Soviet Aerospace Literature

This month: *Computational Fluid Dynamics*

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A87-46090   Effect of the inhomogeneity of surface temperature distribution on the stability of a laminar boundary layer (Vliianie neravnomernosti raspredeleniia temperatury poverkhnosti na usto-ichivost' laminarnogo pogranichnogo sloia) IU. B. LEBEDEV and V. M. FOMICHEV, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Mar.-Apr. 1987, pp. 43-47. 5 Refs.

The effect of a longitudinal surface temperature gradient on the stability characteristics of a subsonic laminar boundary layer of a gas is analyzed on the basis of the linear theory of hydrodynamic stability with allowance for the variability of the physical properties of the gas. It is shown that, for a constant total heat flux, the point of stability loss may shift either upstream or downstream, depending on the surface temperature distribution. It is concluded that an additional increase in the length of laminar flow can be achieved by appropriately selecting temperature distribution.

A87-25233   Numerical modeling of shock wave intersections (O chislennom modelirovanii peresechenii udarnykh voln) IU. M. LIPNIT-SKII and A. V. PANASENKO, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Sept.-Oct. 1986, pp. 134-140. 18 Refs.

The nonstationary intersection of shock waves is investigated by solving numerically the axisymmetric boundary value problem associated with the diffraction of a plane shock wave by a cone in supersonic gas flow. In the context of linear theory, an analysis of stationary flow parameters leads to the existence of five qualitatively different flow regimes. It is shown, that, even in the case of low-intensity shock waves, the five flow regimes result in different formulations of the corresponding boundary value problems.

A87-41847   Calculation of the aerodynamic characteristics of a helicopter rotor under conditions of atmospheric gusts (K raschetu aerodinamicheskikh kharakteristik nesushchego vinta vertoleta pri vozdeistvii na nego atmosfernykh poryvov) N. A. GRITSENKO, V. V. KOZIN, and M. I. NISHT, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Mar.-Apr. 1987, pp. 153-158.

A numerical method is presented for calculating the nonstationary aerodynamic characteristics of a helicopter rotor gradually enveloped by an atmospheric gust incoming from an arbitrary direction. The problem is solved for an incompressible medium using a nonlinear formulation. Flow around each rotor blade is modeled by a system of discrete vortices, and allowance is made for the distortion of the trailing vortex of the blades due to the effect of the gust.

A87-47505   Calculation of separated flows in a rectangular depression (Raschet otryvnykh techenii v priamougol'noi vyemke) I. G. MAKAROV, *Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika* (ISSN 0579-9368), Mar.-Apr. 1987, pp. 85-87.

Flow of a viscous compressible ideal gas in a square depression induced by an external laminar flow is investigated numerically. Full nonstationary Navier-Stokes equations are solved using a finite-difference scheme of splitting in terms of physical processes and spatial variables. Heat flow distributions in the vicinity of a depression corner are determined for various thicknesses of the boundary layer of the incoming flow.

A87-26314   A variational model of organized vorticity in plane flows (Variatsionnaia model' organizovannoi zavikhrennosti v ploskikh techeniiakh) IU. N. GRIGOREV, and V. B. LEVINSKII, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Sept.-Oct. 1986, pp. 60-68. 20 Refs.

An approach to the development of models of coherent vortex structures in the plane case is proposed which employs the variational principle for an entropy functional determined on the unknown vorticity field. The additional conditions for which the functional extremum is calculated, may include various information on the properties of coherent vortex structures. The variational principle is applied here to the problem of a regular chain of coherent vortex structures in an infinite shear layer. It is shown that the equation for the flow function is reduced to the Liouville equation for which one of the exact solutions yields a one-parameter class of Stuart vortices.

A87-25234   A solution to the problem of the interaction of a supersonic jet with an obstacle of finite dimensions (Reshenie zadachi o vzaimodeistvii sverkhzvukovoi strui s pregradoi konechnykh razmerov) L. T. DERBENEVA, M. IU. KURSHAKOV, N. I. TILLIAEVA, and IU. N. SHISHKIN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Sept.-Oct. 1986, pp. 179-184. 18 Refs.

