

Soviet and Japanese Aerospace Literature

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Soviet Aerospace Literature This month: Aircraft Engines/Propulsion

A91-35743 Calculation of the cooling system of small-size blades of high-temperature gas turbine engines (Raschet sistemy okhlazhdeniia malorazmernykh lopatok vysokotemperaturnykh GTD). V. M. KLIMENKO and I. M. CHIGAREV, *Promyshlennaya Teplotekhnika* (ISSN 0204-3602), Vol. 13, No. 1, 1991, pp. 88-91.

A small-channel cooling system for small-size gas turbine blades is considered, and a method for calculating such a system is proposed. The method is based on representing small-channel cooling as an equivalent of the internal ribbing of the heat transfer surfaces. The calculation results are compared with calculations based on the electrothermal analogy approach.

A91-35742 Using a locally one-dimensional method for solving the heat conductivity equation to determine the thermal state of cooled rotor disks (Primenenie lokal'no-odnomernogo metoda resheniia uravneniia teploprovodnosti dlia opredeleniia teplovogo sostoiianiia okhlazhdaemykh diskov rotorov). B. D. BILEKA and V. IA. KABKOV, *Promyshlennaya Teplotekhnika* (ISSN 0204-3602), Vol. 13, No. 1, 1991, pp. 37-43. 5 Refs.

A locally one-dimensional method is used for calculating the steady-state thermal condition of rotor disks by consecutively solving the axisymmetric and three-dimensional problems and coordinating the solutions over the reference radius. Unsteady state calculations are also carried out for a disk using a two-dimensional formulation for the part of the disk located below the reference radius. Results of calculations for a series of gas turbine engine disks are presented and compared with experimental data.

A91-19915 Effect of lonol on the formation of deposits by directly distilled jet fuels (Vliianie ionola na obrazovanie otlozhenii pri-amogonnymi reaktivnymi toplivami). E. P. SEREGIN, N. M. LIKHTEROVA, A. F. GORENKOV, V. G. GORODETSKII, I. A. LITVINOV et al., *Khimiia i Tekhnologiiia Topliv i Masel* (ISSN 0023-1169), No. 11, 1990, pp. 20-23. 9 Refs.

Experimental results obtained for samples of TS-1, T-1, and T-2 jet fuels are presented to show that the thermal oxidation stability of directly distilled jet fuels can be increased through the modification of the disperse phase of colloidal solutions by lonol. By using this method, thermally stable aviation kerosenes can be produced at oil processing plants that lack hydrorefining facilities. It is noted that the effect of lonol on other fuel characteristics must be determined before final recommendations are given. In the absence of negative effects, the maximum amount of lonol that can be added to a fuel should not exceed 0.1 percent.

A91-37269 Residual stress control in developing processes for the manufacture of compressor blades for gas turbine engines (Kontrol' ostatochnykh napriazhenii pri otrabotke tekhnologicheskikh protsessov izgotovleniia lopatok kompressorov GTD). V. A. BOGUSLAEV, *Problemy Prochnosti* (ISSN 0556-171X), March 1991, pp. 30-33. 5 Refs.

Methods for generating and controlling residual surface stresses in compressor blades of titanium alloys are examined with reference to production experience in the manufacture of compressor blades of VT3-1 and VT8 alloys. It is shown that residual stresses have a noticeable effect on the fatigue strength of the blade foil. The fatigue strength of the blades can be substantially improved by using manufacturing processes that create residual compressive stresses in the blade surface layer.

A91-17175 Critical regimes of the turbine flow path at high velocities (Problemy krizisnykh rezhimov v protochnykh chastiakh turbin pri bol'shikh skorostiakh). M. E. DEICH, A. A. TISHCHENKO, A. P. SHCHERBAKOV, S. A. DAMAZH, *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport* (ISSN 0002-3310), Sept.-Oct. 1990, pp. 108-124. 11 Refs.

Experimental investigations of the flow structure and gasdynamic characteristics of turbine cascades provide evidence of a critical increase in static pressure fluctuations in individual nozzle cascades at transonic velocities. It is shown that the transonic crisis, which involves an abrupt increase in losses, does not occur in the presence of a downstream perturbation source. A hypothesis concerning the mechanism of the critical regimes observed at transonic and supersonic velocities is proposed and supported by experimental data.

