SELECTED ABSTRACTS OF D.SC. AND PH.D. THESES SUBMITTED AT RUSSIAN TRANSPORT UNIVERSITIES

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Duque Sarango Maria José. Development of a methodology for information support of a telematic management system for urban passenger transport based on the use of instrumental data on the dynamics of passenger traffic. Abstract of Ph.D. (Eng) thesis [*Razrabotka metodiki informatsionnogo obespecheniya telematicheskoi sistemy upravleniya gorodskim pas sazhirskim transportom na osnove ispolzovaniya instrumentalnykh dannykh o dinamike passazhiropotoka. Avtoref. dis… kand. tekh. nauk*]. Moscow, MADI publ., 2021, 24 p.

An analysis of regulatory documents allows us to conclude that at the end of the first decade of 20th century, a regulatory and technical base was developed in Russia, which makes it possible to develop and implement high-quality automated dispatch control systems in urban passenger transport.

However, the analysis of the work of urban passenger transport in large cities showed that the process of passenger transportation is not always consistent with the parameters of passenger traffic, which leads to a violation of the established standards for quality of transportation.

An analysis of the tasks, which are solved by modern dispatch control systems has shown that at present there are no functions and technologies for assessing and predicting changes in the filling of the vehicle cabin during its movement on the route in real time, which may cause violations of the established requirements for quality of transportation, determined by the population of a vehicle.

Compliance with the established requirements for quality of the transportation process is very important in connection with the increased role of urban passenger transport in improving the difficult transport situation in large cities and metropolitan areas.

The above analysis confirms the relevance of the topic of the thesis aimed at harmonising the parameters of passenger flows and the dynamics of movement of passenger vehicles on the routes of urban passenger transport.

The objective of the study is to improve quality of transportation of passengers of UPT based on assessment and forecasting of the filling of the cabin of vehicles in a journey according to data generated by telematics.

A scientific and practical problem has been solved, which consists in finding patterns of changes for filling of the passenger compartment of the UPT vehicle from the parameters of passenger traffic on the route, creating tools for improving and complying with the established permanent or temporary standards for quality of transportation of passengers of UPT. The problem of differential assessment of passenger comfort levels in the process of transportation is solved based on the proposed concept of the phase space of the states of the transportation process.

An analytical relationship has been established between the volume of transport work performed and the parameters of passenger traffic, which will allow the control system to monitor the filling of the cabin on the route, taking into account the level of service and inform passengers at stops about filling the cabin using stop displays.

A technique for predicting the filling of the vehicle cabin at a critical stopping point is proposed, which can be used for information support when making decisions in the dispatch control system to comply with the traffic quality standards established by social standards.

The results of experimental studies proved the high accuracy of the developed model for predicting the filling of the vehicle cabin on the route (forecast error up to 10 %) to prevent possible overflow of the cabin on the journey in excess of the established standard.

The obtained research results were used in development of a new edition of the national standard GOST R 54723-2019, in preparation of guidelines for course design in the discipline «Telematics in organizational and production structures», as well as in preparation of scientific and technical reports on the results

of R&D performed under grants (Project No. 0042671, Project No. 0042614).

The proposed approaches, methods and models can be used to improve the software for dispatch control subsystems, analyze passenger flows and generate reporting data for modern automated dispatch control systems of UPT.

05.22.10 – Operation of road transport.

The work was performed and defended at Moscow Automobile and Road Construction State Technical University (MADI).

Dyakov, I. G. Theory and practice of anode electrolyte-plasma saturation of steel and titanium alloys with nitrogen and carbon. Abstract of D.Sc. (Eng) thesis [*Teoriya i praktika anodnogo elektrolitno-plazmennogo nasyshcheniya stalnykh i titanovykh splavov azotom i uglerodom. Avtoref. dis… doc. tekh. nauk*]. Moscow, MAI publ., 2021, 47 p.

Electrolyte-plasma processes attract considerable attention of researchers from many countries due to new technological possibilities.

Microarc oxidation and electrolytic-plasma polishing have already become widespread in modern production. Anode processes based on metal dissolution allow not only polishing, but also surface cleaning from various contaminants or etching with formation of nanoporous structures. Another group of anodic processes is based on the surface modification of metals and alloys with a change in their composition. These include electrochemical oxidation, which creates thin barrier films and relatively thick oxide strips, as well as microarc oxidation, in which anode layers are formed under the action of electrical discharges.

