HYDROELASTIC VIBRATIONS OF THE COVERS ON WATER TURBINES WITH THE UPPER RING OF THE GUIDE VANES (p. 4–10)

Sergii Misiura

The paper presents a method of numerical study of hydroelastic vibrations of the covers on water turbines with the upper ring of the guide vanes. We have obtained five natural frequencies and mode shapes of cast iron and steel covers on water turbines with the upper ring of guide vanes in vacuum and with account for the effect of water.

In vacuum, the cover of the first-type cast iron has the first natural frequency of 17.3 Hz, while water effect decreases it to 16.9 Hz, which is 2.3 % lower than the frequency in vacuum. The second-type cast iron has the first natural frequency of 14.2 Hz in vacuum, while water effect decreases it to 13.9 Hz, which is 2.1 % lower than frequency in vacuum.

The same variant of cover has been similarly researched with the influence of the steel upper ring of the guide apparatus. The first-type cast iron has the first natural frequency of 15.3 Hz in vacuum, while water effect decreases it to 14.0 Hz, which is 9 % lower than the frequency in vacuum. The ring effect reduced the first natural frequency in vacuum by 13 %, while water effect made it lower by 20.7 %. The second-type cast iron has the first natural frequency of 14.0 Hz in vacuum, while water effect decreases it to 13.4 Hz, which is 4.2 % lower than the frequency in vacuum. The ring reduces the first natural frequency in vacuum by 1.4 %, while the effect of water lowers it by 3.7 %.

It is proved that the influence of water and the presence of the ring reduce the frequency of the natural vibrations.

Keywords: hydroelastic vibrations, finite element method, natural vibrations, water/hydraulic turbine cover.

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THE INFLUENCE OF MECHANICAL ERROR COMPENSATOR ON THE QUALITY OF THIN-SHEET SEPARATING STAMPING (p. 10–15)

Vladimir Mirzak, Viktor Bokov

The quality of the thin-sheet separating stamping depends on the state of the "press-stamp" system, namely the state of the press (rigidity and geometric accuracy) and the deformation degree of the guide assemblies in the stamp and stamping unit plates as a result of the action of technological effort. To reduce the impact of these deformations, different approaches are used: from increasing the rigidity of the unit by the number of guide assemblies and plate thickness to applying compensating devices for unloading the unit from the action of transverse forces and torques. Known compensating devices only partially solve the problem, which is not enough for the conditions of the thin-sheet separating stamping. According to the authors, the deformation of the units can be substantially reduced using the mechanical error compensator of the "press-stamp" system, mounted on the press table instead of the bolster plate, which should positively affect the quality of thin-sheet stamped parts.

In the paper, the effect of mechanical compensator on the stress-strain state of the stamping unit elements and the quality of the thin-sheet separating stamping of the rotor plates was examined through a comparative analysis.

It was found that using the compensator substantially reduces the deformation of the bottom plate of the stamping unit, which leads to more favorable operating conditions of the stamp guide assemblies. The rotation angle of columns, as a result of deformation of the unit plates, has decreased several times.

The mechanism of the effect of the compensator on the stamping quality indices was determined. Measuring variations in the sizes of the rotor plates showed that during stamping with compensator, the deviation is 2.25–2.40 times lower than without it, and the distribution density of sizes during stamping with compensator is 30–40 % higher.

Thus, the research shows the feasibility of using the proposed mechanical error compensator of the "press-stamp" system to enhance the quality of the thin-sheet separating stamping, especially in large scale and mass production of parts such as core plates.

Keywords: separating stamping, "press-stamp" system errors, mechanical compensator, stamping quality.

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RESEARCH OF DEVICE FOR AIR DISTRIBUTION WITH SWIRL AND SPREAD AIR JETS AT VARIABLE MODE (p. 15–23)

Orest Voznyak, Iryna. Sukholova, Khrystyna Myroniuk

The research deals with solving the urgent problem of improving the efficiency of air distribution with the swirl and spread air jets to ensure regulatory parameters of the air in industrial premises. The mathematical model of air supply with the swirl and spread air jets in these premises is improved. It is shown that for maximum air distribution efficiency, air should be supplied with the jets that are intensively damped before entering the working area. The design of the air distributor with the formation of swirl and spread air jets, providing intense damping of the velocity and excess temperature of the resulting air flow is developed and investigated. The feature of this design is the ability to feed two supply air jets, the swirl air jet, formed after having passed through plates, and the spread air jet, which comes from the annular slot. This ensures intense mixing of supply air jets of the ambient air and provides the variable mode. Graphic dependencies are built, and theoretical dependencies are derived based on experimental studies that can be used in further engineering computations. The designs of air distributors for air supply with swirl and spread air jets and feeding the supply air jets in the variable mode are developed and protected by patents Ukraine. The economic efficiency of double-jet air distributors compared to the alternatives is shown, specific performance of air distribution is presented.

Keywords: air distribution, swirl air jet, spread air jet, velocity, excess temperature, variable mode.