A91-13505 Possibilities of small-passage systems of internal convective blade cooling for gas turbines (Vozmozhnosti melkokanal'nykh sistem vnutrennego konvektivnogo okhlazhdeniia lopatok gazovyykh turbin). V. N. KLIMENKO, *Promyshlennaya Teplotekhnika* (ISSN 0204-3602), Vol. 12, No. 4, 1990, pp. 93-98.

The hydraulic and thermal characteristics of turbine blades with small-passage cooling systems are analyzed. It is shown that a generalized hydraulic characteristic can be derived for the cooling systems of gas turbine blades of different dimensions. The initial thermal efficiency of blade cooling is shown to be practically independent of the cooling passage diameter. At the cooling passage outlet, the required cooling efficiency can be obtained only through an increase in air flow rate. The cooling systems described here provide sufficient blade cooling for initial gas temperatures of 1900-1950 K with air flow rates equal to 3 percent of the gas flow rate.

A91-23817 Optimization of process routes in the repair of gas turbine engine components using capillary testing (Ratsionalizatsiia marshrutov remonta detalei gazoturbinnnykh dvigatelei, proveriaemykh kapillyarnymi metodami). IU. A. GLAZKOV, *Defektoskopiia* (ISSN 0130-3082), No. 12, 1990, pp. 76-80. 7 Refs.

Methods are proposed for the optimization of process routes in the repair of gas turbine engine components in order to improve the efficiency of capillary and complex nondestructive testing. The process is optimized by changing the sequence of repair operations, changing the operations themselves, changing test specimen preparation procedures, and changing testing techniques. Examples of repair process optimization are presented for turbine and compressor blades made of a titanium alloy.

A91-15400 Role of colloid systems in the formation of sludge in jet fuels (O roli kolloidnykh sistem v obrazovanii osadkov reaktivnykh toplivami). E. P. SEREGIN, N. M. LIKHTEROVA, V. G. GORODETSKII, A. F. GORENKOV, I. A. LITVINOV et al., *Khimiia i Tekhnologiia Topliv i Masel* (ISSN 0023-1169), No. 9, 1990, pp. 22-24. 11 Refs.

The phase composition of commercial jet fuels TS-1 and RT, as well as some laboratory fuels, were investigated in relation to the susceptibility of the fuels to sludge formation during service. The susceptibility to sludge formation under dynamic conditions was estimated experimentally using electron microscopy. It is shown that the size, shape, and number of disperse phase particles depend on the chemical composition of the heteroatomic compounds. The amount and nature of the disperse phase determine the level of thermal oxidation stability, estimated on the basis of the amount of sludge formed on a heated surface.

A91-13575 Selection of the optimal orientation of single crystal axes in gas turbine engine blades (Vybor ratsional'noi orientatsii osi monokristalla v lopatkakh gazoturbinnnykh dvigatelei). G. N. AZAROVA, B. I. A. KLDNITSKII, and IU. V. SHEKHTMAN, *Akademiiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), July-Aug. 1990, pp. 185-190.

The use of single-crystal nickel-based alloys for the manufacture of gas turbine blades is briefly reviewed, and results of a study concerned with the selection of optimal single crystal orientation in cooled turbine blades are reported. The problem is solved in a three-dimensional formulation, making it possible to analyze the stress-strain state of the blade for arbitrary crystallization axis orientation. Recommendations are given concerning the preferred single crystal orientations for different operating conditions.

A91-13549 Development of jet engines for high-speed flight - Synthesis of achievements in various fields of science and technology (Razvitie vozdušno-reaktivnykh dvigatelei dlia aviatsii vysokikh skorosti poleta - Sintez dostizhenii razlichnykh otraslei nauki i tekhniki). O. N. FAVORSKII and R. I. KURZINER, *Teplotfizika Vysokikh Temperatur* (ISSN 0040-3644), Vol. 28, July-Aug. 1990, pp. 793-803. 8 Refs.

Achievements in thermochemistry are briefly reviewed with particular reference to their role in the synthesis of combined engines based on thermodynamic cycles that are superior to the Brayton cycle traditionally used in jet engines. The possibility of using the high cooling capacity and performance of endothermic fuels is discussed. The results of the study provide a way to increase the flight speed of aviation engines using hydrocarbon fuels.