A promising direction can be associated with anodic electrolytic plasma saturation (AEPS) of metals and alloys with nitrogen, carbon or boron, which combines the possibilities of surface hardening, polishing and the creation of protective coatings. A preliminary analysis of the possibilities of AEPS shows the following advantages of this method:

• High processing speed, allowing to reduce duration of the operation to a few minutes.

• The possibility of combining diffusion saturation with hardening without reheating.

• There is no need for pre-treatment of the surface before processing.

• It is possible to process products with burrs removed during processing.

• Convenience of performing local processing by immersion in the electrolyte of the working surface or by supplying an electrolyte jet to it.

• Relatively deep surface modification compared to microarc oxidation or electroplating.

• No toxic materials or expensive equipment.

The objective of the work is to study the physicochemical mechanism of diffusion saturation of metals under plasma electrolysis conditions and to create the basis for the technology of surface modification of steel and titanium alloys to increase their corrosion resistance and wear resistance.

The main regularities of formation of hardened layers after diffusion saturation of steels with nitrogen and carbon have been clarified. It is shown that distribution of diffusing elements in the modified layer is determined by a combination of processes of surface oxidation with water vapor and electrolyte anions, anodic dissolution of the metal, and diffusion of nitrogen and/or carbon. The thickness of the oxide layer depends on the treatment temperature and concentration of active components of the electrolyte, which confirms participation of high-temperature oxidation in water vapor and electrochemical reactions with electrolyte anions emitted into the gas-vapor shell. The effect of heating parameters on the rate of electrochemical dissolution and high-temperature oxidation of the sample surface has been evaluated.

It has been established that with an increase in concentration of ammonium chloride, the share of the process of electrochemical dissolution increases. An increase in the heating temperature contributes to an increase in the proportion of high-temperature oxidation to a greater extent and to a lesser extent to accelerate the dissolution of iron.

It is shown that formation of an oxide layer can be described in terms of a high-temperature oxidation model in the presence of surface dissolution, which leads to a change in the ratio of iron oxide phases in the layer. It has been shown that the addition of glycerol to the solution based on ammonium chloride leads to

intensification of dissolution processes, which is associated with restoration of the oxidized surface of the sample by the products of glycerol decomposition. It has been established that an increase in the concentration of ammonium chloride in solutions with the addition of USC leads to an intensification of the dissolution processes and, as a result, a decrease in the thickness of the cemented layer.

The carbon potentials of electrolytes containing acetone, glycerol, sucrose, and ethylene glycol were determined based on the analysis of the distribution of carbon in the surface layer of mild steel specimens after anodic carburizing.

The possibility of controlling the thickness of the carburized layer during anodic electrolyte heating by changing the composition of the electrolyte and carburization modes is shown. The use of acetone, glycerin, sucrose and ethylene glycol as carbon-containing electrolyte components for anodic carburizing of steel products makes it possible to provide carbon potentials of saturating atmospheres from 0,9 to 0,6 %. This makes it possible to improve the characteristics of low-carbon steels: to form a martensitic layer with a thickness of 80 to 160 microns during hardening (in 10 minutes of processing) and to increase the conditional tensile strength from 420 ± 20 to 930 ± 50 MPa. The greatest value of the thickness of the martensitic layer after carburizing of steel 20 with subsequent hardening is observed at a concentration of carbon-containing components of 2 % (mass). At concentrations of carbon-containing components less than 2 %, a decrease in the layer thickness is observed due to a decrease in the saturating ability of electrolytes.

At concentrations above 2 %, the current decreases, which determines the intensity of anodic dissolution, as a result of which the thickness of the cemented layer decreases. It has been established that an increase in the wear resistance of low-carbon steels is associated both with an increase in the microhardness of the surface layer and with formation of residual austenite, which provides better surface running-in.

It has been established that the structure of the surface layer of structural steels after their electrolytic-plasma saturation with nitrogen and carbon contains iron oxides in the outer layer, martensite with iron nitrides or carbonitrides, and a solid solution of saturating components in iron. The inhibitory role of the oxide layer and the possibility of reducing its thickness by intensifying the anodic dissolution have been confirmed. The possibility of realizing surface hardening by controlling the thickness of the martensite layer, which is formed only in the area of nitrogen penetration, which lowers the austenitization temperature, is shown. The influence of the concentrations of electrolyte components, temperature and duration of treatment on the structural characteristics of the modified layers, including their microhardness and roughness, has been established. On the basis of the proposed phenomenological models, the direct and cross diffusion coefficients of nitrogen and carbon are determined, which confirm the interaction of flows of diffusing atoms. With an increase in the saturation temperature, an additional acceleration of carbon diffusion due to nitrogen is observed, in accordance with this, the coefficient describing the effect of nitrogen diffusion on carbon diffusion has a positive sign.

