

# CONTENTS

## MECHANICAL AND THEORETICAL ENGINEERING

<b>P. D. Balakin, O. S. Dyundik, I. P. Zgonnik, A. V. Krivtsov.</b> Anti-vibration seat of transport vehicle operator	5
<b>A. M. Lasitsa, I. A. Borodikhin, P. A. Lisin, L. V. Brizhansky.</b> Design of remover system for conveyor lines of food industry	11
<b>A. S. Lifar, A. E. Brom.</b> Evaluation of integrated management strategy for hydropower facilities operation	17
<b>A. O. Belskii, R. A. Akhmedzhanov, P. A. Varavva.</b> New aspects of improvement design for two-axle bogies of freight cars	22

## ELECTRICAL ENGINEERING

<b>F. R. Ismagilov, V. E. Vavilov, R. A. Nurgalieva, A. Kh. Miniyarov.</b> Power supply devices for auxiliary blood circulation	27
<b>D. A. Polyakov, K. I. Nikitin, N. A. Tereshchenko, A. S. Novoselov, Ya. P. Bilevich.</b> Analysis of partial discharges in supporting insulators	32
<b>D. A. Polyakov, K. I. Nikitin, N. A. Tereshchenko, I. V. Komarov, U. V. Polyakova.</b> Study power of partial discharges to voltage intensity in XLPE-insulated cables	39

## INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

<b>V. A. Zakharenko, A. G. Shakhova, A. G. Shkayev.</b> Two-coordinate electromagnetic sensor	45
<b>B. I. Kovalskiy, V. I. Vereshchagin, V. G. Shram, E. G. Kravtsova, O. N. Petrov, M. A. Kovaleva.</b> Method for monitoring thermal oxidative stability of transmission oil TAP-15V	49
<b>B. V. Chuvykin, M. M. Nikiforov.</b> Correction of delays in channels of information-measuring system by methods of digital signal processing by analysis of harmonics of current and voltage	54
<b>B. V. Chuvykin, M. M. Nikiforov.</b> Increasing ADC dynamic range in information-measuring systems by methods of digital signal processing	58
<b>R. B. Burlakov.</b> Photocell with two Schottky barrier contacts Ti-p-Si and ohmic silicide contact NiSi-p-Si	62
<b>A. I. Blesman, R. B. Burlakov.</b> Probe device for electrical measurements of parameters thin doped films ZnO	67
<b>E. V. Leun.</b> Improving product size measurement systems by using piezo-fiber scanner	73

## Anniversaries

<b>A. A. Tatevosyan.</b> To 55th Anniversary of Energy Engineering Institute of Omsk State Technical University	80
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## SUMMARY. KEYWORDS

### MECHANICAL AND THEORETICAL ENGINEERING

**P. D. Balakin<sup>1</sup>, O. S. Dyundik<sup>1</sup>, I. P. Zgonnik<sup>1</sup>, A. V. Krivtsov<sup>2</sup>**  
**Anti-vibration seat of transport vehicle operator**

<sup>1</sup>Omsk State Technical University, Omsk, Russia  
<sup>2</sup>Federal Research and Production Center «Progress», Omsk, Russia

Vibration isolation of personnel and machine units is an urgent problem that requires a comprehensive approach to its resolution. The article presents effective technical solutions of the vibration isolation system, characterized by structural simplicity and having in its composition other elements with a linear stiffness characteristic, but with a special location to the vibration displacements of the protected object. It is shown that in the systems «jump» in a certain range of achievable effect quasi-zero stiffness of the support given by the simplest, tech, universal technical solution of the anti-vibration seat of a transport vehicle.

Keywords: vibration isolation, elastic element, natural oscillation frequency of the system, quasi-zero stiffness.

**A. M. Lasitsa<sup>1</sup>, I. A. Borodikhin<sup>2</sup>, P. A. Lisin<sup>3</sup>, L. V. Brizhansky<sup>4</sup>**  
**Design of remover system for conveyor lines of food industry**

<sup>1</sup>Omsk State Technical University, Omsk, Russia  
<sup>2</sup>Limited Liability Company «Unilever-RUSSIA», Omsk, Russia  
<sup>3</sup>Omsk State Agrarian University named after P. A. Stolypin, Omsk, Russia  
<sup>4</sup>Michurinsk State Agrarian University, Michurinsk, Russia

The article shows that when designing a remover system for conveyor lines of the food industry it is necessary to consider all stages of the technological process. Thermodynamic calculations showing the effect of the degree of crystallization of water, cryoscopic temperature and crystallization rate are presented. The estimation of different methods for approximating temperature dependencies is given. A significant effect of the state of the surface on the separation force of remover is revealed. Recommendations on the setting technological parameters are given.

