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EXPERIMENTAL AND SCALE UP STUDY OF THE FLAME SPREAD OVER THE PMMA SHEETS

ABSTRACT

To explore the flame spread mechanisms over the solid fuel sheets, downward flame spread over vertical polymethylmethacrylate sheets with thicknesses from 1.75 to 5.75 mm have been examined in the quiescent environment. The dependence of the flame spread rate on the thickness of sheets is obtained by one-dimensional heat transfer model. An equation for the flame spread rate based on the thermal properties and the thickness of the sheet by scale up method is derived from this model. During combustion, temperature within the gas and solid phases is measured by a fine thermocouple. The pyrolysis temperature, the length of the pyrolysis zone, the length of the preheating zone, and the flame temperature are determined from the experimental data. Mathematical analysis has yielded realistic results. This model provides a useful formula to predict the rate of flame spread over any thin solid fuel.

KEYWORDS

flame spread, pilot ignition, polymethylmethacrylate, scale up, solid fuel

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REFERENCES [view full list]

1. Zeng, W. R., Li, S. F., Chow, W. K., Preliminary Studies on Burning Behavior of Poly Methyl Methacrylate (PMMA), Fire Sciences, 20 (2002), 4, pp. 297-317
2. Kashani, A., Esfahani, J. A., Interactive Effect of Oxygen Diffusion and Volatiles Advection on Transient Thermal Degradation of Poly Methyl Methacrylate (PMMA), Heat and Mass Transfer, 44 (2008), 6, pp. 641-650
3. Bhattacharjee, S., Wakai, K., Takahashi, S., Prediction of a Critical Fuel Thickness for Flame Extinction in a Quiescent Microgravity Environment, Combustion and Flame, 132

(2003), 3, pp. 523-532
4. Fangart, J., Wolanski, P., One Dimensional Analytical Model of Flame Spread over Solids, Fire Sciences, 9 (1991), 5, pp. 424-437
5. Ito, A., Kashiwagi, T., Temperature Measurements in PMMA during Downward Flame Spread in Air Using Holographic Interferometry, Proceedings, 21th Symposium (International) on Combustion, 1986, The Combustion Institute, Pittsburgh, Penn., USA, pp. 65-74
6. Esfahani, J. A., Kashani, A., One Dimensional Numerical Model for Degradation and Combustion of Polymethyl Methacrylate, Heat and Mass Transfer, 42 (2006), 6, pp. 569-576
7. Esfahani, J. A., Oxygen-Sensitive Thermal Degradation of PMMA: A Numerical Study, Combust. Sci. and Tech., 174 (2002), 10, pp. 183-198
8. Fernandez-Pello, A. C., Williams, F. A., Laminar Flame Spread over PMMA Surfaces, Proceedings, 15th Symposium (International) on Combustion, 1975, The Combustion Institute, Pittsburgh, Penn., USA, pp. 217-231
9. Fernandez-Pello, A. C., Santoro, R. J., On the Dominate Mode of Heat Transfer in Downward Flame Spread, Proceedings, 17th Symposium (International) on Combustion, 1978, The Combustion Institute, Pittsburgh, Penn., USA, pp. 1201-1209
10. Hirano, T., Koshida, T., Akita, K., Flame Spread Mechanisms over PMMA Surfaces, Bulletin of the Japanese Association of Fire Science and Engineering, 27 (1977), 33
11. Krishnamurthy, L., Williams, F. A., On the Temperatures of Regressing PMMA Surfaces, Combustion and Flame, 20 (1973), 2, pp. 163-169
12. Ayani, M. B., Esfahani, J. A., Sousa, A. C. M., The Effect of Surface Regression on the Downward Flame Spread over a Solid Fuel in a Quiescent Ambient, Thermal Science, 11 (2007), 2, pp. 67-86
13. Mamourian, M., Esfahani, J. A., Ayani, M. B., The Effect of the Solid Fuel Dimensions on the Downward Flame Spread, Proceeding, 2th Combustion Conference of Iran (CCI-2), 2008, Mashhad, Iran, pp. 250-259
14. Ayani, M. B., Esfahani, J. A., Mehrabian, R., Downward Flame Spread over PMMA Sheets in Quiescent Air: Experimental and Theoretical Studies, Fire Safety, 41 (2006), 2, pp. 164-169
15. Susuki, M., Dobashi, R., Hirano, T., Behavior of Fires Spreading Downward over Thick Paper, Proceedings, 25th Symposium (International) on Combustion, 1994, The Combustion Institute, Pittsburgh, Penn., USA, pp. 1439-1446
16. Delichatsios, M. A., Heat Flux Distribution in Single Vertical Wall Fires, Proceedings, 26th Symposium (International) on Combustion, 1996, The Combustion Institute, Pittsburgh, Penn., USA, pp. 1281-1293
17. Williams, F. A., Mechanisms of Fire Spread, Proceedings, 16th Symposium (International) on Combustion, 1978, The Combustion Institute, Pittsburgh, Penn., USA, pp. 1281-1294
18. Fernandez-Pello, A. C., Hirano, T., Controlling Mechanisms of Flame Spread, Combustion Science and Technology, 32 (1983), 1, pp. 1-31
19. Krishnamurty, L., Williams, F. A., Laminar Combustion of Polymethyl Methacrylate in O2/N2 Mixtures, Proceedings, 14th Symposium (International) on Combustion, 1973, The Combustion Institute, Pittsburgh, Penn., USA, pp. 1151-1164
20. Lengelle, G., Thermal Degradation Kinetics and Surface Pyrolysis of Vinyl Polymers, AIAA, 8 (1970), 11, pp. 1989-1996
21. Bejan, A., Convection Heat Transfer, John Wiley and Sons Inc., New York, USA, 2004

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