Electrolyte compositions and AEPS regimes are proposed, which make it possible to increase the corrosion resistance of structural steels in sodium sulfate solutions. It is shown that the corrosion current density of steel 20 in a decinormal sodium sulfate solution can be reduced by a factor of 20 by nitrocarburizing it at a temperature of 800–850°C for 5 min in an electrolyte containing 10 % ammonium chloride, from 8 to 12 % glycerol and 10 % ammonium nitrate. It has been established that the corrosion resistance of specimens from structural steels after their AEPS is determined by the protective effect of the outer oxide layer and the content of iron nitrides in the joint zone.

It is shown that the analogy between classical electrolysis and anodic electrolyte heating can be used to qualitatively explain the electrochemical regularities of iron dissolution at the anode.

The predominant accumulation of iron in insoluble forms makes it possible to regenerate industrial electrolytes by means of decantation. It has been established that in the electrolyte operating time interval of up to 60 minutes, the main factor in electrolyte aging is the accumulation of iron dissolved from the anode surface. Reducing the concentrations of ammonium and chlorine ions does not affect thermal parameters of processing. The chlorine ion provides charge transfer from the shell to the anode, making a closed cycle of electrochemical

reactions. Its removal from the solution is carried out by recombination with ammonium ions, followed by the evacuation of ammonium chloride from the heating zone.

Electrolyte compositions and AEPS regimes are proposed, which make it possible to increase the wear resistance of structural steels under conditions of dry and hydrodynamic friction. It is shown that the mass wear of steel 20 can be reduced seven times by its nitrocarburizing at a temperature of 850°C for 5 min. in an electrolyte containing 10 % ammonium chloride, 10 % ammonium nitrate and 8 % glycerol. It is shown that the mass wear of steel 12Kh18N10T can be reduced by a factor of 20 by nitrocarburizing it at a temperature of 850°C for 5 min in an electrolyte containing 10 % ammonium chloride, 15 % urea. It has been established that the increase in wear resistance is explained by the complex effect of a decrease in surface roughness, an increase in its microhardness, an improvement in run-in and retention of lubricant by a porous oxide layer.

It has been established that AEPS of titanium alloys leads to formation of an outer oxide layer containing rutile and a solid solution of nitrogen and carbon in titanium. At processing voltages up to 210 V and an ammonium chloride content of 10 %, the dissolution of titanium prevails over its oxidation, i.e., a decrease in sample weight is observed. With an increase in voltage to 260 V or an increase in the concentration of ammonium chloride to 15 %, an increase in mass takes place, which indicates the dominance of oxidation during processing with an increase in sample temperature. A non-linear dependence of the weight loss on time was also found, which may indicate the exfoliation of a part of the oxide layer during processing.

A positive effect of the oxide layer on the electrochemical behavior of the VT1–0 titanium alloy in Ringer's solution after electrolytic plasma treatment is shown. The dependence of the corrosion current density on the thickness of the oxide layer, which is determined by the temperature and duration of treatment, as well as the cooling conditions of the treated sample, has been established.

A theoretical description of heat transfer during AEPS is proposed, which differs from the known models by considering heat dissipation into the environment through the part of the sample protruding from the electrolyte. The results of the calculation qualitatively explain the nature of the volt-ampere and volt-temperature characteristics (on the ascending branch), the dependence of the PGE thickness on process parameters and the role of the electrolyte flow around the sample. Criteria for similarity of the process parameters are identified, which are the dimensionless energy released in the shell and the ratio of the heat flux densities from the shell to the electrolyte and to the anode sample. A decrease in the average current density with an increase in the depth of immersion of the part in the electrolyte was found, which is explained by the inhomogeneous distribution of the current over the surface of the part. The profile of the anode vapor-gas shell was calculated during heating of a vertical cylindrical sample. The expansion of the shell was found with an increase in the heating voltage and an increase in the length of the sample. A decrease in the proportion of heat entering the anode was found from 16 to 1 % as its length increased from 2 to 7 cm. The values of the vertical temperature gradient of the anode were measured, ranging from 2 to 20°C/cm. It has been found that the temperature gradient increases with increasing voltage and decreasing the length of the anode.

