AIS-2012
«ATMOSPHERE, IONOSPHERE, SAFETY»

Kaliningrad, June 24-30, 2012

Kaliningrad
2012

Determining the source of origin is:
— a matrix method for the controlled image recording area;
— angular way, when the observer is bound to the coordinates of the area;
— range-difference method of the measured arrival times at the points of observation with the known coordinates and have a synchronized grid frequency.

For medium-precision spacecraft positioning precision of angular and matrix methods in the tens of kilometers, and for range-difference method can reach hundreds of meters. The time resolution of the matrix method is less than one millisecond to one microsecond angle method, and for the difference-distance-measuring method of tenths of microseconds.

PL-12

Hydrogen Fuelled Continuous Detonation Burner

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A long-term vector of further developments in power engineering is energy efficient and environmentally friendly production of electric power. In existing power plants and burners the chemical energy of fuel is transformed into heat and mechanical work due to slow combustion — deflagration. However apart from deflagration there exists another known mode of combustion — detonation. In the detonation, the chemical reaction of fuel oxidation proceeds in the mode of self-ignition at high pressure behind a strong shock wave and is 3 to 4 orders of magnitude faster and therefore more energy efficient due to higher expansion potential of combustion products. In addition, due to shorter combustion time, the emissions of NOx and other pollutants in the detonation are expected to be lower.

So far, detonation was not utilized in power engineering. One of the main reasons is low detonability of conventional fuels in air at normal conditions.

At present, a number of research institutions and companies worldwide are working on the advanced gas-turbine combustion systems operating on hydrogen and hydrogen-rich gases containing methane, carbon monoxide, carbon dioxide, steam, and nitrogen. The most popular approach to achieve the target is proper adaptation of the existing turbine frames. The idea of partial or complete replacement of hydrocarbon fuel with hydrogen is based on unique hydrogen properties — low density (0.08 kg/m^3 at 300 K and 1 atm), wide flammability limits (from at normal conditions) and very low ignition energy (0.02 mJ). 4 %(vol.) to 75 %(vol.) in air), high laminar flame velocity (2.3 m/s)

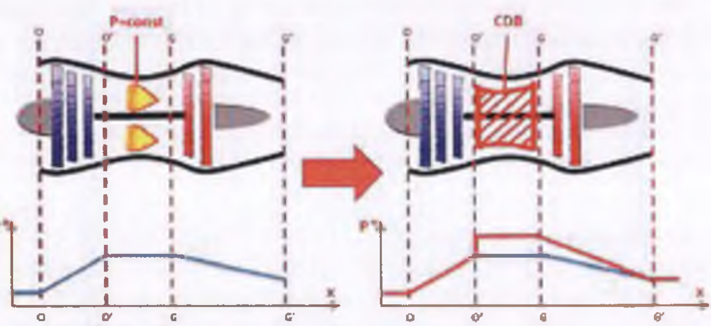

Fig. 1. Pressure-gain CDB concept for advanced gas-turbine power plant. P^* is the total pressure.

Moreover, combustion of hydrogen—air mixtures is known to be accompanied with formation of only nitrogen oxides as pollutants and at fuel—air ratio $\Phi<0.5$ their emissions nearly vanish.

In addition to the attractive physical and chemical properties listed above, hydrogen is known to exhibit very wide detonability limits (from 18.3 % (vol.) to 59.0 % (vol.) in air at 300 K and 1 atm). This property allows considering hydrogen as the best candidate fuel for application in detonation-driven burners for power engineering.

In the Semenov Institute of Chemical Physics and in its Center for Pulse Detonation the R&D program on a hydrogen-fuelled continuous detonation burner (CDB) for an advanced gas-turbine power plant has been launched in 2011. The aim of the program is to develop, fabricate and test a large-scale hydrogen-fueled pressure-gain water-cooled land-based burner fitting an existing turbine frame (Fig. 1). At the first stage of program implementation, three-dimensional (3D) numerical simulations were performed to determine the conditions of the stable CDB operation with pressure gain, the thermal state of the burner walls, as well as the most important parameters of the flow at the inlet and outlet, keeping in mind the possibility of placing the CDB between a compressor and a turbine in a prospective gas turbine installation.

The objective of this communication is to review the status of the theoretical and numerical studies of the CDB fueled either with homogeneous hydrogen—air mixture or with separate delivery of hydrogen and air.

This work was partly supported by the Center for Pulse Detonation, RFBR (grant 11-08-01297) and Russian Academy of Sciences (Program #26, Combustion and Explosion).