A90-46514 Cyclic fracture toughness of VT3-1 and VT-25 titanium alloys (Tsiklicheskaia treshchinostoikost' titanovykh spлавov VT3-1 i VT-25). IU. G. BYKOV, A. N. PETUKHOV, and S. A. CHERKASOVA, *Fiziko-Khimicheskaia Mekhanika Materialov* (ISSN 0430-6252), Vol. 26, May-June 1990, pp. 49-53. 6 Refs.

Fatigue crack growth rates were determined experimentally in 50x50x10-mm compact specimens cut out of the compressor disks of aviation gas turbine engines. The crack growth was monitored by optical, ultrasonic, and acoustic emission methods, and fracture surfaces were studied by electron microscopy. The fractographic studies, aimed at estimating the microscopic crack growth rates from the fatigue striation pitch, have confirmed that the crack growth rates are higher in the VT-25 alloy. The results obtained have made it possible to estimate the lives of compressor disks of VT3-1 and VT-25 alloys and can be used for scheduling nondestructive inspection of gas turbine engines.

A90-12552 Application of three-dimensional methods for the calculation of gas dynamic and thermal processes at the design of gas turbines for air breathing engines. M. I. IVANOV and V. K. KOSTEGE, *Proceedings of the 9th International Symposium on Air Breathing Engines*, Vol. 1, Athens, Greece, Sept. 3-8, 1989, (A90-12501 02-07). Washington, DC, American Institute of Aeronautics and Astronautics, 1989, pp. 497-505. 8 Refs.

This paper is concerned with numerical simulation of three-dimensional gas dynamics and thermal problems of turbine design. The investigation of turbine aerodynamic cleanliness is based on the numerical solution of the Euler and Navier-Stokes equations. Here, the implicit high-order-accuracy difference methods are used. The calculation of thermal processes is fulfilled with the help of the finite-element method. The joint solution of these problems makes it possible to have the correct boundary conditions on turbine element surfaces. The application of the developed computational methods permits the local and integral characteristics of cooled turbines to be obtained at the design stage.

A91-13502 Heat transfer and hydrodynamics at the end surfaces of curvilinear turbine passages and nozzle rings (Teploobmen i gidrodinamika na tortsevoi poverkhnosti krivolineinykh kanalov i soplovykh apparatov turbin). A. A. KHALATOV, A. A. KASHCHENKO, and S. A. KHALATOV, *Promyshlennaia Teplotekhnika* (ISSN 0204-3602), Vol. 12, No. 4, 1990, pp. 30-38.

Results of an experimental study of the hydrodynamics and heat transfer at the end surface of curvilinear turbine passages and nozzle rings of commensurable height and width are reported. Data are obtained which characterize velocity distribution at the outer edge of the boundary layer and local heat transfer coefficients. A similarity equation for heat transfer in curvilinear passages and nozzle rings is derived with allowance for the effects of current line curvature, three-dimensional nature of the flow, longitudinal pressure gradient, and downward and upward flows.

A90-46539 Relation between flow parameters of a gas turbine engine and rotor frequencies (O svyazi kolebani parametrov potoka v gazoturbinnom dvigatele s rotornymi chastotami). I. L. PIS'MENNYI, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 20, No. 4, 1989, pp. 62-72. 14 Refs.

The paper is concerned with the hypothesis of longitudinal oscillations in a gas/air flow path which are characterized by a phase variable over the cross section and treated as a rotating stall. The dynamic characteristic of the flow path is determined analytically, and an oscillation model is developed for an elementary jet. The results of the analysis are examined in comparison with the available experimental data on the rotating stall.

A90-46496 Design of the optimal hardening treatment for the metal surfaces of gas turbine engine components (Proektirovanie optimal'noi uprochniaushchei obrabotki metallicheskh poverkhnostei detalei GTD). S. M. BOROVSII and V. S. MUKHIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 1, 1990, pp. 70-74. 5 Refs.

The possibilities offered by the finite element approach to the modeling of the optimum (with respect to maximum load-bearing capacity) plastic surface working of metal materials are examined with particular reference to the surface treatment of gas turbine components. The problem is solved using a relaxation scheme of plastic working, with the strength limit of the interatomic bonds used as the criterion of surface optimality. The approach proposed here is illustrated by results obtained for VT-9 titanium alloy.