A technological process has been developed for increasing the corrosion resistance and wear resistance of structural steels and titanium alloys by means of their anodic electrolytic-plasma saturation with nitrogen and carbon, followed by quenching in the same electrolyte. Recommendations have been prepared for improvement of electrolytic-plasma processing installations in order to stabilize the conditions and increase the uniformity of the modification of parts over their surface.

2.6.1 – Metal science and heat treatment of metals and alloys.

The work was carried out at Kostroma State University and defended at Moscow Aviation Institute (National Research University).

Osadchiy, G. V. Improving the methods of testing and self-control of hardware and software systems for technical diagnostics and monitoring of railway automation devices. Abstract of Ph.D. (Eng) thesis [*Sovershenstvovanie metodov testirovaniya i samokontrolya apparatno-programmnykh sredstv sistem tekhnichesokgo diagnostirovaniya i monitoring ustroistv zgeleznodorozhnoi*

***avtomatiki. Avtoref. dis… kand. tekh. nauk*]. St. Petersburg, PSTU publ., 2021, 20 p.**

The main objective of the thesis research is to develop methods for organizing test diagnostic support and self-diagnosing devices of systems for technical diagnostics and monitoring (STDM) of railway automation and telemechanics devices (RAT), implementing the principles of testability, self-checking, and self-control.

The results obtained during working on the thesis allow solving one of the most important problems – to improve the technical means for diagnosing the peripheral level of STDM RAT through the application of the principles of testability, self-checking and self-control in implementation of hardware and software. One can conclude the following:

• One of the most vulnerable technical means of modern diagnostic and monitoring systems in terms of reliability are peripheral level objects, including measuring controllers, hardware and software tools for pre-processing and transmission of diagnostic information to concentration points. Failures and persistent failures in technical means of this level lead to a violation of the integrity of diagnostic data, the impossibility of high-quality intellectual processing at the level of concentrators of linear and central points, which inevitably leads to a decrease in reliability of the diagnosis and subsequent forecast.

• Improving STDM RAT, increasing reliability and fault tolerance of their components is facilitated by following the principles of testability, self-checking and self-control in the development of hardware and software.

• One of the effective methods for the synthesis of hardware and software tools of automation, endowed with the properties of error detection in calculations, is the method of logical addition, which makes it much easier to ensure the complete self-checking of the structures of the synthesized devices while minimizing their structural redundancy.

• The method of synthesis of self-checking built-in control circuits for automation and computer technology devices developed in the thesis, using the principle of logical complement to the equilibrium code «1 out of 4» and taking into account statistical data about the object of diagnosis, allows synthesizing simpler self-checking devices than when using duplication, in among other things, it allows to synthesize self-testing devices even when it is impossible to do this, following the principles of duplication. For a sample of 26 control combinational schemes, the average value μ = 84,6 % was obtained (8 % less than without taking into account statistical data (μ = 92,6 %)).

• When implementing built-in control schemes by the method of logical complement to the equilibrium code «1 out of 4», in addition to the statistical approach, it is effective to use the selection of «triples» of outputs of the diagnostic object, as well as to use compression schemes before logical transformation. In the first case, it is possible to both reduce complexity of technical implementation of the self-checking device (μ = 88,5 %) and increase the reliability of the control circuit (p (η) = 97,2 %), and in the second case, it is possible to significantly reduce the structural redundancy of the device (μ = 79,4 %), however, the reliability of error identification slightly decreases ($p(\eta)$ = 96,6 %).

• The algorithms for self-diagnosis of STDM RAT components developed in the thesis can be effectively used to create software tools for their technical diagnostics, which significantly improves the monitoring technology.

• The method proposed in the thesis for selecting the period of self-diagnosis of measuring controllers, based on the selection of high-priority requests for the operating actions of the measuring controller and low-priority requests for test actions, allows determining the best conditions for the moments of implementation of diagnostic procedures without interfering in the main process of functioning of the objects of diagnosis.

• The approach to assessing the reliability of self-diagnosis proposed in the thesis makes it possible to determine the conditions for choosing the periods of self-diagnosis of measuring controllers, taking into account the probabilistic assessment of identification of internal errors.

• The application of the approaches proposed in the thesis to improve the level of testing and self-diagnosis by the technical means of APK-DK allows significantly increasing the efficiency of its work by increasing the reliability of functioning of the components, and also allows switching to the use of intelligent processing of the received diagnostic data.

05.22.08 – Management of transportation processes.

The work was performed and defended at Emperor Alexander I Petersburg State Transport University.