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THERMAL STATE OF THE COMBUSTION ZONE IN MICRO-JET BURNERS WITH STABILIZERS OF VARIOUS CONFIGURATIONS

Summary. *The article presents the results of a comparative analysis of the temperature regime of the combustion zone in burner devices with flat and cylindrical flame stabilizers.*

Key words: *micro-jet burners, flat and cylindrical stabilizers, mathematical simulation, combustion zone.*

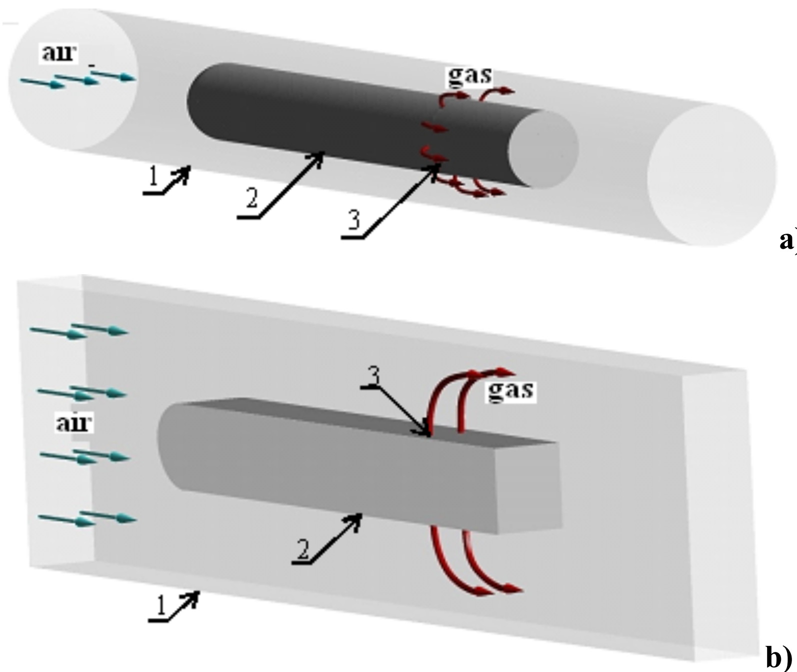
Micro-jet burners with cylindrical flame stabilizers are finding increasingly widespread use in flames-technical objects of relatively low power [1-9]. In this regard, the problem of an in-depth study of various elements of the working processes of these devices is relevant.

A large number of scientific papers are devoted to the study of working processes in burner devices [10-18]. However, of particular interest is the comparative analysis of the patterns of transfer processes in cylindrical burner devices and traditionally used burners with flat flame stabilizers.

The aim of this work is to compare the thermal state of the combustion zone in burner devices with flat and cylindrical flame stabilizers.

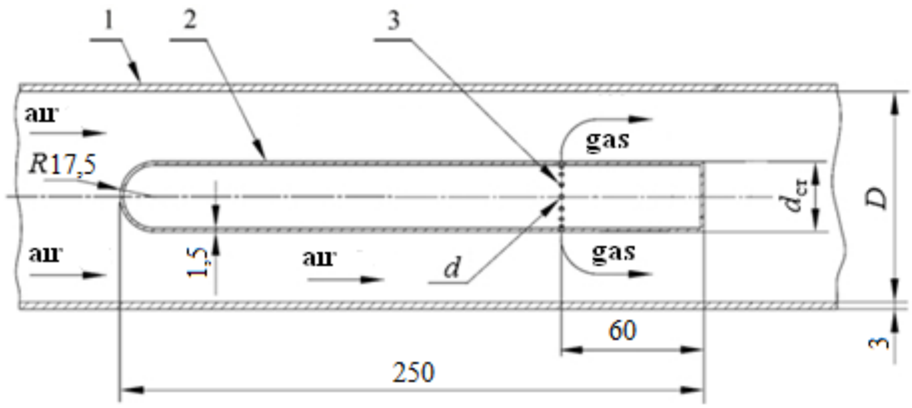
For comparative analysis, the method of mathematical simulation was used. Computational experiments were carried out within the framework of the RANS approach to calculating turbulent flows using the RNG k-ε turbulence model.

The schemes of the burner devices under consideration with cylindrical and flat flame stabilizers are shown in Fig. 1.



a)

b)



c)

Fig.1. Scheme of the burner device with cylindrical (a) and flat (b) flame stabilizers and longitudinal section of the stabilizer burner (c):

1 – channel; 2 – flame stabilizer; 3 – gas supply holes

The formation of a combustible mixture in the burners was carried out by jet injection of fuel into the transverse flow of the oxidizer from the side surfaces of the stabilizers. The consumption of natural gas in the studied situations was G_g = 9 m^3/h, and the excess air coefficient a – 1,1. For the compared burner devices, the equality of the diameter of the cylindrical and the height of the flat flame stabilizers d = 35 mm, as well as the areas of their cross sections, was assumed. The coefficient of blockage of the flow section of the channel k_f =0,3 was also as constant. The specified conditions ensured the equality of the average velocity of the incoming air flow in the gaps between the stabilizers and the channel walls. The diameter of the gas supply holes d and the relative distance S/d of their location for both situations were chosen so that the depth of penetration of the gas jets was approximately 0,75 of the gap height. The values of d found in accordance with this condition for the situations of cylindrical and flat stabilizers were 3 mm and 2,3 mm, and the values of S/d were 3,05 and 5,97. The remaining geometric characteristics of the stabilizer burners are shown in Fig. 1, c. The intensity of the turbulence of the air flow at the entrance to the channel and the gas in the outlet section of the gas supply opening was taken to be 3%. The absolute temperature of the gas and air was 293,15 K. The power of the burner devices was 90 kW.

