Russian and Japanese Aerospace Literature

During 1995 the *AIAA Journal* will carry selected abstracts on leading research topics from Russian aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Transonic and Fluid Flow from Russia and Image Processing from Japan.

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Russian Aerospace Literature
This month: *Transonic and Fluid Flow*

A94-29272   Numerical modeling of the aerodynamic interaction of two turbine stages with intermediate working medium bleeding (Chislennoe modelirovanie aehrodinamicheskogo vzaimodejstviya dvukh turbinnykh stupenej s promezhutochnym otborom rabochego tela). V. I. GNESIN and V. G. SOLODOV, In *Vibrational durability and reliability of aircraft engines and systems* (A94-29268 09-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1989, pp. 25–32. In Russian. 6 Refs. Documents available from Aeroplus Dispatch.

A numerical method is proposed for estimating the variable aerodynamic forces acting on the blades of a two-stage axial flow turbine with intermediate bleeding of the working medium. The method is based on the numerical solution of the direct problem of unsteady three-dimensional transonic flow of a nonviscous gas in a two-stage turbine with an arbitrary ratio of stage blades. An illustrative example is presented.

A95-17524   Numerical solution of Navier–Stokes equations using iterative methods of the variational kind (Chislennoe reshenie uravnenij Nav'e–Stoksa s ispol'zovaniem iteratsionnykh metodov variatsionnogo tipa). I. Y. BABAEV, V. A. BASHKIN, and I. V. EGOROV, *Zhurnal Vychislitel'noj Matematiki i Matematicheskoj Fiziki* (ISSN 0044-4669), Vol. 34, No. 11, Nov. 1994, pp. 1693–1703. In Russian. 8 Refs. Documents available from Aeroplus Dispatch.

An efficient numerical procedure is proposed for solving grid equations arising in the finite difference approximation of steady state Euler and Navier–Stokes equations by monotonic schemes. The procedure employs the Newton method, LU decomposition, and the generalized minimum-residual iterative method. Results of calculations of transonic flow of an ideal gas past a NACA 0012 airfoil are presented.

A95-17522   Exact solutions for some external problems described by unsteady viscous transonic equations (Tochnye resheniya nekotorykh vneshnikh zadach, opisyvaemykh nestatsionarnymi vyazkimi transzvukovymi uravneniyami). Y. V. ZASORIN, *Zhurnal Vychislitel'noj Matematiki i Matematicheskoj Fiziki* (ISSN 0044-4669), Vol. 34, No. 10, Oct. 1994, pp. 1476–1488. In Russian. 11 Refs. Documents available from Aeroplus Dispatch.

Green's functions are obtained in explicit form for a series of initial-boundary value problems associated with unsteady viscous transonic equations. Some aspects of the correct solvability of the problems in Kipriyanov–Schwartz spaces are examined.

A95-13847   Discontinuous solutions for a viscous transonic equation (O razryvnykh resheniyakh vyazkogo transzvukovogo uravneniya). E. D. TERENT'EV, *Zhurnal Vychislitel'noj Matematiki i Matematicheskoj Fiziki* (ISSN 0044-4669), Vol. 34, No. 6, June 1994, pp. 1067–1081. In Russian. 12 Refs. Documents available from Aeroplus Dispatch.

The validity of the integral form of the mass, momentum, and energy conservation equations at possible discontinuities is postulated. After the transition to expressions for flows at discontinuities, the possibility of obtaining relationships for transonic velocities including derivatives for both sides of the discontinuity is investigated. It is shown that, for weak perturbations, relationships different from those of Rankine–Hugoniot are possible when an additional condition for the magnitude of the derivatives is satisfied. An illustrative example is presented.

A94-19821   Transonic flow of a nonideal gas out of a vessel with plane walls (Transzvukovoe istechenie nesovershennogo gaza iz sosuda s ploskimi stenkami). O. M. KISELEV and S. E. MUKHAMETRAKHIMOV, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 6, Dec. 1993, pp. 88–95. In Russian. 12 Refs. Documents available from Aeroplus Dispatch.

The problem of transonic flow of a gas out of a vessel with plane walls is investigated analytically for a real (thermally and calorically nonideal) gas. A method for solving this problem is described. Calculation results are presented which illustrate the effect of the angle between the walls and drag parameters on transonic flow of air.

