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ROTATING DETONATION CHAMBER: PROBLEMS OF INTEGRATING INTO GAS TURBINE ENGINES

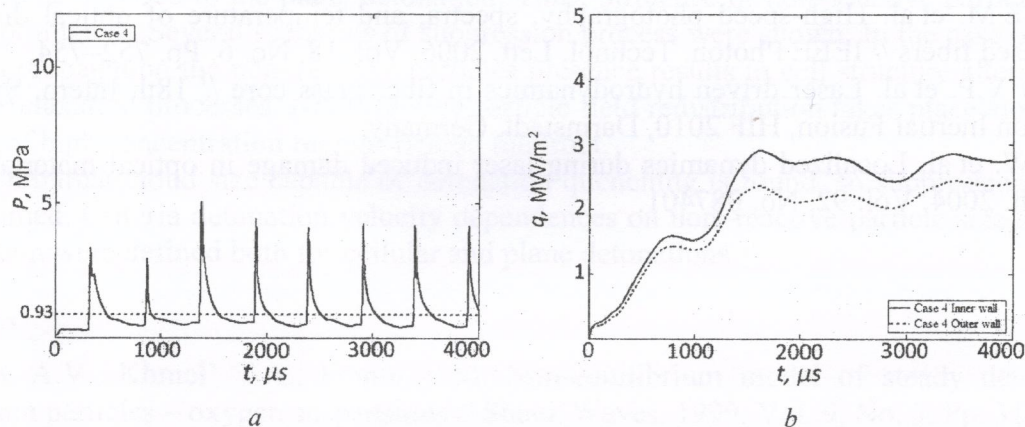
S.M. Frolov, A.V. Dubrovskii, V.S. Ivanov

Semenov Institute of Chemical Physics, Moscow, Russia

The objective of this work was transient three-dimensional numerical simulation of the operation process in a Rotating Detonation Chamber (RDC) with the particular emphasis to the design issues of the combustor and isolators, separating the combustor from the compressor and turbine in a gas turbine engine, as well as thermal management issues. The governing equations were unsteady Reynolds-Averaged Navier – Stokes equations coupled with a turbulence model and with the continuity and energy equations for a multicomponent reactive mixture. The algorithm used was the combination of the Finite Volume Method and Particle Method developed at ICP to properly treat volumetric combustion. The capabilities of the code have been demonstrated for the annular cylindrical combustor with inner and outer diameters 260 and 306 mm operating on homogeneous stoichiometric hydrogen–air mixture (injected axially through the annular gaps of relative area 0.61 in the RDC bottom) with a detonation rotation frequency of about 126000 rpm.

The selected RDC was shown to operate in a stable mode with a single detonation wave. The domain of detonation existence in the RDC was limited from below by the condition $P \geq 1.0$ MPa, where P is the total pressure behind the compressor. In all test cases with the stable operation process, the total pressure in the RDC was higher than P , thus proving that the RDC is the combustor with pressure gain.

Particular attention was paid to the flow patterns at the compressor and turbine sides of the isolators attached to the RDC, although only simple annular geometries of the upstream and downstream isolators were considered. The temperature of the detonation products at the outlet of downstream isolator was about 2500 K which is too high for turbine blades. To decrease this temperature, an attempt was made to design the downstream isolator with special orifices to mix the detonation products with relatively cold secondary air. This solution allowed decreasing both the mean temperature and the amplitude of temperature pulsations at the isolator outlet.



Time history of the local mean static pressure (a) and total heat flux to the walls of RDC (b) with the attached isolator ($P = 1.0$ MPa). Dotted line in (a) shows the static pressure averaged over the RDC at limit cycle conditions

