

# Russian and Japanese Aerospace Literature

Throughout 1993 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 Flow Visualization/Gas Dynamics from Russia and Computational Fluid Dynamics from Japan.

Support for assembling and publishing the selected abstracts has been provided by the Innovative Science and Technology Directorate of the Strategic Defense Initiative Organization (SDIO), with the sponsorship and technical management of the abstract service by the Office of Naval Research (ONR) under ONR Grant N00014-87-J-1137.

Abstracts in this listing have been taken from the semimonthly abstract journal *International Aerospace Abstracts* (IAA), published by the American Institute of Aeronautics and Astronautics (AIAA) in cooperation with the National Aeronautics and Space Administration (NASA) under Contract No. NASW-4373. Additional material can be obtained through searching the Aerospace Database—available online via DIALOG or NASA RECON.

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## Russian Aerospace Literature This month: Flow Visualization/Gas Dynamics

**A92-51324** Characteristics of turbulence in flows with intermittent separation (Kharakteristiki turbulentnosti v potokakh s peremehaiushchimsia otrivom). G. I. EFIMENKO and E. M. KHABAKHPA-SHEVA, *Sibirskii Fiziko-Tekhnicheskii Zhurnal* (ISSN 0869-1339), No. 2, Mar.-Apr. 1992, pp. 116-118. 7 Refs.

Results of experimental measurements of turbulence characteristics in a wide-angle symmetric plane diffuser are presented. The measurements were conducted using the method of stroboscopic flow visualization. It is shown that the method makes it easy to distinguish forward and return flows in the case of intermittent separation. The experimental equipment and details of the experimental procedure are briefly described.

**A92-51318** Visualization of hydrodynamic processes (Vizualizatsiia gidrodinamicheskikh protsessov). E. P. VIZEL', A. G. NIKOLAENKO, V. I. RYBAKOV, and I. U. P. STASEEV, *Sibirskii Fiziko-Tekhnicheskii Zhurnal* (ISSN 0869-1339), No. 2, Mar.-Apr. 1992, pp. 47-51. 6 Refs.

Some currently used methods for visualizing the motion of fluids and typical problems associated with flow visualization are briefly reviewed. In particular, attention is given to the problem of accounting for fluid surface distortions over a moving body and possible solutions; visualization of three-dimensional flows using solid, liquid, and gaseous indicators; and the method of coordinated particles for determining velocity fields. The discussion also covers visualization of cavitation flows and hydrogen-bubble visualization of unsteady flow past plane wings.

**A92-51317** Determination of the dynamic characteristics of unsteady gas flows by interferometric methods (Opredelenie dinamicheskikh kharakteristik nestatsionarnykh gazovykh potokov metodami interferometrii). S. V. IL'IN, V. S. ABRUKOV, and S. A. ABRUKOV, *Sibirskii Fiziko-Tekhnicheskii Zhurnal* (ISSN 0869-1339), No. 2, Mar.-Apr. 1992, pp. 43-46. 3 Refs.

Situations are considered in which interference filters can be used to directly determine the mechanical impulse and the resulting force acting at a section of an unsteady gas flow. It is shown that such situations are also possible in the case of chemically inhomogeneous reacting gas flows.

**A92-51311** All-Union Conference on Optical Methods of Flow Research, 1st, Novosibirsk, Russia, Apr. 1991, Proceedings (Vsesoiuznaia Konferentsiia po Opticheskim Metodam Issledovaniia Potokov, 1st, Novosibirsk, Russia, Apr. 1991, Doklady). *Sibirskii Fiziko-Tekhnicheskii Zhurnal* (ISSN 0869-1339), No. 2, Mar.-Apr. 1992, 136 pp. For individual items see A92-51312 to A92-51325.

The papers presented in this volume provide an overview of theoretical and experimental recent research related to the development and application of optical method for measuring the kinematic, structural, and thermodynamic parameters of flows of gases and condensed media. Topics discussed include systems for the optical diagnostics of flow dynamics and phase structure, integral Doppler anemometry, determination of the dynamic characteristics of nonstationary gas flows by interferometric methods, and visualization of hydrodynamic processes. Papers are also presented on using speckle photography in an aerophysical experiment, spectroscopic studies in a nonequilibrium hypervelocity gas flow, and determination of plasma flow velocity from the droplet shape.

