EXPERIMENTAL INVESTIGATION OF THE HIGH-TEMPERATURE SINTERING FURNACE BASED ON FILTRATION GAS COMBUSTION

A. Kirdyashkin, R. Gabbasov, V. Kitler, and A. Maznoy

Tomsk Scientific Center, Siberian Branch of the Russian Academy of Sciences, 10/4 Akademicheskii Ave., Tomsk 634055, Russian Federation

Abstract: A significant cost-reduction of refractory ceramics is possible through the development of novel high-temperature furnaces based on energy-efficient combustion techniques. In this paper, a sintering furnace based on the principle of filtration gas combustion in porous inert media has been studied experimentally. The operational modes of the furnace were investigated in a wide range of parameters (fuel flow rate, fuel-to-oxidizer ratio, and type of oxidizer) with the use of two types of temperature measurement techniques, namely, thermocouple method and spectral pyrometry. The optimal experimental conditions to obtain high temperatures up to 2220 K are discussed in detail. Test sintering of near-dense ceramic materials was successfully performed at a temperature of 2170 K.

Keywords: filtration combustion; porous inert media; sintering; ceramics

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Figure Captions

Figure 1 Experimental setup: *1* — stainless steel body of the furnace; *2* — gas distribution chamber; *3* — support grid; *4* — bottom plate; *5* — cylindrical heat insulation layer; *6* — packed bed of ceramic spheres; *7* — top plate; *8* — ceramic tubes for thermocouples; and *9* — ceramic tubes for spectral pyrometry

Figure 2 Two schemes of placing the powder samples inside the packed bed

Figure 3 Combustion rate as a function of equivalence ratio for $\gamma = 21\,\%$(vol.): (*a*) $\omega = 70$ nl/s/m^2; (*b*) 110; (*c*) 180; (*d*) 350; and (*e*) $\omega = 570$ (*1*), 710 (*2*), 780 (*3*), and 850 nl/s/m^2 (*4*)

Figure 4 Maximal temperatures of packed bed as a function of equivalence ratio for $\gamma = 21\,\%$(vol.): *1* — $\omega = 70$ nl/s/m^2 ($F_R = 270$ kW/m^2); *2* — 110 (360); *3* — 180 (630); *4* — 350 (1260); *5* — 570 (1990); *6* — 710 (2440); *7* — 780 (2710); and *8* — $\omega = 850$ nl/s/m^2 ($F_R = 2980$ kW/m^2)

Figure 5 Temperature profile measured during combustion mode change

Figure 6 Images of sintered samples upon schemes 1 (*a*) and 2 (*b*)

Table Captions

Table 1 Influence of oxygen concentration in the oxidizer γ on the temperature of the packed bed at different combustion modes

Table 2 Influence of sintering conditions on the porosity, phase composition, and microstructure of the heat-treated powder samples

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Contributors

Kirdyashkin Alexander I. (b. 1954) — Candidate of Science in physics and mathematics, leading research scientist, Tomsk Scientific Center, Siberian Branch of the Russian Academy of Sciences, 10/4 Akademicheskii Ave., Tomsk 634055, Russian Federation; kirdyashkin_a@mail.ru

Gabbasov Ramil M. (b. 1981) — Candidate of Science in technology, research scientist, Tomsk Scientific Center, Siberian Branch of the Russian Academy of Sciences, 10/4 Akademicheskii Ave., Tomsk 634055, Russian Federation; ramilus@yandex.ru

Kitler Vladimir D. (b. 1964) — Candidate of Science in physics and mathematics, research scientist, Tomsk Scientific Center, Siberian Branch of the Russian Academy of Sciences, 10/4 Akademicheskii Ave., Tomsk 634055, Russian Federation; vladimir_kitler1@mail.ru

Maznoy Anatoly S. (b. 1985) — Candidate of Science in technology, senior research scientist, Tomsk Scientific Center, Siberian Branch of the Russian Academy of Sciences, 10/4 Akademicheskii Ave., Tomsk 634055, Russian Federation; maznoy_a@mail.ru