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**30 AUGUST 1979**

**(FOUO 4/79)**

**1 OF 1**

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JPRS L/8639

30 August 1979

# USSR Report

ENGINEERING AND EQUIPMENT

(FOUO 4/79)



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JPRS L/8639

30 August 1979

USSR REPORT  
ENGINEERING AND EQUIPMENT

(FOUO 4/79)

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- a - [III - USSR - 21F S&T FOUO]

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Aeronautical and Space

USSR

UDC 629.78.015.4

THE MINIMIZATION OF WING WEIGHT WITH A LIMITATION ON THE RATE OF DIVERGENCE

Unknown UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTITUTA  
[Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol  
9 No 5, 1978 pp 97-103

BANICHUK, N. V.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.132]

[Text] A generalization of the problem of minimizing the mass of a wing with a limitation on the critical rate of torsional divergence is analyzed for the case of flexible end-restraint and variable parameters. An analytical solution is found for the problem, and it is used to study the influence of end restraint elasticity and wing section variability on the optimum distribution of stiffness over the wing span. Figures 4; references 10.

USSR

UDC 629.78.063(088.8)

A CAM MECHANISM FOR CONVERTING THE RECIPROCATING MOTION OF A DRIVING MEMBER INTO AN INTERMITTENT ROTATION OF THE DRIVEN MEMBER

USSR AUTHOR'S CERTIFICATE No 621920 filed 3 Jan 77 published 21 Jul 78

KOTILEVSKIY, V. A., TERNOVSKIY, V. V. and FEDORKIN, O. T..

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.147P by T. A. Ye.]

[Text] The invention applies to power position actuating mechanisms for transforming the energy in the pressure of a medium into rotational motion, and can be applied to automation systems for aviation and space rocket equipment. The known positional rotation mechanism which is employed for converting the reciprocating motion of a driving member into the intermittent rotation of a driven member contains a roller installed in the driving member, and a driven cylindrical cam with a slot, part of which is made along a screw line, while the edge sections are parallel to the cam. With the reciprocating motion of the driving member, the roller, in moving in the slot of the cam, imparts an intermittent rotational motion to the latter. However, the displacement of the driving member of such a mechanism within limits of  $\pm 3$  mm, for example, in a lateral direction, causes the mechanism to fail. An increase in reliability is achieved by virtue of the fact that the driving member in the cam mechanism is made flexible. Figure 1.

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Nuclear Energy

USSR

UDC 621.311.25:621.039

ON THE PROBLEM OF TRANSMISSION OF HIGH-POTENTIAL HEAT FROM A REACTOR TO A TECHNOLOGICAL CIRCUIT

Moscow ATOMNO-VODORODNAYA ENERGETIKA I TEKHNOLOGIYA in Russian No 1, 1978 pp 150-182

PROTSENKO, A. N. and STOLYAREVSKIY, A. YA.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1U57]

[Text] Some problems of research and development of heat exchangers for nuclear power facilities and their operating conditions are examined. An analysis is made of existing proposals to use various materials for such devices (steels, alloys, ceramics), designs and technological schemes. Estimates are made on the penetration of hydrogen from the technological circuit into the reactor loop as well as fission by-products into the technological circuit under normal and emergency conditions. Various arguments "for" and "against" the use of an intermediate heat transfer circuit are cited. Figures 9; tables 2; references 13.

USSR

UDC 621.311.25:621.039.56(47+57)

SOME RESULTS OF THE INTRODUCTION OF AN AUTOMATED SYSTEM FOR THE CONTROL OF THE TECHNOLOGICAL PROCESSES OF NUCLEAR POWER STATIONS THROUGH THE USE OF CONTROL COMPUTERS

Moscow KIBERNETICHESKIYE PROBLEMY ASU TEKHNOLOGICHESKIMI PROTSSESSAMI [Cybernetic Problems of Automated Systems for Technological Process Control] in Russian 1978 pp 26-30

PROFERANSOV, YU. D., DESYATNIKOV, I. I., POZDNYAKOV, V. A., RUMYANTSEV, L. V., SHCHEDRINA, A. G. and YUMASHEVA, T. G.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U136 by G. I. Korotkina]

[Text] The wide scale development of nuclear power engineering is inseparably tied to the increasing role of automated systems for technological process control in controlling nuclear power stations. The main control system of the most powerful atomic power plants in the USSR with the RBMK-1000 nuclear reactor is the "Skala" information and computer system developed in 1967-1971. The "Skala" system was realized as a two computer complex based on the V-3M control computer. The equipment of this complex consists of two independent processors (V-3M), two independent access channels to the equipment of the object being controlled (V-313, V-31, V-368,

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V-350), peripheral interface equipment (V-377, V-378, V-303, V-317, V-310), which permits the two processors to operate with the peripherals (the NML-V-37 magnetic tape memories, teletypes, alphanumeric printers). The first complete system was supplied for the first unit of the Leningrad Nuclear Electric Plant at the end of 1972 and beginning of 1973 with the first edition of the software. The system was set up over three quarters of the year and placed on-line for the start of the unit in 1973. The "Skala-2" system was introduced in the second unit of the Leningrad Nuclear Electric Plant in the middle of 1975 also with still the first version of programs. The "Skala-3," introduced for the first unit of the Kursk Nuclear Electric Plant in December of 1976, and the "Skala-4" system which has been operating with the unit of the Chernobyl'skaya Nuclear Electric Plant since September of 1977 are operating with the second edition of programs. Depending on the equipment complement, the program system provides for a specified set of industrial process functions. Table 1.

USSR

UDC 621.039

DISPERSION HEAT EMITTING AND ABSORBING ELEMENTS BASED ON GRAPHITE IN A PYROCARBON BINDER FOR HIGH TEMPERATURE GAS COOLED REACTORS

Moscow REAKTORNOYE MATERIALOVEDENIYE. TRUDY KONGRESSA PO REAKTORNOMU MATERIALOVEDENIYU, ALUSHTA, 1976 [Reactor Material Science. Transactions of the Congress on Reactor Material Science, Alushta, 1976] in Russian Vol 6, 1978 pp 308-325

IVANOV, V. YE., ZELENSKIY, V. F., TSYKANOV, V. A., PLOTNIKOV, V. P., ASHIKHMIN, V. P., GURIN, V. A., ONITSENKO, S. I., SUPRUN, I. D., MEDVEDEV, V. L., DANILOV, A. P. and BROVKO, M. M.

[From REFERATIVNYY ZHURNAL, YADERNYYE REAKTORY No 5, 1979 Abstract No 5.50.129]

[Text] It is shown in the report that the utilization of hydrocarbon pyrolysis methods offers broad capabilities for deriving a new class of materials. The chemical composition, structure, density, mechanical characteristics, corrosion and erosion immunity, etc. can be adjusted in a wide range as a function of the area of application of these materials and the requirements placed on them in this case. A scheme for fabricating heat emitting and absorbing elements for high temperature nuclear reactors is described which is based on the utilization of hydrocarbon pyrolysis processes. Results are given from studies of the thermophysical and mechanical characteristics of fuel elements, and the results of corrosion and reactor tests of absorbing materials. The structural features of materials based on a pyrocarbon binder are analyzed. Figures 9; tables 2; references 6.

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NUCLEAR BOILERS WITH REACTORS USING HIGH-TEMPERATURE ORGANIC COOLANTS

Dimitrovgrad SBORNIK DOKLADOV SEMINARA. PERSPEKTIVY ISPOL'ZOVANIYA YADER-  
NYKH REAKTOROV DLYA TEPLSNABZHENIYA GORODOV I PROMYSHLENNYKH PREDPRIYATIY.  
DIMITROVGRAD, 1978 [Collected Papers of the Seminar. Outlook for Using  
Nuclear Reactors in Heat Supply to Cities and Industrial Enterprises.  
Dimitrovgrad, 1977] in Russian, 1978 pp 9-23.