**A92-49202** Reconstruction of the external forcing field on the basis of the velocity field of a quasi-two-dimensional flow (O vosstanovlenii polia vneshnego vozdeistviia po poliu skorosti kvazidvumernogo techeniia). V. A. KRYMOV and D. I. U. MANIN, *Rossiiskaia Akademiia Nauk, Izvestiia, Fizika Atmosfery i Okeana* (ISSN 0002-3515), Vol. 28, No. 2, Feb. 1992, pp. 129-134. 7 Refs.

The applicability of a quasi-two-dimensional theoretical model to a real flow in a thin viscous-fluid layer was tested using experimental data obtained using a previously developed method for reconstructing velocity fields from streak photographs. It is shown that the flow is governed by two-dimensional hydrodynamic equations with Rayleigh friction. Results demonstrate the feasibility of accurately reconstructing the external force driving the fluid motion by substituting the experimental velocity field into the equations of motion.

**A92-49194** Methods and means of heat transfer modeling for high-velocity heterogeneous flows (Metody i sredstva modelirovaniia teploobmena v vysokoskorostnykh geterogennykh potokakh). D. S. MIKHATULIN, I. U. V. POLEZHAEV, and I. V. REPIN, *Teplofizika Vysokikh Temperatur* (ISSN 0040-3644), Vol. 30, No. 3, May-June 1992, pp. 573-579. 7 Refs.

The paper is concerned with the possibility of using a gasdynamic wind tunnel to generate high-temperature supersonic heterogeneous flows (gas-solid particles) for modeling the thermal interaction between a heterogeneous medium and a body surface. The velocity and temperature inhomogeneities of the phases are analyzed. The experimental method and simulation of the thermal and dynamic loading of the models are discussed.

**A92-46523** Experimental investigation of underexpanded wall jets issuing near the bottom section (Eksperimental'noe issledovanie nedorasshirenykh pristenochnykh strui, istekaiushchikh okolo donnogo srezha). E. G. ZAITSEV, *PMTF—Prikladnaia Mekhanika i Tekhnicheskaiia Fizika* (ISSN 0044-4626), No. 2, Mar.-Apr. 1992, pp. 76-81. 9 Refs.

The paper presents an experimental study of two plane-parallel wall jets near the bottom section flowing out of slotted nozzles with sonic velocity, assuming that the distance along the axes between the nozzles could vary in a wide range. Emphasis is placed on a study of the flow characteristics at the initial (gasdynamic) section of the jets. A comparison is made with the case of a single wall jet.

**A92-42727** Stability theory for periodic flows of a viscous gas (K teorii ustoiichivosti periodicheskikh techenii viazkiego gaza). M. A. BRUTIAN and P. L. KRAPIVSKII, *Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 1, Jan.-Feb. 1992, pp. 10-16. 17 Refs.

An analysis is made of the stability of a simple unidirectional periodic flow of a compressible viscous gas induced by a mass force that is periodic with respect to one of the coordinates. The critical Reynolds number of stability loss is calculated, and the characteristics of the large-scale coherent vortex structure, formed in the flow, are determined in qualitative terms. The analysis presented here provides a possible approach to the problem of large-scale structure formation in a viscous gas.

**A92-42753 Effect of macrotransfer processes on changes of gasdynamic parameters under the effect of a resonance radiation pulse (Vliianie protsessov makropere-nosa na izmenenie gazodinamicheskikh parametrov pri vozdeistvii impul'sa rezonansnogo izlucheniia).** V. I. GRABOVSKII and A. M. STARIK, *Rossiiskaia Akademiia Nauk, Doklady* (ISSN 0002-3264), Vol. 322, No. 4, 1992, pp. 674-680. 9 Refs.

Changes in the gasdynamic parameters of a two-component gas mixture during the excitation of the internal degrees of freedom of molecules by resonance radiation are examined analytically with allowance for macrotransfer process, such as diffusion, convection, and heat conduction. It is shown that, in an equilibrium gas, diffusion and heat conduction may give rise to qualitatively new effects even in the case where the pulse duration is less than the characteristic time of these processes. The results indicate the possibility of substantial acceleration of diffusion processes in gases during the excitation of molecular oscillations, which is relevant to the separation of gases and to combustion process control under conditions of deflagration.

**A92-42685 Using velocity profiles for determining surface friction in flow with a positive pressure gradient (Ob ispol'zovanii profi-lei skorosti dlia opredeleniia poverkhnostnogo treniia v potoke s polozhitel'nykh gradientom davleniia).** E. M. KHABAKHPASHEVA and G. I. EFIMENKO, *Sibirskii Fiziko-Tekhnicheskii Zhurnal* (ISSN 0869-1339), No. 1, Jan.-Feb. 1992, pp. 86-93. 21 Refs.