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A VIBRATION ANALYSIS USED IN THE METHODS OF DETECTING UNSTEADY OPERATIONAL MODES OF AXIAL COMPRESSORS (p. 23–34)

Valentyn Chygryn, Sergiy Yepifanov, Farrokh Mohammadsadegi

We have grounded the necessity to devise a system of a comħ pressor surge prevention at the stage of its inception and analysed possible informative parameters characterizing an unsteady flow in a compressor and the possibility of a surge. We have presented the results of numerical simulation of the flow and dynamics of the loss of gas-dynamic stability in the inter-blade channel of the axial compressor impeller.

It has been determined that the process of the loss of dynamic stability begins with the appearance of the initial vortex zone on the back of the blade profile. We have carried out an experimental research with measuring the pressure pulsation and vibration, revealed that the levels of pressure fluctuations on the impeller with

a frequency of rotor blades can signal of the compressor stall, and pointed out the problems of technical use of this criterion. We have experimentally researched the connection of unstable flows in the flow part and vibration levels in the compressor housing. It is proved that the harmonics of the rotating stall that is determined by the level of vibrations is stable and significantly stands out from the background noise, so it can be used to diagnose the rotating stall as a signal of the surge.

The paper contains an experimentally verified dependence for determining the frequency of the rotating stall. We have studied the possibility of using the median and band filters in processing the vibrations and suggested an algorithm for identifying a pre-surge compressor state by the rate of vibrations in the compressor housing, which is aimed at devising of automatic warning systems for the surge prevention at the stage of its inception.

Devising a system of an anti-surge protection with the use of the vibration signal would increase the reliability of its work and raise the operational reliability of a gas turbine engine by eliminating false positives.

Keywords: axial compressor, rotating stall, surge, vibration signal, median filtering, band-pass filter.

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EXPERIMENTAL RESEARCH ON THE THERMAL STATE OF A SHELL FOR NOISE AND HEAT INSULATION OF THE GTE90L2 GAS TURBINE ENGINE USED FOR THE MECHANICAL DRIVE OF THE GCU-C-16S TURBO-COMPRESSOR PACKAGE (p. 35–42)

Oleg Shcherbakov, Dmytro Tkachenko, Volodymyr Paparfiynyk, Volodymyr Gurinenko, Volodymyr Kostiuk, Oleksiy Skrypka, Olena Kyrylash

We have devised a methodology and obtained experimental findings on the thermal state of the noise and heat insulation shell in the GTE90L2 gas turbine engine designed by the State Enterprise Gas Turbine Research & Production Complex (SE GTRPC) Zorya-Mashproekt as a part of the turbine of the GCU-C-16S gas pumping units produced by the Sumy Machine Building Research and Production Association and operated as a part of the Dolyna (Valley) compressor station.

We studied the sustainable mode of the unit with three modes of the shell ventilation to measure the flow rate of air supplied to the shell, air temperature at 23 points and the temperature of the inner surfaces of the walls at 14 points in the shell, as well as the air temperature outside the enclosure. In our measurements, we used the MS-13 cup anemometer and a multi-channel information-measuring system that included temperature measurement sensors based on the TCA-type thermoelectric converters and protected from the effects of infrared radiation, as well as the MPS-M measuring point selection switch and the digital thermometer Technoterm 9503.

The research was predetermined by the inability of the previous research data on the thermal state of the covers of drive turbine engines to prove the adequacy of the mathematical model for the thermal state of standardized shells for noise and heat insulation of engines for gas pumping units designed by the Sumy Machine Building Research and Production Association.

We have determined the thermal state of the noise and heat shell of the GTE90L2 gas turbine engine as a part of the GCU-C-16S gas pumping unit operated as a part of the Dolyna (Valley) compressor station. The research has revealed, in particular, uneven distribution of temperatures of the air and internal surfaces of the shell walls as well as a significant effect of heat radiation from the engine upon the thermal state of the shell.

The obtained data on the thermal state of the shell are useful and important for producers of gas pumping equipment with gas turbine drives since their quality and quantity are sufficient for verifying the generalized mathematical model of the thermal state of shells, and the methods of their obtaining are free from the shortcomings that are inherent in the previous studies.

Keywords: gas pumping unit, gas turbine drive, noise and heat insulation shell, thermal state, temperature measurement

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ANALYSIS OF TECHNOLOGICAL FACTORS THAT SIGNIFICANTLY AFFECT THE FORMATION OF STRESSES IN THE CAST MACHINE PARTS (p. 43–47)

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The results of shrinkage porosity distribution in cast parts of the block-crankcase of the internal combustion engine (ICE) were presented. It was shown that the localization of gas-shrinkage porosity coincides with the localization of residual stresses in a body of cast block-crankcase of ICE. Technological factors that significantly affect the formation of residual stresses were identified. These include the selected inoculant type and alloy inoculation modes; design of the gating system and rods, heat treatment modes. The measures that reduce residual stresses, in particular, a rational choice of the alloy; modifiers having an optimal combination of alloying and graphitizing elements; reduction of shrinkage inhibition during solidification,

ensured by the rational design of rods; developing the gating system for the optimal flow of hydro- and gas-dynamic processes during the mould filling with the melt were proposed.

Keywords: residual stresses, stress-strain state of cast parts, block-crankcase.

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