The problem of the interaction between an axisymmetric supersonic jet and a finite obstacle in submerged space is solved numerically by isolating the jet boundary and the central shock. The flow separation zone is modeled in terms of Euler equations by introducing a region with a specified constant pressure. The boundary of the region is determined by applying the well-known separation criterion for a turbulent boundary layer interacting with a shock wave. The results obtained are compared with experimental data.

A87-25232 **A study of supersonic three-dimensional flow past pointed axisymmetric bodies (Issledovanie sverkhzvukovogo prostranstvennogo obtekaniia zaostrennykh osesimmetrichnykh tel)** V. I. LAPYGIN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Sept.-Oct. 1986, pp. 127-133. 11 Refs.

Flow past bodies of revolution with a long pointed cylindrical nose section is analyzed in the context of an ideal gas model using a numerical model based on McCormak's finite difference scheme. The existence in the shock layer of internal shocks of both longitudinal and transverse orientations is demonstrated. Changes in the aerodynamic coefficients of the configuration are investigated as a function of its length, angles of attack, and the Mach number of the incoming flow. The results obtained are compared with experimental data, and a relationship is established between flow parameters on the body surface and the position of the boundary layer separation line on the lateral surface of the body. A method is proposed for taking account of the effect of the boundary layer on the aerodynamic coefficients of bodies of revolution of large aspect ratios at small angles of attack.

A87-25231 **A study of the shape of the cross-section profile of a minimum-drag three-dimensional conical body moving in a rarefied gas (Issledovanie formy poperechnogo kontura konicheskogo prostranstvennogo tela minimal'nogo soprotivleniia, dvizhushchegosia v razrezhennom gaze)** A. I. BUNIMOVICH and G. E. IAKUNINA, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Sept.-Oct. 1986, pp. 112-117. 9 Refs.

The objective of the study is to determine the optimal shape of three-dimensional bodies characterized by minimum drag during flight in a rarefied gas at intermediate altitudes. The optimal shape of the cross-section profile of minimum-drag bodies is determined by solving a variational problem for a functional in a class of piecewise smooth functions with isoperimetric and closed-profile conditions. The limiting cases of Newtonian hypersonic and free-molecular flows of a rarefied gas are examined. It is shown that star-shaped bodies are more efficient in terms of drag than bodies of revolution at all altitudes. However, the efficiency of using star-shaped bodies in comparison with equivalent bodies of revolution decreases with increasing flight altitude (gas rarefaction).

A87-31929 **A general scheme for three-dimensional local flow regimes (Obshchaia skhema rezhimov prostranstvennykh lokal'nykh techenii)** V. V. BOGOLEPOV, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Nov.-Dec. 1986, pp. 80-91. 22 Refs.

Solutions to the Navier-Stokes equations are obtained for flow perturbation regions near small three-dimensional surface irregularities in the path of subsonic or supersonic flow of a viscous gas at large subcritical Reynolds numbers. Boundary value problems are formulated for various local flow regimes, and the principal properties of the solutions to these problems are examined. A general classification of the regimes of three-dimensional local flows is proposed.

A87-31785 **The transition regime characterizing the start-up of an oscillator in a subsonic boundary layer on a plate (O perekhodnom rezhime, kharakterizuiushchem zapusk vibratora v dozvukovom pogranichnom sloe na plastinke)** O. S. RYZHOV and E. D. TERENTEV, *Prikladnaia Matematika i Mekhanika* (ISSN 0032-8235), Vol. 50, Nov.-Dec. 1986, pp. 974-986. 14 Refs.