A90-46495 Calculation of the efficiency of an active partial-admission gas turbine for counterpressures varying over a wide range (Osobennosti rascheta kpd aktivnoi partial'noi gazovoi turbiny pri izmenenii protivodavlenii v shirokom diapazone). B. V. OVSIANNIKOV, S. E. UVAROV, B. G. KHUDENKO, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 1, 1990, pp. 66-70. 5 Refs.

A mathematical model and a calculation procedure are proposed for determining the efficiency of a partial-admission gas turbine in the case where counterpressures vary over a wide range. The approach proposed here allows for the effect of density on disk losses and also for the effect of the flow angle at the exit section of the nozzle under off-design conditions. It is shown that, as the counterpressure increases significantly, the shock waves enter the post-critical nozzle section, the exit velocity becomes subsonic, and the turbine efficiency is substantially reduced.

A90-43039 Some technological errors in the use of capillary inspection in gas turbine engine repair (Nekotorye tekhnologicheskie oshibki primeneniia kapillyarnogo kontroliia pri remonte GTD). IU. A. GLAZKOV, *Defektoskopiia* (ISSN 0130-3082), No. 3, 1990, pp. 63-69. 9 Refs.

Some typical errors committed during the capillary inspection of gas turbine components in gas turbine engine repair shops are examined. The errors discussed are primarily associated with the application and removal of penetrants, application of the developer, examination of parts and components, and preparation of parts and components for the inspection. Specific errors are illustrated by photographs, and correct test procedures are described.

A90-14573 Design of a language for the testing of aircraft engines (Proektirovanie iazyka ispytaniia aviatsionnykh dvigatelei). IU. V. KOZHEVNIKOV and I. A. ZALIAEV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 66-70.

The paper is concerned with the problem of the development of a problem-oriented language for the man-machine interaction in the dialog mode during the testing of aircraft engines using a computerized testing system. An approach to language design is proposed which is based on the principles of matrix decomposition, language unification, and parametric adaptability. An example of the design of a fragment of the testing language is presented.

A89-47966 Radiation attenuation by a wall layer (Oslableniie izlucheniia pristenochnym sloem). A. B. SHIGAPOV, R. KH. BIK-MULLIN, R. R. NAZYROVA, and Z. KH. GRUZDEVA, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 1, 1989, pp. 59-63.

Results of a parametric study of the effect of various factors determining the wall layer characteristics on the attenuation of radiative heat fluxes are reported. The results obtained are examined from the standpoint of the optimization of aircraft engine operation.

A90-46491 A method for the matching of structural and geometric parameters of the turbocompressors of small gas turbine engines in computer-aided design (Metod soglasovaniia konstruktivno-geometricheskikh parametrov turbokompressorov malorazmernykh GTD v SAPR). V. S. KUZ'MICHEV and I. U. M. SIVTSOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 1, 1990, pp. 50-53. 5 Refs.

A method for matching the structural and geometric parameters of turbocompressors at the design stage is proposed which is invariant to the turbocompressor design scheme. The method allows for state-of-the-art concepts of software development. The relatively small number of equations used, and, correspondingly, the small number of independent variables make it possible to use this method for solving more complex problems of the structural-parametric optimization of small-size turbocompressors during computer-aided design.

A90-39505 Life design of high-temperature turbine blades with minimum cooling requirements (Resursnoe proektirovanie rabochei lopatki vysokotemperaturnoi turbiny s minimal'nymi zatratami na okhlazhdeniie). G. P. NAGOGA, V. I. TSEITLIN, and V. P. BALTER, *Promyshlennaia Teplotekhnika* (ISSN 0204-3602), Vol. 12, No. 2, 1990, pp. 55-62.

The problem of minimizing fuel requirements for the air cooling of gas turbine blades, while providing for a specified service life, is stated and solved for a dual-mode engine. It is shown that, for a multimode engine, the problem should be solved by using nonlinear programming methods. It is further shown that fuel consumption for blade cooling can be minimized only by controlling air flow rate with allowance for the operation mode. Recommendations concerning practical applications of the results of the study are given.

A90-30350 A method and a comprehensive program for calculating the cooling systems and thermal state of gas turbine components (Metodika i kompleksnaia programma sovmeznogo rascheta sistem okhlazhdeniia i temperaturnogo sostoiianiia detalei gazoturbinnoi ustanovki). A. F. SLITENKO and V. I. CHELAK, *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport* (ISSN 0002-3310), Jan.-Feb. 1990, pp. 135-139.

