AIAA JOURNAL
Vol. 34, No. 8, August 1996

Russian and Japanese Aerospace Literature

During 1996 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 Hypersonic Aerodynamics from Russia and Stress Analysis and Tests 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 N00014-93-I-1074.

Abstracts in this listing have been taken from the monthly abstract journal *International Aerospace Abstracts* (IAA), published by the American Institute of Aeronautics and Astronautics (AIAA). Additional materials can be obtained through searching the Aerospace Database—available online via DIALOG or NASA RECON.

Paper copies and microfiche of the original documents cited are available from Aeroplus Dispatch, 1722 Gilbreth Road, Burlingame, CA 94010 (800) 662-2376. Use the "A" number to identify material you want. Please be advised that most of the original documents are in the original language. Direct questions concerning this abstract section of the *AIAA Journal* to Norma Brennan at AIAA Headquarters.

Russian Aerospace Literature This month: *Hypersonic Aerodynamics*

A94-28297 Peak heat flows on a triangular plate with a blunt nose in hypersonic flow (O pikovykh teplovykh potokakh na treugol'noj plastine s prituplennym noskom v giperzvukovom potoke). A. B. LESIN and V. V. LUNEV, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 2, 1994, pp. 131–137. In Russian. 7 Refs. Documents available from Aeroplus Dispatch.

In an earlier study (Gubanova et al., 1992), an experimental investigation of hypersonic flow past a triangular plate with a blunt nose has revealed anomalies consisting of narrow bands of intensified heat transfer on the windward side. Here, this effect is related to the formation of gas spread regions in the wall flow layers, which are induced by the interference between the head shock (from the blunt nose) with the leading edge of the plate. This spreading occurs at a practically constant pressure and therefore is classified as inertial.

A94-28296 Applicability of some approximate similarity laws in hypersonic aerodynamics (O primenimosti nekotorykh priblizhennykh zakonov podobiya v giperzvukovoj aehrodinamike). N. N. PILYUGIN, R. F. TALIPOV, and S. V. UTYUZHNIKOV, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 2, 1994, pp. 121–130. In Russian. 19 Refs. Documents available from Aeroplus Dispatch.

The applicability regions of some approximate similarity laws for heat transfer coefficients, friction, and drag are defined on the basis of the numerical solution of equations of a full viscous shock layer in the case of hypersonic flow past blunt cones. The discussion covers the problem statement and the numerical solution method; results of calculations near the critical line; similarity relationships for slender blunt cones; and verification of similarity relationships in the case of nonuniform flow.

A95-14457 Heat transfer on swept wings with a blunt leading edge in hypersonic flow at angle of attack (O teploobmene na strelovidnykh kryl'yakh s zatuplennoj perednej kromkoj, obtekaemykh geperzvukovym potokom pod uglom ataki). I. G. BRYKINA, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 4, 1994, pp. 170–179. In Russian. 18 Refs. Documents available from Aeroplus Dispatch.

An approximate analytical solution is obtained for relative heat flows on the lateral surface of infinite-span swept wings in hypersonic flow of a viscous gas at angles of attack and yaw. The accuracy of the analytical expressions is evaluated through a comparison with numerical solutions. It is shown that the formulas obtained here can be used for calculating relative heat flows for frozen as well as chemically equilibrium and nonequlibrium flows in the case of an ideally catalytic wing surface.

A94-35313 Aerodynamic characteristics of a delta wing in hypersonic flow (Aehrodinamicheskie kharakteristiki del'ta-kryla v giperzvukovom potoke). V. Y. KISELEV, A. A. MASLOV, and A. N. SHIPLYUK, *Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0869-5032), Vol. 35, No. 2, 1994, pp. 66–69. In Russian. 14 Refs. Documents available from Aeroplus Dispatch.

It is demonstrated that, by using thermostatic control of the strain gauge elements, it is possible to create an aerodynamic balance suitable for reliable measurements in hypersonic high temperature flow. Aerodynamic test results are presented for a delta wing at freestream Mach numbers of 8 and 20. Details of the experimental setup and procedure are presented.

A94-35294 Optimization of hypersonic wings (Optimizatsiya giperzvukovykh kryl'ev). V. N. GOLUBKIN and V. V. NEGODA, *Zhurnal Vychislitel'noj Matematiki i Matematicheskoj Fiziki* (ISSN 0044-4669), Vol. 34, No. 3, 1994, pp. 446–460. In Russian. 9 Refs. Documents available from Aeroplus Dispatch.

