This study presents a numerical simulation of a 3D viscous flow in the VKI-Genoa cascade, taking into account the laminar-turbulent transition. The numerical simulation is performed using the Reynolds-averaged Navier-Stokes equations and the two-equation k-ω SST turbulence model. The algebraic Production Term Modification model is used for modeling the laminar-turbulent transition. Computations of both fully turbulent and transitional flows are carried out. The contours of the Mach number, the turbulence kinetic energy, the entropy function, as well as limiting streamlines are presented. The analysis of the numerical results demonstrates the influence of the laminar-turbulent transition on the secondary flow pattern. The comparison between the present computational results and the existing experimental and numerical data shows that the proposed approach reflects sufficiently the physics of the laminar-turbulent transition in turbine cascades.

**Keywords:** numerical simulation, 3D flow, turbine cascade, laminar-turbulent transition.

**References**

R. Rusanov, P. Lampart, A. Rusanov and N. Paschenko Development of flow parts of cogeneration turbines with a capacity of 2.5 and 5 MW using modern computer technology.............................16

The method for the design of axial flow turbine parts is described. The method is based on the use of methods of analytical describing of the geometry of the flow parts and gas-dynamic calculations of varying complexity. Geometry description of flow parts is performed using analytical methods profiling, initial data which is used a limited number of parameter values. To account for thermodynamic properties of the working medium an analytical interpolation method is used for approximating equations of the formulation IAPWS-95. 3D turbulent flow model is realized in the program complex IPMFlow, developed based on the earlier codes FlowER and FlowER-U. The results of computations obtained from the code IPMFlow have the necessary reliability in the qualitative structure of the flow and in the quantitative characteristics of the isolated turbine cascades and turbine as a whole. Several types of flow parts of cogeneration turbine with electric power up to 5 MWe and thermal power up to 10 MWt are presented. Designs of flow parts are intended to operate year-round - during the heating season they can be operated in the heating mode (extraction), while in the off-season in condensing mode with the maximum efficiency in the production of electricity. Gas-dynamic efficiency of the developed turbine flow parts is adequate for the power machines of this kind.

Key words: cogeneration turbine, numerical method, regulating stage, partial admission, rotatable diaphragm.

References
Boiko A. V., Usatyj O. P. and Maksiuta D. I. Development of the reliable engineering method of the quality estimation of the turbine axial-radial sealing

Loses associated with the leakages through the turbine radial sealing are usually considered while calculating efficiency of the whole turbine stage. Wherein, massflow coefficient of the sealing often is estimated with Stodola’s equations, which includes empirical coefficients substantially depending on the particular form of the sealing. In recent times, axial-radial sealing is increasingly being used in powerful steam turbines. However, there are no reliable equations for estimating massflow coefficient of the axial-radial sealing. The purpose of the research work presented in the paper was to develop the reliable engineering method for calculating axial-radial sealing, which allows to determine massflow coefficient in the sealing considering the influence of geometrical, working parameters and offset of the sealing due to the heat expansion. Axial-radial sealing of the third high pressure turbine stage was decided to be the object of study. 10 parameters were chosen to be varied: u/c speed ratio, flow angle u, number of knife edges in the left side of the sealing, number of knife edges in the right side of the sealing, step between the knife edges, height of the knife edges, radial gap, width of the middle chamber, sealing offset due to the heat expansion. According to goal of the research, experiment plan, which included 132 calculation points, was built. All simulations were performed using CFD. Calculations according to the plan of the experiment allowed to obtain accurate formal metamodel and to plot dependencies of the varied parameters on the massflow coefficient. Developed engineering method allows to define massflow coefficient of the axial-radial sealing depending on its geometrical and working characteristics, also considering rotor offset caused by the heat expansion. Interactive computer program “Clearance” was developed which make possible to define value of massflow coefficient in the axial-radial sealing.

Keywords: axial-radial sealing, massflow coefficient of the sealing, method of the quality estimation of the sealing.
«Clearance», позволяющая в диалоговом режиме определять величину коэффициента расхода через осердадальное уплотнение.