TSYKANOV, V. A., CHECHETKIN, YU. V., KUPRIYENKO, V. A. and BURUKIN, V. P.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1U52]

[Text] It is shown that under conditions that require replacement of fossil fuel with atomic energy, it is advantageous to create special nuclear boilers for heating and hot-water supply. Basic requirements for these devices are formulated. One promising type of reactor for nuclear boilers is the nuclear reactor which uses high-temperature organic coolant. Basic findings of years of operation are cited for the ARBUS nuclear reactor at the Scientific Research Institute of Nuclear Reactors (NIIAR) and experiments carried out on it. Based on results of this research, prospects are considered for creation of nuclear boilers with similar types of nuclear reactors; basic solutions on assuring increased safety and profitability of such devices are noted. Tables 4; references 6.

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UDC 621.311.25:621.039

ON SOME PROBLEMS OF PLANNING NUCLEAR ELECTRIC POWER PLANTS FOR HEAT SUPPLY

Dimitrovgrad SBORNIK DOKLADOV SEMINARA. PERSPEKTIVY ISPOL'ZOVANIYA YADER-  
NYKH REAKTOROV DLYA TEPLSNABZHENIYA GORODOV I PROMYSHLENNYKH PREDPRIYATIY.  
DIMITROVGRAD, 1978 [Collected Papers of the Seminar. Outlook for Using  
Nuclear Reactors in Heat Supply to Cities and Industrial Enterprises. Dim-  
itrovgrad, 1977] in Russian, 1978 pp 139-147

POLISHCHUK, A. A., SKVORTSOV, S. A. and SOKOLOV, I. N.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1U54]

[Text] An examination is made of [elements] of nuclear reactors that determine the reliability and economy of nuclear heating plants: the reactor vessel, the vessel stack designed for working pressure in nuclear reactors, intermediate circuit, nuclear heating plant placement, low energy release rate of the core, A3 + akmu27+l zona control system, etc. A conclusion is drawn on the solvability of most problems associated with development of nuclear heating plants.

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NUCLEAR BOILER BASED ON A WATER-MODERATED WATER-COOLED POWER REACTOR

Dimitrovgrad SBORNIK DOKLADOV SEMINARA. PERSPEKTIVY ISPOL'ZOVANIYA YADER-  
NYKH REAKTOROV DLYA TEPLOSABZHENIYA GORODOV I PROMYSHLENNYKH PREDPRIYATIY.  
DIMITROVGRAD, 1977 [Collected Papers of the Seminar. Outlook for Using  
Nuclear Reactors in Heat Supply to Cities and Industrial Enterprises.  
Dimitrovgrad. 1977] in Russian, 1978 pp 157-171

NALETOV, V. I., VIKHOREV, YU. V., GRISHCHENKO, L. V., DAMRIN, YE. M.,  
YAGOV, V. P. and LUBYANKO, V. N.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1U55]

[Text] In order to determine the possibility of operation of a nuclear  
boiler based on the use of a water-moderated water-cooled power reactor, a  
500 MW boiler is considered with vessel reactor permitting integral and  
divided configuration of the in-pile heat exchanger with natural coolant  
circulation. To exclude possible radioactive contamination of the heat  
network, the technological scheme of the reactor device contains three  
loops with integral and divided configuration of the heat exchangers of the  
in-pile loop and heat network. Basic thermohydraulic characteristics of  
operation of the reactor facility are given for both nominal capacity oper-  
ating mode and fluctuating power conditions in the heat network. Figures  
3; tables 4.

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NUCLEAR HEATING PLANT WITH WATER-MODERATED WATER-COOLED TYPE REACTOR

Dimitrovgrad SBORNIK DOKLADOV SEMINARA. PERSPEKTIVY ISPOL'ZOVANIYA YADER-NYKH REAKTOROV DLYA TEPLOSABZHENIYA GORODOV I PROMYSHLENNYKH PREDPRIYATIY. DIMITROVGRAD, 1977 [Collected Papers of the Seminar. Outlook for Using Nuclear Reactors in Heat Supply to Cities and Industrial Enterprises. Dimitrovgrad, 1977] in Russian, 1978 pp 172-186

DUKHOVENSKIY, A. S., VIKHOROV, YU. V., GRISHCHENKO, L. V., POLISHCHUK, A. A. and REZEPOV, V. K.

[From REFERATIVNYI ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1U56]

[Text] The advisability of using low-temperature WM/WC reactors for heat supply is shown. Questions of control of nuclear reactors are elucidated. The peculiarities of heat load schedules and operating conditions of a nuclear heating plant permit the use of only a boron system for reactor control and protection without mechanical control and safety rods. An estimate is made of the safety and thermotechnical reliability of the device. It is shown that it is economically advantageous to use a nuclear heating plant to cover the base load. Variants of fuel cycles of nuclear reactors are given. Figures 3;

USSR

UDC 621.039.517.3

VELOCITY FIELDS IN FUEL ELEMENT ASSEMBLIES OF FAST REACTORS WITH CHANGE OF GEOMETRY OF PERIPHERAL ZONES

Moscow TEPLOFIZICHESKIYE ISSLEDOVANIYA [Thermophysical Research] in Russian Vol 3, 1977 pp 17-22

ZHUKOV, A. V., SVIRIDENKO, YE. YA., MATYUKHIN, N. M., SOROKIN, A. P., KOTOVSKIY, N. A. and RYMKEVICH, K. S.

[From REFERATIVNYI ZHURNAL, TEPLOENERGETIKA No 11, 1978 Abstract No 11U258]

[Text] Velocity distributions of liquid metal coolant are measured in the channels of cassettes and control and safety rod assemblies with various geometric parameters of models using an electromagnetic method. Methods of calculation are developed which are based on solution of a system of equations of motion for assembly channels allowing for interchannel interaction. General patterns are derived which permit optimization of parameters of peripheral channels.

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DEVELOPMENT OF ELECTRIC DRIVE FOR STEAM TURBINE CONTROL VALVES

Moscow TRUDY MOSKOVSKOGO ENERGETICHESKOGO INSTITUTA [Proceedings of Moscow Power Engineering Institute] in Russian No 362, 1978 pp 108-110

MOSKALENKO, V. V., PREOBRAZHENSKIY, V. I., ANAN'YEV, V. F. and CHIDATKIN, V. M.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1852]

[Text] A regulating valve electric drive was developed to allow for the need to provide variable steam turbine control system speed. A block diagram of the control system is given. To expand experimental resources and compare design variants of the electric drive, provision is made for installing ac and dc electric drives on the turbine. Tests of this system were carried out on a control system model in which the object and the measurement part of the system were simulated on an analog device. Various operating conditions of the syst. were investigated. An oscillogra. is given for the transient process when all or most of the turbogenerator load is relieved. Model tests showed that the system is efficient, provides the necessary speed and maintains the required control quality. Figures 3.

USSR

UDC 621.039.546.5:621.039.531

CHECKING FUEL ELEMENT CLADDING INTEGRITY AND COOLANT RADIOACTIVITY OF THE IN-PILE LOOP OF THE BN-350 REACTOR

TRUDY SOYUZNOGO NAUCHNO-ISSLEDOVATEL'SKOGO INSTITUTA PRIBOROSTROYENIYA [Proceedings of the All-Union Scientific Research Institute of Instrument Building] in Russian No 36, 1978 pp 152-155

BATALIN, YU. D., TVERDOVSKIY, N. D., FILONOV, V. S. and TSURUKIN, YU. P.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 11, 1978 Abstract No 11U241]

[Text] The BN-350 nuclear reactor is equipped with an operational in-loop cladding integrity checker for delayed neutrons and devices for general and spectrometric sensing of the activity of gaseous fission by-products. According to preliminary experimental data obtained during start-up and adjustment work, the standard cladding integrity checker is able to detect one or more fuel elements with leaky cladding. Activity of coolant after decay of  $\text{Na}^{24}$  is due to nuclides of corrosive origin. Tables 3; references 2.