Keywords: conveyor lines, remover system, cryoscopic temperature, degree of crystallization, ice cream production.

**A. S. Lifar, A. E. Brom**  
**Evaluation of integrated management strategy for hydropower facilities operation**

**Bauman Moscow State Technical University, Moscow, Russia**

The task of evaluating the integrated management strategy is solved for hydropower facilities in conditions of changing integrated management of the operation process. Despite the fact that the strategy is integrated, covers all business processes of operation, it is proposed to evaluate it for each of the indicators separately. The proposed method allows to visualize the results of the organization of operation processes and highlight the «bottlenecks».

Keywords: integrated strategy, operation, strategic map, evaluation.

**A. O. Belskii<sup>1</sup>, R. A. Akhmedzhanov<sup>2</sup>, P. A. Varavva<sup>2</sup>**  
**New aspects of improvement design for two-axle bogies of freight cars**

<sup>1</sup>Limited liability company «Energoservis», Omsk, Russia  
<sup>2</sup>Omsk State Transport University, Omsk, Russia

The analysis of technical condition of cast side frames of biaxial three-element bogies of freight cars in operation is carried out. A refined method of calculating the strength of the supporting structure of the side frame, new aspects of design solutions, which

allowed to increase the strength of the supporting structure of the side frame in operation, is proposed.

Keywords: freight car bogie, side frame, analysis, calculation, strength, service life, finite element method, modernization.

### ELECTRICAL ENGINEERING

**F. R. Ismagilov, V. E. Vavilov,  
R. A. Nurgalieva, A. Kh. Miniyarov**  
**Power supply devices for auxiliary blood circulation**

**Ufa State Aviation Technical University, Ufa, Russia**

The article discusses issues, problems and methods for solving them related to the transfer of energy to transplanted assisted circulation devices, which allow for efficient, safe and stable energy transfer. One of the promising methods of energy transfer is wireless energy transfer, which allows patients with implantable devices to lead a more active life, avoiding infection and rejection of the devices.

Keywords: transcuteaneous energy transfer, wireless power transmission system, the unit assisted circulation, heart pump.

**D. A. Polyakov, K. I. Nikitin, N. A. Tereshchenko,  
A. S. Novoselov, Ya. P. Bilevich**  
**Analysis of partial discharges in supporting insulators**

**Omsk State Technical University, Omsk, Russia**

The diagnostics of overhead power lines is an important issue in the modern electric power industry. Sometimes supporting insulators are destroyed by external factors. Cracks in insulators can cause the destruction of the insulator, which increases the electrical injuries of personnel. Therefore, the article investigates the diagnosis of insulators by the method of partial discharges as a tool for personnel protection. The electric field of normal and defective insulators is simulated. Partial discharges (PD) experiments are conducted in the same insulators. The results of modeling the electric field show a high electric field intensity in a porcelain insulator with a slit and in an epoxy insulator with a crack. In these cases, the electric field in the air gap is higher than the electric strength of the air. In other cases, the electric field is not exceed the electric strength of the material. Experimental studies have shown the highest intensity of partial discharges in cases of high electric field strength obtained in the simulation. However, other defective insulators also show the presence of partial discharges. The only case of the absence of partial discharges is a porcelain insulator without a defect. An analysis of experimental data shows that the diagnosis of partial discharges can be effective for insulators only if a voltage higher than the working voltage is used. In the experiments, only voltages of 16 kV and higher made it possible to reliably detect the presence of a defect. Therefore, this method cannot be recommended for the diagnosis of supporting insulators before the disconnecter is used by personnel, which could reduce the electrical injuries of personnel. In addition, monitoring of partial discharges also will not be effective for the studied types of defects.

