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Experimental Study of Flame Stability in SiC Porous Media

S. A. Hashemi, J. Amani, H. Atoof

ABSTRACT

In this paper, the effect of equivalence ratio, pore diameter and firing rate on flame stability in a SiC porous media has been studied experimentally. Based on the position of the flame, four regimes are observed as follows: Surface flame, submerged flame, under-surface and detached flame. The surface flame regime as a rich flame is one of the stability threshold and the detached flame as a lean flame is the other threshold of the flame stability. Change the pore diameter causes so little change in equivalence ratios corresponding to the detached flame threshold but increasing the pore diameter decreases the equivalence ratio changes for the surface flame. Also increasing the firing rate decreases flame stability range in the porous media. Flame position was estimated using axial temperature distribution in the sidewall of the burner. Temperature profiles versus equivalence ratio in a firing rate are approximately similar but the profiles are different for various firing rates. According to the results, flame is stable in near the upper surface or in the half bottom of the porous media.

KEYWORDS :Porous burner, SiC porous media, Flame stability, Flame temperature profile

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ppc / ppc

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(Al₂O₃)

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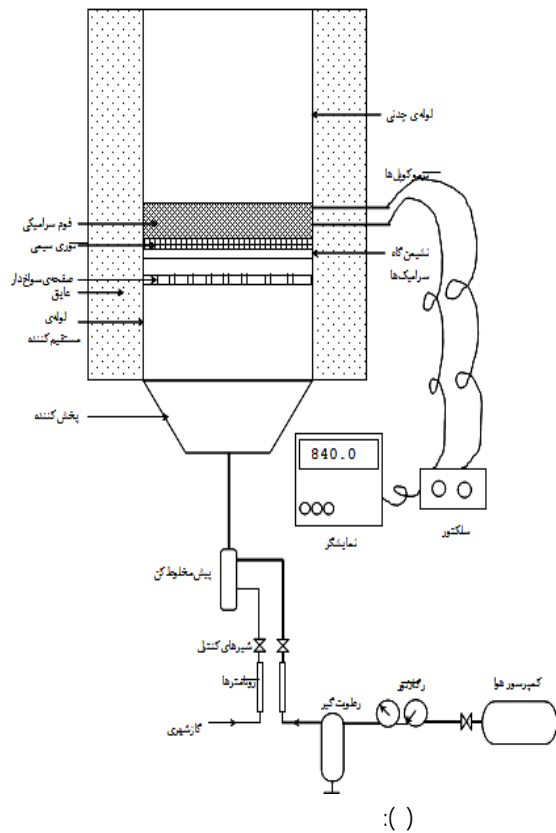
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SiC Al₂O₃

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$$FR = \frac{LHV \times \dot{m}_f}{A}$$

cm

\dot{m}_f

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$$\phi = \frac{FA_a}{FA_s}$$

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LHV

A

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FA_a

FA_s

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$$S_L = \frac{\dot{V}}{A} \text{ cm/sec}$$

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$$V_{eff} = \frac{Q_{mix}}{A_{eff}}$$

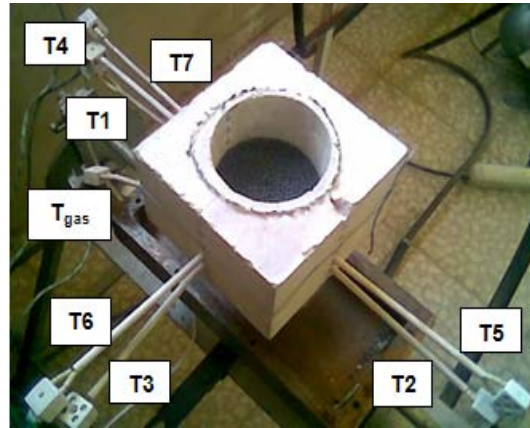
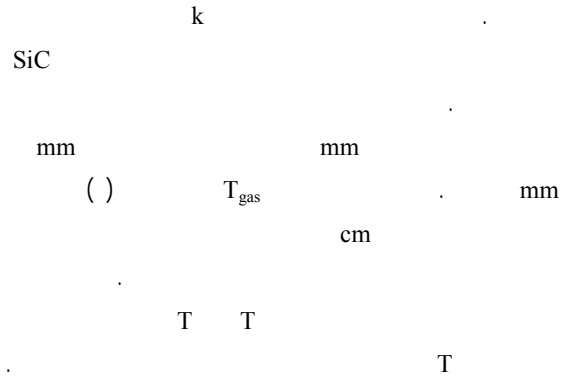
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$$A_{eff} = \frac{A}{\phi}$$

