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ALGORITHMS TO CALCULATE SUPERSONIC FLOW ABOUT A RING WING LAUNCH VEHICLE

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This paper presents algorithms to calculate supersonic flow about a prospective ring wing launch vehicle by the marching method and the relaxation method. The feature of the algorithms is the introduction of two computational subregions in the ring wing zone over the rocket airframe. In the marching algorithm, the computation region is reconstructed according to the position of the marching cross-section relative to the leading and trailing edge of the ring wing. When it finds itself at the leading edge of the ring wing, the computational region is split into a lower subregion between the rocket airframe and the downstream face of the ring wing and an upper subregion between the upstream face of the ring wing and the bow shock front. When the marching cross-section finds itself at the trailing edge of the ring wing, the lower and the upper computational subregions are merged into a single computational region. Based on the marching algorithm and using the authors' rocket flow calculation program, software is developed for a fast numerical calculation of supersonic flow about ring wing rockets.

For a particular ring wing rocket configuration, the paper presents the results of comparative calculations of supersonic flow about the rocket in the form of gas-dynamic parameter isolines in the flow field and the pressure distribution over the rocket airframe and the ring wing. The results for the marching method and the relaxation method are compared. It is shown that the ring wing is responsible for an undulatory pressure distribution between the rocket airframe and the downstream face of the ring wing. The marching method simulates the flow pattern between the rocket airframe and the downstream face of the ring wing more adequately, and its computation time is two orders of magnitude shorter than that of the relaxation method. The relaxation method should be used in the case of subsonic flows between the rocket airframe and the downstream face of the ring wing. The algorithm and software developed are recommended for parametric calculations of supersonic flow about ring wing rockets.

Keywords: *launch vehicle, airframe, ring wing, supersonic flow, marching method, relaxation method, algorithm, numerical calculation, flow field, pressure distribution, aerodynamic performance.*

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