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CERTAIN REQUIREMENTS PLACED ON NUCLEAR-CHEMICAL PLANTS USING HIGH-TEMPERATURE REACTORS

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI SERIYA ATOMNO-VODORODNAYA ENERGETIKA [Problems of Nuclear Science and Technology. Series on Atomic Hydrogen Power] in Russian No 1/4, 1978 pp 19-24

ZAICHKO, N. D., YEMEL'YANOV, I. YA., ALEKSEYEV, A. M., PANCHENKOV, V. M., KORYAKIN, YU. I., ORLOV, A. A., NAZAROV, E. K., CHERNYAYEV, V. A., MIKHAYLOVA, S. A., DUDAKOV, L. P. and RADCHENKO, S. V.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U100 by G. I. Korotkina]

[Text] Plants for the production of ammonia and methanol with a capacity of 2,500--3,000 tons per 24 hours comprise the basis for the engineering, planning and economic design work of the configurations of the first nuclear chemical complexes. The advantages of a two-stage scheme for ammonia production are cited. Possible variants are given for the use of nuclear reactors, the distribution of the thermal power of nuclear reactors among consumers in the production of ammonia based on the two-stage catalytic conversion of methane, as well as the basic values of the process parameters and the working media. A number of technological problems are to be solved, of which the primary ones are: the design and development of reliable nuclear reactors with a coolant temperature at the core outlet of 900-1,400°C and an overall service life of up to 30 years which is in continual annual service for up to 8,000 hours; the design of efficient and reliable means of transferring the heat from the core of a nuclear reactor to the working volume of the industrial process plants; the implementation of engineering measures to assure the protection of the final product and process equipment against induced or added radioactive contamination; the solution of the diffusion problem both as regards the core in the technical channel and in the return direction. Figures 2; table 1; reference 1.

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THE CHOICE OF THE STRUCTURAL DESIGN CONCEPT AND THE SPECIFIC PHYSICAL FEATURES OF THE CORE OF HIGH-TEMPERATURE GAS-COOLED REACTORS FOR ENERGY INTENSIVE PRODUCTION FACILITIES

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA ATOMNO-VODORODNAYA ENERGETIKA [Problems of Nuclear Science and Technology. Series on Atomic Hydrogen Power] in Russian No 1/4, 1978 pp 49-56

GOROSHKIN, G. P., KAMINSKIY, A. S., KOLGANOV, V. D., KUZ'MIN, YE. M., SEGAL', M. D. and SMETANNIKOV, V. P.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U99 by G. I. Korotkina]

[Text] Two directions for the design of high-temperature gas-cooled nuclear reactors (HTGR) are treated: with a stationary core and movable fuel elements in the core. The drawbacks of these approaches in reactor construction are cited. The proposed variant of the equipment has the characteristic physical feature of HTGR's. The following characteristics were obtained as the result of structural design work, neutron physics and thermal hydraulic calculations for the nuclear reactor: a thermal power of 538 MW; a core diameter of 6 m and a height of 5 m; the number of channels is 3,481; the diameter of a fuel element is 60 mm; the uranium charge is 6,570 kg; it is enriched by 6.5% in profiled regions I and III and 10% in region II; the operating period: 800 days for fuel elements of profiled regions I and III, and 800 days for II region fuel elements; the coolant in the nuclear reactor is helium; the mass rate of flow of the coolant in the in-pile loop is 160 kg/sec; the coolant temperature at the reactor input is 306°C; the coolant temperature at the reactor output is 950°C; and the coolant pressure in the in-pile loop is 40 kgf/cm<sup>2</sup>. Figures 5.

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THE PROSPECTS FOR THE DESIGN OF NUCLEAR POWER PLANTS WITH CHEMOTHERMAL HEAT ENERGY STORAGE

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA ATOMNO VODORODAYA ENERGETIKA [Problems of Nuclear Science and Technology. Series on Atomic Hydrogen Power] in Russian No 1/4, 1978 pp 74-86

PONOMAREV-STEPNOY, N. N., PROTSENKO, A. N. and STOLYAREVSKIY, A. YA.

[From REFERATIVNYY ZHURNAL, TELPOENERGETIKA No 10, 1978 Abstract No 10U53 by G. I. Korotkina]

[Text] One of the promising approaches to expanding the possible performance range and scale of introduction of nuclear power stations can be the use of nuclear power plants in conjunction with energy storage units. Such energy storage units can be the following: acid type electrochemical storage batteries; water storage power stations, hydrogen storage and water electrolysis plants which can be combined with peak load gas-steam plants which employ stored hydrogen to cover the peak loads; steam-and-water, oil, air liquid metal and molten salt thermal energy storage units. Possible chemothermal storage cycles and the advantages of such storage are cited: the high specific energy capacity of chemical conversion processes (50--75 Kcal/mole; 1--2 Kcal/g of stored product), which exceeds the specific energy capacity of phase transformations by one to two orders of magnitude; the high level of the equipment and process base for chemical conversion in industry; the simplicity in storing the accumulating substance (converted gas), the unlimited storage duration; the high efficiency of such systems (about 65--75%). Steam with such parameters as 130 bars and 510°C can be obtained in a thermal energy storage system. Figures 10; table 1; references 12.

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UDC 621.039.53.004.2

THE SPECIFIC FEATURES OF THE OPERATION OF THE METAL MATERIALS OF HELIUM COOLED FAST REACTORS

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA ATOMNO-VODORODNAYA ENERGETIKA [Problems of Nuclear Science and Technology. Series on Atomic Hydrogen Power] in Russian No 1/4, 1978 pp 136-141

ARTEMOVA, YE. M., BALANDIN, YU. F., BEREZHKO, B. I., GRIBOV, N. N., BUSHIN, YU. A., IGNATOV, V. A., NIKOLAYEV, V. A., PARSHIN, A. M. and SOLOMKO, YU. V.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U258]

[Text] Based on the operational experience of non-Soviet high-temperature gas-cooled reactors, the influence of helium on the change in the mechanical properties of materials during their operation in nuclear reactors, the phenomenon of helium permeability of materials, processes of high temperature embrittlement of austenitic steels and alloys, problems of radiation embrittlement and swelling of structural materials are treated. In media with an oxidizing potential, which correspond to "normally" contaminated helium, the major components of steels and alloys, Fe and Ni, will not oxidize. The oxidation of Nb is of low probability and Cr, Ti, Al and Si will always oxidize. Figures 4; table 1; references 4.

USSR

UDC 621.039.524.034.3.002.5

CLOSED-CYCLE GAS TURBINE PLANTS FOR SOVIET-MADE HIGH-TEMPERATURE GAS-COOLED REACTORS

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA ATOMNO-VODORODNAYA ENERGETIKA [Problems of Nuclear Science and Technology. Series on Atomic Hydrogen Power] in Russian No 1/4, 1978 pp 161-165

UVAROV, V. V., BEKNEV, V. S., IVANOV, V. L., SUROVTSEV, I. G., YANSON, R. A., BOGOYAVLENSKIY, R. G., NIKIFOROV, YU. D. and GREBENNIK, V. N.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U112 by G. I. Korotkina]

[Text] Three types of gas-cooled nuclear reactors are considered: the thermal HTGR proper, the FBR and fusion reactors based on the principle of the fusion of the light nuclei of hydrogen, deuterium and tritium. Today, HTGR's operate with steam turbine plants at a temperature of the helium

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cooling the nuclear reactor of 720--780°C and pressure on the order of 5--6 MPa, which yields a nuclear power station efficiency of about 37-39% at a power of 300 MW. Plans are being developed for nuclear power stations of this type with capacities of 770 and 1,200 MW. A HTGR with a gas turbine plant is the next promising step in the development of nuclear power engineering. Configurations are shown for a HTGR with a gas turbine plant and with a binary ammonia cycle. The problem of nuclear reactor economy has lead to the development of FBR's capable of breeding fission materials ( $U^{233}$ ), which are the basic fuel for HTGR's. Some results are given for the work carried out in the "Turbine Construction" problem laboratories of the Moscow Order of Lenin and Order of the Red Banner of Labor Advanced Engineering School imeni N. E. Bauman on gas turbine plants for nuclear power stations with HTGR's. An experimental industrial plant is designed around a VGR-50 with a steam turbine circuit. The thermal power of the HTGR is 137 MW, the helium pressure in the core is 4.0 MPa, the maximum helium temperature in the cycle is 800°C, and at the inlet to the HTGR, because of the strength considerations, the helium temperature should not exceed 400°C. The possibility of designing a single circuit, direct cycle, gas turbine plant with a VG-400 nuclear reactor was analyzed in this laboratory, where the reactor has a helium temperature at the output of 950°C at a pressure of 6.0 MPa. Figures 8; references 4.