Fig. 2 and Fig. 3 show typical results of the performed computational studies.

Fig. 2 illustrates the temperature fields in the cross-sections of the burner devices under consideration at different distances *x** from the end surface of the stabilizer. As can be seen, with an increase in *x**, the dimensions of the high-temperature region in the central part of the section increase for both burners with cylindrical and flat flame stabilizers in accordance with the development of the combustion process. In this case, the configuration of this region changes significantly. Thus, for a burner with a cylindrical flame stabilizer near the end surface of the stabilizer (Fig. 2 a, b), the very complex boundary of this region reflects the fact of the presence of still "unblurred" fuel jets. Further, with distance from the end of the stabilizer, this region tends to the shape of a circle.

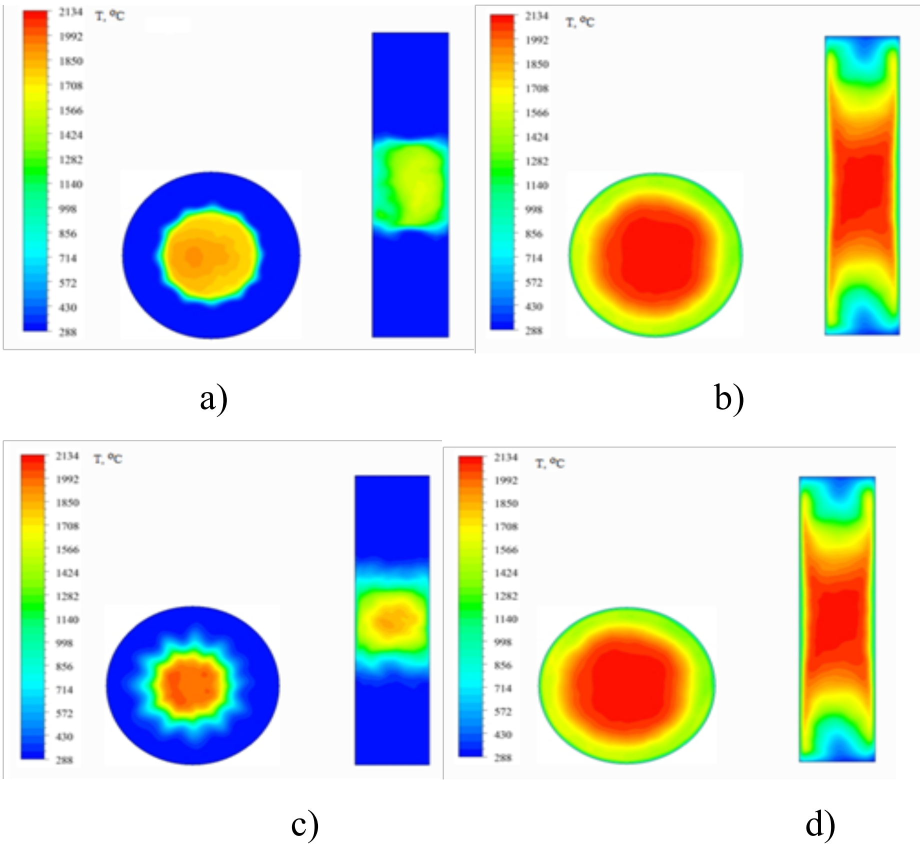


Fig. 2. Temperature fields in the cross-sections of burner devices at different distances *x from the stabilizer's breakaway edge:**

a) *x**= 0,01 m; b) *x**= 0,03 m; c) *x**= 0,1 m; d) *x**= 0,25 m

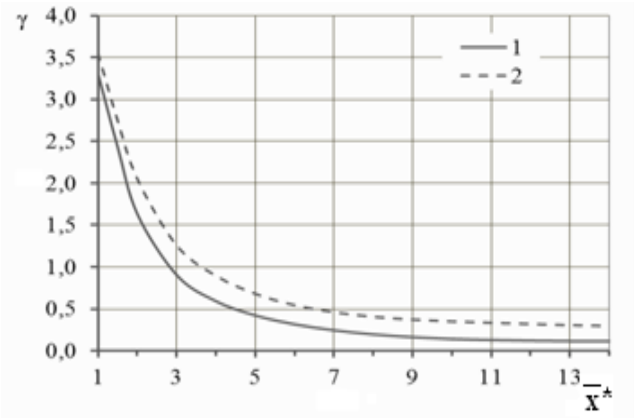


Fig. 3. Relative non-uniformity of the temperature field in the cross-sections of the torch:

1 – cylindrical stabilizer; 2 – flat stabilizer

As is known, an important characteristic of the thermal state of the combustion zone is the relative unevenness of the temperature field γ in the cross-section of the flame $\gamma = \frac{T_{\max} - T_{av}}{T_{av} - T_{air}}$, where $T_{\max}$, T_{av} are the maximum and average temperatures in a given section; T_{air} is the air temperature at the burner inlet.

Fig. 3 shows the dependence of the value of γ on the distance x^* for a burner with a flat and cylindrical flame stabilizer. According to the data obtained, in the case of a cylindrical burner device, the non-uniformity of the temperature field in the cross-sections of the flame is less significant than for burner devices with a flat flame stabilizer along the entire length of the flame. Thus, the value of the coefficient of relative non-uniformity of the temperature field γ decreases to 0,3 at a distance $\bar{x}^*$ from the breakaway edge of the stabilizer equal to approximately 6,0 and 12,5 of its caliber for cylindrical and flat flame stabilizers, respectively.

Conclusion. Based on the results of the conducted studies, it has been shown that in terms of ensuring a high degree of uniformity of the temperature field in the cross-sections of the flame, burners with cylindrical stabilizers are more preferable in comparison with traditionally used burner devices with flat flame stabilizers.

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