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INFLUENCE ON THE MODE OF GRAIN DRYING
IN THE HEAT GENERATOR AND COMBUSTION PRODUCTS

Abstract. This article examines the heat generator impacton the drying regime of the grain and on the toxicity of the combustion products, with its operation modes, different variables and under different conditions. Timely and correct implementation of the procedure for drying grain is an extremely important aspect. We proposed several options for obtaining the optimal result. As a result of the research, the proposed method of grain drying contributes to the improvement of its quality, reduces the ripening time of the grain, and adjust the grain mass in terms of moisture content and grain maturity. It should also be noted, that this method contributes to the improvement of the grain's characteristics, and its appearance. The proposed method suspends the vital activity of microorganisms and pests. The practical and theoretical importance of this work lies in the possibility of applying the obtained data both in practice and in studies on the matter of grain drying.

Keywords: grain drying, Heat generator, Toxicity of combustion products, Drying mode, Grain moisture content, Formula, Temperature mode.

Introduction. By its nature, the grain is colloidal, and by structure it is a capillary-porous body with a complex chemical composition. General patterns of water distribution in such material were developed by S.M. Lipatov (1933), G.A. Rebinder (1933), A.V. Lykov (1968) and Yu.A. Kazakov (1973). In recent years, the teachings on the forms of the connection of moisture in the grain, the processes of internal moisture transfer, have been extended by the works of A.S. Ginzburg (1967), E.D. Kazakov (1973) and G.A. Egorov (1985).

The first Russian studies of the drying process of grain were carried by Demidov P.G. (1938) and Egorov G.A. (2000). They paid attention to the fact that grain under the action of high temperatures loses its germination. They also noticed that high temperatures are particularly detrimental to raw grain. As the drying of grain, high temperatures are also less dangerous.When drying the grain is going on, not only the temperature of the grain heating, but also the duration of the heat exposure are of great importance. The most important characteristic of grain are its thermos physical properties. Until recent time, methods of mathematical calculation of drying processes have not been properly developed, which is largely due to insufficient information about the heat-physical properties of the grain. Studies of Egorov G.A. (2000), Kazaryan Sh. (1934) and others were devoted to studying this issue. Investigations of the thermos physical characteristics of a single grain and a grain layer showed the level of value.We get grain with excess moisturecontent during harvesting. Wet grain is notsubject for long-term storage, as it quickly deteriorates. Timely and correctly carried out drying procedure not only increases the resistance of the grain during storage, but also improves its quality, accelerates the ripening of the grain, smooths the grain mass according to the moisture content (at the level of the conditioned value) and the degree of maturity (at the full ripeness level), improves color and appearance, and stops microorganisms and pests (Zhidko, Rezhchikov & Ukolov, 1982).

The most important characteristic of the grain is its thermal stability, which is determined by its humidity, the heating temperature, the duration of heating, and the temperature of the drying agent. During the drying, temperature-controlling and cooling the grain undergoes a number of profound changes associated with biochemical and physical chemical transformations, changes occur in its colloidal and capillary-porous structure. Saving and improving of grain quality during drying is provided by the use of various technological schemes and drying modes. At the same time, these are common processes for all technological systems of high-temperature grain drying:

1. receiving and storing of the grain before drying in amounts.It ensure stable operation of grain drying equipment;

2. preliminary cleaning of grain and the formation of lots of grain, homogeneous in their value and purpose;

3. the formation of grain transport flows that provide the technological scheme of grain drying (direct flow, recirculation, with or without grain preheating);

4. preparation of the drying agent for the specified parameters and its distribution along the drying zones;

5. preparation of cooling air, including the usage of artificial cold;

6. conducting heat and mass exchange processes (preheating, ripening, drying and grain cooling);

7. unloading grain with the formation of lots of grain with the specified parameters;

8. active grain ventilation, including additional cooling and its drying during cooling;

9. grainstorage (Geansburg, 1973).

Method of system analysis application makes it possible to determine the main criteria of techno-logical flows during grain drying and their interaction with the external environment. In this case, only a combination of the above operations can ensure the drying of the grain and the preservation of its quality, i.e. the technological flow is an integral system of processes. The level of integrity is a characteristic feature of the technological flow, reflecting the measure of its organization and the technology systemic nature determined after diagnostics.

To quantify the various levels of technological processes organization and calculate the level of integrity of the technological system in terms of the stability indicators of its components, it was possible to objectively assess the reliability of the functioning of technological systems for grain drying.

