa; NC - number of sections of the lower distributor; Vpuh - air flow bottom of the sprayer, m3 / s; μ - factor costs hole tubular section; dNp -Diameter n-th hole tubular section, m; DH - inner diameter of the tubular section, m2; NH - combined number of pairs of holes; ρpov - air density, kg / m3; ξts - coefficient of resistance tubular section of the lower distributor; ξnvh - lower drag coefficient distributor at its entrance.

According to equation 3 sets the maximum diameter of the bore of the tubular section, which provides the necessary air flow to the area gas formation (Fig. 4).

When analyzing the graph in Fig. 4. it is evident that a rational considerations dN1max diameter of the hole should be limited, and must vctanovyty optimal number of pairs of holes NH, and based on the diameter of the hole and set the number of pairs of holes DH rational length and diameter of the tubular section dispenser.

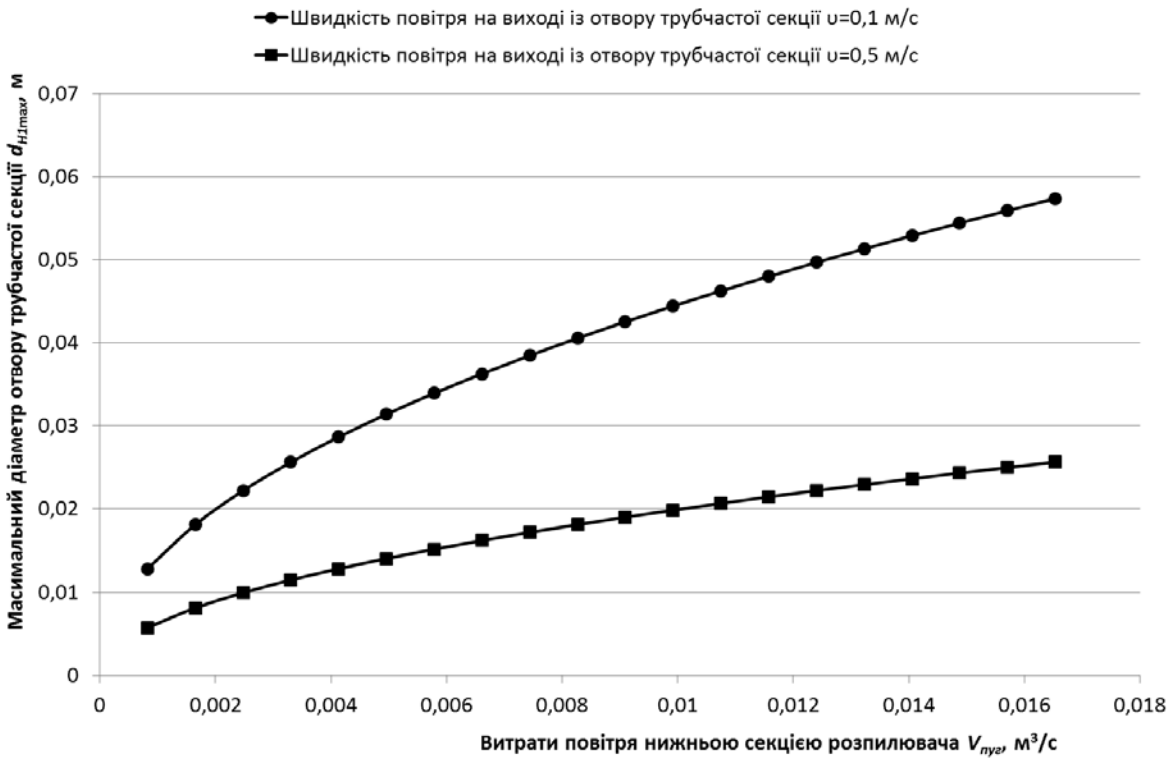


Fig. 4. Dependence of the maximum diameter of the hole on the air supply to the region of formation gas generator (number of pairs of holes n = 8).

Based on the conditions for uniform air supply to the area of formation gas generator and provide minimum resistance tubular section distributor formulas (2), (3) you can set its key design and process parameters (Fig. 5, Tab. 1).