USSR

UDC 621.039.524.034.3

THE MAJOR ENGINEERING REQUIREMENTS PLACED ON THE EQUIPMENT OF HIGH-TEMPERATURE GAS-COOLED REACTORS WITH SPHERICAL FUEL ELEMENTS WHEN COMPREHENSIVE RADIATION ENERGY CHEMICAL PLANTS ARE DESIGNED AROUND THEM

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA ATOMNO-VODORODNAYA ENERGETIKA [Problems of Nuclear Science and Technology. Series on Atomic Hydrogen Power] in Russian No 1/4, 1978 pp 169-172

BREGER, A. KH., GLEBOV, V. P., GREBENNIK, V. N., DUBROVSKIY, YE. M., MAZAREV, V. M., PONOMAREV-STEPNOY, N. N., PROTSENKO, A. N., RUDOY, V. A., SAFRONOV, YE. YA., SEMCHENKO, E. L., SERKOV, E. V., SOLOV'YEV, S. P., STARIZNYI, YE. S., SYRKUS, N. P. and SHAN'GIN, B. V.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U101 by G. I. Korotkina]

[Text] The scales of radiation chemical production and the basic characteristics of the requisite radiation equipment are treated in brief. The unit power of existing and planned irradiators with  $Co^{60}$  sources does not exceed 20-30 KW for technical reasons, while the gamma power of the installations which is required in practice should amount to hundreds of kilowatts. A

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basic schematic is shown for a complex energy radiation installation based on a high-temperature gas-cooled reactor with spherical fuel elements. The technical requirements placed on a fuel element and the irradiator are given, questions of safety of the radiation chemistry installation are analyzed, as well as for the nuclear reactor under normal operating conditions and in emergencies; heat losses from the uranium radiation circuits; protection against mechanical and other effects in case of an emergency in the radiation chemistry installation; the possibility of total or partial detachment of the irradiator from the nuclear reactor and its repair without shutting down the nuclear reactor and the power engineering portion of the installation. Characteristics are given for the irradiator of a VGR-50 installation. Technical requirements placed on nuclear reactor operating modes are presented. Figures 2; references 8.

USSR

UDC 621. 039.524.2.034.44-97

THE RBMK-1000 SERIES PRODUCED POWER REACTOR WITH AN ELECTRICAL POWER OF 1000 MW

VOПРОSY АТОМНОЙ НАУКИ И ТЕХНИКИ. СЕРИЯ ФИЗИКА И ТЕХНИКА ЯДЕРНЫХ РЕАКТОРОВ [Problems of Nuclear Science and Technology. Series on Reactor Physics and Technology] in Russian No 1/21, 1978 Part 1, pp 14-27

VASILEVSKIY, V. P., KUZNETSOV, S. P. and POLUSHKIN, K. K.

[From REFERATIVNYY ZHURNAL TEПЛОENERGETIKA No 10, 1978 Abstract 10U86]

[Text] The equipment of a power facility with the series produced RBMK-1000 reactor with a capacity of 1,000 MW is described. The structural design of the nuclear reactor is described, its neutron physics and thermal engineering characteristics are given, and questions of nuclear power plant safety are treated. Experience acquired in starting and operating the existing nuclear power stations with RBMK-1000 reactors is analyzed.

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UDC 621.039.562+621.039.524.2.034.44-97

THE STATE OF THE ART AND PROSPECTS FOR THE DEVELOPMENT OF MONITOR AND CONTROL SYSTEMS FOR HIGH POWER BOILING WATER REACTORS

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA FIZIKA I TEKHNIKA YADER-NYKH REAKTOROV [Problems of Nuclear Science and Technology. Series on Re-actor Physics and Technology]-in Russian No 1/21 Part 1, 1978 pp 36-40

YEMEL'YANOV, I. YA.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 9, 1978 Abstract No 9U131]

[Text] The structure and functions of the control and monitoring systems for the RBMK-1000 [1,000 MW boiling water reactor] are described, including the system for the local automated control of reactor power (LAR) and the instruments and devices used for these purposes. The factors which stimulated the refinement of these systems for RBMK-1000, RBMK-1500 and RBMK-2400 type reactors are analyzed. The basic directions and stages in the further development of high-power channel reactor monitor and control systems are formulated on this basis, where these systems presuppose the wide-scale application of computers for the regulation of energy distribution. Figure 1.

USSR

UDC [621.311.25.621.039]:697.34"313"

OUTLOOK FOR THE USE OF NUCLEAR REACTORS FOR CENTRALIZED HEAT SUPPLY AND DISTRICT HEATING

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA FIZIKA I TEKHNIKA YADERNYKH REAKTOROV [Problems of Nuclear Science and Technology. Series on Reactor Physics and Technology] in Russian No 1/21, part I, 1978 pp 92-104

BATUROV, B. B., CHERNYAYEV, V. A., GALAKTIONOV, I. V. and SMIRNOVA, YE. S.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 12, 1978 Abstract 12S223]

[Text] Under the conditions of the European part of the USSR, nuclear heat and electric power plants (TETs) with conventional types of nuclear reactors can be economically competitive with fossil-fuel TETs with unity thermal power of the nuclear reactor at 2000-3000 megawatts. This makes it necessary to build nuclear TETs with a large connected heat load (greater than 1000 Gcal/hr) and to connect special condensation facilities to the TETs.

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Central heating turbines of nuclear TETs should have well-developed low-pressure cylinders and operate with constant flow rate of steam even when thermal load is disconnected. The TETs should be placed 40-60 km from large cities and population masses. To reduce thermal effluent into the environment and raise specific production of electrical energy in thermal requirement of the TETs, it is advisable to raise initial parameters of steam before the turbine to 130-240 kgs/cm<sup>2</sup>, 530-560°C. Nuclear boilers can economically provide heat supply at thermal loads of greater than 1500 Gcal/hr and primarily in those regions where it is impossible to erect a nuclear TETs. In the future, in the event of successful development and assimilation of high-temperature nuclear reactors and assimilation of systems for heat transport in the chemically bound state, nuclear and chemical sources of centralized heating can be created nuclear-chemical TETs and combines. The creation of nuclear-chemical combines will permit a significant expansion of the range of effective use of nuclear energy resources for centralized heat supply by encompassing small users of heat. Figures 7; references 7.

USSR

UDC 621.039.566.001.5

A STUDY OF THE FUEL CHARGES FOR AN ORGANIC-COOLED URANIUM-GRAPHITE CHANNEL REACTOR

VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA FIZIKA I TEKHNIKA YADERNYKH REAKTOROV [Problems of Nuclear Science and Technology. Series on Reactor Physics and Technology] in Russian No 1/21, 1978 Part 1 pp 105-111

BULKIN, YU. M., ZHIRNOV, A. D., ZAMORA, P. V., MITYAYEV, YU. I. and SMIRNOV, V. S.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U73]

[Text] Various fuel charges for an organic-cooled uranium-graphite channel reactor used in district heating are analyzed, where the charges differ in the structural design of the fuel channels, the type of nuclear fuel, the power and spacing of the channel lattice. The repeated utilization of plutonium is investigated and the possibility of nuclear power operation on self-supplied plutonium is ascertained. The physical characteristics of various fuel charges are given for nuclear reactors with a thermal capacity of 1,000 MW and their variation is estimated for the case of sectional-modular utilization of a nuclear reactor with a core in the form of a parallelepiped. Figures 3; tables 1; references 3.

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HIGH TEMPERATURE GAS COOLED NUCLEAR REACTORS

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA FIZIKA I TEKHNIKA YADERNYKH REAKTOROV [Problems of Nuclear Science and Technology. Series on Reactor Physics and Technology] in Russian No 1/21, 1978 Part 1 pp 117-124

GUR'YEV, V. V., KRUGLOV, A. L., KUZ'MIN, YE. M., SMETANNIKOV, V. P., ULASEVICH, V. K. and GANEV, I. KH.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 10, 1978 Abstract No 10U96]

[Text] The basic technical characteristics and structural design features are given for an experimental industrial power plant with an AGAT reactor for a chemical combine with a production capacity of 3,000 tons of ammonia per 24 hours, an experimental industrial steam generating plant with a fast helium reactor (of the BGR-300 type), with an electrical power of 300 MW, a fast gas cooled reactor of the DRG series, an experimental BIR loop type nuclear reactor for studies of fuel elements, structural materials, the dynamics of gas cooled systems, improving equipment, etc. Figures 4; table 1.