At present time, there are four ways of convective grain drying: high-temperature drying; high-temperature drying with the use of active ventilation (two-stage drying); combination of high-temperature and low-temperature drying; low-temperature drying by active ventilation (Tsuglenok & Manasyan, 2005). An important element of the technological system is the heat generator, which ensures the tempe-rature mode of drying and ecological compatibility of the system. We propose to use an air nozzle with blade adjustment outlet of recirculation zone amplifier for the heat generator. It will provide the necessary combustion intensity in the technological system of heat generator, as well as reduce the formation of toxic NO_x. 45°is an optimum ZRC, which is positively affected by the intensification of the combustion process. In this case, there is a high temperature, so it can be seen some NOx growth.The completeness of combustion has the highest value at 45° for all types of corners. This is due to the developed ZRC and good mixing, especially with perforation. The decrease in the completeness of combustion at 90° is due to the rapid displacement of the products of incomplete combustion from ZRC that are sucked by the fuel stream. At 15° with perforation, this displacement is insignificant, since the mass of the sucked air is insignificant. Due to this, the fuel is burned to the end of the experimental setup. The lower completeness of combustion at the usual angle can be explained by the insufficiency of oxygen in the ZRC. The increase in the length of the corners leads to low values of the completeness of combustion. At angles below 45° due to insufficient development of the ZRC, and higher due to low temperatures and due to the more air capture in the ZRC.

Methodology. Improvement and prospects for the heat generator development are associated with the possibility of regulating the parameters of the outgoing gas, improving their aerodynamics and reducing toxicity. As a result of generalization of the experimental data and the use of the foundations of the theory of combustion, the following basic principles of the organization of the working process constitute the design of a compact heat generator:

1) Working volume separation of the combustion chamber into two zones of combustion and mixing. At present, the average temperature of the exhaust gases T_c = 750÷950K and the total value of the air excess ratio α_{Σ} = 4÷10. In the space bounded by the body of (1) heat generator, (2) flame tube, isolated volume combustion zones I and mixing II (figure 1). The primary part of the volume of the flame tube (combustion zone) is directed to the primary air G_I – such part of the total air flow G_B, which ensures the formation of a highly reactive mixture that rapidly burns at a sufficiently high average process temperature.
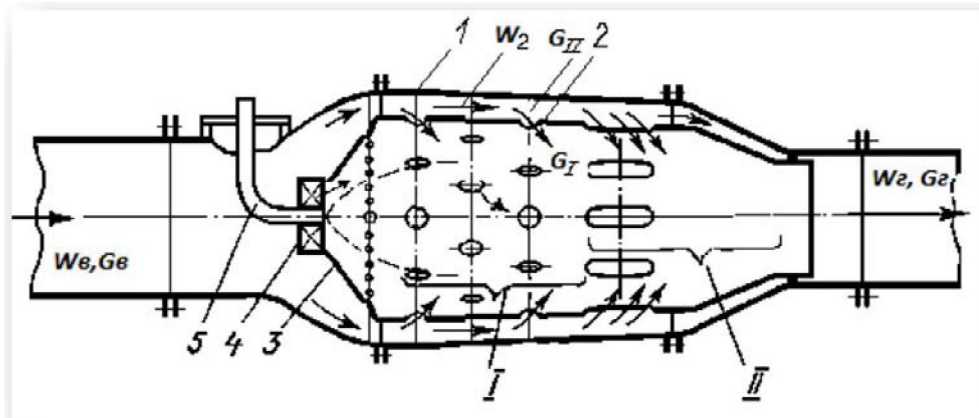

Figure 1 – Heat Generator Circuit

To the combustion zone I into the primary air flow G_I is supplied with fuel G_t by nozzle (5). The rest of the air G_{II} – secondary air, bypassing the combustion zone at a speed (ω_2), through special opening enters the mixing zone II of flame tube. Mixing with combustion products which leaving the combustion zone I, and cooling them, it ensures the set temperature of the gas at the heat generator output.

2) *Gradual (stepwise) supply of primary air along the length of the combustion zone.* For liquid fuels, a gradual dispersed supply of primary air into the combustion zone is even more necessary in contrast to natural gas.So, for example, a drop of liquid fuel before combustion should warm up and evaporate. In order to burn rapidly evaporating of the smallest drops at the very beginning of the combustion zone, a small amount of primary air G_I is required, which is expediently supplied at the injector orifice 5 through the front device 3, providing the temperature necessary for the chemical reaction in this zone.

With a step-by-step approach of the side jets of the primary air, small and burning evaporating medium and large droplets also burn out under optimal temperature conditions. In addition, the total flow is additionally turbulization, the process of mixing and combustion in general is intensified. To completely burn out the fuel, in the ideal case, a definite amount of air should be supplied to the combustion zone. As already noted, excess air is needed to facilitate and guarantee mixture formation, to prevent chemical fuel burn-up and to reduce the level of dissociation high at elevated process temperatures. When designing on the basis oftheoretical concepts of the combustion process and accumulated experience, a certain pattern of air distribution is determined, often as shown in figure 1 with a dashed line.

