Summaries

UDC 621.3

Ushakov V.Ya.
THE MAJOR PROBLEMS OF POWER ENGINEERING AND FEASIBLE METHODS OF THEIR SOLVING

Three groups of the major problems connected with satisfaction of increasing energy demand: energy and energy resource deficiency, growing environmental load, geopolitical and social threat have been considered. On the basis of modern world «energy pattern» analysis it was shown that the implementation of energy saving and energy substitution concepts is the basic method for solving these problems. The fundamental causes of unreasonably high Russian economy energy consumption, energy saving potential and government and social measures for its implementation were introduced. The concept of energy substitution – substitution of customary primary energy resources by additional/alternative fuel ones and unconventional renewable energy sources was revealed; the alternative methods of producing electric and thermal energy were examined. The importance of forming fair world energy market in supporting energy safety was stressed.

UDC 620.91.004

Poltarakov G.I., Vodyankin R.E., Kuzmin A.V.
NUCLEAR FUEL CYCLE CLOSURE IN OVERCOMING WORLD SHORTAGE OF ENERGY RESOURCES. P. 1. PRESENT ASSESSMENTS OF ENERGY CONSUMPTION AND ENERGY RESOURCES

The expert assessment data of global energy consumption per capita, structure and dynamic of changing world energy consumption have been introduced. The analysis of the structure of energy resource world support shows their increasing shortage.

UDC 621.039.577–027.31

Poltarakov G.I., Vodyankin R.E., Kuzmin A.V.
NUCLEAR FUEL CYCLE CLOSURE IN OVERCOMING WORLD SHORTAGE OF ENERGY RESOURCES. P. 2. INNOVATION NUCLEAR POWER SYSTEMS

The current state and the perspectives of nuclear fuel cycle closure in atomic power engineering, the concepts of innovation nuclear power systems which allow omitting the problem of occurring energy famine have been considered.

UDC 62-533.65+681.52

Philippov M.M., Gribenyukov A.I., Kochegurov V.A., Babushkin Yu.V.
OPTIMAL STABILIZATION OF A DISTRIBUTED OBJECT THERMAL FIELD

The problem of optimal stabilization when forming the thermal field predetermined distribution has been considered. The solution is based on transformation to a finite-difference approximation of the subject of research model and obtain of linearized equation system allowing determining optimal control with a compete feedback in the form of proportional regulators on the basis of dynamic programming method and quality quadratic criterion. The accuracy estimates of thermal field stabilization were introduced.

UDC 62-533.65+681.52

Philippov M.M., Gribenyukov A.I., Babushkin Yu.V., Kochegurov V.A.
MODAL CONTROL OF A DISTRIBUTED OBJECT THERMAL FIELD

The problem of thermal field stabilization of the distributed parameters object has been examined by the modal control system including the programed controller; the latter analyses harmonics and control action generation. It was shown that thermal field stabilization accuracy achieved by the given method is comparable with that of control system based on PID-regulator by the example of a long rod with a built in heaters.

UDC 536.24

Vidin Yu.V., Kazakov R.V.
HEAT PROPAGATION ALONG THE HOMOGENEOUS RIB OF A CONSTANT CROSS SECTION

The possibility of using known analytic solutions in respect to more complex engineering problems has been shown. At certain laws of changing the material thermal conductivity coefficient along the constant cross section rod its thermal field may be calculated based on mathematical dependences obtained for variable cross section homogeneous ribs.

UDC 519.635;532.546.3

Alekseev M.V., Kuznetsov G.V.
NUMERICAL SIMULATION OF HEAT AND MASS TRANSFER AT CONDUCTIVE WOOD DRYING IN UNDERPRESSURE

Mathematical model of heat and mass transfer in wood at conductive heating has been stated using the model of moisture front evaporation. Numerical investigation of heat and mass transfer at conductive wood drying in environmental underpressure was carried out. The influence of the process main variables on drying duration was analyzed.