Based on an analysis of experimental data, a modification of the Prandtl-Clauser turbulence model is proposed in order to take into account the effect of a positive pressure gradient. The velocity profile in the inner region of the turbulent boundary layer is determined using a new formula for the damping factor and empirical formulas which specify coefficients in the logarithmic and half-power laws as a function of a pressure gradient parameter. It is noted, however, that experimental data required for the reliable calculation of flows in the preseparation region are not yet available.

**A92-42680 A numerical study of flow of a viscous gas in a Laval nozzle in the narrow channel approximation (Chislennoe issledovanie techeniia viazkogo gaza v sople Lavalia v priblizhenii uzko-go kanala).** P. A. SKOVORODKO and V. A. IAKOVENKO, *Sibirskii Fiziko-Tekhnicheskii Zhurnal* (ISSN 0869-1339), No. 1, Jan.-Feb. 1992, pp. 17-23. 12 Refs.

An approach is proposed for calculating viscous flows in a Laval nozzle in the narrow channel approximation for a wide range of the governing parameters. In accordance with the approach proposed here, the direct problem is solved by using an iteration algorithm for solving a sequence of inverse problems. This approach makes it possible to calculate flows for relatively low Reynolds numbers and to significantly reduce the computation time.

**A92-40745 Stability of solutions for some boundary value problems for hyperbolic equations (Ob ustoi-chivosti reshenii nekotorykh kraevykh zadach dlia giperbolicheskikh uravnenii).** S. A. EGORUSHKIN and A. G. KULIKOVSKII, *Priladnaia Matematika i Mekhanika* (ISSN 0032-8235), Vol. 56, No. 1, Jan.-Feb. 1992, pp. 40-51. 13 Refs.

The paper is concerned with boundary value problems for hyperbolic equations that are relevant to the analysis of shock wave stability in gas dynamics and magnetohydrodynamics. It is shown, in particular, that the interaction of perturbations with a boundary in the case of neutral stability leads to a loss of the solution smoothness. An explanation of this effect is proposed.

**A92-40619 Pressure recovery coefficient (O koeffitsiente vosstanovleniia davleniia).** N. A. SHUSHIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1991, pp. 88-93. 2 Refs.

In engineering calculations using a one-dimensional representation of gas flow, various losses are accounted for by means of a pressure recovery coefficient. Here, the pressure recovery coefficient is related to the displaced boundary layer thickness. The resulting expressions provide a simple way to solve the problem of pressure increase in the boundary layer drain channel for supersonic external flow.

**A92-40616 Calculation of equilibrium compositions—Introduction of continuity (O raschete ravnovesnykh sostavov—Vvedenie nepre-ryvnosti).** R. R. NAZYROVA, A. A. DREGALIN, and D. G. NOVIKOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1991, pp. 78-80. 4 Refs.

A method is presented for introducing continuity into the solution of the problem of calculating the equilibrium composition. The approach proposed here makes it possible to retain the model of independent condensed phases when solving the problem. Computer test runs confirm the efficiency of the method.

**A92-21682 The basis of contact conservation laws in one-dimensional gas dynamics (Bazis kontaktnykh zakonov sokhraneniia v odnomernoi gazovoi dinamike).** V. E. SHEMARULIN, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 320, No. 4, 1991, pp. 851-855. 8 Refs.

For equations describing one-dimensional plane isentropic flows of a polytropic gas, the basis is derived in the space of contact conservation laws of a special kind. The contact laws comprise conservation laws that do not contain derivatives of the dependent variables higher than first-order. For certain assumptions about the nature of the flow, the system of gasdynamic equations is reduced to a single quasi-linear equation.

**A92-40612 Effect of fluid oscillations induced by fuel drainage on the fuel residue (O vliianii na gidravlicheskie ostatok kolebanii zhidkoi, vozvuzhdaemykh pri slive).** N. E. BOITSUN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1991, pp. 65-68. 4 Refs.

The effect of the oscillations of the free surface of the fluid during fuel drainage on the amount of the fuel residue was investigated experimentally using transparent cylindrical tanks. It is shown that the amount of the fuel residue depends to a large extent on the initial tank filling volume. The relationship between the fuel residue and the initial filling volume is determined experimentally for two different tank diameters and presented in graphic form. The results of the study provide a way to minimize the unused fuel residue.