A94-18436   Nonlinear perturbations inducing a proper pressure gradient in a boundary layer on a plate in transonic flow (Nelinejnye vozmushcheniya, indutsiruyushchie sobstvennyj gradient davleniya v pogranichnom sloe na plastine v transzvukovom potoke). V. I. ZHUK, *Prikladnaya Matematika i Mekhanika* (ISSN 0032-8235), Vol. 57, No. 5, Oct. 1993, pp. 68–78, In Russian. 15 Refs. Documents available from Aeroplus Dispatch.

A study is made of nonstationary nonlinear perturbations in a laminar boundary layer on a plate in the case of external transonic flow. The problem of the two-dimensional velocity field is reduced to that of solving an integro-differential equation for a time-dependent and a spatial function coordinate. The theory developed here implements a continuous transition from subsonic to supersonic flow, since the governing equation contains, as the limiting cases, the Burgers and Benjamin-Ono equations, which describe the evolution of perturbations beyond the transonic region.

A93-55015   An airfoil in transonic flow in the presence of wind gusts and weak shock waves (Profil' v transzvukovom potoke pri vozdejstvii poryvov vetra i slabykh udarnykh voln). A. S. FONAREV, *PMTF—Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0869-5032), Vol. 34, No. 3, May–June 1993, pp. 20–27. 14 Refs. Documents available from Aeroplus Dispatch.

The paper is concerned with the problem of the interaction of unsteady perturbations (wind gusts and low-intensity shock waves) with an airfoil in transonic flow of an ideal gas. In particular, attention is given to the dynamics of compression shocks closing local supersonic regions; the effect of shock displacement on the unsteady aerodynamic characteristics is determined. The effect of problem nonlinearity associated with the transonic regime of motion is analyzed. Results of numerical calculations are presented for specific cases of aperiodic perturbations.

A93-53552   Calculation of flow fields near a lifting wing (Raschet polej techeniya okolo nesushchego kryla). S. G. IGNAT'EV, O. V. KARAS', and A. V. SMIRNOV, *TsAGI, Trudy*, No. 2465, 1990, pp. 32–46. 9 Refs. Documents available from Aeroplus Dispatch.

Calculations are made of transonic flow fields near a thick swept wing of finite span. The load increment is estimated for the isolated blade of a hypothetical propeller located in the field of flow from an aircraft wing. The possibility of reducing the load increment by changing the propeller orientation is demonstrated. The calculation results are compared with the available experimental and analytical data.

A93-51903   A finite difference study of the aerodynamic characteristics of wing profiles at transonic velocities (Issledovanie

aehrodinamicheskikh kharakteristik kryl'evykh profilej pri okolozvu-kovykh skorostyakh konechno-raznostnym metodom). G. V. KLIMENKO, In *Problems in the aerodynamics of flight vehicles and their components* (A93-51901 22-02). Moscow, Russia, Moskovskij Aviatsionnyj Institut, 1992, pp. 8–14. 6 Refs. Documents available from Aeroplus Dispatch.

A finite difference method for calculating the aerodynamic characteristics of wing profiles at transonic velocities is proposed which approximates the equation of the full potential of plane flow. The solution is sought on an orthogonal difference grid in Cartesian coordinates. The capabilities of the method are illustrated for a supercritical airfoil, Korn 75-06-12, at a free-stream Mach of 0.7 and an angle of attack of 2. Results are also presented for subsonic symmetric airfoils NACA 0012 and NACA 0018.

A93-51815 **Shock wave formation at the boundary of a local supersonic region (O formirovanii udarnoj volny na granitse mestnoj sverkhzvukovoj zony).** S. A. SHCHERBAKOV, *PMTF-Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0044-4626), No. 1, Jan.–Feb. 1993, pp. 24–32. 11 Refs. Documents available from Aeroplus Dispatch.

A self-similar solution to an equation of plane potential flow is obtained near the point of formation of a shock wave defining the boundary of a local supersonic region. In accordance with this solution, a shock wave of variable intensity exists at the boundary of the local supersonic region. The characteristic at the point of shock wave formation includes continuous derivatives of the gasdynamic parameters along the coordinates. The solution obtained here is consistent with the theorems of Nikolskii and Taganov (1946).

A93-51768 **Steady transonic weakly perturbed flows in a vibrationally relaxing gas (Statsionarnye slabovozmushchennye transzvukovye techeniya kolebatel'no-relaksiruyushchego gaza).** A. N. BOGDANOV and V. A. KULIKOVSKIJ, *PMTF-Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0869-5032), No. 2, March–April 1993, pp. 48–58. 17 Refs. Documents available from Aeroplus Dispatch.