UDC 539.52;621.181

Lyubimova L.L., Makeev A.A., Zavorin A.S., Tashlykov A.A., Fisenko R.N.
REGULARITIES OF CHANGING BOILER STEEL UNIT CELL PARAMETER AS A CRITERION OF DAMAGING ACCUMULATION

Current physical state has been tested for estimating steel pipe individual physical resource on boiler heating surface by a unit cell parameter. The experimental curve allowing estimating initiation of structure damaging at microlevel comparable to a unit cell size; determining velocity and dynamic of accumulating microdamaging in pipe wall structure up to strength loss; testing current physical state and determining pipeline remaining life by maximum change of steel elementary crystal lattice parameter was introduced.

UDC 621.184.3.018.54

Fisenko R.N., Makeev A.A., Lyubimova L.L., Zavorin A.S., Tashlykov A.A.
ROENTGENOMETRIC ESTIMATION OF TEMPERATURE CONDITIONS FOR OPERATING AND DAMAGING STEAM BOILER PIPE ELEMENTS

The technique for estimating temperature conditions at operation and damage of steam boiler pipe elements possessing low error and allowing solving numerous practical problems has been developed and analyzed on the basis of diffraction line integral intensities analysis. The results validity is substantiated by thermal, hydraulic and aerodynamic calculations along with testing with the use of pipe samples with known performance history.

UDC 662.64

Kazakova O.A., Zavorin A.S., Kazakov A.V.
ESTIMATION OF THE PROCESS VARIABLES AT ENERGY USE OF TOMSK REGION TALOVSKOE DEPOSIT COAL

The regularities of transforming coal mineral components under the action of combustion factors based on design estimation of predicting parameters of coal mineral components at its combustion obtained as a result of core sample laboratory research have been determined; the recommendations for using talovsky coal of Tomsk region as a fuel have been worked out. The given materials represent the procedural framework for designing talovsky coal boiler units.

UDC 621.181:519.876

Zavorin A.S., Betkher T.M., Lebedev B.V.
THE ANALYSIS OF FURNACE ENVIRONMENT OF BKZ-210-140 BOILER BASED ON NUMERICAL SIMULATION

Mathematical modeling of furnace environment of BKZ-210-140 boiler at non-design coal rank has been carried out. The compliance of mathematical modeling results to the design and experimental data was obtained. The adequacy of mathematical model used in software product FIRE 3D in respect to dust-coal technology of furnace combustion with burner tangential arrangement was proved.

UDC 621.643

Kuznetsov G.V., Ozerova I.P., Polovnikov V.Yu., Tsygankova Yu.S.
REAL HEAT LOSS ESTIMATION AT COOLANT TRANSPORTATION CONSIDERING TECHNICAL STATE AND REAL OPERATION CONDITIONS OF HEAT NETWORKS

The influence of thermal isolation state inhomogeneity along the pipeline length and consideration of real operation conditions of heat networks on a change of transport heat loss has been analyzed. Real heat losses were compared with the design and normative ones. The conclusion on tightening current standards was drawn.

UDC 697.341

Kolosov M.V., Mikhaylenko S.A.
OPTIMIZATION OF PARAMETERS AND CONFIGURATIONS OF ENERGY SYSTEMS

Statistic material and analysis on one of the main energy resources – thermal energy is introduced. The mathematical model of energy effect optimization of energy system parameters was proposed; the criterion of estimating maximum energy efficiency was proposed as well.

UDC 621.311:548

Prishchepov S.K., Zinatullin I.R., Berg O.I.
DESIGNING ECOLOGICAL POWER SUPPLY SYSTEMS

The analysis of the results of industrial propeller wind turbine has been introduced. It was ascertained that the most widespread wind turbines have significant disadvantages. The alternative direction for wind turbine development – the production of independent mobile electric systems based on vertical rotor wind turbines was introduced. The scientific novelty of the researches consists in optimization of vertical rotor form and suspension for achieving maximum ratio of its rotation torque to starting torque at any direction angles of wind flow to wind turbine blades.