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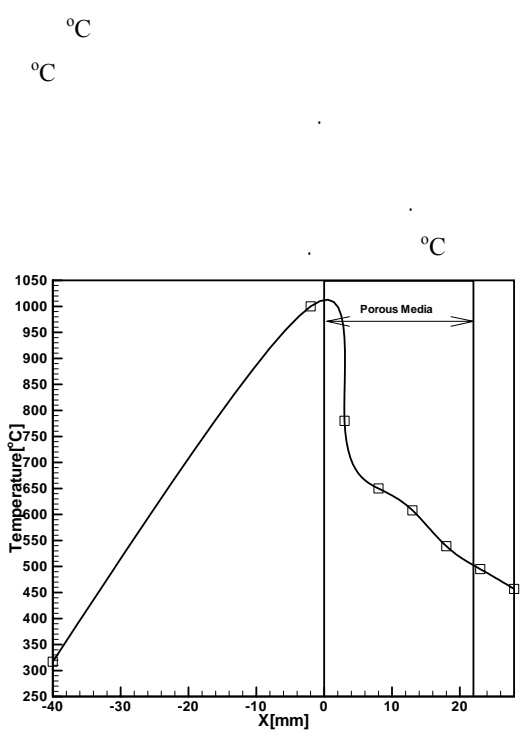
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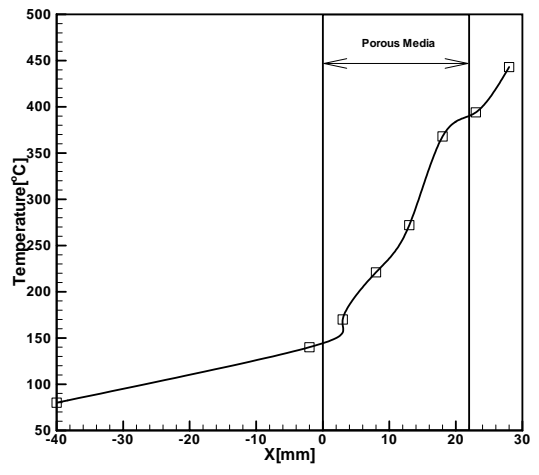
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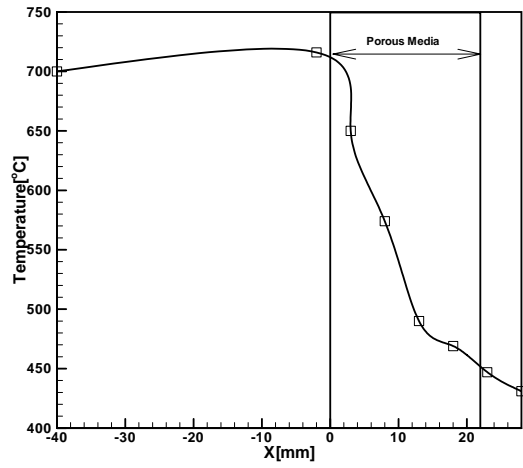
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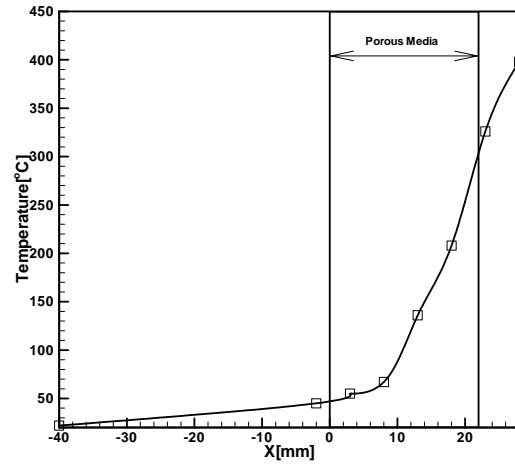
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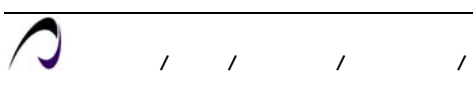


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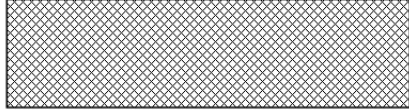
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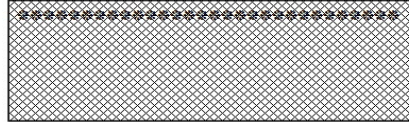