Primary air flow rate in the combustion zone G_I and, consequently, the coefficient of $a_I = a_e = \dfrac{G_I}{G_T \cdot L_0}$ its excess of heat generator, the type of fuel and the organization of the work process. Ensuring the turbulization of the flow in the combustion zone affects the efficiency of the combustion process. As a result, heat and mass transfer processes intensify, mixture formation improves and the flame propagation velocity increases. Turbulization of the flow is achieved by installing, in the front device 3, the front endof the flame tube 2 of the air nozzle 4 with the blade air recirculation zone amplifier, and also by arranging the radial flow of the air jets leaving through the holes in the walls along the length of the flame tube. Since the significant forcing of the flame tube working volume of the heat generator determines the average flow velocity much higher than the turbulent velocity $u_t$the spread of the front of the flame, to hold the torch in a certain area of the front of the combustion zone, it is necessary to carry out special measures. To stabilize the flame front, use blade recirculation zone amplifier located in the front device of

the flame tube. The zone of return currents (ZRC) behind them with reduced static pressure at the chamber axis, which is caused by the gas ejection by the ring jet flowing from the blade recirculation zone amplifier into the expanding channel, and the centrifugal effect, stabilizes the position of the flame front, which ensures ignition of the whole fuel-air mixture. Scheme of fields of axial speeds ω_a in different sections along the length of the flame tube in the combustion zone (without taking into account the effect of the side air jets) is given in figure 2.
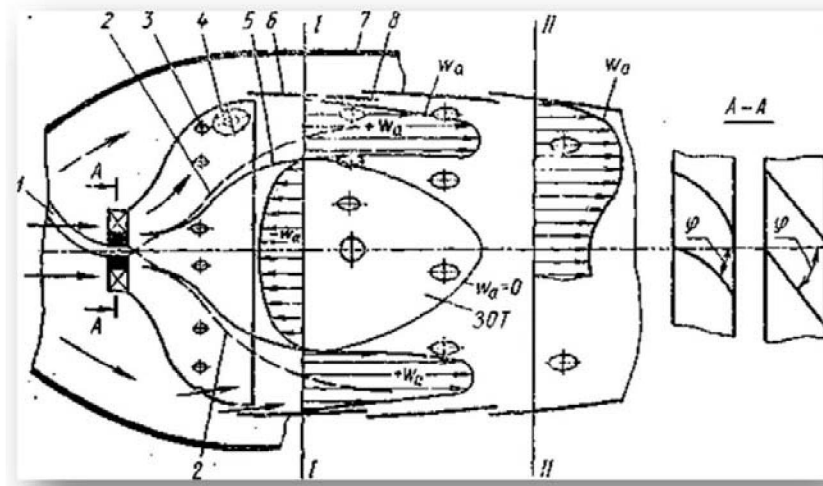

Figure 2 – Scheme of Gas Flow in the Combustion Zone.
Cconventions: 1 – nozzle; 2 – fuel cone; 3 – opening; 4 – possible flow separation zone;
5 – zone boundary of reverse flows; 6 – shell of a flame tube; 7 – body; 8 – slot for cooling air

The radial and tangential velocities depend on the construction of the front-line device and the flow parameters. For example, using a blade recirculation zone amplifier from the angle φ oftilt blades in relation to the axis of the chamber. As usual, $\varphi = 45 \div 65°$ depending on the design of the front-mounted device. In the case of large angles φ the efficiency of the blade recirculation zone amplifier is reduced due to the increase in pressure loss.

3) The optimal distribution of the concentrations (4) of fuels along the sections of the combustion zone. It is expedient, for example, to feed a hollow cone (3) of fuel in the flow region adjacent to theback current region, where the gradient of the axial velocities w_a flow is maximal, which ensures a good mixing of fuel with air. Under such a mixture formation scheme, the fuel ingress onto the wall of the flame tube and inside the zone of the reverse currents must be eliminated.

The noted basic principles of the organization of the working process, the design and calculation of the heat generator in each specific case are supplemented by other provisions related to the features of the heat generator being designed. Thus, for example, with high air inlet parameters in highly heat-stressed high-temperature combustion chambers ($\alpha_\Sigma = 2 \div 3$ and less) the provision on the division of the working volume into the combustion and mixing zones can be replaced by a more promising principle of ensuring uniform micro flame combustion of fuel in a small (especially along the length) volume. The fulfillment of this principle is possible if preliminary prepare the combustible mixture for combustion, evaporate fuel, partially mix it with air, etc.

The principle of ensuring flame stabilization is often associated with the need to create not one but several stabilization zones along the cross-section and the length of the combustion zone, which contributes to the realization of the principle of micro flame combustion, ensuring greater process stability, and, consequently, increasing the heat stress of the working volume of the combustion chamber.

Finally, the requirement to reduce the level of gas toxicity may necessitate the organization of not one but two combustion zones in a two-stage combustion of fuel, with controlled excess air or the creation of homogeneous combustion chambers with a preliminary complete mixture.Therefore, when creating an engineering methodology for the estimation of NO_x emissions, it is necessary to determine the dependence of the residence time of gases on the geometry of the micro flame front device and the conditions for the