USSR

UDC 621.165(088.8)

LOW-PRESSURE REGENERATION SYSTEM FOR A TURBINE UNIT

USSR AUTHOR'S CERTIFICATE No 595523, filed 24 Jan 74 published 10 Mar 78

YEFIMOVICHKIN, G. I., All-Union Scientific Research Institute of Heat Engineering

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA in Russian No 1, 1979 Abstract No 1S81P]

[Text] The purpose of the invention is to improve working reliability, increase deaeration capacity and reduce the dimensions of the preheater. This is done by using a perforated sheet to divide the steam chamber of the mixing preheater into two sections. The upper section is connected to the bleeder steam line, and the lower section is connected to the line for steam extraction from the seals. The water cavity is connected to the lines for removing the drainage and steam-air mixture from the next surface heater on the path of the main condensate. In addition, in order to utilize the heat of the superheated steam coming from the seals and from turbine bleeding, an auxiliary surface heat exchanger is installed at the inlet of at least one steam line to the premixing heater, and this heat exchanger is connected to the pressure line for the main condensate downstream from the mixing heater. Figure 1.

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Non-Nuclear Energy

USSR

UDC 697.34:621.311.22"313"

DEVELOPMENT AND PROSPECTS FOR URBAN CENTRALIZED HEAT SUPPLY

Sofiya RAZVITIE I PERSPEKTIVI NA TSENTRALIZIRANOTO TOPLOSABDYAVANE NA GRADOVETE in Bulgarian Vol 29 No 4-5, 1978 pp 42-45

STOEV, Vladimir

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1S222 by B. N. Gromov]

[Text] The initial development of centralized heat supply (CHS) in Bulgaria dates back to 1955 when the TETs "Sofiya" began providing heat to the administrative center of the Bulgarian capital. In 1965, the connected load of CHS was 360 MW, and in 1975 it was 1860 MW; CHS covered about 16% of the population of cities for which construction of CHS was economical and in Sofiya, coverage was 35%. In the outlook to 1990, it is proposed to increase CHS load to 8600 MW providing heat for 50% of the population of cities with more than 25,000 inhabitants. The development of CHS is economical when the heat release rate is greater than 35-40 MW/km<sup>2</sup> and optimum coefficient of district heating is 0.3 to 0.4. Shortcomings in the realization of prospective heat supply systems are noted. In the near future reliable channel-free heat conduits of 300 millimeters or less diameter, stable anti-corrosion coatings, small noiseless circulation pumps for thermal points, plastic pipelines for distribution grids and heat storage units must be created. The future holds construction of systems of further heat supply from nuclear power plants and CHS using low-quality kinds of fuel. It is necessary to separate hydraulic conditions in mainlines and distribution grids using heat exchangers, remote control and dispatcher systems. Figure 1; table 1.

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UDC 662.997:537.22(02)

TECHNOLOGY AND TESTING OF SOLAR CONCENTRATION SYSTEMS

Tashkent TEKHOLOGIYA I ISPYTANIYA GELIOTEKHNICHESKIKH KONTSENTRIRUYUSH-  
CHIKH SISTEM in Russian Izd-vo Fan 1978 pp 184

ZAKHIDOV, R. A.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 11, 1978 Abstract No 11G73K]

[Text] The foundations for planning, manufacturing and testing of mirror concentrating systems (MCS) are presented. The need is justified for a systems approach to the study of MCS of powerful solar energy devices; the importance is noted of modeling as a primary part of planning. Structural features of MCS, methods of shaping reflective surfaces on glass, metal and polymer substrates, technology of application of mirror and protective coatings are examined. Spinning devices for producing precision paraboloid surfaces are described. Attention is given to the problem of adjustment; some automated adjustment schemes are shown. From assumptions of the theory of automated control, solar device servo systems and means of their improvement are analyzed. The possible use of the principle of invariance to raise accuracy of servo systems is studied. Figures 78; tables 2; references 274.

USSR

UDC 621.182:621.165-596(088.8)

METHOD OF TURBINE AND BOILER PROTECTION

USSR AUTHOR'S CERTIFICATE No 569793, filed 11 May 75 published 5 Oct 77

YERSHOV, V. A., TRAKHTENGERTS, G. M., MORACHEV, V. P. and DAVYDKINA, M. KH.,  
Donetsk Division, All-Union Trust on Organization and Efficiency Promotion  
of Regional Electric Power Plants and Networks

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1S176 by  
G. V. Malevinskiy]

[Text] When the boiler is disconnected by a protector, the turbine is relieved by acting on a motor, rather than being disconnected. Unloading stops when steam pressure drops to the assigned value downstream from the control stage of the turbine. If one of the turbine protectors should operate during load relief, the turbine is disconnected after completion of load relief. This method of protection is more economical than simultaneous disconnection of boiler and turbine (owing to production of additional electrical energy with heat accumulated by the boiler and steam conduits). Turbine reliability does not noticeably decrease.

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Turbine and Engine Design

USSR

UDC 621.224-226.3:621.313.322

RESULTS OF STUDIES OF THE FINISHING OF THE FLOW SECTION OF A TURBINE AND AN INVESTIGATION OF THE LOADS ON THE STATOR BLADES

Leningrad NAUCHNYYE ISSLEDOVANIYA DLYA SAYANO-SHUSHENSKOY GES. MATERIALY NAUCHNO-TEKHNICHESKOY KONFERENTSII, 1977 [Scientific Research for the Sayan-Shushen Hydroelectric Plant. Materials of the Scientific and Technical Conference, 1977] in Russian 1978 pp 165-171

KUZMINSKIY, S. S., NEVSKIY, D. YU., PYLEV, I. M., PISANOV, B. N., IVLEV, A. G. and BUKHALOV, N. S.

[From REFERATIVNYY ZHURNAL, TURBOSTROYENIYE No 3, 1979 Abstract No 3.49.120]

[Text] The flow section of the turbine of the Sayan-Shushen Hydroelectric Plant with a maximum efficiency of about 96% is described. A rotor is obtained with good power engineering and cavitation properties, as well as a good technological shape of the blades. A replaceable rotor was worked out which provides for placing the hydroelectric plant on line ahead of schedule. The profile of the stator blades is completed and data are obtained on the influence of turbine operation of its hydrodynamic and geometric characteristics, including the case of loss of blade control.

USSR

UDC 621.224-253.5:620.193:621.313.322

CAVITATION AND EROSION STUDIES OF PROTOTYPES OF MODEL TURBINE ROTORS

Leningrad NAUCHNYYE ISSLEDOVANIYA DLYA SAYANO-SHUSHENSKOY GES. MATERIALY NAUCHNO-TEKHNICHESKOY KONFERENTSII, 1977 [Scientific Research for the Sayan-Shushen Hydroelectric Plant. Materials of the Scientific and Technical Conference, 1977] in Russian 1978 pp 171-174

BOL'SHAKOV, D. S., BUSYREV, A. I., DOLGOPOLOV, V. A. and STARITSKIY, V. G.

[From REFERATIVNYY ZHURNAL, TURBOSTROYENIYE No 3, 1979 Abstract No 3.49.122]

[Text] The results of cavitation and erosion studies of working prototypes of model rotors of the Sayan-Shushen Hydroelectric Plant carried out at heads of up to 64 m, are given. An optical system is described which is intended for researching the cavitation phenomena at the rotating rotor of the model turbine.

