Generation of Detonation Due to Kinetic Energy of the Supersonic Flow

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In connection with the use of detonation in engines end other energetic facilities a number of problems arise. Among them are detonation initiation and its stabilization within the combustion chamber. Detonation initiation in layers, in stationary medium, and in unlimited space was experimentally studied by many authors. In the case of the combustion chamber, which is limited in the crosswise direction, one might expect new effects under detonation.

The paper considers the problems of detonation initiation in the supersonic flow and stationary stoichiometric air-propane mixture, which partially or fully fills in the plate channel cross-section. In the flow initiation takes place at the cost of a "bench" or a wall which fully blocks the channel, and in the medium at rest it is caused by explosion. The investigation is performed within the framework of single-stage combustion kinetics by the numerical method based on the S.K. Godunov scheme. Critical detonation conditions connected with the inflow velocity and explosion energy were determined. In all the discussed processes one can find then unknown detonation propagation mechanism, which is conditioned by formation of complicated wave flow structure, characterized by shock wave penetration in the inert gas to the layer in front of the detonation wave, with the resulting warm-up and combustion. The process is periodic in nature, and differs from standard cellular detonation in the uniform medium. The existence of critical inflow velocities was established upon which qualitative and quantitative flow pattern is dependent. In the uniform flow two different detonation modes were obtained – with stationary wave on the "bench" and with the wave propagating to inlet channel section. In the combustible mixture layer we found three detonation modes:

- with stationary wave on the "bench" (Figure 1)
- with the wave propagating to the inlet channel section in the form of stationary wave complex (Figure 2)
- in the mode of galloping layered detonation (Figure 3).

As the flow rate increases, the rate of wave travel in direction of the inlet section decreases and at the rate equal to the critical one the wave turns to the stationary mode.

The original computing complex with user-friendly graphical interface (Figure 4) was developed and used to perform numerical investigation.

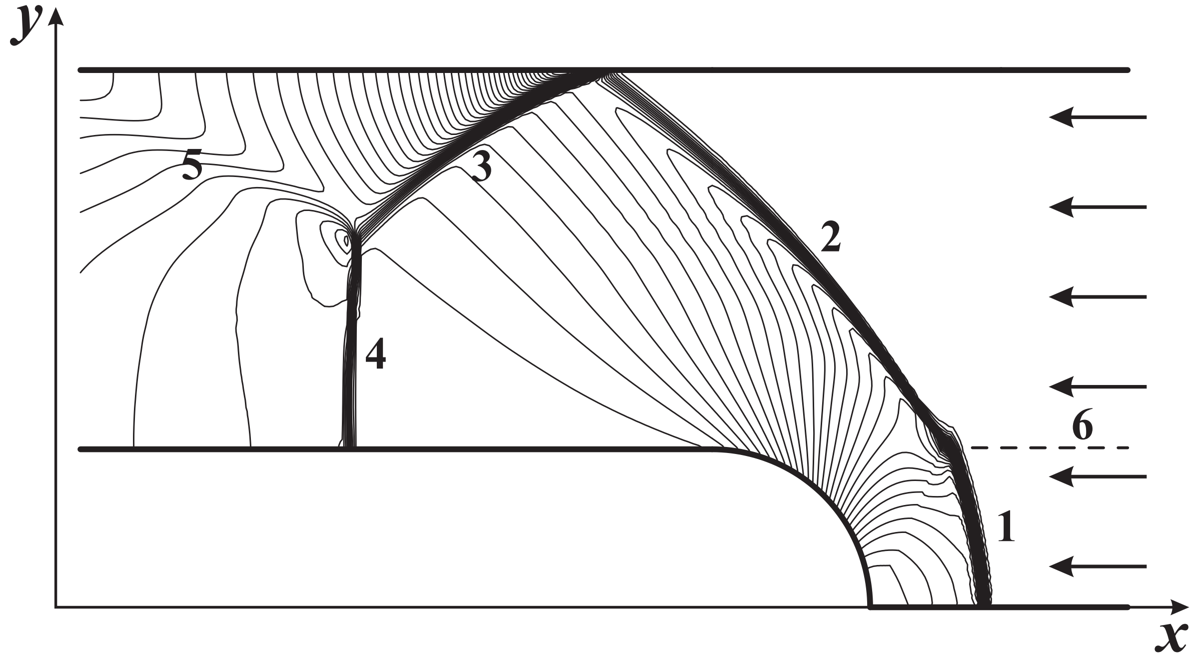

Figure 1: Stationary detonation in the combustible mixture layer (temperature isolines)

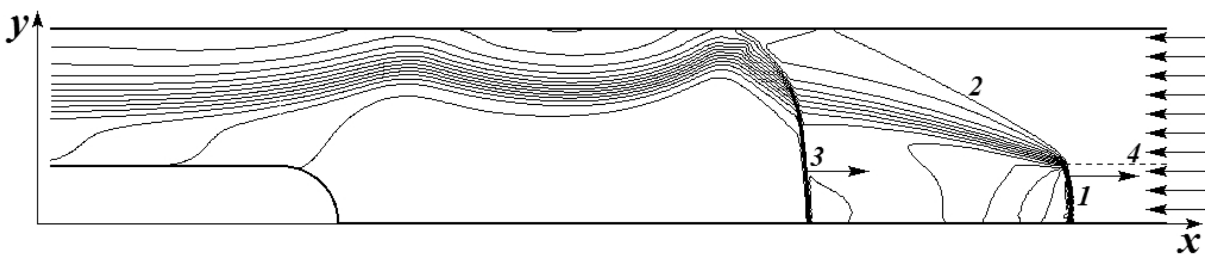

Figure 2: Stationary wave complex propagating to the inlet (temperature isolines)