**Ключевые слова:** осердадальное уплотнение, коэффициент расхода уплотнения, методика оценки качества уплотнения.

**References**


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**Heat Transfer in Engineering Constructions**

Tsentsiper A. I., Kostikov A. O., Safonov N. A. and Bushiets Ya. N. To the orientation of spherical solar collectors .................................................................................................................................................. 31

The design of spherical solar collector and how it works are described. Solar heat receiver is made of a single metal tube that is wound along the spherical spiral line. An advantages of spherical geometry collectors are compared to flat geometry. One of the major advantages of spherical collector compared to conventional flat collectors is that it does not have a special mechanism for turning it in accordance of solar motion and whereby it as "sunflower follows the sun." Proposed collector does not require additional energy for the operation of the rotating mechanism. Numerical-analytical calculation of the quantity of solar energy, that is received by solar collector for the year, on the angle of inclination of its axis relative to the horizon. Using this approximation, it is defined the optimum angle of inclination of the spherical collector, in which he takes the maximum amount of solar energy per year and depends on the geographical latitude on which it is installed.

**Key words:** orientation, spherical, flat, solar, collector, intensity, solar energy.

Представлена конструкция сферического солнечного коллектора и описан принцип его работы. Теплопередача коллектора выполнена из единой металлической трубы, которая ввинтена по сферической витой линии. Приведен ряд преимуществ геометрии сферических коллекторов по сравнению с геометрией плоских. Отмечается одно из основных преимуществ сферического коллектора по сравнению с традиционными плоскими коллекторами — у него отсутствует специальный механизм, поворачивающий его за движением солнца, в силу чего он как «подсолнух следит за солнцем». Предложенный коллектор не нуждается в дополнительной энергии для обеспечения работы этого поворотного механизма. Произведен числово-аналитический расчёт количества солнечной энергии, воспринимаемой солнечным коллектором, в зависимости от его ориентации относительно горизонта. Результаты этого расчёта в качестве интерпретационных данных использованы для получения аппроксимации функциональной зависимости количества солнечной энергии, воспринимаемой солнечным коллектором за год, от угла наклона его оси относительно горизонта. Используя полученную аппроксимацию, определён оптимальный угол наклона сферического коллектора, при котором он воспринимает максимальное количество солнечной энергии за год. При этом угол наклона зависит от географической широты местности, на которой он установлен.

**Ключевые слова:** ориентация, сферический, плоский, солнечный, коллектор, интенсивность, солнечная энергия.

**References**

Mustafayev A. B. Effect of local temperature field on retardation of curvilinear crack with allowance of plastic deformation.

We investigate the effect of a heat source on the development of curvilinear crack in the elongated plate in view of plastic deformations in the crack end zones. For retardate the curvilinear crack growth on the crack path in vicinity of the both ends by heating of domains $S_1$ and $S_2$ to temperature $T_0$ are created zones of compressive stresses. The elastic-plastic problem for an infinite plate weakened by a curvilinear crack is considered. The crack faces outside of the end zones are free from external loads. The solution of this problem is obtained by the perturbation method and by reducing it to a boundary value problem of linear conjugation. The plane problem of the development of initial plastic deformation in the end vertices of curvilinear crack in elongated plate, when on the path of the crack growth has heated zone is solved. The basic relations describing the critical fracture are obtained. The elastic-plastic problem for an infinite plate weakened by a curvilinear crack is considered. The crack faces outside of the end zones are free from external loads. The solution of this problem is obtained by the perturbation method and by reducing it to a boundary value problem of linear conjugation. The plane problem of the development of initial plastic deformation in the end vertices of curvilinear crack in elongated plate, when on the path of the crack growth has heated zone is solved. The basic relations describing the critical fracture

Keywords: curvilinear crack, temperature field, end zone of plastic deformation, thermal stresses.

