ALGORITHMIZATION OF PLACEMENT OF ADDITIONAL UNITS IN THE OPTIMIZATION OF DEVELOPING MULTISERVICE NETWORKS

D.E. Elizarov, Postgraduate, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: elizarovdm@list.ru

V.L. Burkovsky, Doctor of Technical Sciences, Full Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: bvl@vorstu.ru

The article describes the model of multi-service networks optimal development, that consists of the model of the optimal service nodes placement in network structure and the model of optimal technical devices choice from a variety of alternative devices from different manufacturers. A formal statement of the problem of placement of nodes is considered, the objective function and optimization criteria are described. To solve this problem are encouraged to use the modified Gomory method, which uses branch and bound method to generate the solution graph. Formalized algorithm method is presented, it is concluded that the mechanism of alpha-beta pruning can be used to speed up the algorithm. An example of practical implementation of this algorithm is solved for the placement problem of three nodes. The conclusion about the possibility of using the method developed to speed up the optimization algorithm is made

Key words: linear programming, discrete programming, multiservice networks

References

1. Elizarov, D.Je., Burkovskij V.L. Optimizacionnye modeli formirovanija struktury razvivajushhihsja mul'tiservisnyh setej informacionnogo obsluzhivanija naselenija [Optimization models of structure formation in developing multi-service networks of information services to the population] // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta. – 2015.-T. 11. - № 4. – P. 20-23.

2. Stepanov, S.N. Osnovy teletrafika mul'tiservisnyh setej [Basics of teletraffic in multiservice networks]. – M.: Jeko-Trendz, 2010. - 392 p.

3. Elizarov D.Je., Burkovskij V.L., Voropaev A.P. Obobshhennaja optimizacionnaja model' razvitija mul'tiservisnyh setej [Generalized optimization model of multi-service networks] // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta. – 2015-T. 11, - №3. - P 28-30.

4. Elizarov D.Je., Burkovskij V.L. Model' optimal'nogo razvitija struktury mul'tiservisnyh setej na osnove apparata dinamicheskogo programmirovanija [Model of optimal development of the structure of multi-service networks based on dynamic programming] // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta. – 2016-T. 12, - №1. - P 21-24.

5. Elizarov D.Je., Burkovskij V.L. Modifikacija metoda Bellmana reshenija dinamicheskoj zadachi o rance [Modification of Bellman's method for dynamic knapsack problem] // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta. – 2015.-T. 11. - № 5. – P. 31-33.

6. Elizarov D.Je., Burkovskij V.L. Algoritmizacja reshenija zadachi dinamicheskoj optimizacii struktury mul'tiservisnyh setej [Algorithmic solution of dynamic optimization of multi-network design problems] // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta. – 2015-T. 11, - №6. - P 59-61.

7. Korbut A.A. Finkel'shtejn Ju.Ju.Diskretnoe programmirovanie [Discrete programming].– M.: Nauka, 1969. – 367 p.

8. Elizarov D.Je., Burkovskij V.L. Modeli proektirovanija razvivajushhihsja mul'tiservisnyh setej [Models of developing the design of multiservice networks] // Perspektivnye issledovanija i razrabotki v oblasti informacionnyh tehnologij. - 2014. – P. 4.

9. Burkovskij, V. L. Matvienko I. M., Burkovskij A. V. Analiz razvivajushhihsja informacionnyh sistem na osnove apparata modelirovanija i optimizacii [Analysis of developing information systems based on modeling and optimization of the machine]: monografija. – Voronezh: GOU VPO VGTU, 2009. – 136 p.

ON ADUANCED TYPES OF CONTROL OPERATION IN THE DEFENCE SPHERE BASED ON EMPLOYMENT OF CSRP-TECHNOLOGIES

P.A. Korobeynikov, Adjunct of the Air Forces Education and Research Centre 'Air Forces Academy', Voronezh, Russian Federation, e-mail: panich07@mail.ru

O.G. Nikitin, Candidate of Technical Sciences, Doctoral Candidate of the Air Forces Education and Research Centre 'Air Forces Academy', Voronezh, Russian Federation, e-mail: nikson601@yandex.ru

Developed proposals for improving the working methods of officials of management bodies in the defense sector through the introduction in their work of intellectual systems of support of decision-making Consideration; the principles of intellectual systems of decision support, allowing to speak about the application of the new method of work of the officials - with the help of "virtual headquarters" built based on the standard functioning of GSRP systems. It is shown that the DSS is a component of the management subsystem, in which one of the decisions taken and implemented by the officials in "manual" mode, and the other part of the decisions taken and implemented by technical machines using the technology of "delayed decisions", namely that, for each sample of the situation in advance is justified, is formed and stored in the library pending solutions opti-

mal, or close to it. Further, on comparison between the current situation stored in the knowledge base of typical situations corresponding rational solution is automatically selected. The use of such DSS will change the approach to organization of work of the management bodies, to optimize their number with a simultaneous increase in the efficiency and validity of decisions

Key words: decision support systems, automation techniques control procedures, control officials, knowledge base, virtual headquarters

References

1. Larichev, O.I. Sistemy podderzhki prinjatija reshenij. Sovremennoe sostojanie i perspektivy razvitija [Deci-sion Support System. Current status and prospects]. Itogi nauki i tehniki. Ser. Tehnicheskaja kibernetika. – 1987. – T.21. – P. 131–164.

