MECHANISM OF FUEL DROP 'MICROEXPLOSION'

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Combustion of multicomponent fuel drops is known to exhibit disruption ('microexplosion') under certain conditions. The mechanism of microexplosion is still the issue of discussion. The objective of the research summarized in this paper is to understand the role of internal liquid circulation on the drop-heating pattern and on the possibility of bubble nucleation in drop interior.

The mathematical statement of the problem is based on the set of differential equations governing drop motion in gaseous flow, internal circulation of liquid induced by shear stress at the gas–drop interface, and transient heat transfer in the drop. Depending on the Reynolds number of gas and drop relative motion, three different modes of drop heating were found: (*i*) conductive, (*ii*) convective, and (*iii*) intermediate. The conductive mode corresponds to the classical theory of drop heating due to molecular thermal conductivity. In the convective mode, a drop is heated mainly due to intense convective heat transfer caused by internal liquid circulations. In the intermediate mode, both mechanisms of heat transfer — conductive and convective — play a

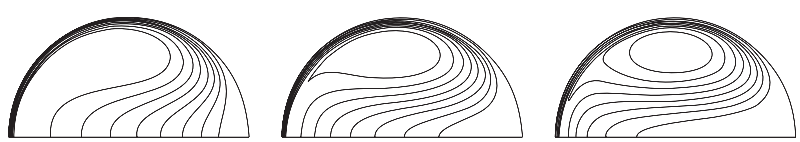

Figure 1 Predicted isotherms in a liquid drop subjected to a hot gas flow at three successive times *1*, *2*, and *3*. Gas flows from left to right

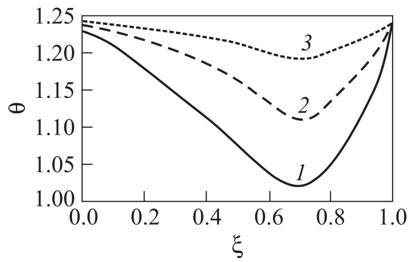

Figure 2 Dimensionless radial temperature profiles in the drop mid-section normal to the gas flow. Curves *1* to *3* correspond to time instants of Fig. 1. Temperature is normalized to the initial liquid temperature. Distance is normalized to drop radius

comparable role in the evolution of temperature field inside the drop. Figures 1 and 2 show predicted temperature distributions in a fuel drop in the convective mode of drop heating at three successive times *1* to *3*. Shown in Fig. 1 are the liquid isotherms, with gas flowing from left to right. Figure 2 shows the corresponding dimensionless radial temperature profiles in the drop mid-section normal to the gas flow. Clearly, the temperature field in the drop differs from the classical monotonic pattern. Central regions of the drop are heated nearly to the temperature attained at the drop surface. Analysis of the bubble nucleation conditions following Zel'dovich approach indicates that in these regions, bubble nuclei — prerequisites of drop microexplosion — can form.

Acknowledgments

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