By using the theory of a thin shock layer, a method is developed for solving the optimization problem for wings of low aspect ratio in hypersonic flow at angle of attack, aimed at maximizing the lift-drag ratio. The bifurcation nature of the optimization process is demonstrated. Characteristic configurations of optimized wings are presented. A substantial gain in hypersonic lift-drag ratio is obtained over a wide range of angles of attack.

A94-31577 Computation of supersonic/hypersonic flow near complex configurations. N. V. VOEVODENKO (TsAGI, Zhukovsky, Russia), *Proceedings of the 19th ICAS Congress*, Anaheim, CA, Sept. 18–23, Vol. 1, 1994 (A94-31534 10-01), Washington, DC, American Inst. of Aeronautics and Astronautics, Inc., 1994, pp. 406–412. 7 Refs. Documents available from Aeroplus Dispatch.

A numerical method based on the hypersonic small-disturbance theory, the high incidence slender-body Sychev theory, together with Godunov's method, have been developed for computing supersonic/hypersonic flows near complex aircraft at arbitrary angle of attack. This method permits the calculation of the aerodynamic characteristics of complex aircraft and airspace configurations, where two or more bodies are placed close together to influence each other. The basic theory is asymptotic, but in practice it was shown that the applicability range of this method is between Mach 2 and 10, for alpha below 90 deg. The program can be quickly adjusted for many classes of shapes by creating a corresponding geometry. (Author)

A94-22204 Russian aerospace plane TU-2000. A. L. PUKHOV (Aviation Scientific and Technical Establishment, Moscow, Russia), *AIAA and DGLR, 5th International Aerospace Planes and Hypersonics Technologies Conference*, Munich, Germany, Nov. 30–Dec. 3, 1993, p. 3. Documents available from Aeroplus Dispatch.

Russian Experimental Aerospace Plane (RASP) TU-2000 provides scientific and technical basis for development of hypersonic and aerospace vehicles. Special experimental aircraft as a natural model is the only possibility to simulate complicated processes of engine burning and aerothermodynamic phenomena at M greater than 6–8. The strategic purpose of the program is to develop a single-stage multiple RASP featured with horizontal takeoff and landing. It will be universal, adaptable, economical and ecologically clean vehicle of 21st century. (Author (revised))

A94-22187 The integration of a hypersonic vehicle airframe with an airbreathing engine. V. N. GUSEV, N. A. BLAGOVESHCHENSKIJ, and S. M. ZADONSKIJ (TsAGI, Zhukovski, Russia), *AIAA and DGLR, 5th International Aerospace Planes and Hypersonics Technologies Conference*, Munich, Germany, Nov. 30–Dec. 3, 1993, p. 9, 6 Refs. Documents available from Aeroplus Dispatch.

The problems of the integration of a hypersonic vehicle airframe with an airbreathing engine are considered when the lower surface of the vehicle becomes a part of the power plant. The requirements concerning the selection of the law of the variation of the cross-section areas of an integral configuration vehicle are formulated theoretically so that a minimum drag or a maximum lift-to-drag ratio of a vehicle is provided at hypersonic velocities. Along with

the theoretical investigation data, the test results aimed at the search of the most efficient integration technique of the propulsion with the airframe are given. These investigations conducted on schematized models in hypersonic wind tunnels identify the contributions of the main components of the configuration to its aerodynamics, lay the basis for a data bank of the aerodynamics characteristics of a given vehicle class, and can be used to assess the accuracy level of the computational aerodynamics methods applied at the design stage. Respective comparisons are presented. (Author)

A94-18419 Hypersonic flow past a body and optical luminescence in atmospheric flight (Rezhim giperzvukovogo obtekaniya tela i opticheskoe svechenie pri polete v atmosfere). V. A. KIRILLOVYKH and V. M. NIKOLAEV, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1993, pp. 202–204. In Russian. 13 Refs. Documents available from Aeroplus Dispatch.

A method is proposed whereby the moment of the laminar-turbulent transition under realistic conditions of hypersonic flight of a body in the earth's atmosphere can be determined through an analysis of the body luminescence as a function of the flight altitude. A simple algorithm is proposed for determining the moment of the transition to turbulence from the amount by which the local turbulent heat flow exceeds the laminar flow. The algorithm is validated by comparing calculations with experimental data.

A94-18418 Structure of hypersonic flows in a large-scale multiple-diaphragm shock tube (O strukture giperzvukovykh potokov v krupnomasshtabnoj mnogodiafragmennoj udarnoj trube). N. A. ANFIMOV, I. V. ERSHOV, E. I. RUZAVIN, S. S. SEMENOV, and S. K. SHIMAREV, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1993, pp. 158–165. In Russian. 14 Refs. Documents available from Aeroplus Dispatch.

