Flame acceleration in presence of polyurethane foam on the channel walls

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Flame acceleration in hydrogen-air, acetylene-air and methane-air mixtures and influence of polyurethane foam pore size on flame velocity were experimentally investigated in rectangular cross-section channels with solid walls and polyurethane foam on two channel walls. The combustion channel consisted of 200 mm long driver section with 20 mm inner diameter and a 400 mm long test section with rectangular cross-section. Top and bottom inner surfaces of the rectangular section were covered with porous material. Four types of polyurethane foam were used with a number of pores per inch ranging from 10 to 80. The equivalence ratio (ER) of the combustible mixture ranged from 0.25 to 1. High-speed schlieren image sequences of flame propagation in hydrogen-air, acetylene-air and methane-air mixtures with polyurethane foam on the walls were presented. It was discovered that the flame starts to propagate in turbulent manner earlier when using polyurethane foam with biggest pores. The acceleration of the flame front was the highest in polyurethane foam with biggest pores (10 pores per inch), it was lower in polyurethane foam with 20 pores per inch for all mixtures used in the experiments. Flame acceleration in polyurethane foam with 40 and 80 pores per inch was found to be similar. The flame velocity was up to 4 times higher by the end of the porous section in polyurethane foam with 10 PPI compared to polyurethane foam with 80 PPI (135 m/s and 35 m/s for hydrogen-air mixture with ER 0.4). Peclet number (Pe) was used as a criterion of the flame propagation possibility in the porous material. It was found, that when Pe was higher than 30, porous material affected flame acceleration greatly. We can see that porous material greatly affect flame propagation when Pe>30. In this case porous material acts as a number of obstacles that promote turbulence and cause flame acceleration. For Pe<30 the pore size of the porous material has little or no effect on flame propagation since flame cannot propagate inside the pores and this porous material acts as a flexible surface.