Research on Application of Continuously Rotating Detonation Combustion Chamber to Turbine Engine

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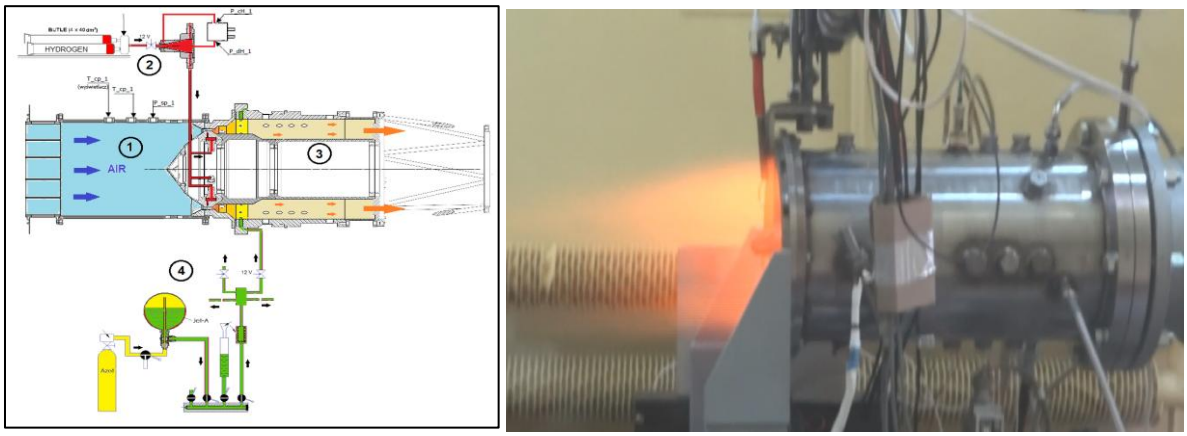
Abstract

The possibility of establishment of the continuously rotating detonation was first demonstrated in early sixties of last century by Voitsekhovskii at all for the oxy-acetylene mixture [1], but continuous detonative combustion for fuel-air mixtures was demonstrated only at the end of XX Century [2]. Later many research on rotating detonation were conducted for air mixtures with different gaseous fuels [3-7], but no conclusive results were reported for liquid fuels-air mixtures. Only recently research on application of the continuously rotating detonation combustion chamber to the turbine engine where conducted at the Institute of Aviation (IoA) in Warsaw, both for gaseous and dual fuels (gas+liquid).



a) b)

Fig. 1. Schematic diagram of the research stand (a) and picture of chamber operating under conditions of continuously rotating detonation.

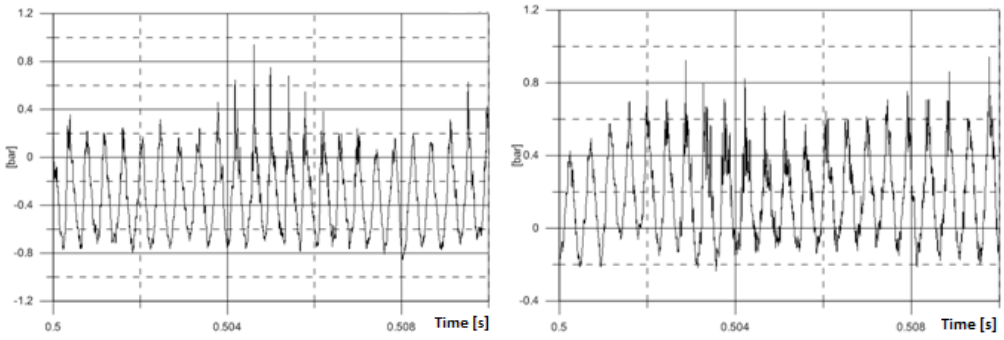


Fig.2. Typical pressure records of rotating detonation in cylindrical chamber.

Since 2010 in Institute of Aviation in Warsaw research aimed to develop combustion chamber with rotating detonation for turbine engine has been carried out. Schematic diagram and picture of experimental chamber is shown on Fig.1 and typical pressure records from conducted experiments on Fig.2. Both hydrogen as well as hydrogen and kerosene mixed with air were tested. One of the important problems which has to be solved on the way to design such engine, was the initiation of rotating detonation in combustible mixture which required the fulfillment of several conditions:

1) good mixing of combustible mixture components,
2) respectively fast flow of combustible mixture in the cylinder-shape channel,
3) the appropriate height of the flow channel, associated with detonation cell size for the combustible mixture,
4) use of a source of initiation of detonation of a correspondingly high energy and power for a given combustible mixture.

There were considered and tested in practice several different types of initiators:

a) spark discharge in air,
b) plasma electric discharge (the so-called "exploding wire"),
c) micro-explosive charges,
d) blank cartridges,
e) gas initiator (with detonation of acetylene-oxygen stoichiometric mixture induced by spark electric discharge).

The paper summarizes conducted research on the test stand. In the course of those research the pressure waves generated by the continuously rotating detonation of fuel-air mixtures were recorded (Fig.2). Experiments were conducted for a different mixtures compositions.

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