COMPUTATIONAL VISUALIZATION OF SUPERSONIC FLOW PAST HYPERSONIC FLYING VEHICLES MODELS

V.K. GOLUBEV

Russian Federal Nuclear Center – VNIIEF, Sarov, 607188, Russia

Tel: +79506185098; Fax: +78313051546; E-mail: mytrail@hotmail.com

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ABSTRACT: A large quantity of calculating results on the nature of supersonic flow past the models of various hypersonic flying vehicles has been obtained in a velocity range from 2 up to 6 Mach numbers. In this paper the results obtained and partly reported before for models of flying vehicles with the control flaps of different shape and size [1] and for a model separating in flight [2] are presented in a full-scale volume. The five models with different control flaps have equal nominal outlines and the same base diameter d = 60 mm. The separating model consists of two parts, a leader and block. In the initial assembled state the block having a base diameter d = 60 mm is partially inserted into the leader having a base diameter d_l = 0.814d. The method of numerical solution of the complete Navier-Stokes equations averaged according to Reynolds and supplemented by the k-ε turbulence model, which is enabled in the EFD.Lab engineering fluid-dynamic software, has been selected for simulations. Results on the influence of flap area and shape on the nature of flow and aerodynamic characteristics were obtained for the models with control flaps in a wide range of angles of attack α. The balancing angles of attack were determined. Results on the influence of leader and block relative positions on the nature of their aerodynamic interaction were obtained for the separating model. The distances between the leader and block, starting from which the change of the nature of their interaction took place and the block moving in a turbulent track began to come off the leader, were determined for various flow velocities. Several examples of computational visualization pointed out the role of a control flap and the influence of a distance h between the leader and block on the nature of flow past examined models are shown in Fig. 1. The results of experimental visualization of the supersonic flow past the considered models obtained with the use of the shadow method of optical recording are presented in work [3].

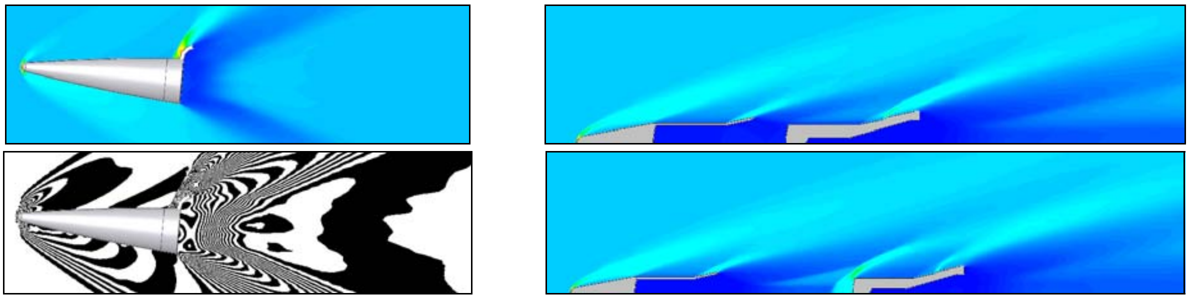

Fig. 1. Flow past a model with a cylindrical control flap (left, pressure field, M = 2, α = 5°) and a separating model (right, density field, M = 3, h = 0.5d_l (top) and h = 2.5d_l (bottom)).

References

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