The behavior of steady and unsteady perturbations in transonic gas flows is considered. The stability of a transonic flow to small unsteady perturbations is determined using a nonlinear partial equation. Results show that the vibrational excitation of N_2 and CO molecules results in the conversion of steady transonic flows of these gases into unsteady flows. Transonic flows of molecular O_2 are steady as its vibrational excitation quickly relaxes to steady states. Results obtained can be applied to problems of transonic gas flow through a nozzle and around a body with formation of a local supersonic region.

A93-50965 **Minimizing the wall effects in wind tunnels with a sectional pressure chamber (Minimizatsiya vliyaniya stenok v trubakh s sektsionirovannoj kameroj davianiya).** K. G. SAYADYAN, *TsAGI, Trudy*, No. 2414, 1989, pp. 14–25. 10 Refs. Documents available from Aeroplus Dispatch.

The induction effect of porous wind tunnel walls on flow past an airfoil is investigated theoretically for the case where the desired pressure distribution is set in an external pressure chamber with an arbitrary number of sections. For subsonic and transonic regimes with weakly developed supersonic regions, analytical expressions are obtained for the additional velocity due to the wall effect, and conditions are determined under which the velocity becomes zero with a specified accuracy. The effect of the porous walls on flow past an airfoil is analyzed, and an algorithm is developed for calculating the pressure levels in the external chamber that are required to minimize this effect.

A93-43027 **Stability conditions for a transonic decelerating flow in a duct (Usloviya ustojchivosti transzvukovogo techeniya tormozheniya v kanale).** A. G. KUZ'MIN, *Zhurnal Vychislitel'noj Matematiki i Matematicheskoj Fiziki* (ISSN 0044-4669), Vol. 32, No. 10, Oct. 1992, pp. 1628–1640. 11 Refs. Documents available from Aeroplus Dispatch.

The problem considered here concerns isentropic deceleration of a supersonic gas flow to subsonic velocities in a duct of variable cross section. The velocity perturbation field is investigated numerically for different perturbation distributions over the inlet cross section of the duct and different porosities of the upper wall. The effect of perturbation cumulation at the point of sonic line intersection with the upper wall is analyzed. The generation of compression and rarefaction waves at the sonic line near its point of origin is discussed.

A93-39196 **Experience in the design of supercritical cascades for the flow straightener of a transonic fan (Opyt proektirovaniia superkinetich-eskikh reshetok spriamliaiushchego apparata transzvukovogo ventil-iatora).** L. G. BOIKO, V. N. ERSHOV, A. E. DEMIN, and D. V. KALIAMIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1992, pp. 82–85. 5 Refs. Documents available from Aeroplus Dispatch.

By using the basic principles of the design of supercritical cascades, an airfoil cascade providing for shock free flow deceleration in supercritical flow regimes is designed using several approximations. It is shown that the cascade design proposed here has a sufficiently wide range of operating regimes with respect to impingement angles and Mach numbers of the incoming flow. Mach number distributions in the cascade are presented in graphic form.

A93-18222 **Effect of airfoil porosity on the shock wave position and intensity at transonic velocities (O vliianii pronitsaemosti profilia na polozhenie i intensivnost' skachka uplotneniia pri transzvukovykh sko-rostiakh).** A. N. BELOGLAZKIN and V. I. SHKADOV, *Moskovskii Universitet, Vestnik, Seriia 1—Matematika, Mekhanika* (ISSN 0579-9368), No. 5, Sept.–Oct. 1992, pp. 64–69. In Russian. 6 Refs. Documents available from Aeroplus Dispatch.

Transonic flow over a wing profile with a porous surface is investigated numerically using an implicit method based on a solution to an equation for the full potential. It is shown that there exists an optimal position of the porous region on the airfoil surface which corresponds to the greatest reduction in wave drag.

A93-15215 **A fast method for calculating three-dimensional transonic potential flows in turbomachine blade rows (Bystryi metod rascheta prostranstvennykh transzvukovykh potentsial'nykh techenii v ventsakh turbomashin).** P. M. BYVAL'TSEV and M. I. IVANOV, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 32, No. 7, July 1992, pp. 1093–1113. In Russian. 26 Refs. Documents available from Aeroplus Dispatch.

An efficient method is presented for calculating three-dimensional steady-state subsonic, transonic, and supersonic potential flows in isolated turbomachine blade rows. The method is based on the numerical integration of a three-dimensional equation for the full velocity potential by means of a modified implicit relaxation method characterized by a high convergence rate. Calculation results are presented for three-dimensional flows in turbine blade rows and in a fan rotor.