A study is made of the development of two-dimensional linear perturbations in a boundary layer due to the start-up of an oscillator. The problem is solved by using the Fourier transform along the longitudinal coordinate and Laplace transform with respect to time. Inverse transformations are calculated for large values of the characteristic time and all values of the longitudinal coordinate. Attention is given to regions downstream of the oscillator. In the first of these regions, perturbations assume the form of Tollmien-Schlichting waves, which are transformed to wave packets in the second region.

A87-41839 **Flow structure of a viscous gas near the trailing edge of a flat plate (Struktura techeniia viazkogo gaza vblizi zadnei kromki ploskoi plastiny)** N. P. GRIDNEV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Mar.-Apr. 1987, pp. 27-30. 10 Refs.

The flow of a viscous heat conducting gas near the trailing edge of a flat plate is investigated analytically by solving a full system of Navier-Stokes equations. The equations are solved using a third-order difference scheme for a finite plate (12 cm long) in supersonic flow at M = 2 and Re = 1000. The results confirm the experimentally observed decrease in local friction coefficient with decreasing distance to the trailing edge.

A87-36088 **Three-dimensional hypersonic flow of a dusty gas past a wing (O prostranstvennom obtekanii kryla giperzvukovym potokom zapylennogo gaza)** V. N. GOLUBKIN, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Jan.-Feb. 1987, pp. 15-20. 12 Refs.

Three-dimensional hypersonic flow of a gas containing solid particles past a low-aspect-ratio wing is investigated analytically using the method of a thin shock layer. The analysis allows for the mutual effect of the solid and gas phases. The corresponding similarity parameters are defined, and the effect of a solid impurity on the pressure distribution over the wing is determined.

A87-41732 **A monotonic second order approximation scheme for the finite-difference calculation of nonequilibrium flows (Monotonnaia skhema vtorogo poriadka approksimatsii dlia skvoznogo rascheta neravnovesnykh techenii)** A. V. RODIONOV, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 27, April 1987, pp. 585-593. 9 Refs.

With reference to the analysis of stationary supersonic flows of a nonequilibrium gas, a finite difference scheme based on the Godunov-Kolgan scheme is proposed which provides second-order approximation in all directions. Calculations carried out for several problems, including flow of a calorically ideal gas and supersonic flow of a multicomponent gas mixture into a submerged space, demonstrate the efficiency of the scheme proposed here.

A87-35911 **Calculation of supersonic flow of a chemically nonequilibrium gas past three-dimensional blunt bodies (O raschete sverkhzvukovogo obtekaniia prostranstvennykh zatuplennykh tel khimicheski neravnovesnym potokom gaza)** V. P. KOTENEV, V. I. SAKHAROV, and G. A. TIRSKII, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 27, March 1987, pp. 411-415. 7 Refs.

A numerical method is proposed for calculating supersonic flow of a viscous gas past blunt bodies in the subsonic region of the flow with allowance for chemical reactions. The system of equations describing such a flow is separated into a gasdynamic system and a relaxation system, which are solved consecutively. The gasdynamic equations are solved by using Godunov's finite difference scheme and an explicit finite difference scheme of second order of accuracy; the relaxation equations are integrated using an implicit scheme. Results of calculations for axisymmetric and three-dimensional flow of nonequilibrium air are presented.

A87-42173 **Wave resistance of an exponential body with a front-mounted disk in supersonic flow (Volnovoe soprotivlenie tela stepennoi formy s ustanovlennym vperedi diskom v sverkhzvukovom potoke)** I. A. BELOV, S. A. ISAEV, V. N. KONOVALOV, and A. IU. MITIN, (Leningradskii Mekhanicheskii Institut, Leningrad, USSR) *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki* (ISSN 0002-3434), Feb. 1987, pp. 24-29. 9 Refs.

The wave resistance of a body of exponential geometry with a front-mounted disk in supersonic flow is investigated theoretically and experimentally over a wide range of geometrical parameters and free-stream Mach numbers. The optimal disk diameter, the optimal length of the exponential part of the body, and the exponent corresponding to a minimum wave resistance are determined. It is shown that, by mounting a disk in front of an exponential body, it is possible to decrease the wave resistance of the body in supersonic flow by a factor of 1.5-2.