Keywords: partial discharges, supporting insulators, overhead power transmission lines, diagnostic, insulator testing.

**D. A. Polyakov<sup>1</sup>, K. I. Nikitin<sup>1</sup>, N. A. Tereshchenko<sup>1</sup>,  
I. V. Komarov<sup>1</sup>, U. V. Polyakova<sup>2</sup>**  
**Study power of partial discharges to voltage intensity in XLPE-insulated cables**

<sup>1</sup>Omsk State Technical University, Omsk, Russia  
<sup>2</sup>ONHP, Omsk, Russia

The article investigates partial discharges (PD) as a mechanism of insulation destruction. Some of the known mathematical models of insulation aging take into account the effect of partial

discharges. These models are based on the dependence of partial discharges power on voltage, so this dependence is investigated in the article. Experimental studies of the dependence of the characteristics of partial discharges are presented. As a source of an increased level of partial discharges, a defect is used in the termination area of the 10 kV cable with XLPE insulation. The voltage range of experiments is from 8 to 15 kV. The results show the presence of a dangerous defect in the cable. Partial discharges at 8 kV are insignificant. However, 10 kV leads to the appearance of significant partial discharges. PD at 15 kV have the most devastating effect on insulation. The results are processed to assess the dependence of PD power on voltage. The resulting dependence is consistent with existing research results. However, the obtained characteristics may change over time due to the growth of the defect.

Keywords: partial discharges, dependence of the power of partial discharges on voltage, aging of insulation, aging mechanism, defect of the cable sleeve.

#### INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

**V. A. Zakharenko, A. G. Shakhova, A. G. Shkayev**  
**Two-coordinate electromagnetic sensor**

**Omsk State Technical University, Omsk, Russia**

A two-coordinate non-contact sensor for detecting increased sensitivity is developed, which operates on the principle of electromagnetic saturation of the transformer core under the action of an external magnetic field. The sensor operation, its design version is described, functional and electrical circuits are shown. The results of implementation of prototype sensors in the process of production of technical carbon for control of rotation of drying drums are presented. The sensors retain detection capability when removing the object of control caused by thermal expansion of the material of the drum structure by 150-200 mm.

Keywords: contactless detection sensor, core saturation, magnetic core, permanent magnet, ferrite core, drying drum.

**B. I. Kovalskiy, V. I. Vereshchagin, V. G. Shram,  
E. G. Kravtsova, O. N. Petrov, M. A. Kovaleva**  
**Method for monitoring thermal oxidative stability of  
transmission oil TAP-15V**

**Siberian Federal University, Krasnoyarsk, Russia**

This paper presents the results of a study of the mineral transmission oil TAP-15V for the determination of thermal oxidative stability indicators including optical density, viscosity, and volatility. The effect of temperature on oxidative processes is shown. Thus, the study of thermo-oxidative stability using the optical form of non-destructive testing using the photometry method of oxidized gear oils allows us to evaluate the kinetics of changes in optical properties determined by the absorption coefficient of the light flux to determine the relationship between optical properties and viscosity, as well as the rate of oxidation processes and the volatility of oils, which allowed as a parameter of thermo-oxidative stability of oils to offer a complex coefficient of thermo-oxidative destruction, considering the optical properties and the viscosity at their oxidation.

Keywords: optical method, light flux absorption coefficient, viscosity, evaporability, thermo-oxidative stability, thermo-oxidative destruction, coefficient of thermo-oxidative destruction.

**B. V. Chuvykin<sup>1</sup>, M. M. Nikiforov<sup>2</sup>**  
**Correction of delays in channels of information-measuring  
system by methods of digital signal processing by analysis of  
harmonics of current and voltage**

**<sup>1</sup>Penza State University, Penza, Russia**

**<sup>2</sup>Omsk State Transport University, Omsk, Russia**

The article considers an effective algorithm for group delay correction in the channels of multichannel information and measurement systems. The description of the method is carried out for the case of harmonics measuring for current and voltage in electrical networks. The algorithm is based on the linear

interpolation method using a non-recursive digital filter. The filter coefficients are a discretized windowed sinc. After the description of the method, the results of effective band modeling of the interpolating filter are presented. In conclusion, recommendations are given to reduce the amount of processor memory in the implementation of the algorithm.