Study to uniform distribution of air distributor in the region generating gas formation suggest that air flow Vpuh the formation of gas generator are in the range from 3 to 59.5 m3 per hour, with a smaller value provides a thermal power boiler pk 10 kW and 200 kW, and resistance ΔrNP distributor air generator gas formation region is small and is in the range of 0.9 (pk = 10 kW) to 37.4 Pa (pk = 130 kW).

The maximum size of the holes dN1max distributor has a range of 13 (pk = 10 kW) to 26 mm (pk of 130 to 200 kW), the diameter of the holes to achieve uniformity of feed air into the region generating gas formation increased from the beginning of the distributor to the center of the step ΔdHi 0.3 (pk = 10, 40 and 50 kW) to 0.7 (pk = 130 kW) mm, the number of pairs of holes varies from NH 8 (pk = 10 kW) to 40 (pk = 200 kW).

The length of the tubular section lN distributor varies from 0.2 (pk = 10 kW) to 0.6 m (pk of 130 to 200 kW) and a diameter of 0.03 DH (pk of 10 to 70 kW) to 0.05 m (pk of 140kVt 200 kW).

1. Basic parameters distributor air generator gas formation region (at a rate of leakage of air into the region of formation of gas υNi = 0.1 m / s, the number of tubular sections nc = 4).

Theoretical thermal power boiler Pk, kW	Air flow in the formation of gas generator Vpuh, m3 / h	The maximum diameter holes distributor dN1max mm	Step reduce the diameter of the holes distributor, ΔdHi, mm	Number of pairs of holes in the distributor section n NH	Diameter section distributor DH, m	The length of the section distributor IN city	Resistance distributor ΔrNP, Pa
10	3.0	13	0.3	8	0.03	0.2	0.9
20	6.0	15	0.5	12	0.03	0.3	3.4
30	8.9	15	0.4	18	0.03	0.3	5.9
40	11.9	15	0.3	24	0.03	0.3	9.0
50	14.9	15	0.3	30	0.03	0.3	12.6
60	17.9	20	0.6	20	0.03	0.4	26.8
70	20.8	20	0.5	24	0.03	0.4	32.9
80	23.8	22	0.6	22	0.04	0.5	13.8
90	26.8	22	0.5	24	0.04	0.5	16.6
100	29.8	22	0.5	26	0.04	0.5	19.6
110	32.7	22	0.4	30	0.04	0.5	22.0
120	35.7	22	0.4	34	0.04	0.5	24.6
130	38.7	26	0.7	26	0.04	0.6	37.4
140	41.7	26	0.5	28	0.05	0.6	14.8
150	44.6	26	0.5	30	0.05	0.6	16.4
160	47.6	26	0.5	32	0.05	0.6	18.1
170	50.6	26	0.4	34	0.05	0.6	19.8
180	53.6	26	0.4	36	0.05	0.6	21.6
190	56.5	26	0.4	38	0.05	0.6	23.5
200	59.5	26	0.4	40	0.05	0.6	25.4

The obtained parameters provide uniform air distribution in the region of formation gas generator that maximizes output generator gas in the boilers designed for burning biomass.