2. Dovzhenko, V.N., Zavgorodnij V.N. Podderzhka prinjatija reshenij pri upravlenii vojskami i oruzhiem [Support for decision-making within control of troops (forces)]. Voennaja mysl'. – 2014. – № 6. – P. 19–25.

3. Shpak, V.F. Informacionnye tehnologii v sisteme upravlenija VMF (teorija i praktika, sostojanie i per-spektivy razvitija [Information technology in the Navy control system (theory and practice, current status and prospects]. – SPb.: «Jelmor», 2005. – 832 p.

4 Vypasnjak V.I., Gural'nik A.M., Tihanychev O.V. Sistema podderzhki prinjatija reshenij kak «virtual'nyj sht-ab» [Decision Support Systems as a «virtual headquarters»]. Voennaja mysl'. – 2015. – № 2. – P. 23–29.

5. Donskov, Ju.E., Nikitin O.G., Besedin P.N. Rol' intellektual'nyh sistem podderzhki prinjatija reshenij pri upravlenii radiojelektronnoj bor'boj v obshhevojskovyh takticheskih formirovanijah [The role of intelligent decision-making support systems during control of electronic warfare at combined-arms tactical formations]. Voennaja mysl'. –2015 . - № 10. – P.33-41.

DESIGN OF PROCEDURES FOR NUMERICAL OPTIMIZATION OF OBJECTS WITH STRUC-TURALLYVARIABLE CONTROL BASED ON THE USE OF POPULATION-BASED ALGORITHMS

B.N. Tishykov, Postgraduate, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: tishykov_boris@mail.ru

Ya.E. Lvovich, Doctor of Technical Sciences, Full Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: sapris@vorstu.ru

In the submitted article the description of objects with the structurally variable form of government, their main features is considered. The purpose and problems of optimization of objects of this type are defined, techniques of their decision are considered. The descriptive problem definition of structural optimization with variability elements is offered, the optimizing model of objects of the considered type is under construction and described. As the mathematical device for the solution of the described class of tasks use of population algorithms (algorithm of behavior of monkeys) is considered, theoretical bases of construction and the principles of their functioning are studied, need of their application is proved. Procedures of numerical optimization of objects with the structurally variable form of government which cornerstone the device of population algorithms is are developed. By the received results of development conclusions about efficiency of the offered technique of the solution of problems of structural optimization with use of variable components are drawn

Key words: object with structuralization form of management, optimization model, a numerical optimization procedure, a population-based algorithm

References

1. Karpenko A.P. Populjacionnye algoritmy optimizacii. Obzor novyh i maloizvestnyh algoritmov [Population algorithms of optimization. Review of new and little-known algorithms.] Application to academic periodical "Information Technologies" N 7/2012. – 30p.

2. Lvovich Ya.E. Prinjatie reshenij v jekspertno-virtual'noj srede : monografija [Decision-making in the expert and virtual environment: monography.] Voronezh: IPTs "Scientific Book", 2010. – 140p.

OPTIMAL CALENDAR SCHEDULING OF WORK IN SYSTEM OF ACCIDENT-FREE MANAGEMENT OF NUCLEAR POWER PLANTS

S.A. Tkalich, Candidate of Technical Sciences, Assistant Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: sergeytkalich@mail.ru

V.L. Burkovsky, Doctor of Technical Sciences, Full Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: Bvl@vorstu.ru

The possibility of optimal scheduling of maintenance work in the complex of measures on creation of system trouble-free management of extreme productions. The main parameters considered indicator of lead time, which reflects the temporal distance of the object to the alleged failure, the degree of proximity of the object to the emergency determined prediction system, the degree of influence of the accident a separate object on the functioning of the whole system, determined by an expert. The mathematical formulation of the problem is reduced to finding the extremum of the objective function: the degree of the accident served system. The solution of the task performed by the method of undetermined Lagrange multipliers. An algorithm for minimizing the degree of emergency systems. An example of the implementation of the solution found for the four classes of safety equipment of NPP. From the analysis of the graphs to their proximity to the emergency, the amount of resources used in equipment maintenance and the amount of time available conclusions about the importance of safety equipment classes

Key words: calendar planning, algorithmization, forecasting, accident-free management

References

1. Tkalich S.A. Diagnosticheskie jekspertnye sistemy bezavarijnogo upravlenija tehnologicheskimi processami // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta, tom 3, №5, 2007, s.38-43.

2. Tkalich S.A., Povarov V.P., Burkovskij A.V. Modeli prinjatija reshenij v sistemah upravlenija potencial'no-opasnymi proizvodstvami // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta. 2014. T. 10. № 5-1. S. 129-132.

3. Tkalich S.A. Algoritmizacija optimal'nogo kalendarnogo planirovanija v sisteme bezavarijnogo upravlenija proizvodstvom// Jelektrotehnicheskie kompleksy i sistemy upravlenija, № 1 (21), 2011. – S. 60-65.

4. Tkalich S.A. Nejrosetevaja model' processa prognozirovanija avarijnoj situacii // Sistemy upravlenija i informacionnye tehnologii, №3.1, 2008, s.196-200.

5. Tkalich S.A. Issledovanie sistemy prognozirovanija avarijnyh situacij na baze termodinamicheskoj modeli // Sistemy upravlenija i informacionnye tehnologii, №3.3(33), 2008, s.399-403.