A method for the combined calculation of the cooling system and temperature field of gas turbine components is proposed, and some calculation results are presented. It is shown that the use of a comprehensive program, developed for the combined cooling system-temperature field calculation, makes it possible to reduce the time required for the design of efficient cooling systems for gas turbines and to improve their reliability.

A90-23425 Effect of the control of turbocompressor guide vanes on the throttle characteristics of a bypass engine (Vliianie upravleniia napravliaiushchimi lopatkami turbokompressora na drossel'nye kharakteristiki dvukhkонтournogo dvigatel'ia). I. N. EGOROV, I. A. EFIMOV, A. M. IVANOV, and V. N. FOMIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1989, pp. 87-89. 6 Refs.

The objective of the study was to determine a vane ring control law that would minimize the flow rate under off-design conditions, with no allowance made for the effect of the air scoop and the nozzle. The vane ring characteristics of the compressor were calculated on the basis of an analysis and statistical processing of experimental data obtained for axial-flow stages. The stability margin of the compressor cascades was maintained by using a controlled mixer. The effect of a fully controllable compressor on the throttle characteristics of a two-shaft bypass engine is evaluated.

A90-23410 Optimal selection of the parameters to be measured during the identification of gas turbine engines. I - Problem statement (Optimal'nyi vybor izmeriaemykh parametrov pri identifikatsii GTD. I - Postanovka zadachi). S. V. EPIFANOV, D. F. SIMBIRSKII, and S. A. KAPLUN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1989, pp. 39-44. 9 Refs.

A method is proposed for the optimal selection of measured parameters and other significant experimental factors for the parametric identification of gas turbine assemblies in a full-scale engine system. The approach based on the use of a limited number of measured parameters of the gasdynamic path together with mathematical model is briefly reviewed, and some problems associated with this approach are identified. It is then shown how these difficulties can be solved by using a special parameterization procedure.

A89-48084 Justification for increasing oil change period in aircraft (Obosnovanie uvelicheniia sroka smeny masel v aviatsionnoi tekhnike). B. G. BEDRIK, V. A. BAZDERKIN, V. S. UGRUMOV, A. I. ECHIN, and I. S. KRICHINSKII, *Khimiia i Tekhnologiya Topliv i Masel* (ISSN 0023-1169), No. 6, 1989, pp. 24-26. 5 Refs.

The possibility of extending oil change periods for aviation gas turbine engines is examined with reference to data obtained for oils used in real engines for different periods. The analysis allows for the interrelation between the elements of the oil-engine system during service. It is shown that oil viscosity can be stabilized by the fresh oil added to compensate for oil losses from the system; the adaptability of the oil also contributes to the stabilization of oil quality during operation. These factors act to offset the degradation of the antiwear characteristics during service. The discussion is illustrated by results for MS-8p, IPM-10, and B-3V oils.

A90-23407 A study of the working process and losses in annular turbine nozzle cascades with a low contraction ratio (Issledovanie rabocheho protsessa i poter' v kol'tsevykh soplovykh turbinnnykh reshetkakh ponizhennoi konfuzornosti). I. V. AFANAS'EV, O. N. EMIN, V. I. KUZNETSOV, and A. K. SITNIKOVA, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1989, pp. 28-30. 5 Refs.

Experimental and analytical data are presented on the operation of low-contraction nozzle cascades that are typically used in the fan turbines of high-temperature bypass engines with relatively small bypass ratios. The results presented here demonstrate the possibility of using generalized empirical relations, obtained for plane cascades, for the rough estimation of profile and secondary losses, with three-dimensional flow contraction ratios substituted into these relations.

A90-21324 Finite element analysis of nonstationary temperature fields in gas turbine components (Konechnoelementnyi analiz nestatsionarnykh polei temperatur v detaliakh GTU). I. U. G. ISPOLOV and N. N. SHABROV, *Problemy Prochnosti* (ISSN 0556-171X), Dec. 1989, pp. 82-87. 5 Refs.

A finite element method is proposed for the numerical solution of the nonstationary heat conductivity problem arising in the analysis of the high-temperature strength of the structural elements of power generating equipment. The method has a second degree of accuracy and is absolutely stable. It is shown that the method proposed here has advantages over the traditional methods, such as the Euler and Galerkin methods, in solving stationary heat conduction problems with rapidly varying boundary conditions.

