JR SMIT 2015

Japan-Russia Workshop

SUPERCOMPUTER MODELING, INSTABILITY AND TURBULENCE IN FLUID DYNAMICS

March 3-6, 2015

Keldysh Institute for Applied Mathematics
Russian Academy of Sciences, Moscow, Russia

BOOK OF ABSTRACTS

Moscow-2015

COMPUTATIONAL STUDIES OF ROTATING DETONATION ENGINE

S. Frolov, A. Dubrovskii, V. Ivanov
[1]Semenov Institute of Chemical Physics, Moscow, smfrol@chph.ras.ru

Presented in the paper are the results of 3D numerical simulations of the operation process and thrust performance of air-breathing hydrogen-fueled rotating detonation engine with separate delivery of fuel and oxidizer. The simulation is based on the coupled RANS – Monte-Carlo approach taking into account finite-rate turbulent and molecular mixing with multistage chemistry, turbulence – chemistry interaction and wall effects. The thrust is determined as an integral of pressure force and viscous stress over all solid walls of the engine. The calculations are aimed at the design optimization of an experimental engine prototype operating at mass flow rates of fuel components up to 10 kg/s. The calculation campaign includes variation of the design of air flowpath and hydrogen injectors, combustor dimensions, nozzle shape, etc. The underlying physical and mathematical model has been thoroughly validated against experimental data for the engine prototype of basic configuration with the annual combustor of 406 mm in diameter and a gap of 25 mm width (see figure below). The operation processes with one to multiple detonation waves simultaneously rotating in the annular combustor have been obtained. The predicted fuel-based specific impulse for the engine of basic configuration (~3000 s) agreed well with the measured value. As a result of design optimization the predicted specific impulse attained 4200 s.