

ABSTRACTS of Ph.D. THESES

**Selected abstracts of Ph.D. theses submitted at
Russian transport universities.
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Bolshikh, I. V. Identification of metal-polymer tribosystems with a composite coating of cold hardening. Abstract of Ph.D. (Eng) thesis [Identifikatsiya metallopolimernykh tribosistem s kompozitsionnym pokrytiem kholodnogo otverzheniya. Avtoref. dis... kand. tekhn. nauk]. Rostov-on-Don, RGUPS publ., 2019, 22 p.

A cold hardening matrix compound for large tribosystems has been developed that is also a coating adhesive providing sufficient strength and adhesion. The results of multicriteria optimization in the form of a composite antifriction material with a cold hardening matrix for heavy-loaded large-sized friction units have been obtained.

Results of theoretical studies of the contact temperature in the friction zone, numerical results of computer modeling and data of experimental temperature studies are summarized. A set of models has been created that reflect the dependence of tribotechnical parameters of a metal-polymer friction pair (friction coefficient, contact zone temperature, wear rate, resource) on operating modes of tribosystem loading.

The technique and results of implementation of multicriteria (strength, adhesion, viscoelastic properties, coefficient of friction, wear) optimization of the compositional composition of antifriction coating based on simplex lattice experimental designs are analyzed.

Calculations were made of threshold and actual values permissible during operation of coating, temperature and of established dependence of temperature of the friction zone in the investigated metal-polymer tribosystem on loading conditions; computer simulation by the finite element method (COMSOL Multiphysics complex) of temperature distribution in the contact zone and adjacent areas was made.

The optimal composition of the polymer matrix binder of cold hardening has been established, which provides required strength, adhesive, viscoelastic and tribotechnical characteristics of antifriction coatings.

The parameters of the technology of applying antifriction coatings on two types of materials (steel and copper alloys) have been determined, and the range of rational load-speed modes of operation of antifriction composite coatings has been determined. For engineering calculations of antifriction polymer composite coatings, a set of interpolation regression models has been obtained, which make it possible to determine the following triboparameters: resource, wear rate, friction coefficient, temperature.

Industrial tests of bearings developed as a result of research carried out on the technological equipment of the Rostov-on-Don Electric Locomotive Repair Plant (RERZ) made it possible to increase wear resistance of the friction unit by 22–23,5 %. All experimental studies were carried out according to full-factorial and simplex-lattice designs with subsequent statistical processing of the results. The number of parallel experiments was no less than 3–5. The results obtained have found application in research carried out with the financial support of the Russian Foundation for Basic Research in the framework of scientific project No. 10-08-00777 A.

Specialty 05.02.04 – Friction and wear in machines. The work was carried out at Rostov State Transport University.

Machekhin, N. Yu. Influence of low temperatures on the rational choice and frequency of replacement of engine oils in maintenance of cars. Abstract of Ph.D. (Eng) thesis [Vliyaniye nizkikh temperatur na ratsionalniy vybor i periodichnost' zameny motornykh masel pri tekhnicheskoy obsluzhivaniy avtomobilei. Avtoref. dis... kand. tekhn. nauk]. Omsk, SibADI publ., 2019, 20 p.

A theoretical justification has been developed for increasing efficiency of vehicle operation based on a rational choice and determination of rational terms of maintenance of their engines due to peculiarities of operating conditions at low temperatures. The dependence of the change in the performance indicators of engine oils during vehicle operation at low temperatures was revealed. An algorithm has been developed for choosing engine oil, considering the effect of low temperatures on operation of vehicles.

Based on revealed dependencies, a method has been developed for determining the rational timing of engine oil replacement during vehicle maintenance, taking into account operating conditions on the basis of the indicator most

significant in assessing performance of engine oil. An experimental evaluation of theoretical dependences has been made. The adequacy of theoretical and experimental data has been verified. The correction factor for frequency of engine oil change has been determined. Technical assessment of the research results was carried out.

An algorithm has been developed for preliminary selection of oil for lubricating the power plant of cars based on existing classifications, taking into account climatic and operational factors; regularities of changes in the main indicators of quality of engine oil were obtained and the most significant indicators were substantiated for assessing its performance when operating cars at low temperatures; a method has been developed for determining the rational terms of maintenance, taking into account operation of vehicles at low temperatures.

Specialty 05.22.10 – Operation of road transport. The work was carried out at Siberian State Automobile and Highway University.

Petrov, A. A. Running tests of freight wagons using a tensometric wheel set. Abstract of Ph.D. (Eng) thesis [Khodovie ispytaniya gruzovykh vagonov s primeneniem tenzometricheskoi kolesnoi pary. Avtoref. dis... kand. tekhn. nauk]. St. Petersburg, PGUPS publ., 2019, 16 p.

A mathematical model has been developed that makes it possible to establish rational locations for strain gauges on wheels of a wheel set, the necessary and sufficient number of them. Testing devices for recording dynamic forces acting near the contact patch of the «wheel–rail» system were developed and put into practice to carry out running dynamic tests and to assess the impact of rolling stock on a railway track.

A tensometric wheel set (TWS) has been developed, which has significant differences from all currently known analogues, which allows registering all three components of the force action of rolling stock on railway track (vertical, lateral and longitudinal forces), ensuring discreteness of measurements with a step of 190 mm per wheel revolution, registering the displacement trajectory of the contact patch over the rolling surface of the wheel.

The application of a wireless data transmission system (Wi-Fi) from the rotating parts of the wagon (the rotor part is the TWS registration unit) to the data collection and processing system (the stator part is a personal computer located in the laboratory wagon) has been tested. The software has been developed for a complex of technical means for

determining the scale of measurements, registration and processing of dynamic processes; methods for assessing dynamic qualities and the impact of rolling stock on the railway track using TWS have been tested.

