Technical sciences

UDC 536.24:533

Fialko Nataliia
Doctor of Technical Science, Professor, Head of Department,
Honored Worker of Scientist of Ukraine, Corresponding Member
Institute of Engineering Thermophysics of Ukraine of the
National Academy of Science of Ukraine

Prokopov Viktor
Doctor of Technical Science, Professor, Leading Researcher
Institute of Engineering Thermophysics of Ukraine of the
National Academy of Science of Ukraine

Sherenkovsky Yulii
Candidate of Technical Science (PhD),
Senior Scientific Researcher, Leading Researcher
Institute of Engineering Thermophysics of Ukraine of the
National Academy of Science of Ukraine

Meranova Nataliia
Candidate of Technical Science (PhD),
Senior Scientific Researcher, Leading Researcher
Institute of Engineering Thermophysics of Ukraine of the
National Academy of Science of Ukraine

Alioshko Sergiy
Candidate of Technical Science (PhD), Leading Researcher
Institute of Engineering Thermophysics of Ukraine of the
National Academy of Science of Ukraine

Polozenko Nina

Candidate of Technical Science (PhD), Senior Researcher

Institute of Engineering Thermophysics of Ukraine of the National Academy of Science of Ukraine

Maletska Olha

Candidate of Technical Science (PhD), Senior Researcher

Institute of Engineering Thermophysics of Ukraine of the National Academy of Science of Ukraine

Rokytko Konstantin

Junior Researcher

Institute of Engineering Thermophysics of Ukraine of the National Academy of Science of Ukraine

Abdulin Mikhail

Doctor of Technical Science, Senior Researcher

Institute of Engineering Thermophysics of Ukraine of the National Academy of Science of Ukraine

BASIC PRINCIPLES OF THERMOGASDYNAMICS OF MICROJET BURNER DEVISES WITH ASYMMETRIC SUPPLY OF FUEL GAS

ОСНОВНЫЕ ПРИНЦИПЫ ТЕРМОГАЗОДИНАМИКИ МИКРОФАКЕЛЬНЫХ ГОРЕЛОЧНЫХ УСТРОЙСТВ С АСИММЕТРИЧНОЙ ПОДАЧЕЙ ТОПЛИВНОГО ГАЗА

Summary. *The basic principles of thermogasdynamics of microjet burner devices with one-sided supply of fuel gas are formulated. The analysis of the resulting factors associated with the implementation of these technologies are performed.*

Key words: *fuel gas combustion, stabilizer type burners, asymmetric fuel supply, basic principals of thermogasdynamics.*

Аннотация. *Сформулированы основные положения термогазодинамики микрофакельных горелочных устройств с односторонней подачей топливного газа. Выполнен анализ результирующих факторов, связанных с реализацией указанных технологий.*

Ключевые слова: *сжигание топливного газа, горелочные устройства стабилизаторного типа, асимметричная подача топлива, основные положения термогазодинамики*

Important apply for microjets burners is their use in relatively high excess air. Under these conditions, it seems appropriate to use microjets burners with asymmetric fuel supply. The shema of this burner device is shown in Fig. 1. Flat flame stabilizers are located in the channel. The primary air is supplied to the canals near walls, and the secondary air to the interstabilizer canal. Fuel gas is supplied by introducing into the blow-off stream of the oxidizing agent only from one of the surfaces of the stabilizer facing the channel wall. The stabilizers are equipped with flat flaps mounted on their end surfaces from the side of the interstabilizer channel.

Comprehensive studies of working processes in the burner in question made it possible to formulate the basic principles of their thermo-gas dynamics [1-8]. Figure 2 provides the wording of the main propositions regarding the organization of the working processes of the studied burners. In addition, the resulting effects that are realized through the implementation of these propositions are indicated.

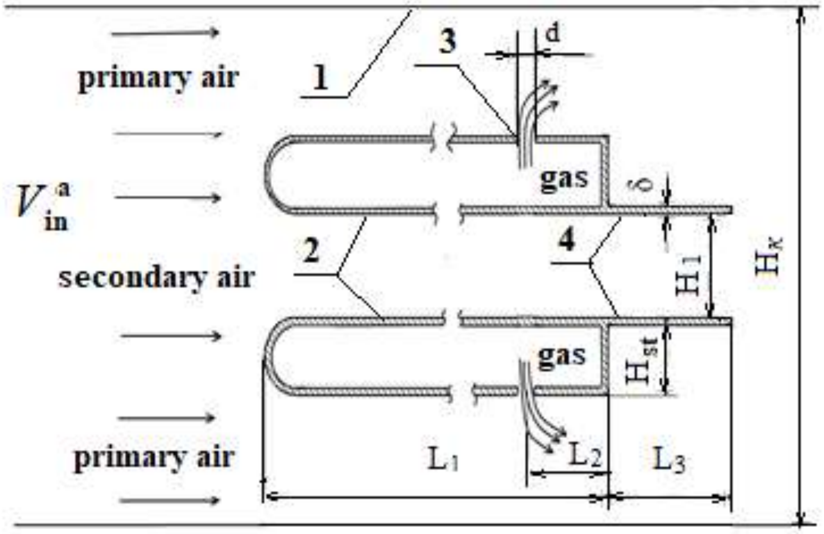

Fig. 1. Scheme microjets burner divice stabilizer type with asymmetric fuel supply: 1 - flat channel; 2 - flame stabilizers; 3 - gas supply holes; 4 - flaps.