distribution of air in the combustion zone. In the chamber under consideration with MFD (micro flame front device) the twisting of the flow at the inlet leads to the formation of reverse current ashes (RCA) which ensures stable operation of the camera in a wide range of parameters. In these conditions RCA reaches 30-40% of the total volume of the primary zone of the combustion chamber. Recirculation of gases through RCA increases the residence time of combustion products in the high-temperature zone, which, naturally, must be taken into account by the procedure for calculating the yield of nitrogen oxides. Unlike micro flame devices (MFDs) for gas, the design of liquid-fuel multifunction devices must provide preliminary preparation of the combustible mixture in the pre-chamber zone, special nozzles or in the air supply channels, and also provide dispersion of the front surface in the form of a multitude of micro flame along the input section of the combustion zone (Pchelkin, 1984). One of the approaches for coming micro flame combustion is the arrangement of a perforated cone with an air nozzle. In air (or pneumatic) nozzles, the kinetic energy of the air flow is spent on crushing the fuel jet, so a large amount of air is re-quired to obtain a high quality spray. As part of the combustion chamber GTD with front perforation, an air nozzle stabilizer was investigated (Sudarev & Maev, 1968). The air entering the burner, twisting in the blades of the input register, picks up the fuel jets that flow out of the fuel tube at excess pressure and mix with it. Then the fuel-air mixture, flowing through the cone of stabilization and passing through the output register, exits a swirling flow into the combustion zone of the chamber,the perforated front cone of the chamber (Dostiyarov, Tumanov & Umyshev, 2016). At the same time, there is a developed micro flame combustion along the front. In this part, the role of stabilizers is performed by shaded perforation sectors.

The combustion chamber was investigated on an experimental test bench by burning Kerosene TS-1 (at the stand of Moscow State Technical University named after N.E. Bauman) (Dostiyarov, 1999) and natural gas (at the stand of AUES (Almaty University of Energy and Communications)) (Dostiya-rov,2000c) in several stages:

1. assignment of blades optimum angles for input and output recirculation zone amplifiers of air nozzle;

2. accurate grinding of micro flame front device of GTD combustion chamber while natural gas combustion.

The angle choice of assignment of the recirculation zone amplifiers blades affects the quality of mixing of the fuel-air mixture and the hydraulic losses in the burner device (Sudarev & Antonovskiy, 1985). Figure 3 shows dependence of the coefficient of resistance on the angle of installation of the blades.
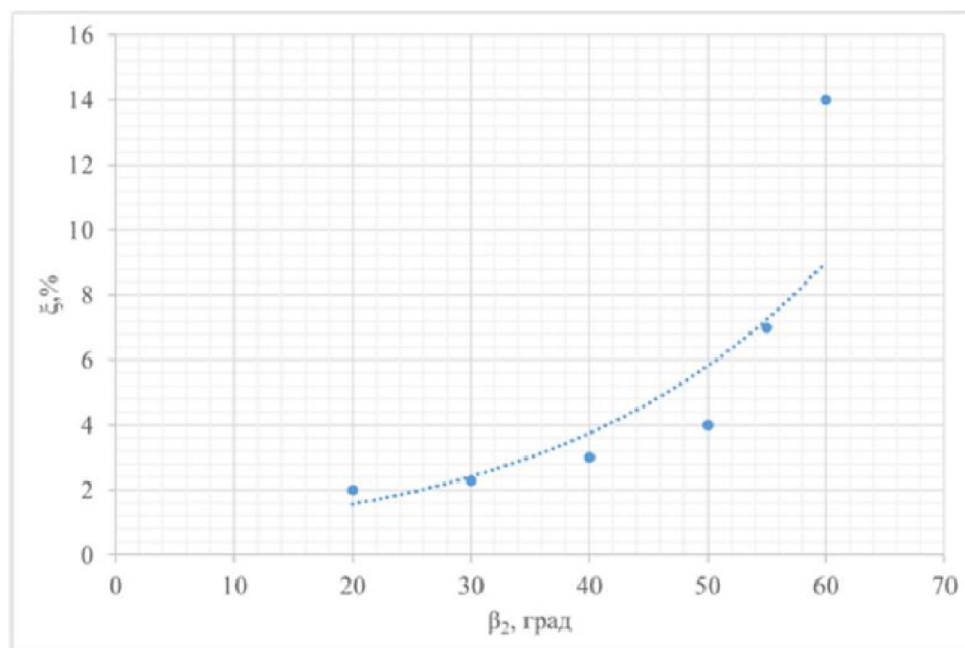

Figure 3 – Dependence of the Coefficient of Resistance on β_2

Dependence of the coefficient of resistance ξ_{op} on the assignment angle (β_1) is given in the works (Narezhniy & Sudarev, 1973), which show, that when $\beta > 40°$ hydraulic losses increase dramatically, and a decrease of β_1 to 30°and less reduces the generation of turbulence in the burner chamber. For the combustion of heavy fuel draws can be used an air-stabilizer nozzle, but it should be performed as shown through (Buhman, 1994) a central hole (8) for ejection of high-temperature combustion products into the fuel-air mixture preparation chamber.

Plate perforating has certain advantages when used in combustion chambers with a preliminary preparation of a lean mixture.

The quality of the mixing was determined from the results of the experiment on the dependence $\eta_r = f(\alpha_\Sigma)$ and $C_{NO_\Sigma} = f(\alpha_{dr.})$ (figures 4, 5).

