Power Engineering

An advanced variant of an experimental method of investigating the blades torque using models of the Kaplan turbine runner was suggested. The investigation is based on using modern miniature electronics devices and wireless technologies. The experience of implementing the method suggested on the hydrodynamic test bench at IPMash NAS of Ukraine and the results of measuring the torque for a six-blade model of the PL40 runner are given. The torque was measured using a strain gauge transducers and an runner model developed by LLC Kharkovturboengineering specialists. Experiments on the hydrodynamic test bench yielded the values of blade torques for the entire hill diagram range. The torque for acceleration conditions, as well as the torque vs. centrifugal force values was measured.

***Keywords**: runner model, Kaplan turbine, blade, torque, strain gauge transducer, experiment.*

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Heat Transfer in Engineering Constructions

Principal possibility of heat-pumping technologies application for heat recovery of the traditionally lost low-grade heat on the thermal electric stations with the purpose of efficiency increase of the primary fuel use is considered. On the example of municipal heat-electric generating plant work during a year analysis waste heat potential suitable for the use in heat-pumps as low-grade heat is appraised. Characteristics of heat-pumps that are present in the world market and suitable for thermal power-stations waste heat utilization are considered. The credible consumers of producible heat-pumping installations heat on thermal power-stations and the simplest basic schemes are analyzed. The brought results show technical feasibility and perspective of heat-pumping direction of the thermal electric stations low-grade heat utilization and necessity of further researches realization for the ground of his technical and economic expediency.

***Keywords:** heat-pump, heat-pump installation, thermal power-station, heat-electric generating plant, power efficiency, increase, waste heat, utilization.*

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Dynamics and Strength of Machines

This work deals with the computational and experimental investigation of the dynamic characteristics of the model Kaplan turbine blades. Experimentally and numerically eigenfrequency spectrum of the blade in the air and in the water has been determined. Also, the parameters of the damping of the blades and it frequency response have been obtained.

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The paper considers the problem of calculating the stress-strain state, creep and creep-damage of multilayer orthotropic plates on elastic foundation. Plate may be loaded by the transverse load, normal and tangential contour loads and the temperature field. A variational formulation of the problem is made in the terms of refined theory of plates and shells. Cauchy problem in time for the main unknown functions of initial-boundary value problem is formulated. To solve the nonlinear initial-boundary creep and creep-damage problem is proposed to use a combination of R-functions, Ritz and Runge-Kutta-Merson methods. R-functions method allows to accurately account for the geometry of the domain and the boundary conditions of the most general form. The solution of the boundary value problem is represented as a formula - structure of the solution that exactly satisfies all (general structure of the solution) or part (partial structure of the solution) boundary conditions. Structure of solution is invariant with respect to the shape of the domain. An example of calculating of stress-strain state of two-layer plate on elastic foundation has been shown. The developed method can be used to investigate the stress-strain state and the long-term strength of road surface.

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Semi analytical finite element method is suggested to calculate cylindrical shells supported by longitudinal stiffness. The displacements, which are expanded into the Fourier series by circumference coordinate, are the main unknowns of the suggested approach. One dimensional finite elements are used to calculate amplitudes of the harmonics. Clamped cylindrical shells with three and twenty longitudinal stiffness are analyzed numerically. The properties of the shell deflected mode are analyzed numerically using the suggested approach.
***Keywords**: finite elements method, stiffness shells, stiffness matrix.*

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Selection of the most optimal design of low-pressure cylinder's steam pipe for high power steam turbines is not possible without usage of scientific achivements of the last decade. Different software systems can be used to optimize blades' geometry of low-pressure cylinder's steam pipe. Three dimensional models of steam flows are used for improvement of evaluation methods for biphasic medium flow in conditions of liquid medium formation and its interaction with blades.
Modern evaluatinal methods allow to increase reliability of blades by means of erosional wear-out minimization. Improved design of blade tails developed to optimally decrease strains is also important for reliability. Complex approach to design of low-pressure cylinder's steam pipe is useful for newly developed high power turbines as well as for upgrade of existing ones. This approach allows to design high quality blade tails which correspond to actual industry requirements to effectiveness and reliability.
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quality blade tails which correspond to actual industry requirements to effectiveness and reliability.

Keywords: *the last stage of the turbine blade, stress-strain state, bearing surface of the tooth, stress concentration factor, photoelasticity method, finite element technique, blade profile*

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Applied Mathematics

Yaskov G. N. Packing non-equal hyperspheres into a hypersphere of minimal radius.................. 48

The problem of packing different hyperspheres into a hypersphere of minimal radius is considered. All hypersphere radii are supposed to be variable. Solving the problem is reduced to solving a sequence of mathematical programming problems. A special way of construction of starting points is suggested. A smooth transition from one local minimum point to another providing a decrease of the objective value is realized using the jump algorithm is fulfilled. Then, solution results are improved due to reduction of the solution space dimension by step-by-step fixing radii of hyperspheres and rearrangements of hypersphere pairs. Non-linear mathematical programming problems are solved with the IPOPT (Interior Point Optimizer) solver and the concept of active inequalities. A number of numerical results are given.

Key words: *hypersphere, packing, mathematical modeling, jump algorithm*

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Non-traditional Power Engineering

The article presents the physical and mathematical model of heating coal dust particles microwave discharge plasma at atmospheric pressure in a stream of carbon aerosol. Calculation of the temperature of the coal particles, depending on the time when it moves together with the gas medium is reduced to the solution of the Cauchy problem for an ordinary differential equation modeling the process of heating a coal particle. To calculate the temperature distribution in the microwave discharge plasma used transient heat conduction equation with internal heat sources. It was believed that the source is only Joule heating; convection and thermal conductivity are considered drains energy in the equation is also not taken into account in the amount of energy release due to viscous friction forces, as well as due to compression and expansion volume. The results of numerical studies of the air temperature and the coal particles in the discharge volume in relation to the experimental plasma-coal burner.

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Materials Science in Mechanical Engineering

Differences in mechanisms of damage accumulation for low-cycle and high-cycle fatigue in terms of efficiency of use of the coercive force method in diagnostics of presence of defects in metal under cyclic loading are considered.

It is pointed out that, depending on level of loading amplitude, different kinds of fracture are dominant with different probability.

In case of low loading amplitudes, the most probable mechanism comprises an intracrystalline fracture.

In case of cyclic loading with high amplitudes, there is a high probability of fracture along crystal boundaries, which causes accumulation of more coarse fracture elements and leads to greater nonuniformity of metal. Therefore energy consumption required for shifting the domain boundaries during remagnetization is increased. A substantial change in coercive force as one of the most important characteristics of the hysteretic loop, which area represents energy consumption for metal remagnetization, results from more coarse change of magnetic structure.

It is concluded that a high sensitivity of the coercive force method to development of low-cycle fatigue and far lesser sensitivity to high-cycle fatigue is connected with the said differences in metal fracture.

Keywords: *low-cycle fatigue; high-cycle fatigue; intercrystalline fracture; intracrystalline fracture; submicrocracks; damage accumulation; coercive force.*

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