

Development of a method for determining the flashback limits when using methane-hydrogen fuel in the combustion chambers of gas turbine engines

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To design new low-emission combustion chambers that stably operate on methane-hydrogen fuels, it is necessary to reliably determine the boundaries of stable operation of combustion chambers, in particular, the conditions for the occurrence of flashback into the burner device. The solution to this problem is possible using computational gas dynamics methods. However, at present, mathematical models of methane-hydrogen fuel combustion have been verified only in a narrow range of parameters under study. Also, there are insufficient experimental results of studies of the combustion of methane-hydrogen-air mixtures under various conditions in relation to complex technical devices, which does not allow qualitative verification of mathematical models.

The paper proposes a method for determining the boundaries of flashback when using methane-hydrogen fuel, the use of which reduces the error in predicting flashback from 40-50% to 5% in burner devices of combustion chambers of gas turbine engines and power plants. A kinetic mechanism for the oxidation of methane-hydrogen fuel has also been developed, which makes it possible to simulate the laminar flame speed with higher accuracy in relation to the operating process parameters of the combustion chambers of aviation gas turbine engines and power plants, characterized by an additional set of elementary reactions and refined rate constants. New dependencies have been proposed that make it possible to simulate the laminar flame speed of a methane-hydrogen flame in relation to the operating process parameters of the combustion chambers of aviation gas turbine engines and power plants, differing by taking into account a wider range of temperatures, pressures, mixture composition and the type of fuel used. The paper presents the results of validation of the proposed method for determining the boundaries of flashback in a model combustion chamber, which is a prototype of the low-emission combustion chambers used with preliminary mixture preparation, as well as the combustion chamber of the GTE-65.

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