The effect of the air flow twisting by the structural elements of the vortex burners on the burning rate of the fuel and the NO_x output has been repeatedly confirmed by experiments (Dostiyarov, 1983). The same effect was clearly traced in experiments with "air" nozzles (Ahmedov & Tsirulnikov, 1984). This circumstance made it possible to determine the significant influence of the installation angles of the profiles in the MFD on the NO_x emission. In order to test this assumption, special studies were carried out on
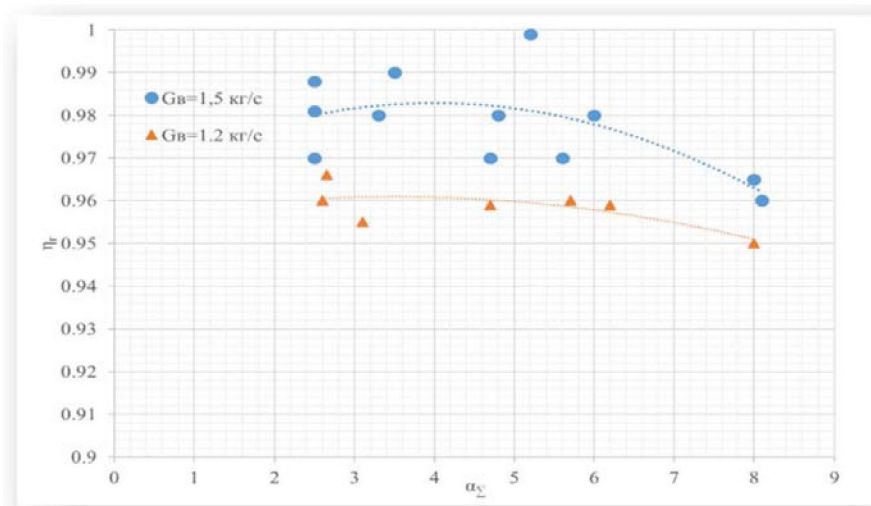

Figure 4 – Dependence of the Completeness of Combustion in the Air Nozzle on the Total Excess Air Factor
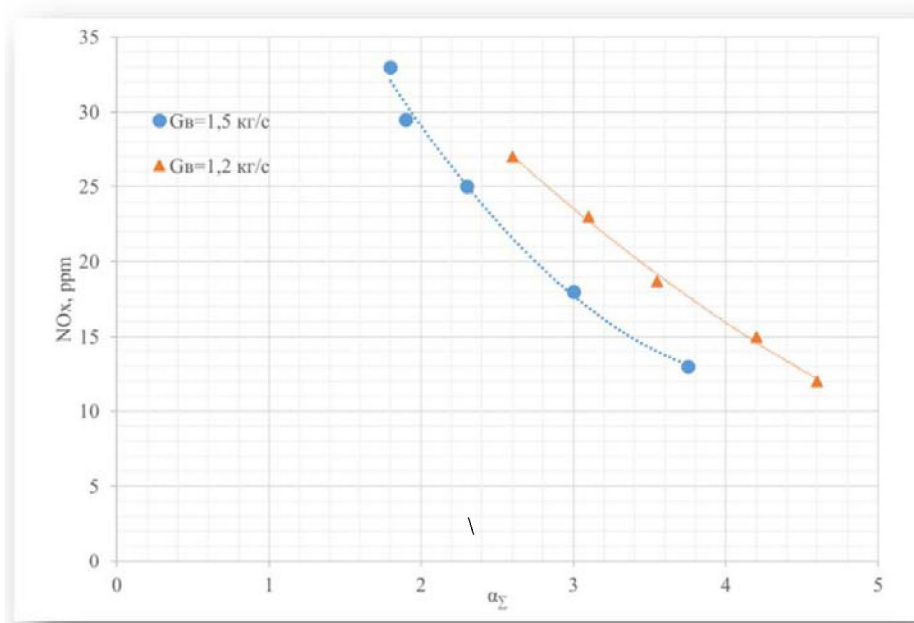

Figure 5 – Dependence of the NO_x Output on the Excess Air Factor in the Combustion Zone

the combustion chamber options equipped with an "air" stabilizer nozzle (ASN), performed by the authors (Lefebvre & Ballal, 2010) with different angles of output flow twist of the fuel-air mixture. Figures 6 and 7 show the influence of setting the output register items angle of ASN β_2- for two variants of the combustion chamber with different angles of output of the front portion of the flame tube ($\theta = 70°$ and $120°$). From the studies carried out at the corners $\beta_2 = 20°$; $30°$; $40°$ and $60°$ it follows that for the chamber version with $\theta = 70°$ the smallest output of NO_x was observed at $\beta_2 = 20°$, and for variant $\theta = 120°$, with $\beta_2 = 30°$.The explanation of the obtained results can be given by analyzing the flow structure in the head section of the flame tube, which determines the distribution of the temperature field and significantly influences the parameter of the residence time of the combustion products in the fire zone, as noted in the studies (Umyshev, Dostiyarov, Tumanov & Wang, 2017).
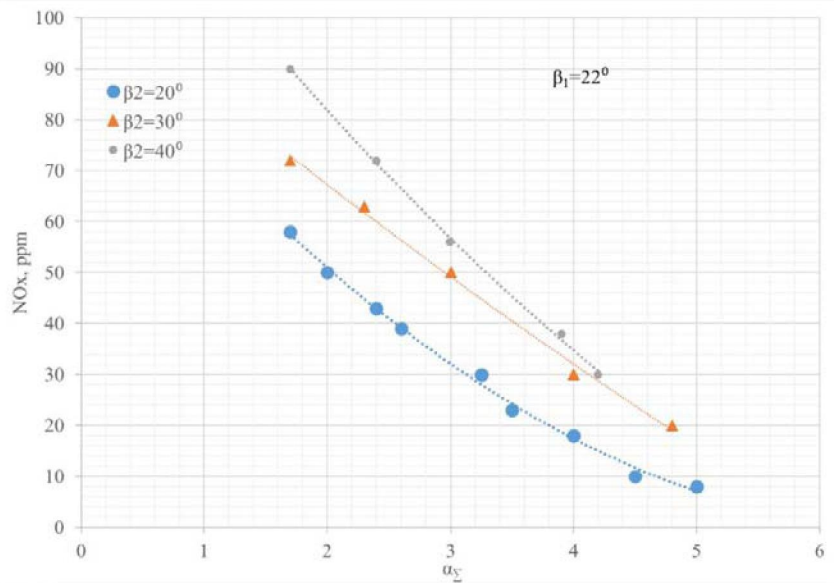

