PULSED COMBUSTION OF FUEL–AIR MIXTURE IN THE CAVITY UNDER THE BOAT BOTTOM: SIMULATION AND OUTDOOR TESTS

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For reducing the hydrodynamic drag of a boat, a gas cavity can be made under the boat bottom, which will partially isolate the bottom from direct contact with water and provide "gas lubrication" by forced supply of atmospheric air or exhaust gases from a boat motor. When properly shaped, such a gas cavity can significantly (by 20%–30%) reduce the hydrodynamic drag of the boat at a very low power consumed for gas supply (less than 3% of motor power). In addition to air supply, we have proposed to supply fuel to the cavity for arranging continuous or pulsed combustion/detonation in it [1, 2] (Fig. 1). This will allow us, on the one hand, to increase the buoyancy force (due to the thermal expansion of combustion products) and, on the

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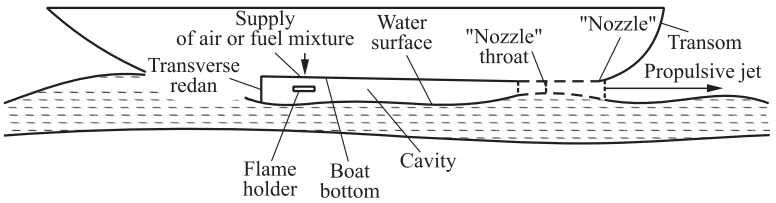

Figure 1 Schematic of the boat with a bottom gas cavity with continuous or pulsed combustion

(*a*) (*b*)

Figure 2 The photographs of the boat with a bottom gas cavity (*a*) and the outdoor test of the towed boat in the assembly with a tug (*b*)

other hand, to create a propulsive force (thrust) sufficient for boat movement.

To check the idea, we have developed and manufactured a towed model of a boat with the bottom gas cavity and equipped the model with the pulsed burner, air and fuel (hydrogen) supply system, as well as ignition and data acquisition system with the aim to conduct outdoor tests (Fig. 2). The overall dimensions of the model correspond to the dimensions of the ship (on a scale of 1 : 8.5) provided by the Alekseev's Hydrofoil Design Bureau (Nizhny Novgorod, Russia): 2616 mm long and 52 mm wide. The bottom gas cavity is designed based on the preliminary multidimensional computational fluid dynamics simulations and experimental studies involving purging nonreactive and reactive gas through it. The model's hull material is an aluminum sheet 2 mm thick. The cavity material is stainless steel. In the outdoor tests, the velocity of the tug-boat was 10–12 km/h.

Outdoor tests show that pulsed combustion of hydrogen in the bottom gas cavity of the towed model creates a propulsive force act-

ing in the direction of motion. In the tests, the maximum values of the propulsive force reached 120–130 N. In general, the results of our studies form the theoretical and experimental foundations for the creation of ships, the movement of which is ensured solely due to the combustion/detonation of a fuel mixture under their bottom and allows one to abandon the use of conventional propulsion devices like propellers, impellers, etc. The future work will be focused on measuring the propulsive force produced by pulsed detonations in the bottom gas cavity under the boat.

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