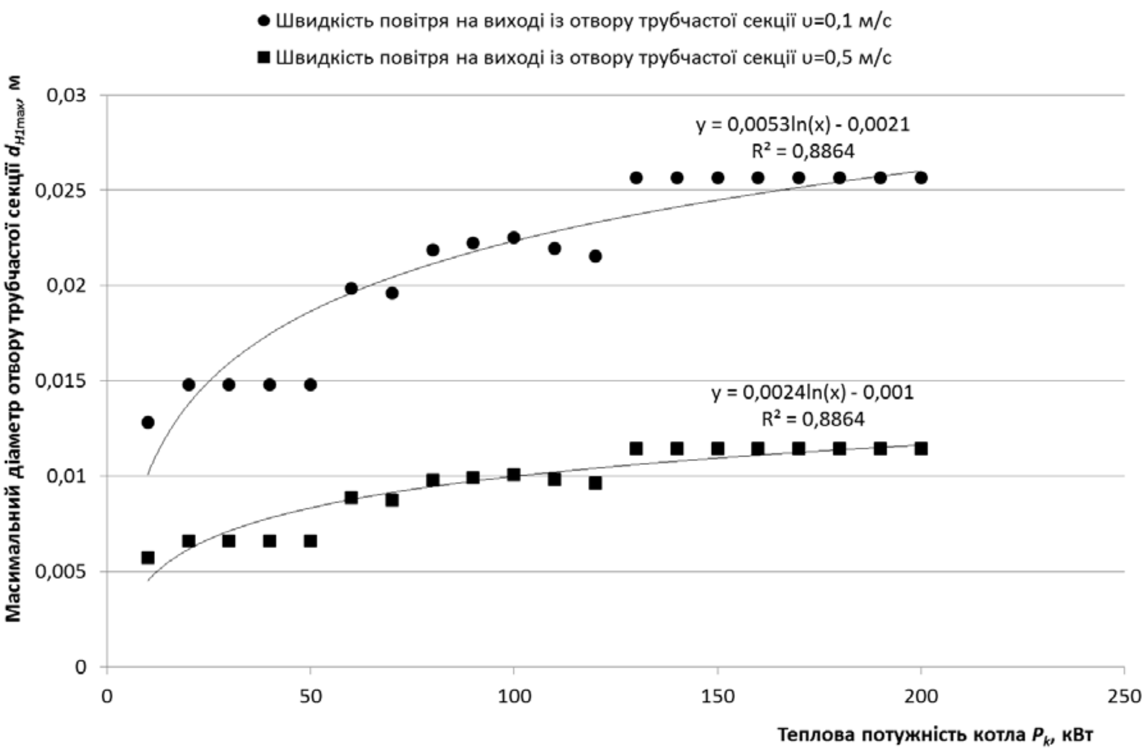


Fig. 5. Dependence of the maximum diameter of the hole tubular section of thermal power boiler with rational structural parameters.

Consider the air supply to the area of gas burning upper section of the distributor that the implementation of a truncated pyramid with the base square (Fig. 6).

Knowing Vsd air flow in the combustion can set the desired diameter *dVvyh* the distributor holes:

$$d_{B0} = \sqrt{\frac{4V_{cд}}{\pi n_B \upsilon_{вс}}}, \qquad (5)$$

where *dV0* - Diameter holes for air in the combustion area, m; Vsd - actual air flow in the combustion m3 / s; υvs - average air velocity at the outlet of the holes, m / s; NB - the number of holes.

When the air supply to the combustion gas region is important to ensure the completeness of its receipt, and to form the boundaries between regions aerodynamic formation and combustion gas generator speed the air υVi sections with holes distributor must be greater at the bottom of the distributor and described function:

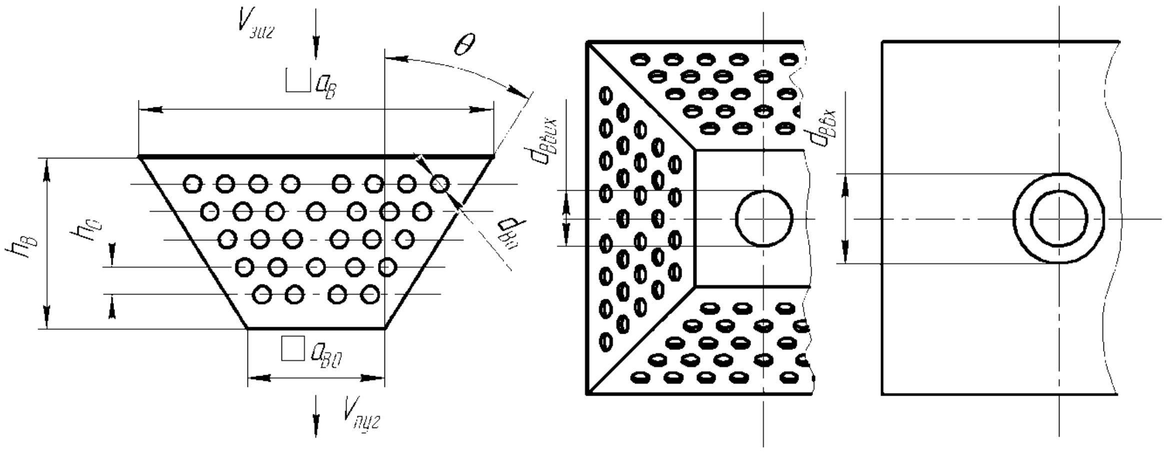
$$\upsilon_{вi} = f(h_B, h_0, d_B, a_B, \theta, V_{cг}). \qquad (6)$$