Figure 6 – Influence of the Installation Angles of the Input and Output Recirculation Zone Amplifier and the Angle of Front Opening Flame Tube on the Output of NO_x
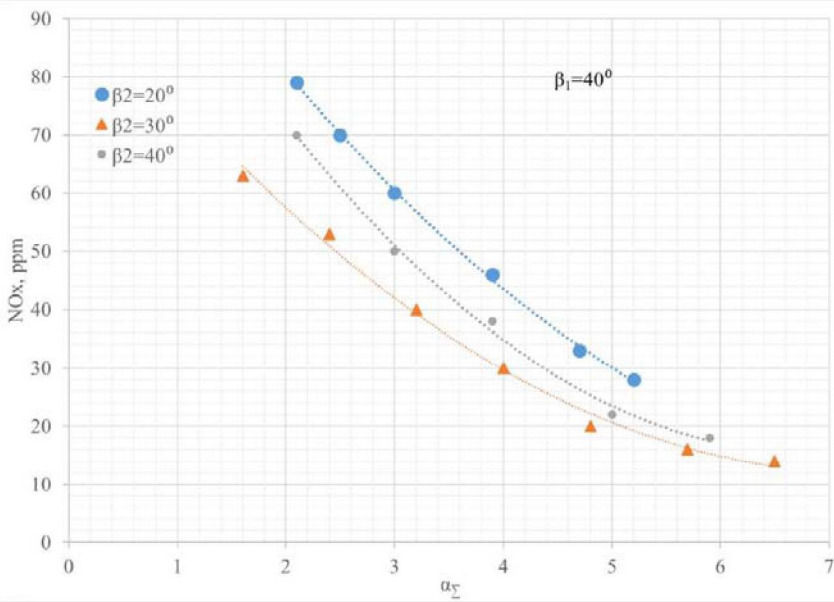

Figure 7 – Influence of the Installation Angles of the Input and Output Recirculation Zone Amplifier and the Angle of Front Opening Flame Tube on the Output of NO_x

Thus, increasing the flow twisting angle in ASN increased the size of ZRC and hence the share of circulating gases, which increased the "residence time" in the high-temperature zone. In accordance with this emission NO_x with $\beta_2 = 40°$ became larger than, in the case of $\beta2 = 30°$. Here it should be noted that for small values of β_2 in the case of flame tube as $\theta = 120°$ was a separation of the flow from the walls of the transition cone, while the amount of gas circulating here considerably exceeded that in the center of the chamber, i.e. actually in the ZRC which also increased the total "residence time" and predetermined the increased NO_x output in combustion products.

The largest emission of NO_x during the experiments was observed at $\beta_2 = 20°$, which was explained by the increased size of recycling zones (including in the peripheral sections of the transition cone). In general, the deterioration in emission results in NO_x with $\beta_2 = $ especially, in comparison with the ASN options. Also, preliminary twist of the flow is being performed at the input recirculation zone amplifier $\beta_1 = 22°$ and $40°$ (figures 6 and 7), which was caused by a significant decrease in the quality of the preliminary preparation of the combustible mixture along the ASN path. The latter once again indirectly confirmed the need for such "preparation" in MFD structural elements.

Findings. Analysis of the results shows that the correct perforation increases the efficiency of the combustion process, increases the completeness of combustion of the fuel and reduces the formation of nitrogen oxides, especially when the chamber is operating in the design mode. In air burners, it is very important to choose the correct ratio of mass flow rates of air and fuel (for liquid fuels it can vary from 3 to 5). The angle of conicity of the front part of the flame tube exerts a significant effect on the quality of combustion. Therefore, for a detailed study of the effect of the angle of installation of blade recirculation zone amplifiers, as well as the perforation of the front and the stepwise supply of cooling air, it is necessary to perform numerical simulation of the process in the burner and in the primary zone of the combustion chamber [8].