Figure 2 provides the wording of the basic principals regarding the organization of the working processes of the studied burners. In addition, the resulting effects that are realized through the implementation of these principals are indicated.

Let us consider in more detail the content of each of the above principals. Regarding the first of these principals, the following should be noted. When burning fuel gas at relatively high values of the coefficient of excess air ($\alpha > 2.0$), as is known, there may be increased chemical incompleteness of fuel combustion. The proposed burner device is free from this drawback. This is achieved due to the organization of two-stage combustion with the distribution of air flows to primary, fed into the flame, and secondary, which is fed directly into the flame behind the flap. That is, in the burner under consideration, the following scheme is implemented: “combustion with relatively small excess air” → “different dilution” and “poor combustion”. The use of such a two-stage scheme makes it possible to increase the temperature in the first stage of combustion, sharply reduce the emission of CO, and then provide a high degree of completeness of combustion of fuel gas.

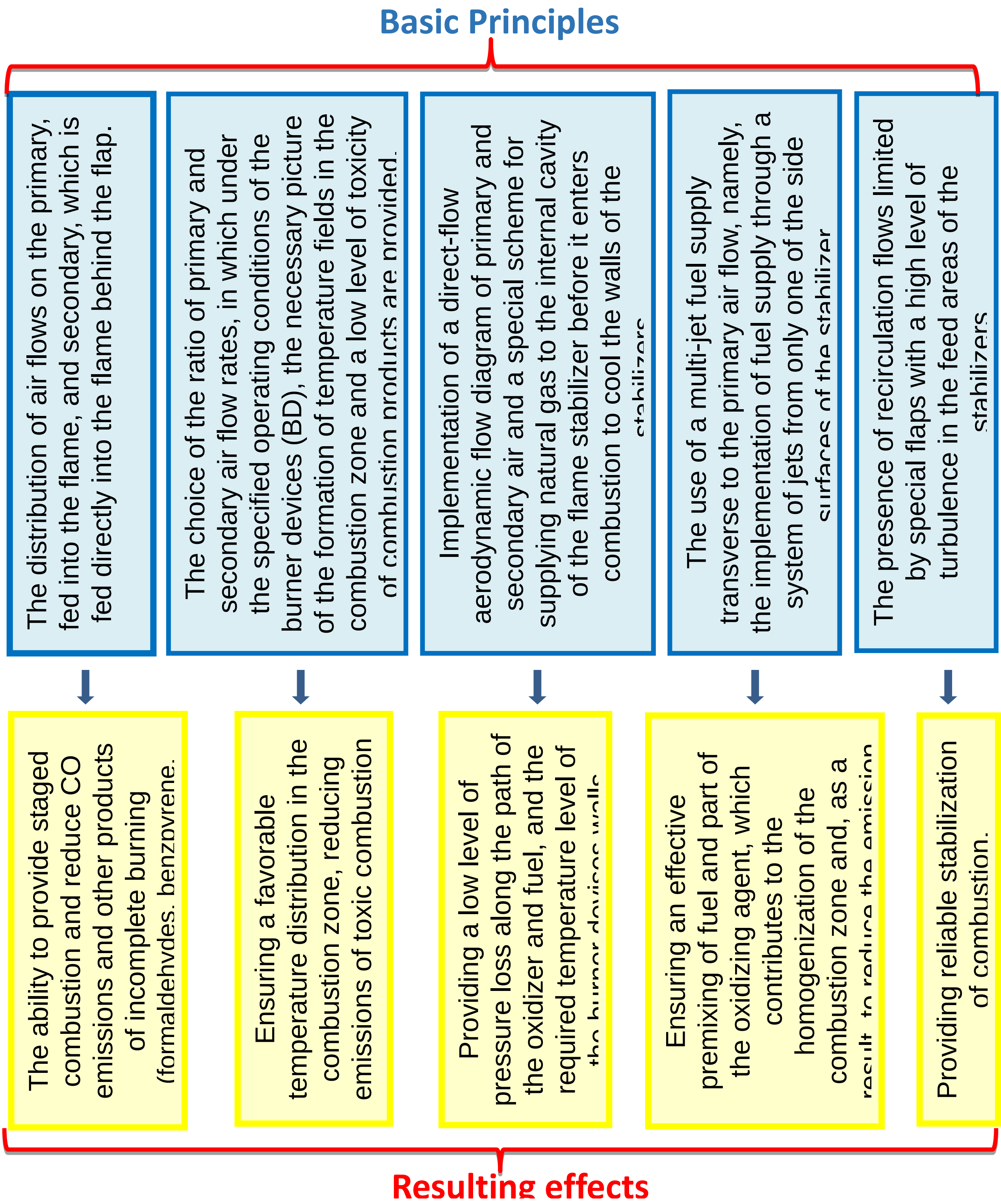

Fig. 2. Basic principles for the organization of work processes of burners with asymmetric fuel supply

Regarding the second principle related to the choice of the relation of primary and secondary air consumptions, which is provided by varying the width of the interstabilizer canal and canals near walls. Studies have shown that this relation significantly affects the environmental and energy characteristics of the burner device. Moreover, with a certain value of the relation of primary and secondary air consumptions, high efficiency of fuel gas combustion is ensured. This conditions the statement of the problem of determining such a relation.