A93-12975 **Calculation of separated axisymmetric flow past bodies by solving Euler equations in the inner vortex region (Raschet otryvnogo osesimmetrichnogo obtekaniia tel na osnove resheniia urav-nenii Eilera vo vnutrenei vikhrevoi oblasti).** V. V. VYSHINSKII, and S. A. KRAVCHENKO, *TsAGI, Trudy*, No. 2494, 1991, pp. 22–41. In Russian. 17 Refs. Documents available from Aeroplus Dispatch.

By using a nonstationary model based on Euler equations in the separation region, a numerical method is developed for calculating transonic axisymmetric flow past bodies, including the backflow region near the rear section of the body. Solutions are obtained for separated flow past bodies with a rear step, a sphere, and a body of revolution with an elliptical generatrix of the rear section. Various mechanisms of vorticity generation in the flow are examined.

A93-12764 **A flow calculation and aerodynamic design method for turbomachine cascades (Ob odnom metode rascheta obtekaniia i aerod-inamicheskogo proektirovaniia profilei reshetok turbomashin).** P. M. BYVAL'TSEV, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 32, No. 4, April 1992, pp. 598–612. In Russian. 28 Refs. Documents available from Aeroplus Dispatch.

An efficient method is proposed for the aerodynamic design of cascades of turbomachinery blades. The calculation of flow past a plane cascade is based on the numerical integration of the full velocity potential equation using a modified implicit relaxation method. Characteristic numerical results are presented to demonstrate the capabilities of the method.

A93-12760 **Effect of heat supply on the gasdynamic parameters of gas flow in Laval nozzles (O vliianii teplopodvoda na gazodinamicheskie parametry techeniia gaza v soplakh Lavalia).** A. A. FROLOVA, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 32, No. 3, March 1992, pp. 472–477. In Russian. 4 Refs. Documents available from Aeroplus Dispatch.

The quasi-one-dimensional flow model is used to determine the causes of pressure stabilization in the subsonic part of the gas flow in a Laval nozzle with heat supply. This model is used to study the dependence of the gasdynamic parameters (pressure, density, discharge rate, and velocity modulus) on the heat supply, and to determine the factors that affect pressure stabilization in the subsonic and transonic regions.

A92-53882 **Pulsation characteristics of one-phase and two-phase steam flows in Laval nozzles under off-design conditions (Pul'satsi-onnye kharakteristiki odnofaznogo i dvukhfaznogo potokov para v soplakh Lavalia na neraschetnykh rezhimakh).** M. E. DEICH, M. I. OSHCHEPKOV, A. A. TISHCHENKO, and S. K. AL'DZHANABI, *Rossiiskaia Akademiia Nauk, Izvestiia, Energetika* (ISSN 0002-3310), No. 2, March–April 1992, pp. 104–128. In Russian. 16 Refs. Documents available from Aeroplus Dispatch.

A study is made of transonic flow of superheated saturated and wet steam in four plane Laval nozzles with different profiles of the subsonic and supersonic sections. The results confirm the effect of wall turbulence decay in the critical section of the nozzle. It is shown that the use of an extended subsonic section makes it possible to achieve flow laminarization up to an initial humidity of 12 percent. It is also shown that the longitudinal gradient in the supersonic nozzle section has a substantial effect on pressure pulsations excited by the interaction between stationary condensation and adiabatic discontinuities with the boundary layer.

A95-16639 **Calculation and modeling of the aerodynamic characteristics of space vehicles under conditions of jet braking during the descent in a planetary atmosphere (Raschet i modelirovanie aehrodi-namicheskikh kharakteristik kosmicheskikh apparatov pri strujnom tor-mozhenii na ehtape spuska v atmosfere planet).** V. T. KALUGIN and A. Y. LUTSENKO (Moskovskij Gosudarstvennyj Tekhnicheskij Univ., Moscow, Russia), *Moskovskij Gosudarstvennyj Tekhenicheskij Universitet, Vestnik, Seriya Mashinostroenie* (ISSN 0236-3941), No. 3, Sept. 1994, pp. 71–87. In Russian. 7 Refs. Documents available from Aeroplus Dispatch.

A number of comprehensive aerodynamic studies of flow past segmented conical vehicles descending in an atmosphere have made it possible to identify the possible physical flow structures, develop adequate mathematical models of these structures, and to carry out the corresponding parameter computations. Comparisons between the experimental and theoretical data demonstrate the possibility of using the integral method proposed here for evaluating the efficiency of various kinds of active jet braking over a sufficiently wide range of design and gasdynamic parameters.