On some methods of improvement of aerodynamic characteristics of supersonic flying vehicles

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In a supersonic flight, when the free-stream Mach number is equal or greater than 3 ($M_\infty \geq 3$), a flying vehicle cannot be considered as a configuration producing small disturbances. At these Mach numbers, a flying vehicle generates strong disturbances accompanied by the shock waves appearance. To perform a flight at high supersonic speeds, the use of fuels with large volume requirements is needed. Consequently, when designing a flying vehicle for high supersonic speeds it is advisable to follow the requirement of providing volume and lift based on the same shock waves in the flow. Such an approach results in a necessity of the use of the integrated method of the design of flying vehicles when the total drag constituents are combined in an optimal way to provide the lowest total drag value. In the present work, the ways of improvement of the aerodynamic characteristics of supersonic flying vehicles using such a method are considered.

Because of a significant influence of the nose part on the main characteristics of a flying vehicle, the choice of the nose shape and geometrical parameters must be based on the results of the investigations including not only the required aerodynamic characteristics, but also the necessary volumes. In the present work, the capability of enhancement of the value of the maximum lift-to-drag ratio of a supersonic flying vehicle depending on the droop angle of the fuselage nose section is considered (fig.1). Computational investigations on the choice of the droop angle of the fuselage nose section indicate the significant possibility of enhancement of the value of the maximum lift to drag ratio of a supersonic flying vehicle.

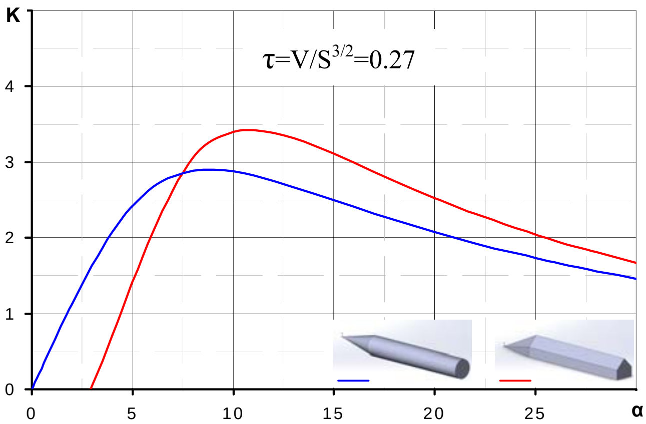

Fig.1. Aerodynamic characteristics of the investigated configurations

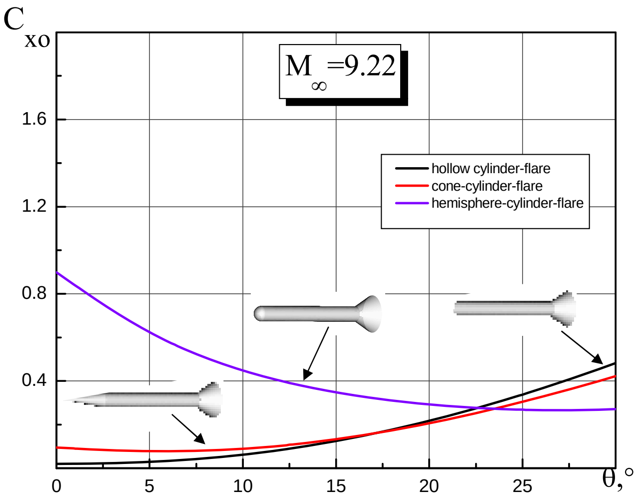

Fig. 2. Dependence of the drag coefficient C_{xo} of the considered configurations on the conical stabilizer semiapex angle at a Mach number of 9.22

Also, computational studies of supersonic flow around an aerodynamic configuration with various noses (hollow cylinder, cone, and spherical bluntness) with a stabilizing device in the form of a truncated cone (flare) for a wingless flying vehicle are performed (fig. 2). Analysis of

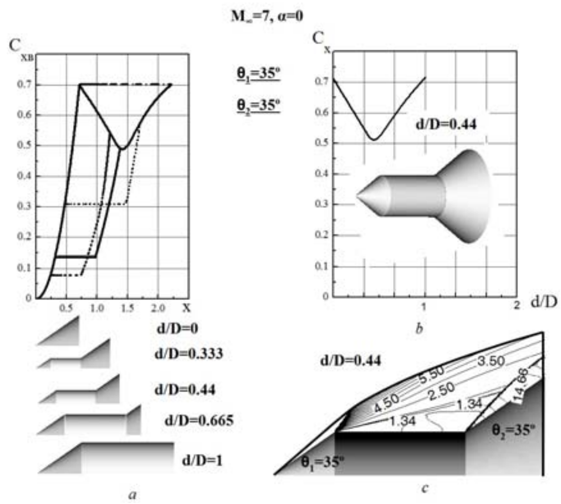

Fig. 3. Minimum in the drag of the cone–cylinder–flare configuration. $M_\infty = 7$, $\alpha = 0$

the results of the computational investigations indicates the key influence of the pressure distribution along the surface of the tail stabilizer on the total value of the wave drag coefficient for the considered aerodynamic configurations of the flying vehicle. Fundamentally new approaches were obtained in choosing optimal parameters for the given class of aerodynamic configurations. A common feature of existence of a minimum in the dependence of the drag on the ratio of the diameter of the cylindrical portion to the diameter of the maximum cross section (d/D) of configurations with a conical stabilizer is revealed (fig. 3). A mechanism of occurrence of a minimum in the drag of aerodynamic configurations with a stabilizing device in the form of a truncated cone is studied.