UDC 621.311.016.361

Gotman V.I., Glazachev A.V., Batseva N.L.
SERIES COMPENSATION OF LONG-DISTANCE POWER LINES WITH INTERMEDIATE SYSTEMS

The technique of selecting compensating device parameters of long-distance extra-high voltage power lines with intermediate systems for increasing transmission capacity by static stability conditions has been considered. The intermediate and receiving systems are proposed to be introduced by the equivalent parameters for solving the problem. The technique of equivalenting receiving system was given. It was shown that it is appropriate for problem analytic solution to introduce the criterion of static dead-beat stability based on steepness coefficients of generalized static characteristics of electric system voltage reactive power.

UDC 537.1:537.3

Nosov G.V., Kuleshova E.O.
THE EXTENDED METHOD OF EQUIVALENT GENERATOR AT SINUSOIDAL CURRENTS

The extended method of equivalent generator at sinusoidal currents allowing determining current in a load and total active and reactive power in original circuit has been introduced. The composite equivalent circuit of the extended equivalent generator was proposed; the design formulas for determining its parameters at standard conditions of changing complex resistance of load and power in the original circuit were introduced.

UDC 621.314.21

Serikov A.V., Kuzmin V.M.
RECOMMENDATIONS FOR DESIGNING TRANSFORMER WITH A SHORT-CIRCUIT RING SECONDARY WINDING

The construction of transformer type heating element with a short-circuit ring secondary winding has been introduced. The features of electromagnetic and thermal calculations of this device were described. The results of designing the transformer with capacity of 25 kW were given. It was ascertained that aluminum alloy AMG5M is appropriate to be used as a secondary winding material. Using the experiment planning method the recommendations for designing minimum cost transformers with capacity from 10 to 160 kW were given.

UDC 537.876.4

Vaynshteyn V.B., Nikitin V.D., Tolkacheva K.P.
THE CALCULATION OF LIGHTNING NETWORKS BY VOLTAGE LOSS AT UNEVEN PHASE LOAD BY THE REDUCED POWER TECHNIQUE

The existing engineering calculation techniques of voltage loss in electric, first of all lightning, networks considering the degree of unevenness of load phase distribution have been analyzed and the new advanced techniques have been proposed.

UDC 621.313.13

Polishchuk V.I.
SIMULATION OF MAGNETIC LEAKAGE FIELD IN A FRONT ZONE OF SYNCHRONOUS MACHINE

The mirror image method including correction factors is proposed to be used at calculation of magnetic leakage fields in a front zone of synchronous machines. The technique for simulating the magnetic leakage fields in a front zone of synchronous machines which allows computing with high accuracy the built-up induction converter parameters was developed.

UDC 621.7-5+621.314.521+621.314.572

Abd El Vkhab Amr Refki, Karakulov A.S., Dementyev Yu.N., Kladiev S.N.
COMPARATIVE ANALYSIS OF VECTOR AND DIRECT TORQUE CONTROL OF PERMANENT MAGNET SYNCHRONOUS MOTOR

This paper presents a comparative analysis of two most popular frequency control systems of permanent magnets synchronous motor drives – a classical frequency «vector» one with PWM control and the system with torque direct control by a switching table based on relay controllers. The comparison is based on criteria including the principle control static and dynamic characteristics, computational burden of microintegrated control system and implementation complexity. The study was carried out using simulation systems in the environment of Simulink MATLAB. The simulation was performed using the parameters of the real permanent magnets synchronous motor and inverter.

UDC 621.313.333

Tyukov V.A., Pastukhov V.V., Korneev K.V.
THREE-SLOT MODEL FOR DETERMINING PARAMETERS OF ASYNCHRONOUS MOTOR SQUIRREL-CAGE ROTOR BAR

The methodology of determining rotor parameters by finite element analysis theory has been introduced. It was shown that three-slot mathematical model of asynchronous motor squirrel-cage rotor is sufficient for determining rotor active and inductive parameters. The calculated data of rotor parameters, mathematical simulation and experimental determination of asynchronous motor starting characteristics were introduced.

UDC 621.292.001.2

Vigriyanov P.G.
POWER CHARACTERISTICS OF NINE-PHASE VALVE ENGINE AT COMPLETE AND PARTIAL SWITCHING

The possibility of providing algorithmic redundancy in multiphase valve engines applying partial switching algorithms has been shown and the necessity for computing power characteristics of multiphase valve engines for complete and partial switching has been described. The characteristics of nine-phase valve engine were introduced; the conclusions on the behavior of electromagnetic power and electromagnetic efficiency at switching algorithm change were drawn.