6. Taha H. Vvedenie v issledovanie operacij. Kn. 2. – M.: Vil'jams, 2007. – 912s.

7. Alekseeva E.V. Teorija prinjatija reshenij / E.V.Alekseeva. – M.: MGTU imeni N.Je. Baumana, 2008. – 412s.

DEVELOPMENT OF METHODS FOR IMPROVED HEAT TRANSFER IN MICROCHANNEL HEAT EXCHANGERS HYBRID COOLING SYSTEMS

D.A. Konovalov, Assoc. Prof. of Dept of Theoretical and industrial heat power engineering, Ph. D. in Engineering, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: dmikonovalov@yandex.ru

I.N. Lazarenko, Postgraduate, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: rd-vgtu@mail.ru

N.N. Kozhukhov, Assoc. Prof. of Dept of Theoretical and industrial heat power engineering, Ph. D. in Engineering, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: k0zhukhov@yandex.ru

I.G. Drozdov, Prof., Head of Dept. of Theoretical and industrial heat power engineering, D. Sc. in Engineering, e-mail: rd-vgtu@mail.ru

The present work is devoted to the development of heat transfer enhancement techniques in microchannel heat exchang-ers, thermal stabilization of hybrid systems. One of the possible schemes for thermal stabilization of the hybrid system was proposed. Approaches to the creation of heat exchanger design for cooling the electronic module. As possible design solutions for heat exchangers for cooling the electronic module offered three models: - model with a flat channel - channel model with a flat-filled porous medium and solid model with porous inserts with inter-channel transpiration cooling. For all three models produced thermal-hydraulic calculations. In order to improve the efficiency of the heat exchanger to the preferred methods for in-intensification of heat transfer: the use of nanofluids as coolant, the implementation of pulsations in transit and presence of phase transition

Key words: intensification, microchannel heat exchanger, a hybrid system of thermal stabilization

References

1. Kalinin Je.K., Drejcer G.A., Kopp I.Z. Effektivnye poverhnosti teploobmena [Efficient heat transfer surface]. M.: Energoatomizdat, 1998. – 408 p.

2. Konovalov D.A., Drozdov I.G., Shmatov D.P., Dakhin S.V., Kozhukhov N.N. Razrabotka i modelirovanie mikrokanalnykh sistem okhlazhdeniia [Design and modeling of micro-channel cooling systems]. Voronezh, 2013. – 222 p.

3. Dziubenko B.V., Kuzma-Kichta Iu.A., Leontev A.I., Fedik I.I., Kholpanov L.P. Intensifikatciia teplo- i mas-soobmena na makro-, mikro- i nanomasshtabakh [The intensification of heat and mass transfer at the macro, micro and nano scale]. M.: FGUP «TcNIIATOMINFORM», 2008. – 532 p.

4. Kalinin E.K., Dreitcer G.A., Iarkho S.L. Intensifikatciia teplootdachi v kanalakh [Intensification of heat transfer in the channels]. M.: Mashinostroenie, 1990. – 200 p.

5. Poliaev V.M., Maiorov V.A., Vasilev L.L. Gidrodinamika i teploobmen v poristykh elementakh konstruktcii letatelnykh apparatov [Hydrodynamics and heat transfer in the porous structural elements of aircrafts]. M.: Mashi-nostroenie, 1988. – 168 p.

6. Popov I.A. Gidrodinamika i teploobmen v poristykh teploobmennykh elementakh i apparatakh. Intensifikatciia teploobmena [Hydrodynamics and heat transfer in porous heat exchange elements and devices. Intensification of heat exchange]. Kazan: Tcentr innovatcionnykh tekhnologii, 2007. – 240 p.

7. Kuznetcov G.V., Sheremet M.A. Ob odnom podkhode k matematicheskomu modelirovaniiu teplovykh rezhimov radioelektronnoi apparatury i elektronnoi tekhniki [An approach to mathematical modeling of thermal modes of electronic equipment and electronic engineering]. Mikroelektronika, 2008; 37; 2 – 150-158.

8. Panfilov C.A., Kalikanov V.M., Fomin Iu.A., Savanin A.S. Proektirovanie i ispytaniia okhladitelei silovykh poluprovodnikovykh priborov [Design and testing of cooling power semiconductors]. Pribory i sistemy. Upravlenie, kontrol, diagnostika, 2008; 3 – 41-43.

9. Pat. 51441 Russian Federation, IPC H01L 23/34. Ustroistvo okhlazhdeniia elektronnykh komponentov [The cooling device of electronic components]. Drozdov I.G., Mozgovoi N.V., Shmatov D.P., Kozhukhov N.N. Voronezh State Technical University. - № 2005121936/22; 11.07.2005; 10.08.2004; № 4. – 5 p.

10. Pat. 58788 Russian Federation, IPC H01L 23/34. Ustroistvo okhlazhdeniia dlia elektronnykh komponentov [Cooling device for electronic components]. Drozdov I.G., Kozhukhov N.N., Mozgovoi N.V., Konovalov D.A., Shma-tov D.P.; Voronezh State Technical University. - № 2006113838/22; 24.04.2006; 27.11.2006; 33. – 4 p.

11. Pat. 2440641, IPC H01L 23/34. Ustroistvo otvoda teploty ot kristalla poluprovodnikovoi mikroskhemy [Re-moving heat from the device chip semiconductor crystal]. Savinkov A.Iu., Drozdov I.G., Shmatov D.P., Dakhin S.V., Konovalov D.A., Kozhukhov N.N., Nebolsin V.A.; Zakrytoe aktcionernoe obshchestvo «KODOFON». – № 2010146036/28; 10.11.2010; 20.01.2012; № 2. – 8 p.