For a long time, nitrogen oxides were not given enough attention. The presence of nitrogen oxides in the air is one of the reasons for the formation of smog in industrial regions of Kazakhstan and large cities. But even today in the Republic of Kazakhstan, car toxicity is measured only on CO content in the exhaust gas (Dostiyarov, 2000). Analysis of the main reasons for the formation of nitrogen oxides in various devices and prospects for the development of energy showed that traditional methods of burning fuel do not provide the required parameters.

Increasing the efficiency of fuel combustion can be obtained with the use of micro flame combustion (Dostiyarov, 2000). Despite the limited amount of experimental data on the use of micro flare incineration, various authors (Dostiyarov, Userov & Maisutov, 2006) noted the following positive qualities of this method: low losses of gas head, reduction of structural dimensions, low temperature field unevenness at the outlet from CS, low yields of nitrogen oxides with products combustion, reduced radiation losses (Lebedev, 1984; Kibarin, 1991; Maisutov, 2008). It was known from the middle of the twentieth century (Patent FRG No876936, 1953), that the technology of micro flare combustion has begun to attract scientists' attention relatively recently. At present, there are several main directions of micro flame combustion, but all have one thing in common: the "smearing" of the flare along the front and the volume of combustion (Dostiyarov, 2000). For calculation the concentration of nitrogen oxides taking into account the above, the following procedure was proposed. In the combustion zone, are distinguished forward flow and zone of reverse currents. The direct stream is divided into *i-belts*, which are bounded by the surfaces of the carp tube, the zone of the reverse currents and the cross-sections of the aperture passing through the axes for supplying secondary air perpendicular to the carousel axis. With a distinguished distribution of air flows, the volume concentration of nitrogen oxides in the combustion zone can be determined by the equation:

$$(C_{NO})_I = \sum (i=1)^{\wedge} n \cdot (C_{NO})i + 2G_{o6p} \cdot \sum_{i=1}^{n} \cdot (C_{NO})i + G_{o6p} \cdot (C_{NO})зот / G_I; \qquad (1)$$

n – belts count; G_i – air flow consumption through i – *belt*, kg/sec; G_{wh} – consumption of recycled gases through ZRC, kg/sec; G_I – total air flow through the combustion zone, kg/sec; $(C_{NO})i$ – volume concentration of nitrogen oxides in i-belt, whirl/%; $(C_{NO})ZRC$ – volume concentration of nitrogen oxides in in i-belt, whirl/%.

The volume concentration of nitrogen oxides NO_x in each zone is calculated by the equation:

$$(C_{NO})j = 37 \cdot 10^{11} \sqrt{(C_{O_2})j} \cdot (C_{H_2})j \cdot \exp\left(-\frac{65000}{T_{эфj}}\right) \cdot \sqrt{0,1 \cdot \frac{P_B}{T_{эфj}}} \cdot \tau_{npj}; \tag{2}$$

where $j=n+1$ – count of zones (count of belts + ZRC); T_{prj} – the residence time of the combustion products in j-zone, (sec); T_{eff} – the effective temperature in j-zone chamber (K); P_v – air pressure at the input to the combustion chamber, (mPa); $(C_{O!})(C_{!!})$ – volume concentrations of oxygen and nitrogen in j-zone.

For micro flame combustion it is reasonably possible to assume uniform distribution of air-fuel ratio in the combustion zone. In this case, it can be assumed that there is an average effective temperature that determines the release of nitrogen oxides, which depends on the quantities a_g and T_v, heat loss and the coefficient of completeness of combustion. For these conditions, formula (1) and (2) for chambers with one row of holes can be formed:

$$(C_{NO})к = 13 \cdot 10^{11} \left[\frac{\alpha_z(\alpha_z-1) \cdot L_o^3}{(1+\alpha_z \cdot L_0)3}\right] 0,5 \cdot \exp\left(-\frac{65000}{T_{эф.ср}}\right) \cdot \sqrt{\frac{0,1 \cdot P_B}{T_{эф.ср}}} \cdot K[K_{фр} \cdot \tau_1 + 2Koбp(\tau_1 + \tau_2) + K_{oбp} \cdot \tau_{3OT}] \cdot$$
$$\cdot \frac{\alpha_z}{\alpha_\Sigma}; [млн^{-1}]$$

where a_g – coefficient of excess air in the combustion zone; L_o – stoichiometric coefficient; α_Σ – the total coefficient of excess air from the combustion chamber; $K_{фp=}\frac{C_{фp}}{G_I}$ – relative air flow through the front device combustion chamber; $\tau_1, \tau_2, \tau_{3OT}$ – the residence time in the zones, respectively, up to the secondary air intake opening, afterthe opening and in ZRC; $K_{oбp=}\frac{C_{oбp}}{G_I}$ – relative air flow through the back-flow zone.

For calculation it is necessary to know the size of the zone of reverse currents and the number of gases recirculating in it. These values depend on the geometry of the front device, the flow parameters and the dimensions of the hole along the length of the carpal tube. The results of calculations on the proposed method and comparison with the experimental data are shown in figures. The discrepancy of data does not exceed 12% in the whole range of parameters of the regimes studied, which allows us to recommend this technique for use [9].