Results of experimental/theoretical studies of the structure of a shock wave and gas flow behind a shock wave are reported. In particular, data are presented on the time of existence of high-temperature working flows, contact zones, and regions of uniform cold flow parameters in single- and multiple-diaphragm versions of a large-scale (0.5 m diam, 200 m long) shock tube with nozzle inserts.

A94-18416 Hypersonic flow of a viscous gas past a delta wing under moderate interaction conditions with allowance for the wake flow (Obtekanie treugol'nogo kryla giperzvukovym potokom vyazkogo gaza na rezhime umerennogo vzaimodejstviya s uchetom techeniya v slede). G. N. DUDIN, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 5, 1993, pp. 142–149. In Russian. 14 Refs. Documents available from Aeroplus Dispatch.

The paper presents results of calculations of flow past a plane delta wing of finite length, with allowance made for the wake flow under conditions of moderate interaction with the external hypersonic flow. The results are compared with data on flow past a delta wing with a specified pressure at the trailing edge. In the range of parameters investigated, the calculated aerodynamic characteristics are shown to differ by 10–15% from those obtained for the wing with a specified trailing edge pressure.

A94-13321 Aerodynamic characteristics of hypersonic flight vehicles with lateral powerplant ducts (Osobennosti aehrodinamiki giperzvukovykh letatel'nykh apparatov s bokovym raspolozheniem traktov silovoj ustanovki). Y. P. GUN'KO and I. I. MAZHUL' (RAN, Inst. Teoreticheskoj i Prikladnoj Mekhaniki, Novosibirsk, Russia), *Sibirskij Fiziko-Tekhnicheskij Zhurnal* (ISSN 0869-1339), No. 3, 1993, pp. 106–120. In Russian. 11 Refs. Documents available from Aeroplus Dispatch.

Results of experimental (M = 0–6) and computational (M = 5–12) studies of hypersonic flight vehicles with lateral powerplant ducts are reported. The results obtained have made it possible to identify some characteristic features of such configurations in comparison with configurations in which powerplant ducts are located under the fuselage. It is shown, in particular, that the air intake flow rate and therefore the thrust and efficiency characteristics of configurations with lateral ducts are practically independent of the angle of attack. The lifting characteristics and the longitudinal moment are largely determined by the external surfaces and depend only slightly on the powerplant regimes.

A94-10942 Optimal body shapes with limits on local heat flux (Optimal'nye formy tel pri ogranichenii na lokal'nyj teplovoj potok). M. A. ARGUCHINTSEVA and N. N. PILYUGIN, *Kosmicheskie Issledovaniya* (ISSN 0023-4206), Vol. 31, No. 3, 1993, pp. 57–63. In Russian. 10 Refs. Documents available from Aeroplus Dispatch.

The paper is concerned with the problem of determining optimal shapes of plane and axisymmetric bodies which would limit local heat overloads in addition to reducing the total (convective and radiative) heating of a body during the entry into a planet atmosphere. Examples of calculations of optimal body shapes and heat flow distributions over the body surface are presented. The aerodynamic and thermal characteristics of such bodies are compared with those of other bodies.

A94-10932 Aerodynamic characteristics of V-shaped wings with a detached shock wave at the leading edge at hypersonic flight velocities (Aehrodinamicheskie kharakteristiki V-obraznykh kryl'ev s otoshedshej udarnoj volnoj na perednikh kromkakh pri giperzvukovykh skorostyakh poleta). N. A. OSTAPENKO, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 4, 1993, pp. 145–154. In Russian. 35 Refs. Documents available from Aeroplus Dispatch.

A solution is presented for the direct problem of hypersonic flow past a V-shaped wing with a detached shock wave at the leading edge. Calculations for the reduced normal force coefficient and lift-drag ratio are presented for a configuration with a V-shaped lower surface and flow-aligned upper surface. It is shown that, in accordance with the theory of a thin shock layer, the V-shaped wing is particularly efficient, in comparison with a flat delta wing, in flow regimes with a shock wave attached to the leading edge.

A94-10888 Up-to-date gasdynamic models of hypersonic aerodynamics and heat transfer with real gas properties. G. A. TIRSKIJ (Moscow State Univ., Russia), *Annual Review of Fluid Mechanics*, Vol. 25 (A94-10885 01-34), Palo Alto, CA, Annual Reviews, Inc., 1993, pp. 151–181. 104 Refs. Documents available from Aeroplus Dispatch.