12. Konovalov D.A., Drozdov I.G., Shmatov D.P., Dakhin S.V., Kozhukhov N.N. Ob odnom podkhode k soz-daniiu modeli integrirovannogo teploobmennika [An approach to the creation of a model of an integrated heat exchang-er]. Problemy gazodinamiki i teplomassoobmena v energeticheskikh ustanovkakh: Trudy XVIII Shkoly-seminara mo-lodykh uchenykh i spetcialistov pod rukovodstvom akademika RAN A.I. Leonteva. M.: Izd. MEI, 2011; 1 – 431-434.

13. Belov K.I., Zhukov V.M., Kuzma-Kichta Iu.A., Lenkov V.A. Intensifikatciia teploobmena pri kipenii zhidkostei na sferakh s keramicheskimi submikronnymi pokrytiiami na osnove AL_2O_3 [Intensification of heat exchange with boiling liquid on areas with submicron ceramic coatings based on AL_2O_3]. Problemy gazodinamiki i tep-lomassoobmena v energeticheskikh ustanovkakh: Trudy XKh Shkoly-seminara molodykh uchenykh i spetcialistov pod rukovodstvom akademika RAN A.I. Leonteva. M.: Izd. MEI, 2015 – 281-284.

14. Shustov M.V., Kuzma-Kichta Iu.A., Lavrikov A.V., Chursin P.S. Issledovanie kipeniia na poverkhnosti s rele-fom iz nanochastitc [Research on the boiling surface topography of nanoparticles]. Problemy gazodinamiki i tep-lomassoobmena v energeticheskikh ustanovkakh: Trudy XKh Shkoly-seminara molodykh uchenykh i spetcialistov pod rukovodstvom akademika RAN A.I. Leonteva. M.: Izd. MEI, 2015 – 346-349.

15. Iu.A. Kuzma-Kichta, A.V. Lavrikov, M.V. Shustov and others. Issledovanie intensifikatcii teploobmena pri kipenii vody na poverkhnosti s mikro- i nanorelefom [Research of intensification of heat transfer in boiling water on a surface with micro and nano topography]. Teploenergetika. – M.: OOO MAIK «Nauka/Interperiodika», 2014; 3 – 35-38.

16. Shustov M.V. Issledovanie kipeniia v mikrokanale s pokrytiem iz nanochastitc [Research boiling in a micro-channel with a coating of nanoparticles]. 01.04.14; 22.04.15; 12.11.15, 2003. – 119 p.

17. Kuzma-Kichta Iu.A., Lavrikov A.V., Stenina N.A. Issledovanie kipeniia pri estestvennoi tcirkuliatcii v trube s relefom iz nanochastitc [Research boiling in a microchannel with a coating of nanoparticles]. Trudy Shestoi Rossiiskoi natcionalnoi konferentcii po teploobmenu. M.: Izdatelskii dom MEI, 2014; 2 – 55-56.

18. Effect of nanopartic leson heat transfer in mini double-pipe heat exchangers in turbulent flow [Text] / Aghayari Reza [and oth.] // Heat MassTransfer, 2015. – № 51. – P. 301- 306.

19. Bardakhanov S.P., Novopashin S.A., Serebriakova M.A. Issledovanie teploprovodnosti nanozhidkostei na os-nove nanochastitc oksida aliuminiia [Study nanofluids thermal conductivity of the alumina nanoparticles]. Nanosiste-my: fizika, khimiia, matematika, 2012; 3(1) – 27-33.

20. Zharov A.V., Savinskii N.G., Pavlov A.A., Evdokimov A.N. Eksperimentalnyi metod izmereniia tep-loprovodnosti nanozhidkosti [The experimental method of measuring the thermal conductivity of nanofluids]. Fiziko-matematicheskie nauki fundamentalnye issledovaniia, 2014; 8 – 1345-1350.

21. Kutateladze, S.S. Osnovy teorii teploobmena [Fundamentals of heat transfer theory]. Novosibirsk: Nauka, 1970 – 660 p.

22. Iagov V.V. Nauchnoe nasledie D.A. Labuntcova i sovremennoe predstavlenie o puzyrkovom kipenii [Scien-tific heritage D.A. Labuntsov and modern idea of nucleate boiling]. Teploenergetika, 1995; 3 – 2-10.

23. Labuntcov, D.A. Fizicheskie osnovy energetiki. Izbrannye trudy po teploobmenu, gidrodinamike, ter-modinamike [Physical bases of power. Selected works on heat transfer, fluid dynamics, thermodynamics]. M.: MEI, 2000. – 388 p.

24. Овсянник, А.В. Моделирование процессов теплообмена при кипении жидкостей [Текст] / А.В. Овсян-ник. – Гомель: ГГТУ им. Г.С. Сухого, 2012. – 284 с.

24. Ovsiannik A.V. Modelirovanie protcessov teploobmena pri kipenii zhidkostei [Modelling of processes of heat exchange at boiling liquids]. Gomel: GGTU im. G.S. Sukhogo, 2012. – 284 p.

25. Gortyshev Iu.F., Popov I.A., Zubkov N.N. Kipenie vody na mikrostrukturirovannykh poverkhnostiakh [Boil-ing water on microstructured surfaces]. Trudy Akadenergo, 2012; 1 – 14-31.

COMPUTER SIMULATION OF STATIC SHORT-CURRENT LIMITING DEVICES IN THE POWER SYSTEM

V.N. Krysanov, Candidate of Technical Sciences, Voronezh Technical University, Voronezh, Russian Federation, e-mail: sovtech2000@mail.ru.

Yu.V. Sharapov, Postgraduate, Voronezh Technical University, Voronezh, Russian Federation, e-mail: y.v.sharapov@list.ru.