References

Shulzhenko N. G. and Kolyadyuk A. S. Assessment of influence of the form of the central camera on the current of steam and creep of the hull of the adjusting valve of the turbine.

The characteristics of a current of steam are numerically calculated in system of steam distribution and the intense deformed state and creep of the hull of the valve of the K-325 steam turbine in the stationary mode for two options of the central camera of the valve. Speeds, temperature and a vapor pressure on the walls of the hull are defined on the basis of numerical solution of the equations of Navier-Stokes in three-dimensional statement. The semi empirical Menter model of turbulence was applied. A program complex ANSYS/CFX was used. It was established that the shape of the central chamber affects the distribution of the flow of steam through RK1 and RK3. The equations are integrated creep explicit Euler scheme. We used the model of implicit creep hardening, which takes into account the initial and steady creep. The effect of the form of the central chamber on the characteristics of the control valve body strength. The results of the research indicate that the maximum cumulative creep deformation can not be the cause of cracking after 35,000 hours of robots. Solution of the problem of creep housing for two variants of the central chamber in three-dimensional statement showed that the strength characteristics of a second embodiment of the valve body is preferred because in the central chamber maximum creep deformation in two times less than in the first embodiment of the valve body.

Keywords: calculation, current of steam, creep, system of steam distribution, turbine.

References
Ainabekov A. I., Suleimenov U. S., Avramov K. V., Kambarov M. A., Abshenov C. A. Experimental and numerical analysis of deflected mode of cylindrical tanks with pinches.................54

The results of the experimental analysis of tanks models are considered. The cylindrical panels are used for the tank models. Such structures with imperfections describe the deflected mode of big cylindrical tanks with imperfections. The results of the experimental investigations of the deflected mode in the region of imperfections are presented. The results are obtained by tensometric approach. The stress concentration factors in the regions of imperfections are analyzed in details. The deflected mode of the cylindrical tank with spherical imperfections is simulated numerically. It is assumed that the tank material meets the Hooke law and deformations and displacements satisfy the linear equations. As the tank is filled by fuel oil, then the constant internal pressure acts on the internal surface. The finite element method is applied to simulate numerically the deflected mode. The dependence of the stress concentration factors on the dimensionless parameters of imperfections is analyzed.

Key words: cylindrical tanks, imperfections, deflected mode, circumferential stresses

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P. P. Shygorin Rotational dynamics for the spherical body with displaced center of mass..........................60

In the article has been considered the theoretical description of the rotational mechanics for the spherical body with displaced center of mass (SBDCM). In terms of the general equations for dynamics of a rigid body the equations of translational and rotational motion for SBDCM was constructed. The solution of these equations near turning-over point has been analyzed. In particular, has shown that the parameter \( \xi \), that describe dependence of rotation frequency on the inclination angle, evolves from the initial value \( \xi_0 = Cn_0 \) through the oscillations near value \( \xi^* \). When angle increases \( \theta \), the amplitude of oscillation decreases. Near state \( \theta = \pi \) the ampli-
tude of oscillation will increase again. The critical rotation frequency, when body turning from stable state to unstable was calculated too.

Key words: spherical body, dynamics, rotational motion, stable state.

В работе рассмотрено теоретическое описание механики вращения сферического тела со смещённым центром масс (СТСМ). На основании общих уравнений динамики твердого тела были сконструированы уравнения поступательного и вращательного движения (СТСМ). Проанализировано решения этих уравнений вблизи точки переворачивания. В частности, показано, что параметр $\xi$ который определяет зависимость частоты вращения тела от угла наклона, эволюционирует от начального значения $\xi_0 = C\theta_0$ посредством осцилляций вокруг значения $\xi$. При увеличении угла $\theta$ амплитуда осцилляций уменьшается. Вблизи состояния $\theta = \pi$ амплитуда осцилляций снова начинает расти. Также рассчитано критическую частоту вращения, когда тело переворачивается из устойчивого состояния в неустойчивое.

Ключевые слова: сферическое тело, динамика, вращательное движение, устойчивое состояние.

References