A90-21318 Strength of the guide vane components of gas turbines (K voprosu o prochnosti detalei napravliaiushchikh apparatov gazovykh turbin). A. R. BELIAKOV, L. B. GETSOV, A. E. GINZBURG, K. M. KONONOV, and V. V. BARSKOV, *Problemy Prochnosti* (ISSN 0556-171X), Nov. 1989, pp. 119-124. 8 Refs.

The principal types of damage observed in the components of guide vanes of gas turbines, such as cracking, irreversible deformation, and blade edge bends, are analyzed. Methods for calculating the safety factor of guide vane components under conditions of thermal cycling are then presented which are based on the adaptability theory. The discussion is illustrated by experimental results obtained for guide vane components made of 20Kh23N18 steel and EI868 nickel alloy.

A90-14569 A minimal permissible radial clearance in a gas turbine (Minimal'no dopustimyi radial'nyi zazor v turbine GTD). R. A. KIRZHNER and B. I. MAMAEV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 52-56.

The factors affecting the minimal permissible radial clearance in a gas turbine, which is sufficient to prevent the dangerous contact between the rotor and the casing, are examined. It is shown that the radial clearance changes with the operating conditions and may be relatively large if special efforts are not made to reduce it. Methods of reducing the permissible radial clearance are discussed.

A90-14568 Validation of the accelerated equivalent testing of gas turbine engines for multivariant applications (Obosnovanie uskorennykh ekvivalentnykh ispytaniy GTD mnogovariantnogo primeneniia). A. S. GISHVAROV, O. V. IVANOV, R. G. SARVARETDINOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 49-52.

The paper is concerned with the problem of selecting the optimal number, conditions, and duration of accelerated equivalent tests for aircraft gas turbine engines designed for use on a variety of aircraft operating in different climatic regions. An approach to the selection of the optimal program of accelerated testing is proposed which makes it possible to obtain a guaranteed estimate of the reliability and service life of the engine for each of all the possible applications. The method proposed here is illustrated by a specific example.

A89-52830 Fatigue life of ZhS6U alloy with protective coatings under thermal cycling loading (Dolgovechnost' splava ZhS6U s zashchitnymi pokrytiiami pri termotsiklicheskom nagruzhenii). K. P. BUISIKH and V. G. BARILO, *Problemy Prochnosti* (ISSN 0556-171X), Aug. 1989, pp. 42-47. 6 Refs.

Empirical equations are obtained which relate the fatigue life of ZhS6U, a turbine blade alloy, to the parameters of the thermal and stress-strain states. The equations obtained here provide a way to predict the thermal cycling fatigue life of ZhS6U alloy with different coatings under conditions of inhomogeneous stressed state in the temperature range 1040-1100 C and thermal stress range 220-470 MPa.

A89-48007 Effect of a bend in the contour of the Laval nozzle of a gas turbine engine on flow in the supersonic section (Vliianie izloma kontura sopla Lavalla GTD na techenie v sverzvukovoi chasti). I. U. I. TSYBIZOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1989, pp. 73-75.

Results of experimental studies of a series of plane and axisymmetric Laval nozzles (subsonic convergence angle, 0-40 deg; supersonic convergence angle 30-10 deg) are generalized and discussed with particular reference to the adjustable nozzles of aircraft gas turbine engines. Three characteristic regions are identified on the curve describing wall pressure distribution in the supersonic section; flow characteristics in each of these regions are briefly examined.

A90-14590 Effect of the angle of attack on the efficiency and thrust ratio of axial-flow microturbines with full admission (Vliianie ugla ataki na ekonomichnost' i stepen' reaktivnosti osevykh mikroturbin s polnym vpuskom). N. T. TIKHONOV and E. E. PFAIFLE, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 104-106.

The effect of the angle of attack on the efficiency and thrust ratio of axial-flow microturbines was investigated experimentally for angles of attack varying from -16 to +13 deg using eight different rotors. It is shown that there exists an optimal range of angles of attack for each value of $Y_t = u/c_1s$. Thus, for $Y_t = 0.3$, this range is from -4 to +2 deg. An increase in the angle of attack by 2 deg (i.e., to +4 deg) leads to a 6.8-percent decrease in efficiency; a decrease by 2 deg from the optimal range (i.e., to -6 deg) leads to a 3.5-percent decrease in efficiency. As Y_t decreases, the effect of the angle of attack on efficiency becomes less pronounced and remains constant for $Y_t = 0.1$.

