ABSTRACTS

Grzegorz Żywica, Paweł Bagiński
Investigation of Gas Foil Bearings with an Adaptive and Non-Linear Structure

The article discusses the results of simulation-based and experimental research carried out on gas foil bearings. Owing to the use of a set of flexible thin foils in such bearings, they exhibit certain beneficial features that cannot be found in other types of bearings. They have nonlinear operational characteristics and allow the dissipation of excess energy, thus reducing the vibration level. Moreover, gas foil bearings can self-adapt themselves to the current operating conditions by changing the shape of the lubrication gap. Therefore, they can be used to improve the dynamic performance of rotors, in particular, those operating at very high rotational speeds. This article explains the mechanisms for changes of stiffness and vibration damping in compliant components of a foil bearing. The results of the analysis of the bearing's subassemblies using advanced numerical models are presented. They are followed by conclusions that were drawn not only from these results but also from the results of the experimental research. It has been proven that the rotor supported on carefully designed foil bearings is capable of maintaining a low vibration level, even if it operates at a high rotational speed.

Volodymyr Zelenyak
Mathematical Modeling of Stationary Thermoelastic State for a Plate with Periodic System Inclusions and Cracks

Two-dimensional stationary problem of heat conduction and thermoelasticity for infinite elastic body containing periodic system of inclusions and cracks is considered. Solution of the problem is constructed using the method of singular integral equations (SIEs). The numerical solution of the system integral equations are obtained by the method of mechanical quadrature for a plate heated by a heat flow, containing periodic system elliptic inclusions and thermally insulated cracks. There are obtained graphic dependences of stress intensity factors (SIFs), which characterise the distribution of intensity of stresses at the tops of a crack, depending on the length of crack, elastic and thermoelastic characteristics inclusion, relative position of crack and inclusion.

Piotr Gierlak
Position/Force Control of Manipulator in Contact with Flexible Environment

The paper presents the issue position/force control of a manipulator in contact with the flexible environment. It consists of the realisation of manipulator end-effector motion on the environment surface with the simultaneous appliance of desired pressure on the surface. The paper considers the case of a flexible environment when its deformation occurs under the pressure, which has a significant influence on the control purpose realisation. The article presents the model of the controlled system and the problem of tracking control with the use of neural networks. The control algorithm includes contact surface flexibility in order to improve control quality. The article presents the results of numerical simulations, which indicate the correctness of the applied control law.

Serpil Şahin, Hüseyin Demir
Numerical Solution of Natural Convective Heat Transfer under Magnetic Field Effect

In this study, non-Newtonian pseudoplastic fluid flow equations for 2-D steady, incompressible, the natural convective heat transfer are solved numerically by pseudo time derivative. The stability properties of natural convective heat transfer in an enclosed cavity region heated from below under magnetic field effect are investigated depending on the Rayleigh and Chandrasekhar numbers. Stability properties are studied, in particular, for the Rayleigh number from $\mathbf{10^4}$ to $\mathbf{10^6}$ and for the Chandrasekhar number 3, 5 and 10. As a result, when Rayleigh number is bigger than $\mathbf{10^6}$ and Chandrasekhar number is bigger than 10, the instability occurs in the flow domain. The results obtained for natural convective heat transfer problem are shown in the figures for Newtonian and pseudoplastic fluids. Finally, the local Nusselt number is evaluated along the bottom wall.

Grzegorz Mieczkowski
Static Electromechanical Characteristics of Piezoelectric Converters with Various Thickness and Length of Piezoelectric Layers

The paper presents the analysis of electromechanical characteristics of piezoelectric converters subjected to an electric field and mechanical load. The analyses were performed based on a method consisting implementation of special segments responsible for electrical boundary conditions to a homogeneous beam. Constitutive equations were developed, allowing one to obtain static electromechanical characteristics for piezoelectric actuators with freely defined boundary conditions and geometry. Moreover, based on constitutive equations obtained, a particular solution for cantilever transducer subjected to concentrated force has been developed. The resulting analytical solution was compared with the data available in the literature, and the developed FEM solution. Furthermore, the influence of factors such as relative length, thickness and location of particular piezoelectric layers on electromechanical characteristics of the transducer was defined.