Keywords: electric energy quality, current and voltage harmonics, Dirac Delta function, interpolation error, digital filter, window methods, linear transformations.

**B. V. Chuvykin<sup>1</sup>, M. M. Nikiforov<sup>2</sup>**  
**Increasing ADC dynamic range in information-measuring  
systems by methods of digital signal processing**

**<sup>1</sup>Penza State University, Penza, Russia**

**<sup>2</sup>Omsk State Transport University, Omsk, Russia**

The article deals with the method of increasing the dynamic range of a standard analog-to-digital converter. The method is based on interpolation of signal sections, which are limited in amplitude, using undistorted sections. Interpolation is performed by solving a system of linear equations. The error estimation and factors limiting the application of the method is made. Simulation results are presented. The conclusion is made about the prospects of using the least squares method, since in this case the interpolation error is the smallest in the mean square sense.

Keywords: analog-to-digital converter, dynamic range, interpolation, interpolation error, system of linear equations, non-uniform sampling, interpolating series.

**R. B. Burlakov**  
**Photocell with two Schottky barrier contacts Ti-p-Si and ohmic  
silicide contact NiSi-p-Si**

**Dostoevsky Omsk State University, Omsk, Russia**

Way for the fabrication and results of studies of photoelectric features of twospectrum photocell with two Schottky barrier contacts Ti-p-Si on one party of the silicon plate and ohmic silicide contact NiSi-p-Si situated on the opposite party of the plate are considered. It is shown that explored photocell can be used for the transformation of the energy of the radiation in the electrical energy at room temperature in two ranges: or in near infrared region of the spectrum (0,9–1,4) micron, or in the field of (0,5–1,4) micron. This characteristic of the designed photocell will allow increasing its application. Photocell possesses a simple structure and technology with a time of its fabrication in the interval (2,5–3) of the hour.

Keywords: method of fabricating the photocell, p-type silicon, Schottky barrier contacts Ti-p-Si, silicide contact NiSi-p-Si.

**A. I. Blesman<sup>1</sup>, R. B. Burlakov<sup>2</sup>**  
**Probe device for electrical measurements of parameters thin  
doped films ZnO**

**<sup>1</sup>Omsk State Technical University, Omsk, Russia**

**<sup>2</sup>Dostoevsky Omsk State University, Omsk, Russia**

Probe device for electrical measurements of parameters thin doped films ZnO is considered. On the base of use of this probe device there is measured by the Hall Effect method the concentration of electrons of the conductivity in indium doped thin films ZnO with thickness in the interval (0,065–0,3)  $\mu\text{m}$  concentration of electrons of the conductivity in the interval  $(2–3,4) \cdot 10^{19} \text{ cm}^{-3}$  and low mobility of electrons of the conductivity —  $(4–8,5) \text{ cm}^2/\text{Vs}$ . Dignity of probe device is a possibility of the reduction of the voltage asymmetry of hall probes.

Keywords: electrical measurements of parameters, probe device, Hall Effect method, thin films ZnO.

**E. V. Leun**  
**Improving product size measurement systems by using piezo-  
fiber scanner**

**Lavochkin Association, Moscow region, Khimki, Russia**

The article discusses the physical and technical basis for the construction and operation of systems for measuring the size of

complex products, taking into account the use of a new spatial light modulator — a piezo-fiber scanner. Its device, operating principle, and main technical characteristics are described. The paper considers the joint operation of a piezo-fiber scanner and a low-coherence interferometer as part of three measurement systems: scanning hybrid 3D measuring heads (MH) with the introduction of an ultra-wide-angle optical system and a corundum tip, as well as two active control devices.

It is proposed to use a reference channel for the discussed MH design, and to measure the clearances  $I_{c1}, I_{c2} \dots I_{cn}$  when contacting the product arising between the corundum tip and the product near the formed contact zone with the subsequent calculation of

the so-called equidistant contours and the final compensation of elastic deformations.

**Keywords:** coordinate measurements, measuring head, corundum tip, low-coherence interferometer, piezo-scanner, active control device, probe microscopy, ultra-wide-angle optical system.

#### **Anniversaries**

**A. A. Tatevosyan**  
**To 55th Anniversary of Energy Engineering Institute of Omsk State Technical University**