UDC 621.313.2

Smirnov A.O., Langraf S.V., Kazakov V.S., Bekishev R.F.
STUDYING THE DYNAMIC MODES OF FREQUENCY-CONTROLLED INDUCTION DRIVE OPERATION AT LOW TEMPERATURES

A frequency-controlled induction drive of a stop valve has been studied at different environmental temperatures. Temperature influence on drive mechanical characteristics was shown. Simulation model considering temperature influence on drive element operation was proposed. The recommendations for improving reducer service characteristics were given.

UDC 621.313.3

Pushkarev I.I., Dudarev V.V., Golemgrein V.V., Muravlev O.P.
THE FIREPROOFNESS OF MAJOR VENTILATION BLOWER OF AN UNDERGROUND RAILWAY

The ventilation blower operation of the underground railway VGPM-20 has been tested at 400 °C. A new generation induction motor with a rectangular shape core slot of rotor and stator, copper short-circuit rotor winding, special bearings with a heat-stable lubricant and ventilator blades are made of high-temperature aluminum alloy was produced for supporting this ventilator fireproofness. Such ventilator was tested for fireproofness at 400 °C in a special unit designed at «V.V. Vakhrushev Tomsk electromechanical plant» for the first time in Russia. The results of the test were certified. The certificate № SSPB.RU.UP001.V.07662 was obtained.

UDC 621.313.33

Vedyashkin M.V., Muravlev O.P.
PARAMETERS ESTIMATION OF FAILURE DISTRIBUTION LAWS OF STATOR WINDINGS UNDER OPERATING CONDITIONS OF CRANE INDUCTION MOTORS

Parameters of failure distribution laws and quantitative indices of survival function showing the stator windings reliability of crane induction motors under operating conditions have been determined. The given data concerning serviceability allow estimating operation mode and conditions influence and may be used in comparative technical and economical calculations as well as in designing and manufacturing crane induction motors.

UDC 62-52;51-74;519.711.3

Krasnov I.Yu., Gusev N.V., Langraf S.V., Lyapushkin S.V.
PROVIDING SMOOTH START AND SMOOTH STOP OF INDUSTRIAL MECHANISMS

The algorithm of smooth start and smooth stop for industrial mechanisms having alternative current (asynchronous) motors in its structure has been introduced. The results of modeling transients in alternative current motors at its smooth starting and stopping were given. They showed that using starting and stopping S-sections of lifting device electric drive, in particular the passenger lift, provides its cabin motion smoothness that affects passengers comfort as well as mechanical part safety of the equipment (drive reducer).

UDC 621.791.011

Knyazkov A.F., Dementsev K.I., Lukyanchikova A.O.
THE INFLUENCE OF COATED ELECTRODE HEATING TEMPERATURE ON ITS MELTING RATE AT MODULATED CURRENT WELDING

Numerical calculation of coated electrode heating temperature at modulated current welding has been carried out. It was shown that the electrode temperature at modulated current welding increases most of all in basic pulse intervals.

UDC 681.5.015

Voronov A.Yu., Gerasimov V.A.
COMPRESSED ARC CURRENT CONTROL IN PLASMATRON CHANNEL

The compressed arc combustion stability in plasmatron channel increases due to the quality improvement of current control process in automatic control system circuit of arc current. The parametric optimization technique of current controller was introduced; theoretical calculation was checked on a real object and the results were shown in the paper.

UDC 621.314:621.382:621.314.572

Kharitonov S.A., Garganeev A.G.
THE CALCULATION PROCEDURE OF MECHATRONIC SYSTEM EFFICIENCY FOR GENERATING DIRECT CURRENT ELECTRIC ENERGY

The technique for calculating resistance losses in the elements of direct current generating system based on magneto-electric synchronous generator and semiconductor converter has been proposed. Special attention was paid to analyzing electric losses in synchronous generator: both form deformation of synchronous generator current and voltage and the change in its shaft speed were considered; it allows increasing calculation accuracy and quality of designing the system unit cells.