A87-36093 **Modeling of large-scale mixing processes in an expanding supersonic jet (Modelirovanie protsessov krupnomasshtabnogo peremeshivaniia v rasshiriaiushcheisia sverkhzvukovoi strue)** N. A. ZHELTUKHIN, N. M. TEREKHOVA, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Jan.-Feb. 1987, pp. 59-65. 9 Refs.

Mass and momentum redistribution in the initial section of an axisymmetric turbulent supersonic jet due to its interaction with natural oscillations of finite amplitude is simulated numerically. The waves produce additional large-scale mixing which may cause the distortion of the mean flow characteristics and, consequently, affect jet noise. Flow distortions can be detected through systematic measurements in different azimuthal planes.

A87-31774 **Application of the integral method to the calculation of two-phase boundary layers (Primenenie integral'nogo metoda k raschetu dvukhfaznykh pogranichnykh sloev)** I. M. DRUZHININSKAIA, *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport* (ISSN 0002-3310), Nov.-Dec. 1986, pp. 111-115. 5 Refs.

The problem of flow of an incompressible medium containing particles past an impermeable surface is investigated analytically. Particle concentration is assumed to be small, and their interaction is therefore neglected; the particles have a spherical shape and are of the same diameter. The force interaction between the phases is assumed to satisfy the Stokes law; the effect of the surface film and heat transfer are not considered. Approximate methods for calculating the two-phase boundary layer (laminar and turbulent) are proposed which use integral equations of phase momenta. The methods make it possible to estimate the effect of the additional friction due to the presence of particles.

A87-31715 **Limiting self-similar laws in the theory of swirling jets (Predel'nye avtomodel'nye zakony v teorii zakruchennykh strui)** V. I. KOROBKO, V. K. SHASHMIN, and Z. P. SHULMAN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Nov.-Dec. 1986, pp. 156-160. 10 Refs.

Limiting self-similar laws for swirling jets are examined for the case where the flow parameter Omega = $L/(KR)$ (L is the moment of momentum, K is the momentum, and R is the nozzle radius) is much greater than 1. Velocity and pressure distributions in the cross sections of swirling jets are determined. The limiting self-similar laws and experimental data show that the flow parameter has a significant effect on the hydrodynamic characteristics of the flow.

A87-44284   **Numerical method for the solution of the equations of a viscous shock layer (Chislennyi metod resheniia uravnenii viazkogo udarnogo sloia).** S. A. VASIL'EVSKII, G. A. TIRSKII, and S.V. UTIUZH-NIKOV, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669)*, Vol. 27, May 1987, pp. 741-750.

The paper proposes a method for calculating supersonic flow past blunt bodies on the basis of the numerical solution of the complete two-dimensional equations of a viscous shock layer. The upstream transmission of disturbances in subsonic regions is taken into account through global iterations along the entire region of the shock layer considered. Each global iteration is calculated via a marching procedure. Consideration is given to the stability of the iteration process and to the well-posedness of the problem at each global iteration. The calculation results are found to agree well with experimental data.

A87-31714   **Axisymmetric forms of fluid equilibrium in a toroidal container in zero gravity (Osesimmetrichnye formy ravnovesiia zhid-kosti v toroidal'nom sosude pri nevesomosti)** A. M. BUDNIK and V. K. POLEVIKOV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Nov.-Dec. 1986, pp. 154-156. 5 Refs.

The axisymmetric problem of the evolution of the free surface of a fluid during the filling of a toroidal container under conditions of zero gravity is formulated in closed form and solved numerically using the grid method. The effect of the fill factor is investigated for wetting angles of 45, 90, 135 deg and radius ratios of 1 and 5. It is shown that, for each set of values of these parameters (with the fill factor between 0 and 1), there are two stable solutions that are symmetric relative to the equatorial plane.