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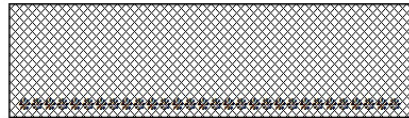
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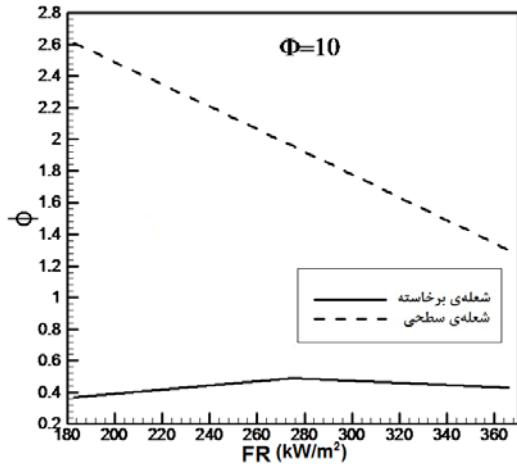
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(ppi)	(Kw/m ²)	(lit/min)				
			ی	(cm/s)	ی	(cm/s)
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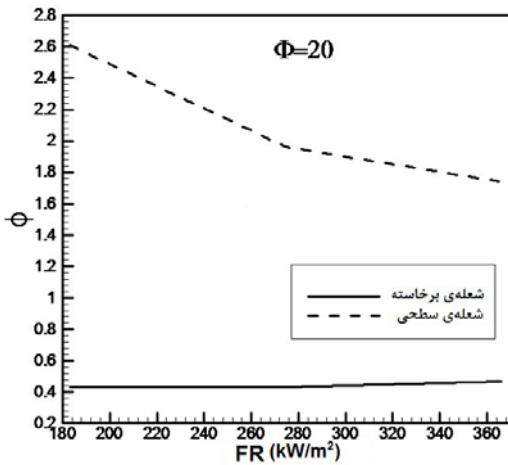
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چگالی حفره (ppi)	نرخ آتش (kW/m ²)	دبی گاز (lit/min)	دبی هوا (m ³ /hr)	نسبت هم‌ارزی	سرعت مخلوط (cm/s)
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kW/m2

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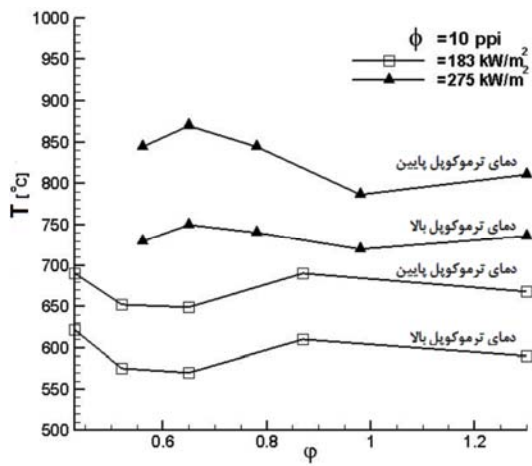
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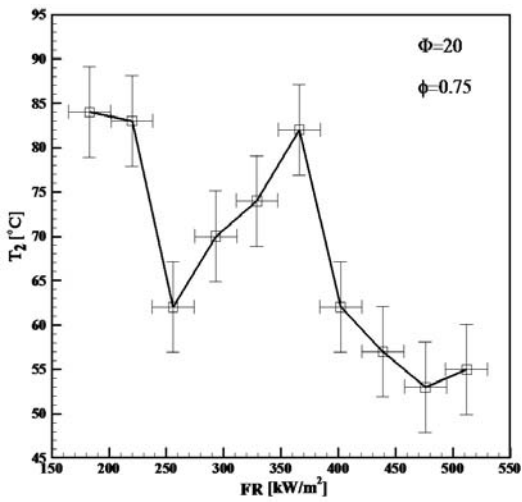
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kW/m

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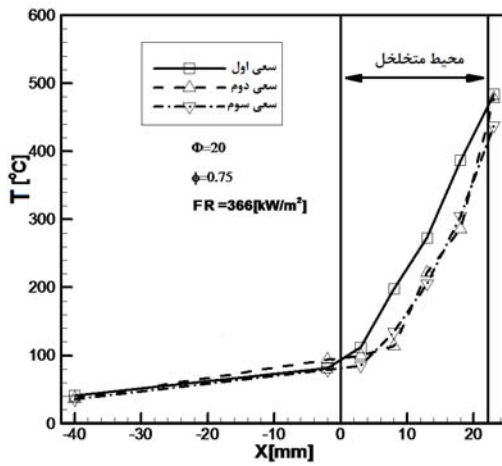
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kW/m