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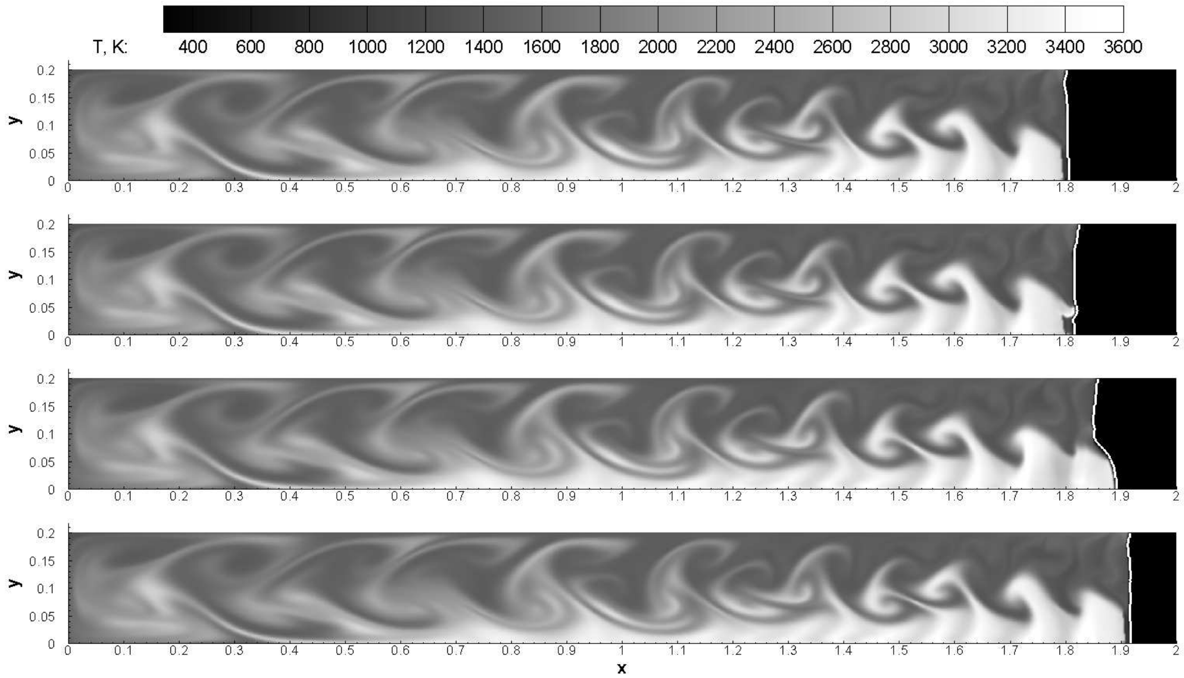

Figure 3: Phases of galloping layered detonation (temperature fields)

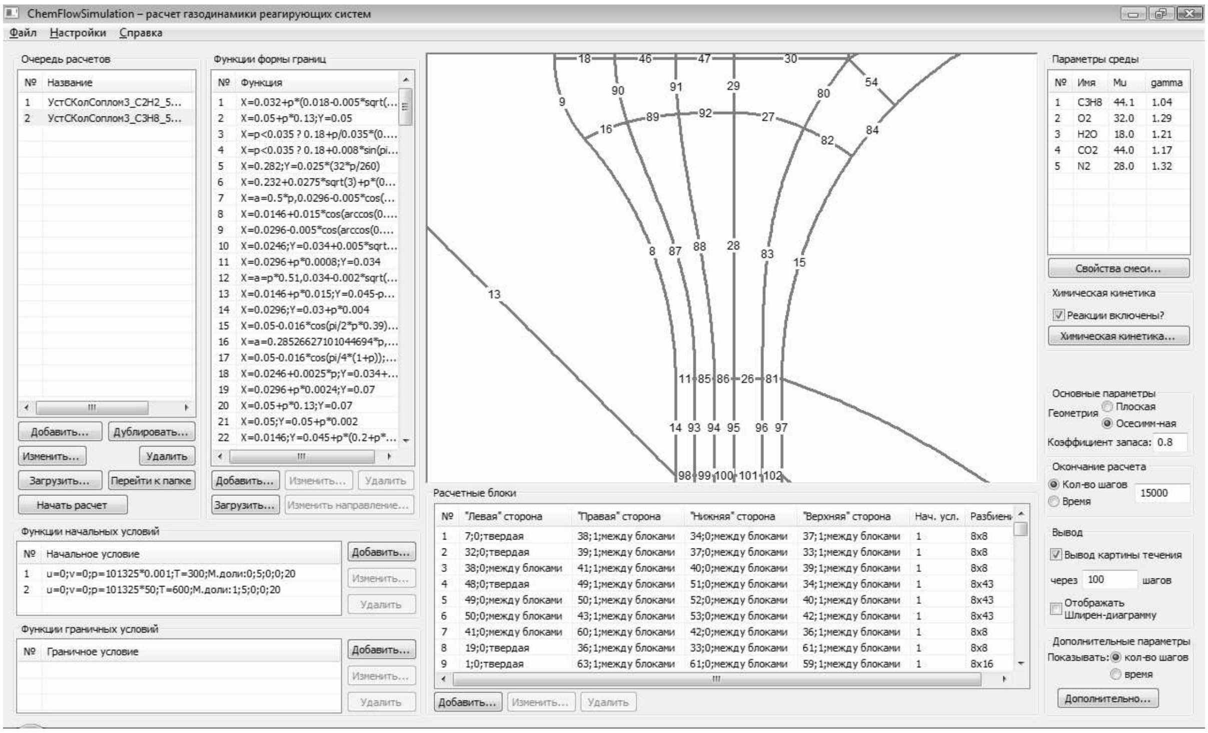

Figure 4: Graphical user interface of the computing complex