A87-31713   **Hypersonic nonuniform flow of a viscous gas past a blunt body (Giperzvukovoe obtekanie zatuplennogo tela ner-avnomernym potokom viazkogo gaza)** N. N. PILIUGIN and R. F. TALIPOV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Nov.-Dec. 1986, pp. 120-125. 12 Refs.

A self-similar solution to equations of the viscous boundary layer near the critical point is obtained for the case of supersonic flow past an axisymmetric blunt body located behind another body. The results are then used to develop a criterion for nonseparated flow. The effect of flow nonuniformity and Reynolds number on shock detachment, convective thermal flow, and the friction resistance of the blunt body is examined. (V.L.)

A87-43497   **Calculation of air distribution in cooled gas turbine blades with a partially perforated deflector (Raschet raspredeleniia vozdukha v okhlazhdaemykh lopatkakh gazovykh turbin s chastichno perforirovannym deflektorom)** E. P. DYBAN and A. I. MAZUR, (AN USSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR) *Promysh-lennaia Teplotekhnika* (ISSN 0204-3602), Vol. 9, no. 2, 1987, pp. 41-47. 5 Refs.

Air distribution over the cooling path of a hollow deflector-type blade is determined from a numerical solution to a system of nonlinear algebraic equations describing pressure losses in the hydraulic path of the blade. The combined effect of injected jet parameters and slot channel width on the hydraulic characteristics of the blade is analyzed, and hydrodynamic similarity numbers are determined for the mixing jet and channel flows for the case where some of the cooling path sections are practically ineffective. It is shown that efficient distribution of cooling air flow can be achieved by varying not only the perforation size but also the width of the cooling channels.

A87-35837   **Problem-oriented program package for the study of processes in gas generators (O problemno-orientirovannom pro-grammnom komplekse pri issledovanii protsessov v gazogenera-torakh)** A. M. LIPANOV, (Moskovskii Institut Khimicheskogo Mashinos-troeniia, Moscow, USSR) *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 293, no. 1, 1987, pp. 33-37. 5 Refs.

A program package for the investigation of gas generators is proposed which has two major features: (1) the decomposition of the solution of the gasdynamic problem in an initial volume of complex shape to several standard problems in characteristic volumes composing the initial volume; and (2) the application of two modularity principles which reduce the volume of programming. The performance of the package is demonstrated on the motion simulation of a gas with suspended condensed particles. Results are presented for processes in a solid-fuel engine.

A87-31969   **The relationship between Reynolds stress tensor in-variants and a scheme for calculating the pulsation characteristics of turbulent flows (O sviazi mezhdu invariantami tenzora napriazheniia Reinol'dsa i skheme rascheta pul'satsionnykh kharakteristik turbu-lentnykh techenii)** V. A. PAVLOVSKII, (Leningradskii Korablestroitel'nyi Institut, Leningrad, USSR) *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 292, no. 1, 1987, pp. 51-55. 15 Refs.

The ideas developed by Novozhilov (1948) regarding the relationships between invariants in the mechanics of deformable solids are applied to fluid mechanics. An analysis of a large amount of experimental data on turbulent flows yields two empirical expressions relating Reynolds stress tensor invariants. It is then shown how these expressions can be used to determine the pulsation characteristics of turbulent flows, with simple shear flows used as an example.

A87-31711   **Turbulence models for the description of flow in a compressible gas jet (Modeli turbulentnosti dlia opisaniia techeniia v strue szhimaemogo gaza)** V. E. KOZLOV, A. N. SEKUNDOV, and I. P. SMIRNOVA, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Nov.-Dec. 1986, pp. 38-44. 23 Refs.

A mechanism for the effect of high-velocity compressibility on turbulent mixing is proposed which involves changes in the structure of large-scale vortices (i.e., changes in the low-frequency region of the pulsation spectrum), rather than changes in the kinetic energy balance. This mechanism is used to refine two existing differential turbulence models including Kovazhnyi's equation for turbulent viscosity. The validity of the models is verified using experimental data from the literature.