The article discusses the possibility of using the transformer-thyristor voltage regulator as a current-limiting device during short circuits in electrical networks. A mathematical model of discrete transformer-thyristor short-circuit current limiting device with an analog microcontroller control and locking semiconductor thyristor switched keys as a natural and artificial disconnection of thyristor keys External device (switching devices). Conducted by mathematical simulation of the modified voltage regulator shown that gates off the external device reduces the maximum current flowing in the circuit of the autotransformer, to a predetermined value. This is achieved by increasing the resistance of the inductance of the transformer, caused by opening of the primary winding. Another option is the construction of such a device with a locking keys in a natural way (in the case of locking the passage of current through zero) is not effective, due to the current increase during the half-cycle before the shutdown valve and reaches the critical values for the device installed on the input threshold. The resulting device and a description of discrete control function allows you to use the resulting program code and a power converter circuit further laboratory prototyping and modeling of 3-phase version of the device

Key words: modeling, thyristor short circuit, booster transformer, autotransformer

References

1. Krysanov V.N. Tyristornyj regulator napryazhenya kak sredstvo povysheniya propusknoy sposobnosty I snizheniya v LEP [Thyristor voltage regulator as a tool for increasing of carrying capacity and decline of overvoltage in power transmission line], Energeticheskie komplecsy I sistemy upravlenia, 2009; №1; 12-15.

2. Krysanov V.N., Astafev S.V. Bystrodeystvuyuschee regulirovanie napryazhenia pri korotkom zamykanyy v vysokovoltnykh lyniyakh. [Fast-acting regulation of voltage in the tim of short current in high-voltages lines]. Energeticheskie komplecsy I sistemy upravlenia; 2010 №1; 56-60.

3. Krysanov V.N., Sharapov Y.V. Ispolzovanie sovremennykh microcontrollernykh sredstv vychislenij dlya uprovleniya ustroystvamy gibhikh system peredachi peremennogo toka [Using modern microcontroller devices of computing for control FACTS system devices]. Energeticheskie komplecsy I sistemy upravlenia; 2014 №3; 62-66.

4. Krysanov V.N., Kyrilov A.B. Uchet nelineynosty magnitoprovoda silovogo transformatora v staticheskikh regulatorakh napryazheniya dlya tntrgopotrebitele [The Accounting of nonlinearly of the magnetic core of power transformer in static voltage regulators for energy consomers] Nauchno-tekhnicheskyj zhurnal; Electrotekhnicheskie kompleksy I sistemy upravlenia; Voronezh; Kvarta; 2015 №3; 35-39.

THE DEFINITION OF THE FUEL CONSUMPTION IN THE SYSTEM OF SEQUENTIALLY CONNECTED HEAT PUMPS IN ENERGY-EFFICIENT MODE OF OPERATION

A. V. Isanova, Candidate of Technical Sciences, docent, Voronezh state University of architecture and construction, Voronezh, Russian Federation, e-mail: a.isanova@bk.ru

V. I. Lukyanenko, Candidate of Technical Sciences, docent, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: lukyanenko1@yandex.ru

Considered heating system, consisting of two heat pumps with a series-connected evaporators and condensers. This connection scheme allows to achieve the conditions that the temperature of the condensation are very close to the coolant temperature at each heat pump. The most favorable mode of operation of the station relative to the order of series-connected heat pumps, at the outlet of the capacitors which is the difference between the temperatures of the coolant and refrigerant are different. Given several options for the ratio of the parameters of the system. The first time that the efficiency and the finite temperature difference between working fluid and the coolant of the first heat pump slightly more than the same values of the other. The second case in which the efficiency of the first heat pump to a greater extent differs from the value of another. On the basis of the mathematical model with the use of perturbation theory analytical dependences of the temperatures of condensation of working fluids heat pumps that minimize fuel consumption. Using results, it is possible to determine the influence of various parameters in a thermal power plant, consisting of heat pumps, condensers which are connected in series, and evaporators in parallel, and the peak boiler to cover the load of heating and hot water supply

Key words: heat pump, heating system, refrigerant, energy saving

References

1. Petrakov G.N., Stognej V. G., Martynov A. V. Raspredelenie teplovoj nagruzki mezhdu teplovym nasosom i pikovoj kotel'noj [The distribution of heat load between a heat pump and peak boiler]. Vestnik Voronezh. gos. tehn. un-ta. Ser. Jenergetika. 2004. Vyp. 7.4. P. 121- 125.

2. Sokolov E. Ja., Brodjanskij V.M. Jenergeticheskie osnovy transformacii tepla i processov ohlazhdenija [Energy basis of transformation of heat and cooling processes]. Moscow. Jenergoizdat. 1981. 320 p.

3. Sokolov E. Ja. Teplofikacija i teplovye seti [District heating and heat networks]. Moscow. Izdatel'stvo MJeI, 1999. 472 p.

4. Vezirishvili O.Sh., V. I. Gomelaur Vybor optimal'noj moshhnosti teplonasosnyh ustanovok [The choice of optimum capacity of heat pump installations]. Teplojenergetika. 1982. №4. P. 47-50.

