INVESTIGATION OF THE EFFECT OF DIMETHYLETHER ADDITION ON THE KINETICS OF SOOT FORMATION IN A STANDARD PREMIXED ETHYLENE/AIR FLAT LAMINAR FLAME

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Abstract: The article presents the results of experimental study of soot formation with addition of dimethyl ether (from 0% to 100%) to the ethylene/air premixed flame. The volume fraction of the condensed phase was determined using the laser extinction method at a wavelength of 520 nm. The flame temperature profiles in the flame central axis were measured using thermocouples. It is shown that addition of dimethyl ether to ethylene flame leads to a change in the temperature profile in the flame and to a significant decrease in the volume fraction of condensed phase. With the substitution of 30% to 60% ethylene by dimethyl ether, a decrease in the volume fraction of soot to 0.01 ppm was observed, which is an order of magnitude less than this value in pure ethylene/air flame. Kinetic modeling of the growth of the volume fraction of soot in all investigated flames was carried out using the kinetic mechanisms CRECK and OpenSMOKE ++ software. Good agreement was obtained between the experimental and calculated data for ethylene/air flames and flames with additions of 15% to 60% dimethyl ether. For flames of 75% and 90% dimethylether + ethylene, and 100% dimethyl ether with air, experimental values of soot volume fraction were below the measurement sensitivity limit, and the calculated values indicated a decrease in the volume fraction by more than two orders of magnitude relative to a pure ethylene/air flame.

Keywords: premixed ethylene/dimethylether/air flame; volume fraction; soot; kinetic modeling

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Figure Captions

Figure 1 Profiles of the axial temperature (*a*) and of laser extinction at a wavelength of 520 nm (*b*) of the investigated flames depending on the height above a burner. Fuel compositions: *1* — 100% C_2H_4; *2* — 85% C_2H_4 + 15% DME; *3* — 70% C_2H_4 + 30% DME; *4* — 55% C_2H_4 + 45% DME; *5* — 40% C_2H_4 + 60% DME; *6* — 25% C_2H_4 + 75% DME; *7* — 10% C_2H_4 + 90% DME; and *8* — 100% DME

Figure 2 Volume fraction of condensed soot particles in the investigated flames depending on the height above a burner H (*1* — experiment; and *2* — calculation): (*a*) 100% C_2H_4 / air; (*b*) 85% C_2H_4 + 15% DME / air; (*c*) 70% C_2H_4 + 30% DME / air; (*d*) 55% C_2H_4 + 45% DME / air; (*e*) 40% C_2H_4 + 60% DME / air; (*f*) 25% C_2H_4 + 75% DME / air; (*g*) 90% C_2H_4 + 10% DME / air; and (*h*) 100% DME / air

Figure 3 The final maximum value of the volume fraction of soot at a height of 22 mm above a burner depending on the DME content: *1* — experimental measurements by laser light extinction; and *2* — calculation

Figure 4 The results of calculating the volume fraction of the condensed phase from the height above a burner in the DME/air flame using the temperature profiles shown in Fig. 1*a*: *1* — profile *1*; and *2* — profile *8*

Table Caption

Compositions of the investigated flames

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