A90-14586 Effect of the radial clearance on the efficiency of a partial microturbine (Vliianie radial'nogo zazora na effektivnost' partial'noi mikroturbiny). B. A. KRYLOV and S. A. GUSAROV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 96-98.

Results of an experimental study of the effect of the radial clearance on the efficiency of partial microturbines with a shroudless rotor are reported. With reference to results obtained for radial clearances of 0.1, 0.3, 0.5, and 1.0 mm and axial clearances of 0.1 and 1.0 mm, it is shown that the effect of the radial clearance on the turbine efficiency significantly increases with the decreasing partial admission ratio and increasing axial clearance. An analysis of the results obtained indicates that high-efficiency partial microturbines can be designed provided that the radial and axial clearances are sufficiently small.

A89-47993 Limiting the service period of gas turbine engine components on the basis of technical/economical efficiency (Ogranichenie narabotki uzlov GTD iz usloviia tekhniko-ekonomicheskoi effektivnosti ego ispol'zovaniia v ekspluatatsii). M. A. KABESHOV, M. E. SHAIKIN, and V. T. SHEPEL', *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1989, pp. 34-36.

A technical/economical approach is proposed for determining the optimal service period of gas turbine engine components before repairs. A criterion based on the cost effectiveness of engine operation is used which takes account of the profit resulting from engine operation and losses due to parametric failures. The approach proposed here is illustrated by a specific example.

A89-42422 Determination of the natural frequency spectra and modes of the fan blade rings of aviation gas turbine engines (K opredeleniiu spektrov sobstvennykh chastot i form kolebaniil ventilatornykh lopatochnykh ventsov aviatsionnykh GTD). V. V. MALYGIN, *Problemy Prochnosti* (ISSN 0556-171X), May 1989, pp. 92-95. 13 Refs.

An approach to the study of the natural frequency spectra of the fan rotors of bypass engines is proposed which is based on the use of both analytical and experimental data. The advantages of the approach, which allows the identification of all frequencies and modes of blade rings, are demonstrated. A method for the identification of the natural modes of rotors, which has been tested on various designs of bypass engines, is presented.

A89-40596 Hydraulic resistance of the inlet channels of a rotor cooling system (Gidravlicheskie soprotivleniia vkhodnykh kanalov sistemy okhlazhdeniia rotora). E. P. DYBAN, B. D. BILEKA, and V. A. MEL'NIKOVA, *Promyshlennaia Teplotekhnika* (ISSN 0204-3602), Vol. 11, No. 2, 1989, pp. 3-7. 13 Refs.

The paper is concerned with the problem of calculating the hydraulic resistance coefficient for short ($L/d = 3-5$) cylindrical and plane channels under static conditions and in the case of rotation about an axis normal to the channel axis. Calculated values of the hydraulic resistance coefficients are presented for the inlet channels of the cooling system of a static and operating gas turbine. It is shown that the hydraulic resistance of the rotating cylindrical and plane channels is higher than that of the static channels by a factor of 1.5-2.3 and 5.6-7.5, respectively.

A90-14584 Determination of the effective areas of the mixing exhaust ducts of a bypass engine from autonomous test results (Opredeleniie effektivnykh ploshchadei kanalov zatrubinnogo ustroistva TRDD po rezul'tatam avtonomnykh ispytaniil). V. I. VASIL'EV, I. V. ZEMNUKHOV, S. I. KRASHENINNIKOV, M. D. MIRSKII, and A. D. PORTNOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 93, 94.

The effective cross-sectional areas of the mixing exhaust ducts of a bypass engine are determined experimentally as a function of the exhaust configuration using small-scale (Re 10 to the 6th) and large-scale (Re 10 to the 7th) models. Dependences of the effective cross-sectional area on the exhaust geometry are obtained for lobe-type mixing exhausts. It is noted that the efficiency of bypass engine control with allowance for actual changes in the effective cross-sectional area is 20-30 lower than in the case of control based on changes in the geometrical area, which should be taken into account in the analysis of engine performance.

A90-14578 Effect of the roughness of deposits in a compressor cascade on the flow lag angle (Vliianie sherokhovatosti otlozhenii v kompressornoi reshetke na ugol otstavaniia potoka). I. U. N. MAL'TSEV and V. G. SHAKHOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 80-82.