Jerzy Jaroszewicz, Krzysztof Łukaszewicz, Vladimir Antonyuk
Design of the Vibrostabilisation Stand for Reducing Residual Stresses in Discs used in the Construction of Multi-Plate Clutches and Brakes

Heavy-duty, oil-cooled brake discs (MMOTs) are often used in heavy-duty brake systems manufactured by companies such as Caterpilar, Clark, Komatsu and Liebherr. These discs are usually made of special steels, and in most cases, the flatness of the working surfaces should not exceed 0.15–0.30 mm. Although the technological processes of friction disc production include several stages of heat treatment and grinding, the required accuracy is not achieved in some cases. In addition, the remaining residual stresses lead to the deformation of the discs during their lifetime. In production practice, three methods are used to reduce residual stresses: thermo-fixing, dynamic stabilisation and vibratory stabilisation consisting in bringing discs to transverse resonance vibrations and maintaining resonance until significant stress reduction. The article proposes a method of stabilising the discs using the resonance phenomenon at the first few frequencies. In this article, Cauchy's function method and characteristic series method are used to develop solution value problem for clamped circular plates with discrete inclusions as concentrated masses and springs. Calculation methods for quick estimation of the own frequency of discs with additional ring mass enabling the use of low power vibration inductors are presented. The use of a special membrane and a pneumatic cushion in the construction of the stand allows to induce vibrations of higher frequencies.

Mariusz Leus, Marta Abrahamowicz
Experimental Investigations of Elimination the Stick-Slip Phenomenon in the Presence of Longitudinal Tangential Vibration

The article presents a scheme and description of the test stand as well as selected experimental results of the influence of longi-tudinal tangential vibrations on the stick-slip phenomenon. The tests were carried out at a constant forced vibration frequency f = 2000 Hz, as a function of the amplitude of the vibration velocity v_a. The position of the sliding body and the drive force necessary to make the body slip and maintain this motion were measured. The measurements were made in two successive stages. In the first stage, when the substrate on which the sliding occurred was stationary. In the second one, the substrate is in a vibrating motion in the direction parallel to the slip. The conducted experimental analyses have shown that longitudinal tangential vibrations can contribute to the reduction or even complete elimination of the stick-slip phenomenon.

Grzegorz Górski, Grzegorz Litak, Romuald Mosdorf, Andrzej Rysak
Periodic Trends in Two-Phase flow Through a Vertical Minichannel: Wavelet and Multiscale Entropy Analyses Based on Digital Camera Data

By changing the air and water flow relative rates in the two-phase (air-water) flow through a minichannel, we observe aggregation and partitioning of air bubbles and slugs of different sizes. An air bubble arrangement, which show non-periodic and periodic patterns. The spatiotemporal behaviour was recorded by a digital camera. Multiscale entropy analysis is a method of measuring the time series complexity. The main aim of the paper was testing the possibility of implementation of multiscale entropy for two-phase flow patterns classification. For better understanding, the dynamics of the two-phase flow patterns inside the minichannel histograms and wavelet methods were also used. In particular, we found a clear distinction between bubbles and slugs formations in terms of multiscale entropy. On the other hand, the intermediate region was effected by appearance of both forms in non-periodic and periodic sequences. The preliminary results were confirmed by using histograms and wavelets.

Tetiana Cherepova, Galyna Dmitrieva, Oleksandr Tisov, Oleksandr Dukhota, Myroslav Kindrachuk
Research on the Properties of Co-TiC and Ni-TiC HIP-Sintered Alloys

Three types of sintered alloys were fabricated based on cobalt, nickel and high-temperature alloy ZhS32-VI matrix with titanium carbide strengthening phase. TiC content was in a range of 30–50 vol. %. The melting temperatures of alloys are higher than 1320°C, and they may undergo undamaged through all technological procedures together with turbine blades, including soldering and outgassing. DSC analyses indicates no additional thermal effects until melting, which confirms their structural stability. The examinations of microstructure revealed three types of constituents – TiC particles, matrix solid solution and blow outs – structural defects having negative effects on all the studied properties. It was found that heat resistance of nickel based sintered alloys at the temperature of 1100°C is superior as compared with the alloys based on cobalt and alloy ZhS32-VI. It has been established that wear resistance in conditions of fretting wear at temperatures of 20, 850, 950 and 1050°C of sintered alloy with ZhS32-VI matrix is mostly superior as compared with the other alloys. The properties of produced alloys allow to use them for manufacturing of components of friction couples operating in conditions of high temperature fretting wear, including protective pads of turbine blades top shrouds contact faces.