The proposed method for calculating the concentration of nitrogen oxides, taking into account the structure of the flow, allows us to select the geometry of the front of the combustion chamber at the design stage, not only from the point of view of ensuring minimum hydraulic losses and stability.

Conclusion. An analysis of the causes of the toxic substances formation in the combustion of natural fuels was concluded. General principles of the combustion process and chain reactions were considered. Various options and approaches for reducing and suppressing the formation of toxic substances werepresented. Technological methods of suppression were considered, which include: injection of water and steam, recirculation of combustion products, optimal air distribution, intensification of the mixture formation, stepwise combustion, catalytic combustion.

Devices based on poorly flowing bodies in view of their simplicity and high environmental parametersare of particular interest. It is shown that the use of poorly flowing bodies allows to provide combustion in a wide range of air consumption. One of the options for using poorly flowing bodies are the angle stabilizers. The analysis of the methods of the micro flame combustion method and various devices based on the MFS makes it possible to draw the following conclusions:

the supply of fuel to the combustion zone, the placement of injectors, fuel nozzles, the location of obstacles in the form of well-worn or poorly flowing bodies greatly influence the combustion process, its characteristics and the release of toxic substances, in particular nitrogen oxides;

the main principle of micro flame combustion is the "smearing" of the flare along the combustion volume, however, the implementation of such a principle can be different. In some cases, multiple nozzles are used, others use perforated surfaces or poorly flowing bodies;

the principle of micro flame combustion has a great potential. On the basis of the principle, various devices have been developed in which the gas burns both diffusively and kinetic;

the closest to the idea of the dissertation are jet-stabilizing burners based on poorly flowing bodies.

As a result of research, the conceptual principles of creating highly efficient methods of drying grain, aimed at intensifying processes and rational use of material and energy resources were formulated, which is achieved by modeling and optimizing the perspective designs of heat generators. Also, the hydrodynamic, kinetic and heat mass-exchange regularities of the grain drying process are identified and mathematically described. Numerical values and range of variation of the main kinetic and hydrodynamic characteristics with variable heat supply are determined. Mathematical model of the process of grain drying was developed. A mathematical model of stabilization of material and heat flows has been developed. Balanced distribution of thermal and material flows allows you to achieve the fullest possible use of energy. The minimization of thermodynamic losses by 20% from the effective inside of the cyclic and external regeneration of the "heat sinks" of the main and auxiliary outfits has been achieved.

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ЖЫЛУ ГЕНЕРАТОРЫНДА ЖӘНЕ ЖАНУ ӨНІМДЕРІНДЕ АСТЫҚТЫ КЕПТІРУ РЕЖИМІНЕ ӘСЕРІ

Аннотация. Мақалада жылу генераторының әсер етуі, оның әртүрлі айнымалы және әр түрлі жағдайларда жану өнімдерінің уыттылығына әсер етуі қарастырылады. Астықты кептіру процедурасын уақтылы және дұрыс орындау өте маңызды аспект болып табылады. Оңтайлы нәтиже алудың бірнеше нұсқасы ұсынылды. Жүргізілген зерттеулер нәтижесінде астықты кептірудің ұсынылған тәсілі оның сапасын жақсартуға ықпал етеді, астықтың пісу уақытын қысқартады, сондай-ақ астықтың ылғалдылығы мен жетілуі

тұрғысынан астық массасын түзеледі. Сондай-ақ, бұл әдіс астықтың сипаттамасын және оның сыртқы түрін жақсартуға ықпал ететінін атап өткен жөн. Ұсынылған әдіс микроорганизмдер мен зиянкестердің тіршілігін тоқтатады. Жұмыстың практикалық және теориялық маңыздылығы алынған деректерді астықты кептіру мәселелері бойынша практикада және зерттеулерде қолдану мүмкіндігіне негізделеді.

Түйін сөздер: астық кептіру, Жылу генераторы, жану өнімдерінің уыттылығы, кептіру режимі, астық ылғалдылығы, Формула, температуралық режим.

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ВЛИЯНИЕ РАБОТЫ ТЕПЛОГЕНЕРАТОРА НА РЕЖИМ СУШКИ ЗЕРНА И НА ТОКСИЧНОСТЬ ПРОДУКТАХ СГОРАНИЯ

Аннотация. В статье рассматривается влияние теплогенератора, режимов его работы с различными переменными и при различных условиях на режим сушки зерна и на токсичность продуктов сгорания. Своевременное и правильное выполнение процедуры сушки зерна является чрезвычайно важным аспектом. Предложено несколько вариантов получения оптимального результата. В результате проведенных исследований предложенный способ сушки зерна способствует улучшению его качества, сокращает время созревания зерна, а также корректирует зерновую массу с точки зрения влагосодержания и зрелости зерна. Следует также отметить, что данный метод, способствует улучшению характеристик зерна и его внешнего вида. Предлагаемый способ приостанавливает жизнедеятельность микроорганизмов и вредителей. Практическая и Теоретическая значимость работы заключается в возможности применения полученных данных на практике и в исследованиях по вопросам сушки зерна.

Ключевые слова: сушка зерна, теплогенератор, токсичность продуктов сгорания, режим сушки, влажность зерна, Формула, температурный режим.

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