**A92-40610 Low-frequency vibrations of the shutters of the variable Laval nozzle of gas turbine engines (Nizkochastotnye kolebania stvorok reguliruемого sople Lavalia GTD).** I. I. TSYBIZOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1991, pp. 48-52. 2 Refs.

The factors responsible for the low-frequency vibrations of the shutters of a variable Laval nozzle are identified, and the mechanisms of this phenomenon are examined. Expressions for calculating the shutter vibrations are presented. It is shown that the low-frequency vibrations can be significantly reduced by profiling the subsonic section of the nozzle.

**A92-40609 Heat transfer on a cylindrical surface in the cavities of gas turbine engine rotors (Teplootdacha na tsilindricheskoi poverkhnosti v polostiakh rotorov gazoturbinnnykh dvigatelei).** N. N. SALOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1991, pp. 43-48. 2 Refs.

Experimental data on heat transfer on a cylindrical surface inside rotating annular cavities are presented for different coolant flow patterns. The results of the experiments are generalized in the context of similarity theory. The cooling schemes considered are compared in terms of cooling efficiency.

**A92-36420 Structure of the separated flow region in a dihedral corner in front of an obstacle in supersonic flow (Struktura oblasti otrynnogo techeniia v dvugrannom ugle perezd prepriatstviem, obtekaemym sverkhzvukovym potokom).** A. I. ZUBKOV, B. E. LIAGUSHIN, and I. A. PANOV, *Moskovskii Universitet, Vestnik, Seria 1—Matematika, Mekhanika* (ISSN 0579-9368), No. 1, Jan.-Feb. 1992, pp. 107-110. 4 Refs.

The paper is concerned with supersonic flow past an obstacle located at an inner side of a dihedral corner. In particular, wind tunnel test results are presented for a model in the form of a 90-deg dihedral angle formed by two tapered 170x300-mm plates, with a cylindrical obstacle introduced through a hole in one of the plates. The structure and size of the separated flow region are determined.

**A92-33762 An implicit method for solving equations of radiation gas dynamics (Neiavnyi metod resheniia uravnenii radiatsionnoi gazovoi dinamiki).** A. I. ZUEV, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 32, Jan. 1992, pp. 82-96. 23 Refs.

An implicit method is proposed for solving equations of radiation gas dynamics within the framework of a multiple-group kinetic model of radiation transfer. Particular attention is given to the organization of the iteration process for solving equations of radiative-convective heat transfer in a multiple-group quasi-diffusion radiation transfer model. The efficiency of the approach proposed here is evaluated.

**A92-31990 A multiple-frame ultrafast laser schlieren system for the observation of prebreakdown phenomena in fluids in the nanosecond range (Mnogokadrovaia sverkhskorostnaia lazernaia shlieren-sistema dlia nabliudeniia predprovivnykh iavlenii v zhidkostiakh v nanosekundnom diapazone).** V. F. KLIMKIN, *Zhurnal Tekhnicheskoi Fiziki* (ISSN 0044-4642), Vol. 61, Sept. 1991, pp. 15-19. 9 Refs.

The design and applications of a six-frame ultrafast schlieren photography system for studying the initial stage of the electric breakdown in fluids are discussed. The system is based on a compact optical delay line which allows a simple continuous adjustment of the time interval between the frames over the range 5-50 ns. The light source consists of a 5-ns ruby laser. The static spatial resolution of the schlieren system is 20-25 microns. Results of observations of transient prebreakdown processes in fluids in the nanosecond range are presented.

**A92-31856 Effect of the nonequilibrium excitation of the vibrational degrees of freedom of nitrogen on the stagnation pressure behind a compression shock in high-enthalpy hypersonic gas-dynamics tunnels (Vliianie neravnovesnogo vozvuzhdeniia kolebatel'nykh stepenei svobody azota na davlenie tormozheniia za skachkom uplotneniia v giperzvukovykh vysokental'piinykh gazodinamicheskikh ustanovkakh).** O. I. POLIANSKII and G. N. SAIAPIN, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 22, No. 1, 1991, pp. 48-53. 7 Refs.

A computer simulation is used to investigate the effect of nonequilibrium excitation (deactivation) of the vibrational degrees of freedom of nitrogen on the stagnation pressure behind a direct compression shock in the case of nitrogen flow past blunt bodies in high-enthalpy hypersonic gas-dynamics tunnels. Allowance is made for nonequilibrium processes occurring in both the nozzle and shock layer near the body. It is found that, in modern gas-dynamics tunnels using nitrogen, nitrogen is in the nearly frozen state in the vicinity of the nozzles for measuring the integral pressure behind a shock wave.