

MARCHING ALGORITHM TO CALCULATE SUPERSONIC FLOW PAST A TILTING-NOSE ROCKET

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This paper presents a marching algorithm for the calculation of supersonic flow past a tilting-nose rocket. A feature of the algorithm is that the marching direction of supersonic flow calculation for the nose does not coincide with that for the main part of the rocket surface. Because of this, at first flow past the nose is calculated in a cylindrical coordinate system, the flow field parameters being stored at marching cross-sections. The start and the end of the parameter storage interval in the flow field are determined from the condition of the intersection of the bow shock wave with a plane in which an initial flow field is to be specified for the calculation of flow past the main part of the rocket surface. The flow field is interpolated in two stages. First, in the cylindrical coordinate system bound to the main part of the rocket surface in the initial data plane, the radial coordinates of the bow shock wave are determined at meridional sections. From the radial coordinates of points on the rocket surface and the bow shock wave, new computational grid node coordinates are determined at meridional sections in the cylindrical coordinate system of the main part. Using the new computational grid coordinates specified in the cylindrical coordinate system of the main part, old coordinates specified in the cylindrical coordinate system of the nose are determined with the use of expressions that relate the two coordinate systems to each other. The flow parameters at a point with the calculated coordinates are calculated using linear interpolation of the stored flow field parameters in the cylindrical coordinate system bound to the nose. The calculated flow field is used as initial data for the marching calculation of the main part of the rocket.

The paper presents the results of calculation of the aerodynamic characteristics of a tilting-nose rocket in a supersonic flow at different values of the nose angle. The proposed algorithm may be used in a prompt calculation of the aerodynamic characteristics of rockets with tilting elements. In doing so, use may be made of a standard program of rocket flow calculation with an added block for the storage and interpolation of the flow field in a tilted cylindrical coordinate system with a shifted origin, which allows the marching direction to be changed,

Keywords: aerodynamic characteristic, computational algorithm, nose tilt, supersonic flow, rocket, flight control.

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