Given that *AB0 >> dV0* Pressure loss is negligible (according to [9, 12] λ → 0, η → 0) and therefore can be taken diameter holes for air in the area of gas combustion same.

Resistance of the upper section of the distributor will be:

$$\Delta p_{ВП} = \frac{2\rho_{пов}}{\pi^2}\left(\frac{V_{сд}^2}{\mu^2 n_B^2 d_{B0}^4} + \frac{\xi_{вх} V_{заг}^2}{d_{Bвх}^4} + \frac{\xi_{вих} V_{пуг}^2}{d_{Bвих}^4}\right); \qquad (7)$$

where ΔrVP - Resistance top distributor, Pa; ξvh - drag coefficient of the upper inlet distributor; ξvyh - drag coefficient of the upper distributor output; dV0 - diameter holes for air in the combustion area, m; NB - the number of holes; μ - coefficient cost air outlet; Vzah - total costs of air in the spray boiler m3 / s; Vpuh - air flow bottom of the spray m3 / s. dVvyh - diameter of the air outlet of the distributor, m; dVvh - diameter of the inlet air valve, m.



a) b) c)

Fig. 6. Diagram of the upper section of the distributor (feed air into the combustion area): a) front view; b) a bottom; c) top view; aB - the size of substrate distributor inlet (max), m; AB0 - the size of substrate distributor output (minimum) m; HB - height distributor, m; h0 - step series of holes, m; θ - side opening angle, deg; dV0 - diameter holes for air in the combustion area, m; dVvyh - diameter of the air outlet of the distributor, m; dVvh - diameter of the inlet air valve, m; Vzah - total costs of air in the spray boiler m3 / s; Vpuh - air flow bottom of the spray m3 / s.

Having taken:

$$a_B \approx 2l_H;\; a_{B0} \approx 2d_{Bвих};\; d_{Bвих} \approx 2D_H;\; d_{Bвх} \approx 1{,}5 d_{Bвих}, \qquad (8)$$

where *DH* - Inner diameter of the tubular section, m; lN - the length of the tubular section, m; aB - the size of substrate distributor inlet (max), m; AB0 - the size of substrate distributor output (minimum) m; dVvyh - diameter of the air outlet of the distributor, m; dVvh - diameter of the inlet air valve, m; You can define the parameters of air distributor, providing complete combustion gas in combustion (Table. 2). Study to completeness air supply distributor in the region combustion gas generator suggest that Vsd air flow to the combustion gas generator are in the range of 10.3 to 206.3 m3 per hour, with a smaller value provides a heat output of 10 kW boiler pk and 200 kW, and resistance ΔrNV distributor of air in combustion gas generator area is small and is in the range of 0.06 (pk = 10 kW) to 2.87 Pa (pk = 130 kW).

2. Basic parameters distributor air generator gas combustion region (at a rate of leakage of air into the region of burning gas uNi = 0.2 m / s).

