# ABSTRACT AND REFERENCES

## INDUSTRIAL AND TECHNOLOGY SYSTEMS

### DEVELOPMENT OF NEW CASTING MAGNESIUM-BASED ALLOYS WITH INCREASED MECHANICAL PROPERTIES (p. 4–10)

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Influence of a number of alloying elements (Nd, Ge, Si, Y, Sc, Zr, Ti and Hf) on structure formation, room-temperature mechanical properties and high-temperature strength of ML5 magnesium alloy have been studied.

Influence of the alloying elements on a shape and size of intermetallic compounds has been established. A quantitative and qualitative analysis of the intermetallic phase in additionally alloyed ML5 have been made, its influence on the structure, room-temperature mechanical properties and high-temperature strength of magnesium castings has been investigated.

Influence of morphological and topological features of the structure constituents of the magnesium alloys on their properties has been established. It was shown that micro alloying of the magnesium alloys within a range of 0.05–0.1 % wt. results in an increase of the intermetallic compound volume percent by ~ 1.5 times, reducing their size with simultaneous formation of spherical intermetallic compounds located in the grain centre and serving as additional solidification nuclei. It was found out that at the volume fraction of the intermetallic compounds within a range of 0.35...0.45 % a maximum ductility of the magnesium alloy is attained. Further increase of the intermetallic compound amount leads to decrease in the ductility due to their excessive precipitation and greater strengthening of the metal.

Introduction of the studied magnesium alloys ensures a higher level of room-temperature mechanical properties and a high-temperature strength of the castings that makes them a good candidate material to be used in newly developed machines and assemblies.

**Keywords:** magnesium alloy, alloying elements, structure, intermetallic compounds, mechanical properties, high-temperature strength.

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### DETERMINATION OF RATIONAL ROUGHNES OF THE SIDE SURFACE OF THE RAIL TOP IN CURVED SECTIONS OF THE UNDERGROUND RAILWAY TRACK (p. 11–17)

**Serhii Voronin, Oleksii Skoryk, Yevhen Korostelov**

This work provides a series of studies are aimed at determining the forces acting in the contact «wheel-rail» in curvilinear sections of the underground railway track.

To define the dependence of the friction coefficient on the parameters of microgeometry of contact surfaces, the technique of laboratory tests on a friction machine was developed. The laboratory tests were carried out on the friction machine by testing specially made models, whose material directly and size in conversion corresponds to the components of the contact «wheel-rail». In order to determine parameters

of force impact on model samples, calculation of contact voltages, which occur in the real contact under conditions of unlubricated friction and their conversion into the «modeling» contact were performed.

As a result of testing, rational values of the friction coefficient and wear rate of the contact «wheel-rail' at unlubricated friction under conditions of contacting in curvilinear sections of the underground railway track were defined.

The obtained values of parameters of microgeometry of contacting surfaces under conditions of their practical implementation can significantly reduce the wear rate in the contact «wheel-rail» in curvilinear sections of the underground railway track. In turn, the decrease in wear rate will lead to the decrease in costs on maintenance of the underground railway track.

**Keywords:** contact voltages, model samples, rational roughness, «wheel-rail», underground railway track.

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## VISCOSITY EVALUATION OF THE MIXTURE OF COAL TARS FROM COLLECTION MAIN AND PRIMARY COOLER ON THE BASE OF RHEOMETER MEASUREMENTS AND EMPIRICAL FORMULAS (p. 17–23)

**Alexander Pasternak, Leonid Bannikov, Anna Smirnova**

Viscosity of heavy and light coal tars from the coking process of coal blends with a decreasing portion of Ukrainian coal was measured. In addition, measurement of viscosity of mixtures of coal tar was carried out. Concentration of mixture met the standards of the regulations of the washing liquids for gas space of primary cooler. The temperature dependence of the viscosity of the tar mixture was evaluated according to some empirical equations. In particular, the equations have been used considering deviations from the ideal state. The viscosity of the individual samples of heavy and light tars was not appropriately investigated. This also applies to the temperature dependence. This is common practice for coal tar viscosity measurements in Engler units. Also, there are no empirical relationships; we cannot predict the viscosity of the tar when mixed, as we do for the petroleum oil matter. Anomalous decline in viscosity with the addition of 5–20 % light tar that corresponded to the minimum activation energy of viscous flow was revealed experimentally.