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UDC 621.224:539.4

STRENGTH STUDIES OF TURBINE STRUCTURES

Leningrad NAUCHNYYE ISSLEDOVANIYA DLYA SAYANO-SHUSHENSKOY GES. MATERIALY NAUCHNO-TEKHNICHESKOGO KONFERENTSII, 1977 [Scientific Research for the Sayan-Shushen Hydroelectric Plant. Materials of the Scientific and Technical Conference, 1977] in Russian 1978 pp 179-187

ARONSON, A. YA., KAGAN, YE. M., KOVALENKO, V. A., KOMOV, N. P., PETROV, YU. P. and YAVITS, S. N.

[From REFERATIVNYY ZHURNAL, TURBOSTROYENIYE No 3, 1979 Abstract No 3.49.128]

[Text] The design calculations and experimental substantiation are given for the most heavily loaded components of a hydroelectric turbine set: the volute chamber and the rotor. The volute chamber is a steel-reinforced concrete structure. The distribution of stresses in the steel shell of the chamber is obtained, as well as in the components of the stator and the reinforcement of the turbine block. Experimental and theoretical studies of the rotor are cited for minimum starting and maximum head modes. The pulsations of the pressure at the blades were determined for the same operational modes. The frequencies and waveforms of the natural oscillations of the rotor are determined and an analysis is made of the possibility of resonance oscillations arising in it. The research which was carried out made it possible to work out a reliable structural design for the rotor and the volute chamber of the Sayan-Shushen Hydroelectric Plant. Figures 2; references 5.

USSR

UDC 621.165:621.313.322

STUDIES TO SUBSTANTIATE THE STRUCTURAL DESIGN OF A TURBINE BLOCK WITH A STEEL REINFORCED CONCRETE VORTEX CHAMBER

Leningrad NAUCHNYYE ISSLEDOVANIYA DLYA SAYANO-SHUSHENSKOY GES. MATERIALY NAUCHNO-TEKHNICHESKOY KONFERENTSII, 1977 [Scientific Research for the Sayan-Shushen Hydroelectric Plant. Materials of the Scientific and Technical Conference, 1977] in Russian 1978 pp 187-192

AYZENBERG, V. I., ARKHIPOV, A. M., ZUBRITSKAYA, M. A., KARAVAYEV, A. V., KARTELEVA, G. A., KOSMATOVA, G. E. and SOKOLOV, I. B.

[From REFERATIVNYY ZHURNAL, TURBOSTROYENIYE No 3, 1979 Abstract No 3.49.127]

[Text] The structural design of the turbine block adopted for use at the Sayan-Shushen Hydroelectric Plant is described. The design calculation procedure for massive steel reinforced concrete structures using computers is



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presented. Results are given for the tests of three large scale models of the power plant. Figures 2.

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ENERGY SYSTEM MODEL FOR INVESTIGATING THE EFFICIENCY OF UNLOADING STEAM TURBINES

Kharkov VESTNIK KHAR'KOVSKOGO POLITEKHNICHESKOGO INSTITUTA in Russian No 143, 1978 pp 28-31

ABRAMOVA, L. I., GURARIY, M. I., KRASOVSKIY, V. V., MASHCHENKO, V. P.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 1, 1979 Abstract No 1S48]

[Text] The problem is reproducing functional relationships according to the basic equation of motion of a turbine rotor is solved. A model is proposed for an energy system to study the effect of various factors on efficiency of the process of turbine load relief. References 3.

USSR

UDC 621.438-226.2(088.8)

METHOD OF FEEDING COOLANT INTO THE GUIDE VANE ASSEMBLY OF GAS-TURBINE EQUIPMENT

USSR AUTHOR'S CERTIFICATE No 585303, filed 2 Aug 76 published 23 Dec 77

BALASHOV, YU. A., All-Union Scientific Research Institute of Heat Engineering imeni F. E. Dzerzhinskiy, Moscow

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 11, 1978 Abstract No 11S106P]

[Text] The purpose of the invention is to raise economy and reliability of operation of the device in starting modes. At the instant of turn-on of the combustion chamber and during subsequent overshoot of gas temperature, the relative consumption of coolant is increased to a value which exceeds by a factor of 1.5-2 its nominal value; after overshoot the flow rate is reduced to a value of 0.25-0.3 and is kept constant up to the temperature limit of vane strength; subsequently the flow rate is increased to the nominal value in proportion to the rise in power of the facility. During temperature overshoot, coolant is fed from an external source, and after overshoot, from the turbine compressor. Figures 2.

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UDC 629.7.036.3:621.65(088.8)

A FLUID FEED SYSTEM

USSR AUTHOR'S CERTIFICATE No 630451 filed 25 Oct 76, published 19 Sep 78

BAN'KOVSKAYA, I. Z., PETROV, V. I., CHEBAYEVSKAY, Z. F. and LITIN, V. V.

[From REFERATIVNYY ZHURNAL, AVIATIONNYYE I RAKETNYYE DVIGATELI No 5, 1979  
Abstract No 5,34,44P]

[Text] A liquid feed system is patented which contains a vane pump with an auger impeller, a cylindrical inlet line and a high pressure fluid nozzle mounted coaxially with the impeller, where the nozzle is connected to the chamber of the high pressure pump by a line. To increase operating economy and expand the range of stable operational modes by means of assuring the constancy of the attack angles of flow along the inlet edges of the vanes and eliminate counter flows at the periphery of the rotor which is oversized in terms of area, the nozzle is positioned at a distance from the inlet edges of the vanes of the rotor amounting to 4.5--6.5 of the diameter of the inlet pipe. Figure 1.

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Navigation and Guidance Systems

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UDC 629.78.017.2

APPLIED PROBLEMS OF THE STABILITY OF STABILIZED OBJECTS

Moscow PRIKLADNYE ZADACHI USTOYCHIVOSTI STABILIZIROVANNYKH OB'YEKTOV in Russian 1978 Mashinostroyeniye Publishers, 232 pp

RABINOVICH, B. I.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.66]

[Text] The monograph is devoted to applied problems of the stability of objects, the motion of which is stabilized by continuous or discrete regulators. Engineering methods of studying the stability of a closed control object--controller system are presented, both analytical and numerical types, including new algorithms for deriving and solving the characteristic equation which can be realized on computers. These methods are illustrated using the example of a flight vehicle and several promising transport systems and structures. The first four chapters of the book are devoted to the derivation, transformation and solution of the characteristic equation of an object--controller system using approximate and exact methods, where this system corresponds to the stabilized object. The results are the basis of a strategy for studying the stability of stabilized objects, taking their specific properties into account. The solution of stability problems for linear continuous and discrete systems, presented using a number of specific examples, which relate to various fields of engineering, comprise the content of the last three chapters. The book is intended for scientific workers and design engineers and specialists in applied mechanics. It can be useful to students and graduate degree candidates of the higher technical educational institutes.

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THE STABILIZABILITY OF SPACE VEHICLES, NEW PROBLEMS AND METHODS

Moscow STABILIZIRUYEMOST' KOSMICHESKIKH LETATEL'NYKH APPARATOV. NOVYYE ZADACHI I METODY in Russian 1978 Mashinostroyeniya Publishers, 207 pp

CHEREMNYKH, S. V.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.65K by T. A. Ye.]

[Abstract] The questions of stabilizing space vehicles in the active portions of flight are analyzed from the viewpoint of several new methods of motion control theory. A new approach to the study of the dynamic properties of a space vehicle as a control object is set forth, which is an extension of Kalman controllability and observability theory as applied to this class of objects. Diverse problems of space vehicle dynamics analysis are considered, which are encountered in various stages of their design. Several problems characteristic of contemporary linear control system theory (questions of dynamic instability, controllability, observability, modal control in various situations, etc.) are treated in Chapter 1 using an extremely simple model incorporating two coupled oscillators. Chapter 2 is devoted to a presentation of stabilizability theory. The content of chapters 3 and 4 is of an applied nature: questions of the stabilizability of various models of spacecraft are investigated in them, as well as related questions which concern the design of optimum objects (in a dynamic sense). The mathematical models of the space vehicles employ a level of completeness which is satisfactory for the initial stages of the design of objects of this kind: the equations are assumed, as a rule, to be linear, and the constants are considered invariant ("frozen" for a particular characteristic point in time  $\tau$  of the active portion). In this case, an oscillatory nature is imparted to the control object primarily by the presence of moving components of the fuel which provide for the operation of the in-flight engines, as well as the elasticity of the frame and other structural components. An automatic stabilization unit (in a transverse oscillation mode) is considered as the controllers, while in the case of longitudinal oscillations, the power plant is used directly. The investigations of specific packaged spacecraft configurations and typical modes for its motion provide a basis for assuming that the proposed methods are a sufficiently effective tool for studying the dynamic properties of a spacecraft with a liquid fuel engine under conditions where the a priori information on the stabilization system is incomplete. It is emphasized that the effectiveness of the methods for studying the stabilizability is especially pronounced when they are employed in conjunction with classical analysis methods, preceding them in the general process of studying the stability of the class of objects considered here. For this reason, a number of traditional methods are presented in Chapter 5 for analyzing the

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stability of a closed spacecraft-controller system, and questions of amplitude stabilization are considered. Primary attention is devoted to the interpretation of the regions of stabilizability of spacecraft when studying the stability of the control processes in the active portion of the flight. The book is intended for engineering and technical workers who are engaged in the design of rocket and aviation equipment.