Theoretical thermal power boiler Pk, kW	Air flow to the combustion gas generator Vsd, m3 / h	The number of openings for supplying combustion air to the region nIn	Bore holes for air in the combustion area dV0 mm	Height distributor HB mm	Party foundations distributor inlet aB, m	Party foundations distributor output AB0 city	The diameter of the inlet dVvh mm	The diameter of the outlet dVvyh mm
10	10.3	40	21	91	0.4	0.24	90	60
20	20.6	80	21	117	0.6	0.24	90	60
30	30.9	120	21	209	0.6	0.24	90	60
40	41.3	160	21	302	0.6	0.24	90	60
50	51.6	200	21	393	0.6	0.24	90	60
60	61.9	240	21	342	0.8	0.24	90	60
70	72.2	280	21	417	0.8	0.24	90	60
80	82.5	320	21	342	1	0.32	120	80
90	92.8	360	21	401	1	0.32	120	80
100	103.1	400	21	460	1	0.32	120	80
110	113.5	440	21	519	1	0.32	120	80
120	123.8	480	21	577	1	0.32	120	80
130	134.1	520	21	498	1.2	0.32	120	80
140	144.4	560	21	528	1.2	0.4	150	100
150	154.7	600	21	577	1.2	0.4	150	100
160	165.0	640	21	625	1.2	0.4	150	100
170	175.4	680	21	674	1.2	0.4	150	100
180	185.7	720	21	722	1.2	0.4	150	100
190	196.0	760	21	770	1.2	0.4	150	100
200	206.3	800	21	818	1.2	0.4	150	100

The number of openings for supplying combustion air to the region nIn ranges from 40 (pk = 10 kW) to 800 (pk = 130 kW), and the diameter dV0 not variable and is 21 mm.

The obtained parameters ensure complete combustion gas generator that allows you to maximize heat output when operating boilers designed for burning biomass.

Given the specific gas output *us* of biomass and knowing to heat boiler output can be set pk of total gas output Vhh and determine fuel consumption.

Knowing fuel consumption and considering the geometric dimensions of the air distributor can be installed furnaces DK diameter and height NC boiler and its number of downloads per day (Table. 3).

3. The main design parameters of boilers for biomass (cereal straw bales).

Theoretical thermal power Pk, kW	The cost of biomass per day GB, kg	Total expenditure Vzah air, m3 / s	Number of downloads nzav	The diameter of the furnace DTK city	Height furnaces HTK city	HK total height, m	Efficiency ηk	Working RRC thermal power, kW
10	66.7	0.00369	2	0.48	1.84	2.20	75	7.5
20	133.3	0.00738	2	0.72	1.64	2.05	75	15
30	200.0	0.01108	2	0.72	2.46	3.05	75	22.5
40	266.7	0.01477	3	0.72	2.18	2.97	75	30
50	333.3	0.01846	3	0.72	2.73	3.69	75	37.5
60	400.0	0.02215	3	0.96	1.84	2.71	80	48
70	466.6	0.02584	3	0.96	2.15	3.16	80	56
80	533.3	0.02954	3	1.2	1.57	2.50	80	64
90	600.0	0.03323	3	1.2	1.77	2.81	80	72
100	666.6	0.03692	3	1.2	1.96	3.12	80	80
110	733.3	0.04061	3	1.2	2.16	3.44	80	88
120	800.0	0.04430	3	1.2	2.36	3.75	80	96
130	866.6	0.04800	3	1.44	1.77	3.01	80	104
140	933.3	0.05169	3	1.44	1.91	3.27	80	112
150	999.9	0.05538	4	1.44	1.53	2.99	85	127.5
160	1066.6	0.05907	4	1.44	1.64	3.19	85	136
170	1133.3	0.06276	4	1.44	1.74	3.39	85	144.5
180	1199.9	0.06645	4	1.44	1.84	3.59	85	153
190	1266.6	0.07015	4	1.44	1.94	3.78	85	161.5
200	1333.3	0.07384	4	1.44	2.05	3.98	85	170

PARAM hover in the table. 3, providing minimize energy loss by burning biomass, due to the separation of the working area to the area of education and generator gas combustion region. The cost of biomass *GB*In such boilers ranges from 66.7 (pk = 10 kW) to 1333.3 kg / day (pk = 200 kW) with the number of downloads from 2 to 4 per day. The height of the boiler varies from 2.05 (pk = 20 kW) to 3.98 m (pk = 200 kW) and the diameter of the boiler furnace of 0.48 m (pk = 10 kW) to 1.44 m (pk of 130 to 200 kW).

