INVESTIGATION OF POSSIBLE WAYS TO IMPROVE PERFORMANCE OF GDT FOR HIGH ENTHALPY FLOW

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In ground tests of rocket engines (RE), designed to work in the upper atmosphere and space, the problem of the flight conditions simulation arises. The engines of this type have a great nozzle area ratio (ratio of the nozzle exit area to the area of the throat). Therefore, one of the main requirements to the ground tests is maintaining of the unseparated flow in the nozzle of the engine, which can be achieved by various methods. The most cheap and technically simple way is to use gas dynamic tubes (GDT). The figure below shows a scheme of the plant with the GDT.

The basic parameters characterizing the GDT are: the start pressure—the minimum pressure in the combustion chamber of a rocket engine, above which the flow mode in the nozzle transits from the separated to the un-separated, and the stall pressure—the minimum pressure in the RE combustion chamber below which the separated flow forms in the nozzle. Gas dynamic tubes can be used either independently or together with other devices which create a vacuum at the outlet of the GDT (ejectors, exhauster). In this case, the ratio of start or stall pressures to the pressure at the exit of GDT instead of pressures itself should be considered. Also it is necessary to establish minimal start and stall pressures to guarantee the specified cyclogram, and operating conditions of RE. For the considered RE these characteristics are mainly defined by the following geometric parameters: the RE nozzle critical section diameter, the RE nozzle exit diameter, the GTD entry diameter, the GTD throat diameter, the supersonic nozzle length, the length of the GTD inlet diffuser, the length of the GTD throat, the RE nozzle exit angle, and GTD entry angle. In addition, there is material effect of the nozzle profile shape, and of the combustion products properties (primarily specific heat ratio). In this paper the possible ways of improving the characteristics of GDT are investigated.

Two-dimensional and three-dimensional numerical simulation approaches to unsteady gas flows with various turbulence models have been employed to evaluate the characteristics of the GDT. To confirm the results obtained by numerical simulation, tests employing modeling RE chamber and modeling GDT have been carried out. Comparison of calculated and experimental data has shown the adequacy of the employed simulation methods.