USSR

UDC 629.78.036.54

THE THEORY OF AUTOMATIC CONTROL OF ROCKET ENGINES

Moscow TEORIYA AVTOMATICHESKOGO UPRAVLENYA RAKETNYMI DVIGATELYAMI in Russian  
1978 Mashinostroyeniye Publishers 288 pp

SHEVYAKOV, A. A., KALNIN, V. M., NAUMENKOVA, N. V. and DYATLOV, V. G.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.113K  
by T. A. Ye.]

[Text] Theoretical work in the field of liquid propellant rocket engine control and regulation is generalized. A method of mathematical modeling of the complete cycle of working conditions is set forth. The elements of the theory and calculation of the basic types of controllers used in liquid propellant rocket engines, and the results of studying their characteristics are given. The book is intended for scientific workers engaged in the control and regulation of flight vehicle engines. It can be useful to teachers, graduate degree candidates and students of the higher educational institutes as well.

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Fluid Mechanics

USSR

UDC 621.165.536.248.2.001.24

APPLICATION OF THE THEORY OF KINETICS OF CONDENSATION TO DESIGN OF STEAM TURBINES

Leningrad TEMPERATURNYY REZHIM I GIDRAVLIKA PAROGENERATOROV [Temperature Conditions and Hydraulics of Steam Generators] in Russian 1978 pp 102-116

KACHURINER, YU. YA. and YABLONIK, R. M.

[From REFERATIVNYY ZHURNAL, TEPLOENERGETIKA No 11, 1978 Abstract No 11S27]

[Text] Questions of theoretical determination of parameters of steam and liquid phases of a high-velocity stream of non-uniformly condensing water vapor near the upper boundary curve are considered in a wide range of pressure change. Features of utilization of equations of condensation growth of drops and equation of state of the vapor phase of a flow as applied to conditions of flow-through portions of wet-steam turbines are analyzed. Comparison of results of systematic calculations of isolated nozzles and flow-through portions of wet-steam turbines with test data prove the need of considering the effect of non-equilibrium of condensation in planning turbines. Figures 7; references 20.

USSR

UDC 629.78.015:533.6.015.4

AN ANALYTICAL INVESTIGATION OF THE NONLINEAR CHARACTERISTICS OF A RECTANGULAR WING WITH A LOW ASPECT RATIO

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTITUTA [Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol 9 No 5, 1978 pp 1-10

MOLCHANOV, V. F.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.76]

[Text] Based on the form found for the main nonlinear expansion term for the lift coefficient for a rectangular wing, the form of all of the expansion terms is found for the lift coefficient and the moment. Generalizations are given for the cases of some nonsteady-state flows. The calculation result is given. Figures 2; references 5.

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UDC 629.78.015:533.6.011.5

AN APPROXIMATE METHOD OF DETERMINING THE WAVE DRAG OF A WING FOR THE CASE WHEN A LOCAL SUPERSONIC ZONE EXISTS

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGODRODINAMICHESKOGO INSTITUTA [Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol 9 No 5, 1978 pp 21-29

BOKSER, V. D. and SEREBRIYSKIY, YA. M.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.71]

[Text] An approximate method is proposed for the determination of the wave drag losses in a field for the case of transsonic flow around a wing based on a known (experimental or theoretical) pressure distribution at its surface. The method is based on the linear nature of the change in the mach number  $M_1$  along the shock wave as well as on wave drag theory. A simple formula is derived to determine the wave drag factor of the wing (separately for the upper and lower surfaces) based on the known experimental (or computed) distribution of the local mach numbers at the surface. The wave drag factor is a function of the mach number  $M_1$  ahead of the shock wave at the surface of the wing and of the curvature of the surface at this point. Figures 5; references 8.

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UDC 629.78.015:532.526

AN EXPERIMENTAL STUDY OF LOCAL HEAT EMISSION IN A LAMINAR BOUNDARY LAYER AT SUPERSONIC VELOCITIES

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTITUTA [Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol 9 No 5, 1978 pp 46-51

SHVALEV, YU. G.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.80]

[Text] Results are given from an experimental investigation of the heat emission in a laminar boundary layer in a range of  $M_0 = 3-6.2$ ,  $Re_\delta = 1.7 \cdot 10^6 - 35 \cdot 10^6$  and temperature factor values of  $T_w/T_1 = 0.235-1.05$ . The influence of the Mach and Reynolds numbers as well as the ratio  $T_w/T_r$  on local heat

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emission is ascertained. An empirical formula is derived for calculating the local heat emission factors in a laminar boundary layer. The results of this study are compared with the data of other literature. Figures 5; references 5.

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UDC 629.78.015:532.526

AN EXPERIMENTAL STUDY OF THE TURBULENT BOUNDARY LAYER ON A SOLID OF REVOLUTION AT A MACH NUMBER OF  $M = 4$

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOG AEROGIDRODINAMICHESKOGO INSTITUTA [Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol 9 No 5, 1978 pp 52-57

ALEKSEYEV, M. A., KUZ'MINSKIY, V. A. and SHVALEV, YU. G.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.79]

[Text] The purpose of these experimental studies was to find the integral characteristics of a turbulent boundary layer in a range of Reynolds numbers from  $10 \cdot 10^6$  up to  $60 \cdot 10^6$ : the displacement thickness, the momentum thickness and energy loss thickness which are of considerable significance in computing the frictional resistance and aerodynamic heating of a flight vehicle, as well as a study of the way that these characteristics are affected by the temperature of the surface subject to streamline flow. The studies were performed on a model of a cylindrical solid of revolution with an overall aspect ratio of 12.7, which had an ogival nose section with an elongation of 4, in a supersonic wind tunnel at a flow velocity with a mach number of  $M = 4$ . The solid of revolution took the form of a thin walled shell made of stainless steel, the outer surface of which was carefully polished. The interior cavity of the solid of revolution had channels to which a measured mixture of liquid and gaseous nitrogen was fed during the trials to achieve the requisite surface temperature. The geometry of the channels were chosen so as to provide for sufficiently uniform cooling of the shell over the length of the model. The liquid nitrogen mass rate of flow was determined from the conditions for obtaining a specified average value of the model surface temperature over the length, while the gaseous nitrogen rate of flow was determined from the condition for achieving the flow of a two-phase medium with shear of the liquid film in the interior channel. In this case, the deviation of the local temperature of the surface from its average value did not exceed 10 K in the majority of trials. Eight thermocouples were installed in the ogive to measure the surface temperature and determine the local heat output coefficients on the inside

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of the shell of the solid of revolution, while 17 temperature sensors were installed in the cylindrical portion. The measurement of the velocity and temperature profiles in the boundary layer was accomplished by 2 combs, one of which had 16 pitot tubes, while the second had 8 shielded thermocouples. The majority of the pitot tubes were arranged in one plane; the probes had circular cross-section entrance openings with an outer diameter of 1.24 mm and an inner diameter of 0.8 mm. The tubes which were placed near the surface were spaced somewhat apart over the surface of the solid of revolution. They had an oval shape of the entrance openings with a height of 0.35--0.40 mm, a width of 2 mm and a wall thickness of 0.12--0.15 mm. The single shielded thermocouples were fabricated in the form of tubes of stainless steel with an outside diameter of 1.2 mm and a wall thickness of 0.1 mm. Ceramic two-channel tubes with a copper-constantan thermocouple were installed in them, where there were four holes 0.2 mm in diameter for air bypass in front of the thermocouple in the side walls of the main tube. All of the thermocouples were positioned in the same plane. Both combs were installed on a mounting ring at the end of the cylindrical portion of the solid of revolution so that the positioning of the receiving openings of the pitot tubes and thermocouple probes corresponded to the last heat sensor, and were spaced 22° apart about the periphery. The dimensions of the combs, the number of probes, as well as their spacing with respect to the surface of the solid of revolution, which was closer near the wall, made it possible to conduct rather detailed measurements of the velocity and temperature profiles in the boundary layer in all modes to determine the integral characteristics. The measurements of the velocity and temperature profiles in the boundary layer were carried out under steady-state thermal conditions on both an adiabatic and a cooled surface of the solid of revolution. Their results were used to determine the displacement thickness, the momentum thickness and the energy loss thickness for two values of the dimensionless surface temperature:  $T_w/T_r = 1$  and 0.36. Figures 5; references 5.