Conclusions

1. Conduct research on the uniform distribution of air distributor in the region generating gas formation suggest that air flow Vpuh the formation of gas generator are in the range from 3 to 59.5 m3 per hour, with a smaller value provides a thermal power boiler *Pk* 10 kW, 200 kW and more, and resistance ΔrNP distributor air generator gas formation region is small and is in the range of 0.9 (pk = 10 kW) to 37.4 Pa (pk = 130 kW). The maximum size of the holes dN1max distributor has a range of 13 (pk = 10 kW) to 26 mm (pk of 130 to 200 kW), the diameter of the holes to achieve uniformity of feed air into the region generating gas formation increased from the beginning of the distributor to the center of the step ΔdHi 0.3 (pk = 10, 40 and 50 kW) to 0.7 (pk = 130 kW) mm, the number of pairs of holes varies from NH 8 (pk = 10 kW) to 40 (pk = 200 kW). The length of the tubular section lN distributor varies from 0.2 (pk = 10 kW) to 0.6 m (pk of 130 to 200 kW) and a diameter of 0.03 DH (pk of 10 to 70 kW) to 0.05 m (pk of 140kVt 200 kW). The obtained parameters provide uniform air distribution in the region of formation gas generator that maximizes output generator gas in the boilers designed for burning biomass.

2. Conduct research on the completeness air supply distributor in the region combustion gas generator suggest that Vsd air flow to the combustion gas generator are in the range of 10.3 to 206.3 m3 per hour, with a smaller value provides a heat output of 10 kW boiler pk and more than 200 kW, and resistance ΔrNV distributor of air in combustion gas generator area is small and is in the range of 0.06 (pk = 10 kW) to 2.87 Pa (pk = 130 kW). The number of openings for supplying combustion air to the region nIn ranges from 40 (pk = 10 kW) to 800 (pk = 130 kW), and the diameter dV0 not variable and is 21mm. The obtained parameters ensure complete combustion gas generator that allows you to maximize heat output when operating boilers designed for burning biomass.

3. In the theoretical parameters obtained boilers providing minimize energy loss by burning biomass, by separating the work area to the area of education and region generator gas combustion. The cost of biomass *GB*In such boilers ranges from 66.7 (pk = 10 kW) to 1333.3 kg / day (pk = 200 kW) with the number of downloads from 2 to 4 per day. The height of the boiler varies from 2.05 (pk = 20 kW) to 3.98 m (pk = 200 kW) and the diameter of the boiler furnace of 0.48 m (pk = 10 kW) to 1.44 m (pk of 130 to 200 kW). Moreover, the total cost of air in the boiler Vzah lie in the range of 3,7 · 10-3 (pk = 10 kW) to 7,38 · 10-2 (pk = 200 kW). Using the proposed research allows you to choose the design of two-zone boilers key design parameters that yield maximum efficiency.

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Results of research Pryvedenы Theoretically rashoda air in boilers szhyhayuschyh grain straw. Ustanovlenы Main parameters of boilers, energy obespechyvayuschyh mynymyzatsyyu rubbed at szhyhanyy byomassы for schet razdelenyya a working region to region education generator and gas region szhyhanyya ego.

The boiler, szhyhanye, straw, byomassa, fuel, air, gas heneratornыy.

The results of theoretical investigations of air flow in boilers burning straw cereals. The basic parameters of boilers that provide minimizing

energy loss in biomass due to the separation of the work area to the area of education and region generator gas combustion.
Boiler, burning, straw, biomass, fuel, air, gas generator.

UDC 631.1.27

TEST CONDITIONS FOR Cab MEW visibility From the operator station

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The problem of feasibility of designing forms tractor cab using ergonomic performance visibility from operator station and obtaining experimental data by computer simulation in three-dimensional space chiaroscuro method.
Tests cabin visibility.

Problem. The effectiveness of the system "man - machine" largely depends on the amount of visual information necessary to manage the system. The visual perception of man gives him about 80% of the information received from the surrounding environment. Ensuring

visibility of the operator station classified as major ergonemsary requirements and key performance indicators tractors.

Analysis of recent research. Requirements for visibility from the workplace tractor formulated directives ЕЭК UN [1]. Based on these data, a number of indicators that pryvedni in Fig. 1.