A87-31709   **A study of flows in hypersonic nozzles using simplified Navier-Stokes equations (Issledovanie techenii v giperzvukovykh soplakh v ramkakh uproshchennykh uravnenii Nav'e-Stoksa)** M. I. MUCHNAIA, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Nov.-Dec. 1986, pp. 20-26. 14 Refs.

Simplified Navier Stokes equations are used to calculate flows in the nozzles of wind tunnels. In particular, calculations are made for conical and profiled hypersonic nozzles over a wide range of Mach and Reynolds numbers; the results are in good agreement with experimental data. It is shown that the role of viscous-nonviscous interaction in the nozzles becomes significant at large hypersonic Mach numbers.

A87-29892   **Application of weight schemes for the statistical model-ing of multicomponent gas flows to the calculation of the shock wave structure (Prilozhenie vesovykh skhem statisticheskogo mod-elirovaniia techenii mnogokomponentnogo gaza k raschetu struktury udarnoi volny)** A. P. GENICH, S. V. KULIKOV, G. B. MANELIS, V. V. SERIKOV, and V. E. IANITSKII, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 26, Dec. 1986, pp. 1839-1854. 18 Refs.

The method of statistical modeling is applied to the calculation of the structure of a plane stationary shock wave (Mach 5) in one-, two-, and three-component gases. Two computational algorithms with weight factors are developed which lead to a kinetic equation approximating, in the case of molecular chaos, the Boltzmann equation. A binary mixture with a mass ratio of 1:10 and a concentration ratio of 100:1 is examined, as is a ternary mixture with a mass ratio of 1:5:10 and a concentration ratio of 100:2:1. All the model particles are represented by perfectly rigid and elastic spheres of the same diameter. Calculated concentration and temperature profiles and velocity distribution functions are presented.

A87-26317   **The aerodynamics of a vortex boundary layer in a vortex chamber (Aerodinamika tortsevogo pogranichnogo sloia v vikhrevoi kamere)** E. P. VOLCHKOV, S. V. SEMENOV, and V. I. TEREKHOV, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Sept.-Oct. 1986, pp. 117-126. 15 Refs.

An analysis is made of a turbulent boundary layer formed at the end wall of a vortex chamber. Solutions are obtained for the integral equations for pulses in the boundary layer; the radial velocity profile in the boundary layer is described using relationships for the propagation of semibounded jets. Friction laws are formulated for a three-dimensional boundary layer formed at the end surface of the vortex chamber. The criteria determining flows in the end turbulent layers are defined, and their effect on the aerodynamics of vortex chambers is analyzed.

A87-35916   **Aspects of the calculation of potential flow past a slat in a system of airfoil profiles (Ob osobennostiakh rascheta po-tentsial'nogo obtekaniia predkrylka v sisteme aerodinamicheskikh profilei)** A. A. ZAITSEV and A. M. KOMAROV, *Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika* (ISSN 0579-9368), no. 6, Nov.-Dec. 1986, pp. 42-46.

A method for calculating potential flow past a system of airfoil profiles is developed which employs special parametrization reflecting the char-acteristics of elements with two corner points. Results of aerodynamic calculations are presented for the system airfoil-slat that is commonly used as a lift-increasing device. Lift coefficients are calculated for each element and for the system as a whole.

A87-31946   **Development of a laminar boundary layer beyond the point of discontinuity in the catalytic activity of a surface (O razvitii laminarnogo pogranichnogo sloia za tochkoi razryva kataliticheskoi aktivnosti poverkhnosti)** E. A. GERSHBEIN, V. IU. KAZAKOV, and G. A. TIRSKII, (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) *Teplofizika Vysokikh Temperatur* (ISSN 0040-3644), Vol. 24, Nov.-Dec. 1986, pp. 1132-1142. 15 Refs.