5. Kostrikin A.I. Vvedenie v algebru [Introduction to algebra]. Moscow. Nauka. 1977. 496 p.

SALES PROGRAM COMPLEX PREDICTION OF THE REGIONAL LEVEL OF ENERGY CONSUMPTION

V.L. Burkovsky, Doctor of Technical Sciences , Professor , Voronezh State Technical University, Voronezh, Russian Federation, e-mail: bvl@vorstu.ru

V.N. Krysanov, Candidate of Technical Sciences , Assistant professor , Voronezh State Technical University, Voronezh , Russian Federation, e-mail: sovteh2000@mail.ru

A.L. Rutskov, Postgraduates, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: alex_8_90@mail.ru

The article deals with improving the accuracy of prediction of the level of consumption of the regional power system . Analyzed the functional relationship between the individual parts of it and revealed the most significant relationship, provides a complete and easy to use a mathematical model of the process being analyzed transport of electrical energy. It described in detail the process of forming the dispatching schedule and the importance of improving its accuracy. Noted the basic economic incentives improve the accuracy of forecasting production and consumption of electric energy in the regional system. The interrelation of activities carried out by the administrator of trading network and system operator of the unified energy system. We describe the steps of creating the elements software package designed to increase the accuracy characteristics of the dispatch schedule. Their implementation is organized through the use of multi-functional programming language - C #. In the process of writing software Windows Forms interface was used, allowing to develop smart clients - applications with advanced graphical functionality. Described as a classic structure prediction , and algorithms that implement the apparatus of fuzzy neural networks (based on Mamdani algorithm) within the software developed for the task in the elements of the Unified Energy System

Key words : power system , improve the accuracy of forecasting , optimization algorithms , software package

References

1. Burkovsky V.L., Kharchenko R.A. Modeli optimal'nogo ehnergoraspredeleniya v sistemah regional'nogo ehnergopotrebleniya [Models of optimal power distribution systems of regional energy]. Voronezh: V G TU, 2006. 137 p.

2. Krysanov V.N., Ruckov A.L., Shukur Omar Shukur Mahmud Osobennosti realizacii tekhnologii Smart Grid v regional'nyh sistemah ehlektrosnabzheniya [Features of the implementation of Smart Grid technology in the regional power supply systems]. Bulletin of Voronezh State Technical University. Voronezh, 2013. – T.10 – № 5-1; 92-97.

3. Burkovskij V.L., Krysanov V.N., Ruckov A.L., Shukur Omar Shukur Mahmud. Model' prognozirovaniya regional'nogo potrebleniya na baze nechyotkoj nejronnoj seti [Model prediction of regional consumption based on fuzzy neural network]. Bulletin of Voronezh State Technical University. Voronezh, 2015. – T.11 – № 5; 41-46.

4. Krysanov V.N., Burkovskij V.L., Ruckov A.L., Sharapov Yu.V. Problemy i resheniya pri vnedrenii Smart Grid v Rossii [Problems and solutions in the implementation of Smart Grid in Russia] // Sovremennye metody prikladnoj matematiki, teorii upravleniya i komp'yuternyh tekhnologij (PMUKT-15) sbornik trudov VIII mezhdunarodnoj konferencii [Modern techniques of applied mathematics , control theory and computer technology Proceedings of VIII International Conference]. Voronezh, 2015; 189-191.

INPUT RAIL-TO-RAIL AMPLIFIER FOR CMOS-COMPARATORS AND OPERATIONAL AMPLIFIERS WITH LOW SUPPLY VOLTAGE

V.S. Kononov, Candidate of Technical Sciences, Research Officer, JSC SKTB ES, Voronezh, Russian Federation, email: casandra1983@mail.ru

Analysis of input common-mode voltage range and transfer functions of well-known rail-to-rail amplifiers is done. It is found, that at low supply voltage of 1,8 ± 5% and typical threshold voltages of 0,9 V, input voltage range is 0,9-1,3 V depending on type of amplifier. It is shown, that rail-to-rail amplifiers based on two differential pairs of PMOS and NMOS transistors, don't have internal scale area with similar transfer function, where PMOS and NMOS transistors are simultaneously in active region. In rail-to-rail amplifiers with one differential pair internal scale area is about 400 mV, which is achieved at the cost of input resistance reduction. New rail-to-rail amplifier with input voltage range equal to supply voltage and high input resistance is considered in this paper. Two versions are offered, one of which has noise neutralizer. Amplifiers are intended for use in low-voltage comparators and operational amplifiers

Key words: CMOS, amplifier, range, comparator, operational amplifier

References

1. Kester W. Analogo-cifrovoe preobrazovanie [Analog-Digital Conversion] / W. Kester – Moscow. – Technosphera, 2007. – 1016 p.

2. Duque-Carrillo J.F. 1-V Rail-to-Rail Operational Amplifiers in Standard CMOS Technology [Text] / J.F. Duque-Carrillo and el // IEEE JSSC. – 2000. – Vol. 35. – №. 1. – P. 33-44.

FEATURES OF DESIGNING DEVICE DIGITAL SIGNAL PROCESSING IN THE FPGA BASIS SERIES 5578

A.V. Srogonov, Doctor of Technical Sciences, Full Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: sto@sci.vrn.ru
P.S. Gorodkov, Postgraduate, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: gorodkoff@gmail.com

The programmable logic integrated circuit (PLD) such as field programmable gate arrays (FPGAs) structure with the logical blocks on the basis of adaptive logic modules of 5578 series developed as part of the import substitution of foreign electronic components programme is considered. According to architectural solutions, new domestic FPGAs are intermediate notched up a series of low-budget between the Altera Cyclone II FPGA and high-performance series of Stratix III. Special aspects of the organization of local and global wiring resources, block for digital signal processing and modes of user memory block are reported. There are examples of the design of digital filters with finite impulse response using CAD Altera Quartus II FPGA and programming issues with the configuration data development environment.