The mechanism by which the surface roughness of deposits in compressor cascades affects the flow lag angle is examined with reference to the results of wind tunnel tests on plane compressor cascades with variable artificially created deposits. The flow rate and blading parameters were selected as close as possible to those of real compressors. It is found that, for a fixed angle of attack, the flow lag angle increases with the deposit roughness. The lag angle also increases with the increasing density of the cascade.

A89-37421 Dynamical calculations of engine components based on elasticity equations (O postroenii dinamicheskikh raschetov detalei dvigatelei na osnove uravnenii teorii uprugosti). N. D. KUZNETSOV, L. I. FRIDMAN, A. I. ERMAKOV, and V. N. UKHOV, *Problemy Prochnosti* (ISSN 0556-171X), March 1989, pp. 3-8. 109 Refs.

An elasticity approach to the vibration analysis of gas turbine engine components of complex configurations is proposed which makes it possible to determine the natural frequencies and modes of structures with a higher accuracy than that obtainable with methods based on kinematic hypotheses. The method consists of the approximation of geometrically complex components by canonic bodies, conjugation of these bodies, and derivation of a frequency equation for the whole system.

A89-30182 Improvement of the complex nondestructive testing of calorized turbine blades (Ratsionalizatsiia kompleksnogo nerazrushaiushchego kontroliia alitiruemykh lopatok turbin). I. U. A. GLAZKOV, *Defektoskopiia* (ISSN 0130-3082), No. 1, 1989, pp. 47-50. 6 Refs.

A study is made of the effect of the fused-slurry calorizing of turbine blades during engine rebuilding on the results of capillary (luminescent or chromatic) and eddy current testing. These methods are found to be incapable of detecting cracks up to 15 mm long in the base metal of the blades. In order to ensure the detection of these cracks, testing prior to the calorizing treatment is essential.

A89-30086 High-viscosity and bitumenous oils - Promising raw materials for the production of jet and diesel fuels (Vysokoviazkie i bitumnye nefli - Perspektivnoe syr'e dlia polucheniia reaktivnykh i dizel'nykh topliv). N. M. LIKHTEROVA, G. R. AVDZHIEV, A. F. GORENKOV, *Khimiia i Tekhnologiiia Topliv i Masel* (ISSN 0023-1169), No. 1, 1989, pp. 7-9. 7 Refs.

High-viscosity oils and natural bitumens containing more than 25 percent of resinous-asphaltene components and having a density of greater than 935 kg/cu m are investigated as possible raw materials for the production of aviation jet fuels. In particular, the composition and properties of bitumens from various deposits are briefly reviewed, and a scheme for the processing of bitumenous sandstone is presented. Jet fuels produced from bitumens are characterized with reference to their physicomachanical properties.

Japanese Aerospace Literature This month: Aircraft Engines/Propulsion

A90-40633 Development of the jet-swirl high loading combustor. Y. YONEZAWA, H. TOH, S. GOTO, and M. OBATA, 26th AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, Orlando, FL, July 16-18, 1990. 8 p. (AIAA Paper 90-2451).

With the view to accelerating the mixture between fuel and air and the combustion of the resulting mixture, a new concept of high combustion loading 'jet-swirl' combustor was derived from qualitative and quantitative analysis of the pattern of flow through the combustion liner. A prototype model combustor designed to embody the features of the jet-swirl concept, was tested to verify its combustion performance. This test on the jet-swirl combustor confirms the superior combustion characteristics at high combustion loading that can be expected from this new concept of combustor.

A90-35951 Development of ceramic components for high-temperature gas turbines. Y. HAMANO, T. MAEDA, M. CHIKARASHI, and M. MATSUNAKA, *Proceedings of the 1st MRS International Meeting on Advanced Materials*, Tokyo, Japan, May 31-June 3, 1988, Vol. 5 (A90-35926 15-27). Pittsburgh, PA, Materials Research Society, 1989, pp. 229-239.

The activities of a Japanese company in the U.S. Advanced Gas Turbine Project is reviewed. Improvement of the fracture strength, stress rupture characteristics, and oxidation resistance of silicon nitride are discussed. The development of materials, process control technology, turbine rotors, and static components is examined and results from engine and rig tests are reviewed.