The flow of a multicomponent gas mixture near surfaces with various catalytic properties is investigated in the context of laminar boundary layer and hypersonic viscous shock layer theories. An asymptotic solution to the problem is obtained in the vicinity of the point of discontinuity in the catalytic properties of the surface. Analytical formulas are presented for the heat and diffusion flows of components toward the surface of an insertion and also for component concentration and temperature profiles across the internal boundary layer.

A87-35812   **Formation and evolution of vortex structures in shear layers (O protsessakh obrazovaniia i evoliutsii vikhrevykh struktur v sdvigovykh sloiakh)** A. N. VERETENTSEV and V. IA. RUDIAK, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Jan.-Feb. 1987, pp. 31-37. 11 Refs.

The evolution of a perturbed shear layer and the development of vortex structures are investigated analytically using the generalized method of discrete vortex particles. It is shown that the development of secondary instability and subsequent shear layer evolution are largely determined by subharmonic perturbations. The mechanisms of vortex structure enlargement depends to a large degree on the initial conditions of the problem, such as the amplitude and phase of the superposed perturbations. The mean flow velocity profile and the momentum loss thickness are calculated, and the results are compared against experimental data.

A87-35818   **Three-dimensional theory for the equation of ablation in a high-temperature gas flow (K trekhmernoi teorii uravneniia obgara tel v vysokotemperaturnom potoke gaza)** V. V. LUNEV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Jan.-Feb. 1987, pp. 143-151. 17 Refs.

An integrodifferential ablation equation allowing for three-dimensional effects in convective heat transfer is obtained by using a locally integral model. Because of the dependence of convective heat transfer on the azimuthal derivatives of the body surface shape associated with the divergence of nonviscous flow lines, the ablation equation is third-order with respect to the three-dimensional variables. In the case of small asymmetry, the equation assumes certain characteristic features of a wave equation.

A87-35817   **A solution to the variational problem of the optimal shape of supersonic nozzles (K resheniiu variatsionnoi zadachi ob optimal'noi forme sverkhzvukovykh sopel)** A. A. SERGIENKO and A. A. SOBACHKIN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Jan.-Feb. 1987, pp. 138-142.

The variational problem of the optimal shape of supersonic nozzles is analyzed using a formulation that does not stipulate a vanishing term in the first variation of the Lagrange functional. The region of existence of a solution to the resulting boundary value problem is examined. Calculations are carried out for such a problem, with the isolation of both an extreme of a known type and uknown boundary extremes.

A87-36091   **Susceptibility of a boundary layer to acoustic perturbations (O vospriimchivosti pogranichnogo sloia k akusticheskim vozmushcheniiam)** V. N. ZHIGULEV and A. V. FEDOROV, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Jan.-Feb. 1987, pp. 30-37. 12 Refs.

A solution is presented to the problem of the excitation of Tollmien-Schlichting waves by external acoustic waves that are scattered by small local surface irregularities. The amplitudes of the generated instability waves in a boundary layer on a plane plate are calcuated for incoming flow Mach 0.2-0.8. The results are found to be in good agreement with the available experimental data. A comparison is made between the efficiencies of the excitation of Tollmien-Schlichting waves by sound at local irregularities and at distributed flow inhomogeneities due to the nonparallelism of the boundary layer.

A87-31717   **Nonstationary and nonequilibrium air flow in the vicinity of the critical flow line Nestatsionarnoe i neravnovesnoe techenie vozdukha v okrestnosti kriticheskoi linii toka)** M. B. ZHELEZNIAK, A. KH. MNATSAKANIAN, and S. V. PERVUKHIN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Nov.-Dec. 1986, pp. 170-172. 5 Refs.

The problem of gas flow ahead of the frontal point of a blunt body moving at a supersonic velocity in air with variable parameters is investigated with allowance for the processes of chemical relaxation behind the front of the shock wave. Numerical calculations are carried out using the method of characteristics, with the isolation of the bow shock. Determinations are made of the position of the shock wave front, which varies with time, and of the distributions of the composition and gasdynamic parameters in the shock layer.