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ON THE CALCULATION OF THE BOUNDARY LAYER AT A TRIANGULAR PLATE FOR THE CASE OF STRONG VISCOUS INTERACTION

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTITUTA [Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol 9 No 5, 1978 pp 65-70

DUDIN, G. N.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.70]

[Text] The results of a numerical solution using the relaxation method are given for the equations of a three-dimensional boundary layer at a triangular plate in the strong viscous interaction mode for the case of symmetrical flow around the plate and where an angle of slip exists. The existence of return transverse flows in the boundary layer is noted, where these flows correspond to boundary layer separation. In this case, the stream lines are not separated from the surface of the body by distances significantly greater than the thickness of the boundary layer. The results of the numerical calculations are compared with experimental data and the results of calculations performed by the integral method. Figures 5; references 10.

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UDC 629.78.015:533.6.011.55

THREE-DIMENSIONAL HYPERSONIC FLOW OF A RAREFIED GAS AROUND A PLATE

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTITUTA [Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol 9 No 5, 1978 pp 77-83

YEROPEYEV, A. I.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract 4.41.69]

[Text] The results of Monte-Carlo calculations of the aerodynamic characteristics and flow field around rectangular and triangular plates are given for the case of values of Mach and Reynolds numbers of  $M_\infty = 10$  and  $20$   $Re_0 \leq 30$ , and attack angles of  $0^\circ$  and  $15^\circ$ . The calculations were performed for a monatomic gas. The collision cross-section of the molecules was assumed constant (the molecules were solid spheres). The results are compared with calculated data for the case of plates of infinite extent. Figures 6; references 5.

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UDC 629.78.015:536.7

AN APPROXIMATE METHOD FOR ESTIMATING THE LOSS OF MASS OF THE HEAT PROTECTIVE COATING OF A SPACE VEHICLE DURING ITS ABLATION IN THE ATMOSPHERE

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTUTA [Scientific Annals of Central Aerohydrodynamics Institute] in Russian Vol 9 No 5, 1978 pp 133-135

KKONYAYEV, V. G.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.64]

[Text] A simple relationship is derived to estimate the mass loss of a heat protective coating of an axially symmetric vehicle due to ablation during aerodynamic braking in the atmosphere, based on Newton's streamline flow theory and an energy model for space vehicle ablation, the shape of which is segmental. A comparison of the derived formula with the results of calculations shows that for a more precise agreement with numerical data, it is sufficient to introduce one correction factor into the derived equation. Figure 1; references 4.

USSR

UDC 621.039.52:536.2.001.5

ON THE PROBLEM OF NONSTEADY-STATE CONVECTIVE HEAT EXCHANGE IN THE TURBULENT FLOW OF AN INCOMPRESSIBLE LIQUID. THE CONVECTIVE HEAT EXCHANGE EQUATION

Moscow VOPROSY ATOMNOY NAUKI I TEKHNIKISERIYA FIZIKA I TEKHNIKA YADERNYKH REAKTOROV [Problems of Nuclear Science and Technology Series on Reactor Physics and Technology] in Russian No 4/4, 1978 pp 58-82

TOKARENKO, Z. F.

[From REFERATIVNYY ZHURNAL, YADERNYYE RAKTORY No 5, 1979 Abstract No 5.50.58]

[Text] The properties of an operator are studied, the action of which on the temperature head determines the nonsteady-state thermal flux at the wall of a channel. The region where this operator is not bounded is ascertained. In the general case, the nonsteady-state thermal flux is determined by a system of differential equations, which consist of three first order differential equations. Estimates are derived for the range of application of both this system and its various approximations for the calculation of convective heat exchange. The results of calculating the nonsteady-state convective heat exchange using the system of equations and using the energy transfer equation are compared for the case of turbulent flow in a cylindrical channel, and the results of calculations based on the system of equations are also compared with experimental data. Figures 8; tables 5; references 13.

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UDC 629.76.017.2

THE INFLUENCE OF A LIQUID OF VARIABLE MASS IN THE CAVITY OF A FLIGHT VEHICLE ON ITS MOTION IN NONINERTIAL FRAMES OF REFERENCE

Alma-Ata SBORNIK PO VOPROSAM MEKHANIKI I PRIKLADNOY MATEMATIKI [Collection on Problems of Mechanics and Applied Mathematics] in Russian 1978 pp 12-15

RETIVOTA, L. D. and SAPA, V. A.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.60 by T. A. Ye.]

[Text] The problem of the translational motion of a rocket with respect to the earth is analyzed. The rocket is modeled by a solid body with a simply connected cavity, partly filled with an ideal homogeneous liquid. In the study of the motion, the question of accounting for the noninertial nature of the earth, related to its rotation on its axis, is posed. Since the motion is translational, the problem reduces to studying the motion of any point of the rocket and the influence that the liquid moving in the cavity has on its parameters (trajectory and velocity). The cavity of the rocket is simulated by a parallelepiped of specified dimensions. The model of the motion is chosen so that the change in the shape of the free surface is disregarded, which is assumed to be horizontal and have a height  $h(t)$  from the base of the parallelepiped. It is also assumed that the law governing the change in the height of the free surface is determined by the law governing the change in the liquid mass. The liquid can escape through an opening in the base of the parallelepiped. With this formulation of the problem, hydrodynamic equations are not used. The problem is solved for the following special cases. 1. The mass of liquid in the cavity changes linearly  $f(t) = \lambda t$ . There is no reactive force. 2. The mass of liquid in the cavity changes exponentially,  $f(t) = e^{-\alpha t}$ . The relative lateral velocity of the escaping liquid is colinear with the vector of the translational motion of the rocket. The velocity and acceleration of the liquid relative to the walls of the cavity are determined in terms of the average velocity of liquid flow. References 2.

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UDC 629.78.076.6

THE MOTION IN THE CENTRAL FIELD OF A FLIGHT VEHICLE WITH A CYLINDRICAL CAVITY  
PARTIALLY FILLED WITH A LIQUID SUBJECT TO THE ACTION OF A TANGENTIAL FORCE

Alma-Ata SBORNIK PO VOPROSAM MEKHANIKI I PRIKLADNOY MATEMATIKI [Collection  
on Problems of Mechanics and Applied Mathematics] in Russian 1978 pp 15-18

RETIVOVA, L. D. and SAPA, V. A.

[From REFERATIVNYY ZHURNAL RAKETOSTROYENIYE No 4, 1979 Abstract No 4.41.61  
by T. A. Ye.]

[Text] The motion in the central field of a flight vehicle carrying a liquid load is analyzed. A solid body with a cavity in the form of a right circular cylinder is used as the dynamic model of the flight vehicle. The cavity is partially filled with a homogeneous ideal incompressible liquid. It follows from the derived solution that to decrease the influence of the liquid, the cavity is to be arranged so that the generatrix at every point in time is directed along the normal to the trajectory of motion. A cavity which is completely filled has no influence on the motion of the vehicle. References 4.

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