**Keywords:** mixture viscosity, empirical relationship, coal tar, gas collecting main, primary cooler.

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## INFLUENCE OF THE NATURE OF BOUNDARY LUBRICATING LAYERS ON ADHESION COMPONENT OF FRICTION COEFFICIENT UNDER ROLLING CONDITIONS (p. 24–31)

**Oksana Mikosyanchyk, Rudolf Mnatsakanov, Aleksandr Zaporozhets, Ruslan Kostynik**

The patterns of the change in antifriction properties of contact due to strength characteristics of boundary films of physical and chemisorbed nature were examined. The purpose of the study was to establish the influence of lubricating and rheological properties of the boundary films, formed on the surface layers of metal activated by friction, on the kinetics of change in the friction coefficient. The method of estimation of tribotechnical properties of contact under non-stationary conditions with cutting off the lubricant feed to the friction zone was used. Its essence is in determining the period of the setting of contact surfaces and registration of lubricating, antifriction and rheological indicators in this period.

An increase in antifriction properties of contact during pure rolling was established, owing to localization of tangential shear stresses in the liquid phase of a lubricant film; an increase in the friction coefficient is caused by an increase in tangential shear stresses of the boundary structured chemisorption films during transition to rolling with slippage.

The influence of slippage between the contact surfaces was analyzed, the increase in which from 3 % to 40 % leads to acceleration of the period of occurrence of the first signs of the setting, which is manifested by an increase in the adhesive component of the friction coefficient during desorption of boundary layers. During the setting of friction pairs, an abrupt periodic decrease in the friction coefficient was established and the manifestation of hydrodynamic effects in contact during melting of boundary layers was observed. The results of the studies may be used for designing the friction pairs of machines and mechanisms, which operate under non-stationary conditions (variable speeds, loads and temperature).

**Keywords:** friction coefficient, shear stress, effective viscosity, slippage, boundary films of lubricant.

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## DETERMINING PARAMETERS OF ELECTRIC DRIVE OF A SLEEPER-TYPE TURNOUT BASED ON ELECTROMAGNET AND LINEAR INDUCTOR ELECTRIC MOTOR (p. 32–41)

**Serhii Buriakovskyi, Artem Maslii, Andrii Maslii**

As a result of the conducted study, we determined parameters of the electric drive of a sleeper-type turnout based on the linear electromagnetic energy converters. By parameters of the electric drive we mean not only the design of a linear electric motor, such as diameters of stator, anchor, their length, the magnitude of air gap, the type of coil, but also availability of additional elements. In this case — availability of the springs that ensure the required force at the motion start. In this case, two variants of the linear motors design were considered and various layouts of electric drive of a turnout, respectively. In both cases, the force from the motor is transmitted directly to the coupling rod between the rail points, which makes it possible to exclude such an additional element as the reducer, which has a relatively low performance efficiency, additional metal consumption and overall size, which also decreases general reliability of the device as a whole. The problem of multicriterion optimization of parameters of electric motors was compiled. Geometric dimensions of the drives were accepted as the variable parameters. The analysis revealed that the best result in the search for global optimum out of 11 variants were demonstrated by the Weyl method (with the mean-square deviation of 680.9N for electromagnet) and the method of cyclic minimum (with the mean-square deviation of 1052.3N for induction motor). The estimation was performed according to results of the optimal (minimal) value of the mean-square deviation of electromagnetic force from the resistance force. As the load we used the 1/22 type of a turnout with the maximum weight of rail points for the P65 rail. The data of the study are necessary for creating a new class of electric drives of the turnouts, which make it possible to increase the performance efficiency of the device, as well as its performance speed and, in doing so, to contribute to fulfillment of the program of implementation of high-speed traffic in Ukraine. As a result of the studies, it was found that it is expedient to use the proposed systems of electromagnetic energy converters as the new type of source of mechanical energy in the turnout.