This review considers the influence of multicomponent diffusion, thermodynamic and chemical nonequilibrium processes, heterogeneous reactions, and the generation of vibrationally and electronically excited particles by recombination on resistance and heat transfer in hypersonic flow past bodies at low and moderate Reynolds numbers. The main feature of recent real gas hypersonic flow studies is that they take into account the various atomic-molecular and ionic processes simultaneously, considering viscosity, heat conduction, and diffusion in the framework of PNS (parabolized Navier–Stokes), VSL (viscous shock layer), or the complete Navier–Stokes equations.

A93-55030 Hypersonic flow of a gas past wing with heat transfer (Obtekanie kryla giperzvukovym potokom gaza s podvodom tepla). V. N. GOLUBKIN (TsAGI, Moscow, Russia), *Teplofizika Vysokikh Temperatur* (ISSN 0040-3644), Vol. 31, No. 2, 1993, pp. 252–256. 10 Refs. Documents available from Aeroplus Dispatch.

Hypersonic flow past a slender wing at angle of attack is analyzed in the approximation of a thin shock layer, with allowance made for heat transfer to the flow from both concentrated and distributed sources. The principal similarity parameters for the problem are determined. Analytical solutions are obtained for the characteristic cases of wings of small and large aspect ratios. Attention is given to the effect of heat release on the shape of the head shock, pressure distribution, and integral characteristics.

A93-52959 Effect of boundary layer suction on the thrust and aerodynamic efficiency of a hypersonic flight vehicle (Vliyanie sliva pogranichnogo sloya na tyagovo-aehrodinamicheskuyu ehffektivnost' giperzvukovogo letatel'nogo apparata). Y. P. GUN'KO, I. I. MAZHUL', and D. V. SHCHERBIK, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No. 1, 1993, pp. 89–92. 4 Refs. Documents available from Aeroplus Dispatch.

The effect of boundary layer suction ahead of the air intake on the thrust and aerodynamic characteristics of a hypersonic flight vehicle with a ramjet engine is estimated analytically. In particular, attention is given to suction by means of a suction wedge. Data are presented for various configurations of an air intake with a suction wedge in a flight vehicle.

A93-51820 A study of turbulent flow in a viscous shock layer in the case of gas flow past oblong blunt bodies (Issledovanie turbulentnogo techeniya v vyazkom udarnom sloe pri obtekanii gazom zatuplennykh udlinennykh tel). I. G. EREMEJTSEV, G. S. ZHURAVLEVA, and N. N. PILYUGIN, *PMTF—Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0044-4626), No. 1, 1993, pp. 69–75. 6 Refs. Documents available from Aeroplus Dispatch.

Hypersonic flow of a gas past oblong blunt plane (a parabolic cylinder) and axisymmetric (a paraboloid of revolution) bodies is investigated numerically within the framework of a viscous shock layer model for turbulent flow conditions. Numerical calculations indicate that the dynamic and thermal characteristics of plane and axisymmetric bodies are largely determined by the body shape, flow conditions (Reynolds number), and effective angle of taper of the body.

A93-51786 Experimental studies of supersonic flow past wedges with longitudinal slots on the windward side (Ehksperimental'nye issledovaniya sverkhzvukovogo obtekaniya klin'ev s prodol'nymi pazami na navetrennoj storone). V. I. VORONIN, G. S. UL'YANOV, and A. I. SHVETS, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 2, 1993, pp. 173–175. 5 Refs. Documents available from Aeroplus Dispatch.

By using a simple hypersonic lifting shape in the form of a wedge as an example, an experimental study is made of a method of increasing the lift-drag ratio of waverider configurations. The method investigated here involves the use of longitudinal slots on the windward side. It is shown that the wave drag can be reduced without any decrease in the lifting force by appropriately selecting the angle of the slot surface and the relative width of the slots. The aerodynamic characteristics of the models tested are presented as a function of the slot angle and relative width.

A93-51775 Heat transfer on tip fins in hypersonic flow (Teploobmen na kontsevykh kilyakh v giperzvukovom potoke). V. Y. BOROVOJ and T. V. KUBYSHINA, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), No. 2, 1993, pp. 18–25. 5 Refs. Documents available from Aeroplus Dispatch.

The paper is concerned with flow and heat transfer on the windward surface of a tip fin and at the wing-fin joint. The analysis is carried out for a schematized wing-fin configuration, and therefore the results cannot be directly used in practice. However, the results give an idea of some important characteristics of flow and heat transfer at the tip fins which should be taken into account in the design of hypersonic flight vehicles.