The third principle concerns the flow pattern of primary and secondary air. Due to the direct-flow aerodynamic flow scheme of the primary and secondary air flow, low levels of pressure loss along the oxidizer and fuel paths are provided. In addition, the use of a fuel gas supply scheme into the internal cavity of the flame stabilizer allows the gas to be used as a cooling agent and to carry out the so-called self-cooling of the walls of the stabilizers.

With regard to the fourth principle associated with the use of a transverse stream of primary air, multi-jet fuel gas supply. Due to this fuel supply scheme, conditions are created for the implementation of a favorable microjets structure of the primary combustion zone. In addition, the specified distributed fuel supply provides effective preliminary mixing of the fuel and part of the oxidizing agent, which ensures a high level of homogenization of the combustible mixture, and as a result, a reduction in the emission of toxic combustion products.

The fifth principle is related to ensuring reliable stabilization of the flame. This stabilization is realized due to recirculation flows in the feed regions of the stabilizers. The performed studies showed that for the formation of such flows it is necessary to install special flaps at the ends of the flame stabilizers on the opposite side of the plane of the gas supply holes.

In conclusion, it should be noted that the developed principles of thermogasdynamics of the microjets burners under consideration are the basis for the design of their specific modifications that meet the specified operating conditions.

References

1. Fialko N.M., Sherenkovsky Ju.V., Mayson N.V., Meranova N.O., Butovsky L.S., Abdulin M.Z, Polozenko N.P., Klishch A.V., Stryzheus S.N., Timoshchenko A.B. Intensification of transport processes in a burner device with a cylindrical flame stabilizer. Scientific Bulletin of UNFU. 2014. 24 (5). P. 136-142. (Rus). ISBN 5-7763-2435-1.
2. Fialko N.M., Sherenkovsky Ju.V., Mayson N.V., Meranova N.O., Butovskiy L.S., Abdulin M.Z., Polozenko N.P., Klishch A.V., Stryzheus S.N., Timoshchenko A.B. Mathematical modeling of processes of flow and mixture formation in a cylindrical stabilizer burner device. Eastern European Journal of Advanced Technologies. 2014. V.3. № 8 (69). P. 40-44. (Rus). ISSN 1729-3774. https://doi.org/10.15587/1729-4061.2014.24895 .
3. Fialko N.M., Prokopov V.G., Sheerenkovskiy Ju.V., Alioshko S.O., Meranova N.O., Abdulin M.Z., Butovskiy L.S., Mirgorodskiy A.H. Computer modeling of transfer processes in cooling systems of stabilizer type burners. Industrial Engineering. 2012. №1. PP. 64-71.
4. Fialko N.M., Sherenkovskiy Ju.V., Prokopov V.G., Meranova N.O., Alioshko S.O., Timoshchenko O.B., Polozenko N.P., Strizheus S.N. Comparative analysis flow characteristics in burners with echeloned arrangement of flame stabilizers in isothermal conditions and during fuel combustion. Scientific Herald of National University of Life and Environmental Sciences of Ukraine. 2016. 242. PP. 33-40.
5. Fialko N.M., Sherenkovskiy Ju.V., Maison N.V., Meranova N.O., Abdulin M.Z., Butovsky L.S., Polozenko N.P., Klishch A.V., Strizheus S.N., Timoshchenko A.B. The influence of plate flow turbulators on the flow characteristics and mixture formation of fuel and oxidizer in a cylindrical stabilizer burner device. Scientific Bulletin of UNFU. 2014. 6(24). PP. 114-121. ISBN 5-7763-2435-1.

6. Fialko N.M., Sherenkovskiy Ju.V., Prokopov V.G., Alioshko S.O., Meranova N.O., Rokitko K.V. CFD simulation of temperature regimes of combustion zone of stabilizer type with asymmetric fuel supply.Thermophysics and Heat Engineering. 2019. 41. №4. PP. 13-18. https://doi.org/10.31472/ttpe.4.2019.
7. Fialko N.M., Aleshko S.A., Rokitko K.V., Maletskaya O.E., Milko E.I., Kutnyak O.N., Olkhovskaya N.N., Donchak M.I., Evtushenko A.A. Regularities of mixture formation in the burners of the stabilizer type with one-sided fuel supply. Technological Systems. 2018, 3(38). PP. 37-43.
8. Fialko N.M., Prokopov V.G., Alioshko S.A., Abdulin M.Z., Rokitko K.V., Maletskaya O.E., Milko E.I., Olkhovskaya N.N., Regragui A., Evtushenko A.A. Computer simulation of flow in microflame burner devices with asymmetric fuel supply. Scientific Bulletin of UNFU. 2018. 28. № 8. PP 117-121.