**Keywords:** turnout, electric drive, linear induction motor, electromagnet, methods of optimization.

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## THE IMPACT OF AN UNEVEN LOADING OF A BELT CONVEYOR ON THE LOADING OF DRIVE MOTORS AND ENERGY CONSUMPTION IN TRANSPORTATION (p. 42–51)

**Anatoly Semenchenko, Mykola Stadnik, Pavlo Belitsky, Dmytro Semenchenko, Olena Stepanenko**

The object of the present study is the process of transporting the mined bulk by a belt conveyor during intensive coal mining. The subject of the study is the impact of uneven load flow patterns on the energy parameters of transportation and the resource of the belt conveyor during heavy mining of coal. The aim of the study is to assess the impact of the weight of the load that is transported by a conveyor belt on the drive motors loading and energy consumption during intensive coal mining. The research is performed through a statistical analysis of experimental results obtained by the Dongiprovuglemach institute (Ukraine) regarding the load flow and the capacity of the belt conveyor 2LU120V used by the mine Dovzhanska-Capital (Sverdlovsk, Ukraine).

The capacities of drive motors were considered through a regression analysis. A correlational and spectral analysis was applied to consider the load flow, the load weight, and the capacities of the drive motors. The study has specified the estimated drag coefficient in the movement of the conveyor belt under conditions of intensive mining of coal. Specific energy consumption for transporting the mined bulk by the conveyor was estimated regarding the loading of the belt. The work was done to assess the effect of the size and type of the load flow and the load weight on energy consumption and the resource of the conveyor and to justify a further increase of the technical level of belt conveyors. The results show substantial irregularities in the load flow and the transported load weight, their impact on the amount and type of an uneven loading of the drive motors, and specific energy consumption for transportation and the conveyor resource.

The study has shown that if the loading is small a bigger load is imposed on the drive motor that is located in the place of the belt running off the drive; if the load in big, a bigger load is imposed on the drive motor that is located in the place of the belt running onto the drive. The main dispersion of the load flow occurs at low frequencies corresponding to the duration of the technological cycle of extracting and transporting coal. When the modes of the conveyor operation are close to the maximum load of the belt, energy is least of all consumed for transporting the load. If the loading is reduced, there is a hyperbolic increase in specific energy consumption for transportation. The drag coefficient of the conveyor belt movement, obtained by the experiment data on the capacity value of the idly running conveyor, is significantly higher than the value that is suggested by the method of a technological calculation of the process. This factor should be taken into account while determining the capacity of a drive and calculating the traction of the machine. The results can be used for creating belt conveyors within mining systems of an improved technical level for highly efficient intensive coal mining.

**Keywords:** intensification of coal mining, conveyor, load flow, load weight, energy consumption.

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## DETERMINING EXPERIMENTALLY THE STRESS-STRAINED STATE IN THE RADIAL ROTARY METHOD OF OBTAINING WHEELS RIMS (p. 52–60)

**Ruslan Puzyr, Tetiana Haikova, Oleg Trotsko, Roman Argat**

Questions of experimental study regarding the stress-strained state in the radial rotary method of producing the steel rims of wheels are examined. The physical simulation of the process of profiling the rims is performed on the installation, designed especially for these purposes. The models of the narrow-profile and wide-profile rims of wheels were tested. The grids method was applied for conducting the experiments. The obtained information was processed by the methods of mathematical statistics and probability theory. The results of experimental data made it possible to arrive at a conclusion about the most dangerous sections of the profiles of the rims of wheels, which, in the process of deformation, obtain compressive radial deformations, which confirms the studies conducted previously. The largest deformations occur in the places of radius couplings of the profile, deformations increase from one transition to the next and their total magnitude can exceed the permitted by 20 % of the initial thickness of the workpiece. No essential difference between the two schemes of profiling the rims of wheels was revealed.

**Keywords:** profiling, wheel rim, plastic deformation, stress-strained state, experiment, intensity of stresses, resource of plasticity.

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