UDC 621.314:621.382:621.314.572

Kharitonov S.A., Garganeev A.G.
THE EFFICIENCY OF MECHATRONIC SYSTEM FOR GENERATING DIRECT CURRENT ELECTRIC ENERGY

The results of calculating the efficiency of the system for generating direct current based on magneto-electric synchronous generator

and semiconductor converter (rectifier) has been introduced. The example of calculation was given for the system of generating electric power with a capacity of 250 kW developed for a wind power installation with a variable frequency of a wind turbine shaft rotation.

UDC 629.7.036.74

Lesnevsky V.A., Makhova L.I., Mikhaylov M.V., Khodnenko V.P., Khromov A.V.
ELECTROJET THRUSTER DEVICE OF THE SPACECRAFT «KANOPUS-V» AND ITS FIRE TESTS

The problems of carrying out fire tests of electrojet thruster device of small spacecraft «Kanopus-V» have been considered. The installation structures, the basic measuring means, the scheme and results of the tests were shown. The features of the considered device: low mass and thrust, wide range of input voltage and increased accuracy of discharge voltage stabilization were.

UDC 621.311

Kazantsev Yu.M., Gordeev K.G., Lekarev A.F., Cherdantsev S.P., Gavrilov A.M.
SOLAR BATTERY ENERGY CURRENT TRANSFORMER IN ELECTRIC POWER SYSTEM OF SPACE VEHICLES

A method for regulating solar battery voltage at the current site of its current-voltage characteristics has been considered. Engineering solutions allowing damping solar battery voltage fluctuations, reducing ripples and supporting high quality of output voltage regulation of power-supply system in a wide range of parameters change were shown.

UDC 621.373.826

Evtushenko G.S., Trigub M.V., Gubarev F.A., Torgaev S.N.
LASER PROJECTING MICROSCOPE WITH IMAGE FRAME-BY-FRAME REGISTRATION

The possibility of recording image obtained by a laser projecting microscope and formed by a single pulse of optical amplifier has been introduced. Synchronization circuit for implementing this method was described. Visualization results of self-propagating high-temperature synthesis attended with a strong background illumination were introduced in real time using the developed synchronous system.

UDC 66.069.8327:66.084.08

Khmelev V.N., Shalunov A.V., Genne D.V., Shalunova A.V., Golykh R.N.
DEVELOPMENT AND INVESTIGATION OF NEW DESIGN PRINCIPLES OF FINE ULTRASONIC VISCOUS LIQUID ATOMIZER

The article is devoted to generation of new types of fine atomizers. Their operation is based on multiple surface or high-frequency ultrasonic action on viscous and dispersed liquids. New structures of ultrasonic oscillation systems were proposed and developed. They allow decreasing the generated drop diameter, increasing atomization capacity, extending atomizer service reliability and supporting viscous liquid atomization with the stated capacity.

УДК 621.182.002(571.16)(092)

Zavorin A.S., Lebedev V.M., Belyaev L.A.
PATRIARCH OF SIBERIAN THERMAL ENGINEERING (THE 130th ANNIVERSARY OF I.N. BUTAKOV'S BIRTH)

Innokenty Nikolaevich Butakov is a perfect example of dedication to the lifework: the beginning of thermal and mechanical education in Siberia, the introduction of advanced production methods in thermal engineering and railway transport, the development of training system of skilled engineers in the Soviet Union, the establishment of Siberian thermal engineering scientific school are associated with his name.

UDC 621.182.002(571.16)(092)

Zavorin A.S.
THE FOUNDER OF TOMSK SCIENTIFIC AND PEDAGOGICAL BOILER-MAKING SCHOOL (THE 100th ANNIVERSARY OF I.K. LEBEDEV'S BIRTH)

The development of thermal engineering education at Tomsk polytechnic institute in the latter half of the twentieth century and the establishment of scientific and pedagogical boiler-making school in Tomsk, and in Siberia as a whole, are associated with the name of professor Ivan Kirillovich Lebedev. The results of his activity in these directions are still in demand and current in modern conditions of higher school reforming.