EXPERIENCE IN VALIDATION OF TURBULENT COMBUSTION MODELS OF THE PaSR CLASS AND PLANS FOR THE DEVELOPMENT OF THESE MODELS IN RELATION TO THE COMBUSTION CHAMBERS OF GAS TURBINE UNITS

R. A. Balabanov, V. V. Vlasenko, and A. A. Shiryaeva

Central Aerohydrodynamic Institute named after Prof. N. E. Zhukovky (TsAGI), 1 Zhukovsky Str., Zhukovsky, Moscow Region 140180, Russian Federation

Abstract: The results of the PaSR (Partially Stirred Reactor) turbulent combustion models application to the numerical simulation of the experiment by P. Magre *et al*. (ONERA) are presented, In the experiment, a subsonic flow with premixed combustion of methane–air mixture inside a model duct with a back facing step was considered. It is shown that the application of the EPaSR (Extended PaSR) model taking into account the duct walls cooling on the change in the turbulent heat and mass transfer intensity due to heat release, makes it possible to give a correct description of the flow structure. A possible mechanism of oscillations in the model duct is discussed. It is associated with the interaction of acoustics and heat release. A new EPaSR-PrOm model of turbulent combustion which takes into account both channels of turbulence–combustion interaction is briefly described. The experiment of P. Magre *et al*. reproduces in an extremely simplified formulation the most significant physical effects characteristic of turbulent combustion in the gas turbine unit (GTU) combustors. This makes it possible to hope for a successful use of the EPaSR-PrOm turbulent combustion model in simulating the operation process in the GTU combustors.

Keywords: turbulent combustion; partially stirred reactor; variable turbulent Prandtl and Schmidt numbers; heat exchange; validation; gas turbine units

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Figure Captions

Figure 1 Simulation of the P. Magre *et al*. experiment [8]: geometry of the computational domain. Dimensions are in meters

Figure 2 Simulation of the P. Magre *et al*. experiment [8] — temperature fields obtained using various models of turbulent combustion: (*a*) without TCI; (*b*) PaSR; and (*c*) EPaSR

Figure 3 Temperature profiles in three cross sections without TCI: (*a*) $x = 0.1$ m; (*b*) 0.26; (*c*) $x = 0.34$ m; *1* — experiment; *2* — calculations of TsAGI; and *3* — calculations of ONERA

Figure 4 Temperature profiles in three cross sections of PaSR models, heat-insulated walls: (*a*) $x = 0.1$ m; (*b*) 0.26; (*c*) $x = 0.34$ m; *1* — experiment; *2*–*4* — calculations of TsAGI (*2* — EPaSR; *3* — GPaSR; and *4* — PaSR); and *5* — calculations of ONERA (EpaSR)

Figure 5 Temperature profiles in three cross sections of EPaSR: (*a*) $x = 0.1$ m; (*b*) 0.26; (*c*) $x = 0.34$ m; *1* — experiment; *2*–*5* — calculations of TsAGI (*2* — heat-insulated walls; *3* — $T_w = 1000$ K; *4* — 800; and *5* — $T_w = 600$ K); and *6* — calculations of ONERA

Figure 6 Instantaneous fields of the heat release rate in the vicinity of the step and velocity vectors at some points: (*a*) inflow of fresh mixture inside the recirculation zone; and (*b*) outflow of combustion products

Figure 7 Temperature profiles (*1* — experiment; and *2* — calculation of ONERA) in three cross sections of EPaSR model with different constant values of Sc_t (*3* — $\mathrm{Sc}_t = 1.0$; *4* — 1.1; *5* — 1.2; *6* — 1.3; *7* — 1.4; and *8* — $\mathrm{Sc}_t = 1.5$): (*a*) $x = 0.1$ m; (*b*) 0,25; and (*c*) $x = 0.34$ m

Figure 8 The Sc_t field obtained using the PrOm model

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Contributors

Balabanov Roman A. (b. 1999) — student, Moscow Institute of Physics and Technology (MIPhT), 9 Institutsky Lane, Dologoprudny, Moscow Region 141701, Russian Federation; engineer, Central Aerohydrodynamic Institute named after Prof. N. E. Zhukovky (TsAGI), 1 Zhukovsky Str., Zhukovsky, Moscow Region 140180, Russian Federation; balabanov.ra@phystech.edu

Vlasenko Vladimir V. (b. 1969) — Doctor of Science in physics and mathematics, deputy head of laboratory, Central Aerohydrodynamic Institute named after Prof. N. E. Zhukovky (TsAGI), 1 Zhukovsky Str., Zhukovsky, Moscow Region 140180, Russian Federation; professor, Moscow Institute of Physics and Technology (MIPhT), 9 Institutsky Lane, Dologoprudny, Moscow Region 141701, Russian Federation; vladimir.vlasenko@tsagi.ru

Shiryaeva Anna A. (b. 1986) — Candidate of Science in physics and mathematics, senior researcher, Central Aerohydrodynamic Institute named after Prof. N. E. Zhukovky (TsAGI), 1 Zhukovsky Str., Zhukovsky, Moscow Region 140180, Russian Federation; anja.shiryaeva@gmail.com