A87-35814   **Nonlinear three-dimensional evolution of turbulence in the Blasius flow (Nelineinoe prostranstvennoe razvitie vozmushchenii v techenii Blaziusa)** A. A. ZAITSEV and A. I. IUROKIN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Jan.-Feb. 1987, pp. 54-61. 9 Refs.

A boundary-layer turbulence model is examined which allows for the interaction of the induced two- and three-dimensional perturbations of the same frequency with all forms of secondary flows generated by these perturbations. A system of differential equations describing the nonlinear three-dimensional evolution of the amplitude of Tollmien-Schlichting waves is obtained and analyzed numerically. The critical amplitudes of two-dimensional perturbations corresponding to the onset of nonlinear three-dimensional evolution of turbulence are determined.

A87-26322   **A method for calculating ideal gas flows in plane and axisymmetric nozzles with bends in the contour (Metod rascheta techenii ideal'nogo gaza v ploskikh i osesimmetrichnykh soplakh s izlomami kontura)** A. N. KRAIKO, N. I. TILLIAEVA, and S. A. SHCHERBAKOV, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 26, Nov. 1986, pp. 1679-1694. 29 Refs.

A method is presented for calculating flows of a nonviscous and non-heat-conducting gas in smooth and nonsmooth nozzles including sharp-throat nozzles. The method combines a difference scheme maintaining the approximation on an arbitrary grid, the method of characteristics, and analytical solutions valid in the vicinity of a bend and near an axis of symmetry. When the supersonic region is calculated by the method of characteristics from the results obtained by the difference scheme, use is made only of the dependence of the velocity vector angle on one of the coordinates on the sonic line, with a correction made on the basis of exact analytical solutions.

A87-35816   **Transonic gas flow past a plate (Obtekanie plastinki okolozvukovym potokom gaza)** S. K. ASLANOV, *(Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Jan.-Feb. 1987, pp. 128-137. 14 Refs.

A solution is presented for the two-sided Tricomi problem arising in the hodograph plane. The solution satisfies a full set of boundary conditions, which ensures its correct asymptotic behavior with respect to the vanishing angle of attack. It is shown that the difference between Guderlei's (1954) solution and the solution proposed here starts with the singular terms.

A87-42172   **The effect of the temperature factor on friction and heat transfer in a turbulent boundary layer (Vliianie temperaturnogo faktora na trenie i teploobmen v turbulentnom pogranichnom sloe)** O. V. DOBROCHEEV, M. N. KISELEV, and V. P. MOTULEVICH, *(Moskovskii Energeticheskii Institut, Moscow, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki* (ISSN 0002-3434), Feb. 1987, pp. 3-7. 13 Refs.

On the basis of a qualitative analysis of experimental data, a turbulent viscosity model is developed which allows for the effect of temperature inhomogeneity on friction and heat transfer. It is shown that the temperature factor has a noticeable effect on the friction and heat transfer coefficients under conditions of strong nonisothermality. Turbulent friction in a boundary layer is also strongly affected by the Reynolds number and the nonisothermality factor. These effects are important in calculating the thermally stressed parts of systems with a high-temperature heat transfer agent.

A87-47436   **An experimental study of tangential stresses on the surface of a plane obstacle in the path of an underexpanded jet of a rarefied gas (Eksperimental'noe issledovanie kasatel'nykh napriazhenii na poverkhnosti ploskoi pregrady, obtekaemoi nedorasshirennoi struei razrezhennogo gaza)** B. F. PANOV, *Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia* (ISSN 0024-0850), Jan. 1987, pp. 72-76. 6 Refs.

Results of an experimental study of tangential stresses on the surface of a plane obstacle oriented parallel to the axis of an underexpanded jet issuing from a sonic nozzle are reported. In particular, the magnitude and distribution of tangential stresses are analyzed as a function of gas rarefaction. Empirical formulas for calculating tangential stresses are obtained which contain the Knudsen number as a parameter characterizing the degree of gas rarefaction.