A hardware and software complex (patent for invention No. 2682567) has been developed for registering and evaluating the results of force interaction in the «wheel–rail» system during running tests of freight wagons using TWS, which is distinguished by registration of efforts in three directions and taking into account the position of the wheel contact patch on the rail.

The proposed method for carrying out measuring of the running dynamic and of the impact of rolling stock on the railway track tests with the use of TWS allows to multiply the amount of statistically significant recorded information. The created set of technical means for collecting information allows to optimize the existing test methods that require sticking strain gauge diagrams on the rails of the railway track, and to abandon the multiple passage of the measuring sections due to the receipt of a significantly larger volume of statistically significant information using TWS.

The reliability of results of measurements of force effects recorded using the TWS was confirmed as a result of running tests of three types of wagons, in which a satisfactory convergence of the results obtained using TWS and existing methods of wagon research was established, the discrepancy does not exceed 13 %.

Specialty 05.22.07 – Railway rolling stock, train traction and electrification. The work was carried out at Emperor Alexander I Petersburg State Transport University.

Rogov, S. A. Intellectualization of methods and algorithms for controlling technological processes on hump yards. Abstract of Ph.D. (Eng) thesis [Intellektualizatsiya metodov i algoritmov upravleniya tekhnologicheskimi protsesami na sortirovochnykh gorkakh. Avtoref. dis... kand. tekhn. nauk]. Rostov-on-Don, RGUPS publ., 2019, 16 p.

A general approach has been developed to intellectualization of automation systems for the sorting process (SP), development of appropriate research tools and functioning of marshalling systems (MS).

Work has been done to improve and systematize the conceptual apparatus of study in identifying and classifying factors that ensure effectiveness and safety of the SP. The adaptation of the tools for intellectualization of production processes for



solving the problems of automation of hump yards was carried out, algorithms and the mathematical apparatus for intellectualization of control of rolling cuts from the hump yard were developed.

The author's innovative concept for development of the MS was created. It is based on the following principles: continuity of various versions of the system, modularity and versatility of its blocks, adaptability of control technology to changing operating conditions, intellectualization of control processes, self-diagnostics of the control complex, friendly human-machine interface of the DSS subsystem, etc. Structure and content of the developed models, methods and mechanisms allows development of technological solutions in different versions of a modular set of functional subsystems of sorting complexes, taking into account local conditions and tasks, and providing a systematic approach to solving the problem of SP automation. The categorical apparatus for investigating safety and survivability of automated MS has been improved. A methodology for managing the SP has been created, taking into account survivability, safety and economic efficiency of the sorting process.

It is proposed to synthesize control actions based on considering three basic criteria: safety, survivability, and economic efficiency of the MS. The type of criterion for economic efficiency has been clarified based on accounting for the costs of maintaining the system. It has been proved that survivability of the system that ensures dissolution of trains is the basis (the root cause) of technological safety of dissolution.

Specialty 05.13.06 – Automation and control of technological processes and production (transport). The work was carried out at Rostov State Transport University.

Strekalov, N. N. Automatic temperature control system of power semiconductor devices of traction converters of locomotives. Ph.D. (Eng) thesis [Avtomaticheskaya sistema regulirovaniya temperatury silovykh poluprovodnikovykh priborov tyagovykh preobrazovatelei lokomotivov. Dis... kand. tekhn. nauk]. Moscow, RUT publ., 2019, 134 p.

An urgent scientific and technical problem has been solved, which consists in development of an automatic system for smooth temperature control of power semiconductor devices of a traction frequency converter through the use of an energy-efficient electric drive of a cooling fan with an asynchronous motor and changing switching frequency of power switches.

As a result of the calculation, it was found that temperature of semiconductor devices of a two-level autonomous voltage inverter begins to exceed the same temperature in a three-level inverter at switching frequencies of 4,5...5,5 kHz.

A combined automatic temperature control system (ATCS) of power semiconductor devices of a traction frequency converter has been synthesized. It is shown that the properties of a temperature-closed ATCS are described by a fourth-order dynamic link when using a P-controller and a fifth-order dynamic link when using a PI controller. Combined ATCS of semiconductor devices, provides a decrease not only in temperature, but also in the range of its change due to regulation of switching frequency of semiconductor devices.

It has been established that an increase in power of an induction motor and, accordingly, semiconductor devices shifts the range of recommended switching frequencies towards lower values. For a 14 kW motor $f_k = 5...36$ kHz, for a 360 kW motor $f_k = 1...8$ kHz. The synthesized system received a patent for a useful model.

It is shown that from the point of view of energy efficiency, it is most rational to use electric drives with asynchronous motors and frequency converters for units with a fan load. To minimize power losses, a control system was synthesized with maintaining a given value of the power factor of the stator winding of an asynchronous motor, the use of which makes it possible to increase efficiency of an electric drive by 18 % in relation to efficiency of an electric drive with a classical scalar control system according to the law of M. P. Kostenko.

A laboratory installation has been developed and manufactured containing a power semiconductor module FF300R06KE3 with its control system, a load in the form of an RL-chain, a cooling fan driven by an asynchronous motor with a semiconductor frequency converter and supplying cooling air to the semiconductor module through a flexible air duct. The unit is equipped with current and temperature sensors and a multifunctional ADC module. The conducted studies have shown adequacy of the developed mathematical model of steady and transient thermal processes, as well as operability of the combined automatic temperature control system, with a regulating effect on switching frequency of power switches. The maximum discrepancy between the results obtained theoretically and experimentally does not exceed 9 %.

05.22.07 – Railway rolling stock, train traction and electrification. The work was carried out at Russian University of Transport. ●