Key words: delay line, multiplier, accumulator, filter, digital signal processing

References

1. Altera. White Paper. FPGAs for High-Performance DSP Applications. May 2005, ver. 1.1.

2. Strogonov A., Cybin S., Gorodkov P. SAPR VTR7 dlja proektirovanija akademicheskih PLIS [VTR7 CAD for designing academic FPGA] // Komponenty i tehnologii, 2016, N3.

3. Strogonov A., Cybin S., Gorodkov P. Osobennosti ispol'zovanija dvuh portovoj pamjati pri proektirovanii posledovatel'nyh KIH-fil'trov v SAPR PLIS Quartus II [Features of use of the two port memory in the design of sequential FIR filters in the CAD Quartus II FPGA] // Komponenty i tehnologii, 2016, N4.

4. Strogonov A., Cybin S., Gorodkov P. Proektirovanie posledovatel'nyh KIH-fil'trov v SAPR PLIS Quartus II [Designing sequential FIR filters in the CAD Quartus II FPGA] // Komponenty i tehnologii, 2016, N1.

5. Strogonov A.V. Cifrovaja obrabotka signalov v bazise programmiruemyh logicheskih integral'nyh shem [Digital signal processing in the basis of programmable logic integrated circuits]: Uchebnoe posobie. – 2-e izd., ispr. i dop. – SPb.: Izdatel'stvo "Lan'", 2015. -310 s.

THE CONCEPT TO CREATE A VERSATILE PARAMETER MONITORING SYSTEM

D.V. Zhuravlev, Candidate of Technical Sciences, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: ddom1@yandex.ru
Yu.S. Balashov, Doctor of Physical and Mathematical Sciences, Full Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: faddey52@mail.ru

D.V. Shekhovtsov, Candidate of Technical Sciences, OAO "NIIET", Voronezh, Russian Federation, e-mail: wex@niiet.ru

The monitoring system developed is a control and technical complex to collect, transfer, process, store, output and strategically analyze data. This article considers a conception model the system of interest involving a block-module system structure. This enables forming a hierarchical structure in a flexible, simple, and application-dependent way. The ways to implement a signal recording unit for a versatile system to monitor various parameters are considered. The basic components of the re-

cording unit are reviewed. Their functional tasks are described. The main software-driven part of the versatile system is implemented within the SoC (System on Chip) integrated circuits. Systems on Chip development steps are determined. The SoC block diagram derived from the system decomposition is shown. The architecture features of the SoC basic blocks are described. The controlled recording unit operation is shown based on the 1874VE96T microcontroller. A system operation in conjunction with various sensors and actuators is demonstrated

Key words: monitoring, remote control, universal system, system on chip, decomposition of the project

References

1. Rusanov A. V., Tkachev A. Ju., Balashov Ju. S. Jekvivalentnaja shema MOP-tranzistora s jelek-tricheski soedinennymi zatvorom i karmanom [The equivalent circuit of MOSFET with electrically connected gate and pocket] // Izvestija vysshih uchebnyh zavedenij. Jelektronika. 2014; № 1 (105); P. 85-86

2. 16-razrjadnyj mikrokonverter [16-bit MicroConverter] [electrody resource] : Access mode : World Wide Web. URL : http://www.niiet.ru/chips/microconvertors/

DELAY TIME UNDER PRESSURE WHEN IS WELDING TITANIM WORKPIECES

M.V. Semenozhenkov, Candidate of Technical Sciences, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: for_maxs@mail.ru
V.V. Peshkov, Doctor of Technical Sciences, Full Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: for_maxs@mail.ru

Were given calculated dependences definitions of hold time of workpieces from the titan under their pressure welding. Have been researched the influence of the mechanical characteristics of titanium alloys ductility and creep state in the contact zone the workpieces being joined, as well as the technological process. Were given the method and results of experimental studies, which allowed to establish the mechanical constants of titanium alloys and create mathematical models and materials OT4-1 VT6. Using the obtained models established the influence of process parameters of welding workpieces (temperature, pressure) for the time necessary to obtain a high-quality connection.

Conducted study of stress-strain states of material in the field of elastic-plastic joining workpieces in the vicinity of the contact zone.

Revealed the kinematics indentation of structural elements, and the dependence of the deformation of the metal from a ratio of sizes of workpieces. Shows the dependence of the vertical movement of the metal sheet from a time point corresponding to the center of the filler, and it is directly proportional to the increase in test time.

Obtained results are necessary for optimization of technological processes of welding workpieces made of titanium alloys.

Key words: creep, time, pressure, deformation, stress-strain state, welding

References

1. Horev, A.I. Razrabotka listovogo titanovogo vysokotemperaturnogo splava VT38, primenjaemogo pri temperaturah do 700̊C [Designing sheet high temperature titanium alloy VT38 used at temperatures up to 700°C] / A.I. Horev / Vestnik mashinostroenija, 2014. - №5. S. 67-69.

2. Chudin, V.N. Soedinenie jelementov korpusnyh konstrukcij davleniem [Joining of elements of hull structures by pressure] / V.N. Chudin / Vestnik mashinostroenija, 2014. - №1. S. 78-80.

3. Rabotnov, Ju.N. Kratkovremennaja polzuchest' [Short-term creep] / Ju.N. Rabotnov, S.T. Milejko – M.: Nauka, 1970. – 234 s.