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- Kotani, Y., Takeno, T., "An Experimental Study on Stability and Combustion Characteristics of an Excess Enthalpy Flame", Proc. Combust. Institute, 19, pp. 1503–1509, 1982. [] []
- Sathe, S.B., Kulkarni, M.R., Peck, R.E., Tong, T.W., "An experimental and theoretical study of porous radiant burner performance", Proc. Combust. Int., 23, 1011–1018, 1990. [] []
- McIntosh, A. C., Prothero, A., "A model of large heat transfer surface combustion with radiant heat emission", Combust. Flame., 83, 111-126, 1991. [] []
- Min, D.K., Shin, H.D., "Laminar premixed flame stabilized inside a honeycomb ceramic", Int. J. Heat Mass Trans., 34, 341–56, 1991. [] []
- Itaya, Y., Miyoshi, K., Maeda, S., Hasatani, M., "Surface combustion of a premixed methane–air gas on a porous ceramic", Int. Chem. Eng., 32, 123–131, 1992. [] []
- Hanamura, K., Echigo, R., "An analysis of flame stabilization mechanisms in radiation burners", Wärme Stofffu" bertrag, 26, 377–383, 1991. [] []
- Hanamura, K., Echigo, R., Zhdanok, S.A., "Superadiabatic combustion in a porous medium", Int. J. Heat Mass Trans., 36, 3201–3209, 1993. [] []
- Mital, R., Gore, J.P., Viskanta, R., "A Study of the Structure of Submerged Reaction Zone in Porous Ceramic Radiant Burners", Combust. Flame, 111, 175–184, 1997. [] []
- Brenner, G., Pickenacker, K., Pickenacker, O., Trimis, D., Wawrzinek, K., Weber, T., "Numerical and experimental investigation of matrix-stabilized methane/air combustion in porous inert media", Combust Flame, 123, 201–213, 2000. [] []
- Glassman, Irvin; Combustion, 2nd Edition, Academic Press, Princeton-Newjersey, 114-151, 1987. [] []
- Charles E. Baukal, Industrial Burners handbook, CRC Press, section 11-13, 2003. [] []
- Kambiz Vafai; Handbook of Porous Media, 2nd Edition, CRC Press Taylor & Francis Group, US, 2005. [] []
- Mößbauer, S., Pickenäcker, O., Pickenäcker K., Trimis, D., "Application of the Porous Burner Technology in Energy-and Heat-engineering", Clean Air, 3, 185–198, 2002. [] []
- Howell, J.R, Hall, M.J, Ellzey, J.L., "Combustion of Hydrocarbon Fuels within Porous Inert Media", Prog. Energ. Combust. Sci., 22, 121-145, 1996. [] []
- Wood, S., Harris, A.T., "Porous burners for lean-burn applications", Prog. Energ. Combustion Sci., 34, 667–684, 2008. [] []
- Abdul Mujeebu, M., Abdullah, M.Z., Abu Bakar, M.Z., Mohamad, A.A., Muhad, R.M.N., Abdullah, M.K., "Combustion in porous media and its applications – A comprehensive survey", J. Env. Man., 90, 2287-2312, 2009. [] []



Vogel, B.J., Ellzey, J.L., "Subadiabatic and superadiabatic performance of a two section porous burner", *Combust Sci Technol*, 177, 1323–38, 2005. []

Qiu, K., Hayden, ACS., "Premixed gas combustion stabilized in fibre felt and its application to a novel radiant burner", *Fuel*, 85, 1094–1100, 2006. []

Diamantis, D.J., Mastorakos, E., Goussis, A., "Simulation of premixed combustion in porous media", *Combust Theor Model*, 6, 383–411, 2002. []

Mathis Jr W.M., Ellzey J.L., "Flame stabilization, Operating Range and Emissions for a Methane/Air Porous Burner", *Combust. Sci. And Tech.*, 175, 825-839, 2003. []

Trimis, D., Wawrzinek, K., "Flame stabilization of highly diffusive gas mixtures in porous inert media", *J. Comput. Appl. Mech.*, 5, 367–381, 2004. []

