EFFECT OF THE DESIGN OF GAS SUPPLY SYSTEM ON THE PERFORMANCE OF CYLINDRICAL RADIANT BURNERS

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Abstract: Radiant burners of cylindrical shape are of high interest for the engineering of advanced water heating boilers. The two main components of the radiant burner are the gas permeable emitting cylinder and the supply system for the fresh mixture. This study examined a cylindrical burner with a thin layered porous emitter made of porous intermetallic material with two types of gas supply systems: (*i*) stream injection through the gas supply duct; and (*ii*) distributed supply through the porous insert. The temperature characteristics, NOx emission, and noise are experimentally studied in the power range of 4.0–9.1 kW and the air-to-fuel equivalence ratio range of 1.0–1.7. It has been established that the distributed supply through the porous insert allows one to reduce NOx emission and noise as well as to increase the uniformity of temperature distribution along the surface of the porous emitter.

Keywords: radiant burner; infrared burner; porous burner; noise; NOx emission

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Figure Captions

Figure 1 The scheme of radiant burner with stream injection (*a*) and distributed (*b*) supply systems for the fresh mixture

Figure 2 The average temperature of the emitter surface vs. the air-to-fuel equivalence ratio for radiant burner with stream injection (*a*) and distributed (*b*) supply systems for the fresh mixture

Figure 3 The temperature of the porous insert versus the air-to-fuel equivalence ratio

Figure 4 Two NOx emission in dry and undiluted by air flue gases vs. the air-to-fuel equivalence ratio for radiant burner with stream injection (*a*) and distributed (*b*) supply systems for the fresh mixture

Table Captions

Table 1 Influence of the fuel supply strategies on the temperature distribution along the surface of the porous emitter

Table 2 Influence of the fuel supply strategies on the noise emission

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References

1. Bone, W. A. 1912. Surface combustion. *J. Frankl. Inst.* 173:101–131. doi: 10.1016/S0016-0032(12)91018-2.
2. Maznoy, A., A. Kirdyashkin, V. Kitler, N. Pichugin, V. Salamatov, and K. Tcoi. 2019. Self-propagating high-temperature synthesis of macroporous B_2 + L_{12} Ni–Al intermetallics used in cylindrical radiant burners. *J. Alloy. Compd.* 792:561–573. doi: 10.1016/j.jallcom.2019.04.023.
3. Vasilik, N. Ya., and V. M. Shmelev. 2020. Infrakrasnoe gorelochnoe ustroystvo na sisteme rekuperativnykh elementov [Infrared burner device on a system of recuperative elements]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 13(2):19–24. doi: 10.30826/CE20130203.
4. Vasilik, N. Ya., and A. A. Zakharov. 2020. Eksperimental'nye issledovaniya infrakrasnoy gorelki s poverkhnostnym rezhimom goreniya v oblasti vysokikh znacheniy udel'noy moshchnosti goreniya [Experimental studies of the infrared burner at high values of specific combustion power]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 13(4):29–36. doi: 10.30826/CE20130404.
5. Maznoy, A., A. Kirdyashkin, and N. Pichugin. 2018. Radiatsionnye gorelki tsilindricheskoy formy s maksimal'noy effektivnost'yu preobrazovaniya energii goreniya

v izluchenie [Cylindrical radiant burners with maximal radiation efficiency]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 11(2):56–65. doi: 10.30826/CE18110208.

6. Maznoy, A., A. Kirdyashkin, A. Gushchin, N. Pichugin, and V. Kitler. 2018. Ekologicheskie kharakteristiki radiatsionnykh gorelok s polym tsilindricheskim izluchatelem [Environmental characteristics of cylindrical radiant burners]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 11(3):21–27. doi: 10.30826/CE18110303.
7. Maznoy, A., and N. Pichugin. 2019. Uluchshenie kharakteristik tsilindricheskoy radiatsionnoy gorelki modifikatsiey sostava toplivnoy smesi [Improving the characteristics of a cylindrical radiant burner by modifying the composition of the fuel mixture]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 12(3):28–35. doi: 10.30826/ce19120304.
8. Buldakov, M. A., I. I. Matrosov, D. V. Petrov, A. A. Tikhomirov, and B. V. Korolev. 2013. Raman gas analyzer for determining the composition of natural gas. *J. Appl. Spectrosc.* 80(1):124–128. doi: 10.1007/s10812-013-9731-6.
9. Petrov, D. V., I. I. Matrosov, A. R. Zaripov, A. S. Tanichev, M. A. Kostenko, and A. O. Nekhoroshev. 2021. Evaluation of the metrological characteristics of Raman analyzer of natural gas. *Measurement Techniques* 64(3):261–266. doi: 10.1007/s11018-021-01927-z.
10. Trimis, D., and F. Durst. 1996. Combustion in a porous medium-advances and applications. *Combust. Sci. Technol.* 121(1-6):153–168. doi: 10.1080/00102209608935592.
11. Ellzey, J. L., E. L. Belmont, and C. H. Smith. 2019. Heat recirculating reactors: Fundamental research and applications. *Prog. Energ. Combust.* 72:32–58. doi: 10.1016/j.pecs.2018.12.001.

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