GEOMETRY GENERATION PROCESS OF TRANSITION SECTIONS DURING COMBINED TREATMENT

O.N. Kirillov, Doctor of Engineering Science, Assistant Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: kirillov.olli@yandex.ru

V.P. Smolentsev, Doctor of Engineering Science, Professor, Voronezh State Technical University, Voronezh, e-mail: vsmolen@inbox.ru

V.I. Kotukov, Postgraduate, Voronezh State Technical University, Voronezh, e-mail: fgupvmz@mail.ru

Process of getting parts mating, manufactured with use of hydroabrasive method in current-conducting fluid medium during effect of external electric field is viewed in the article. Capabilities of developed combined method for finish machining of airfoils of aircraft and rocket engines are presented.

The problem of getting with required accuracy final airfoil of mating surfaces areas was decided with the use of combined hydroabrasive-jet treatment with anodic removal from surface of separation tolerances, sufficient for removal of overact layer. From the theory of dimensional electrochemical machining it is known that speed of material removal with use of anodic dissolution will be higher on concentrators of the field, which are microroughnesses. That is why, application of the electric field helps to reduce roughness. Removal of waste products and recovery of abrasive cutting properties is performed simultaneously. This leads to stabilization process of metal separation, improve quality of machined surface, performance, improve tool life, makes it possible to reduce cost of machining. However, previously obtained results don't provide achievement of required technological parameters during finish dimensional machining of surfaces, type turbine and compressor airfoils, turbo pump assemblies. It is required to establish regularities for jet control and create jet moving process through the surface working area. Description of the surface working area is usually prescribed by table method, consecutive combination of points. It is necessary to establish parameters for each point during designing of combined machining mode. Parameters must to take into account geometry of machined area of the detail and position of fluid jet.

Modern structures of high technology transport products are contain a lot of elements, to which direct access of metal cutting tool is limited. It is necessary to create new technological methods and devices for finish machining. Combined process decides this problem and increase technological opportunities for manufacturers of future products in the article presented here

Key words: hydroabrasive treatment, mating, transition sections, geometry generation process

References

1. Jelektrofizicheskie i jelektrohimicheskie metody obrabotki materialov[Electrophysical and electrochemical treatment methods of materials]: Ucheb. posobie (v 2-h tomah.). T.II/Pod red. V.P. Smolenceva. M.: Vyssh. shk., 1983. – 208 s.

2. Smolencev V.P. Formirovanie poverhnostnogo sloja pri gidroabrazivnom razdelenii metallov s nalozheniem jelektricheskogo polja [Generation of surface layer during hydroabrasive separation of metals with application of the electric field]/ V.P. Smolencev, E.V. Goncharov // Vestnik Voronezhskogo gosudarstvennogo tehnicheskogo universiteta, 2011, Tom 7 №7. – S.74-77.

3. Razi A.A. Traektornye preobrazovateli [Trajectory transducers]/ A.A. Razi. L.: Mashinostroenie, 1984. – 192 s.

4. Bez'jazychnyj V.F. Metod podobija v tehnologii mashinostroenija [Similarity method in technology of machine building]/ V.F. Bez'jazychnyj. M.: Mashinostroenie, 2012.-320 s.

5. Junusov F.S. Formoobrazovanie slozhnoprofil'nyh poverhnostej shlifovaniem [Generation of geometrically-complex surfaces by grinding]. M: Mashinostroenie.1987.-248 s.

6. Smolencev V.P. Kombinirovannoe razdelenie zagotovok gidroabrazivnym metodom [Combined separation of semi-finished products by hydroabrasive method]/ V.P. Smolencev. E.V. Goncharov, V.I. Kotukov. Progressivnye mashinostroitel'nye tehnologii, oborudovanie i instrumenty. Moskva. Spektr.2014. tom 3.- S.118-172.

STRUCTURE AND PROPERTIES OF COPPER MATRIX NANOSTRUCTURED COMPOSITE MATERIAL OBTAINED BY MECHANICAL ALLOYING

Yu.R. Kopylov, Doctor of Technical Sciences, Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: urkopulov@mail.ru

Yu.A. Schetinin, graduate, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: yurii.kbxa@mail.ru

O.V. Gorozhankina, graduate, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: winter.07@mail.ru

By the structural materials used in rocket for the manufacture of "hot machines" (combustion chambers, gas generators, heat exchangers), meet high requirements on the thermal conductivity, heat resistance and heat resistance. Currently, the specified requirements are met by heat-resistant bronze in combination with the thermal barrier coating, for example alloys Narloy Z, bronze or BrHTsrT BrH08 that provide heat flux to eat 36 106 kcal / m2chas. For developed new rocket engine needs a new structural material with high thermal conductivity while maintaining its mechanical properties. The most promising material is pure copper, with the introduction in its metal matrix carbon nanoparticles (nanotubes, fullerenes), which can significantly increase the heat resistance.

This article describes in detail the first technology of obtaining, structure and properties of the composite with a mass fraction of 0.5% CNTs obtained by mechanical alloying. For comparison, the properties of the sample of copper powder ICP-1 without the addition of carbon nanoparticles. For mechanical alloying using a planetary mill "pulverisette 5» (FRITSCH). doping process was carried out for 30 minutes while heating took place capsules with the composition to 60-80 ° C. Next, heat

treatment was performed in a vacuum, and annealing the composition. Pre-compression was carried out in a steel capsule force of 100 ton, cylindrical preform was obtained as a result. It was further held hot isostatic pressing (HIP) in gazostat QVINTUS-250. For mechanical testing the samples were fabricated with cylindrical working portion 5 mm thick.

The results of strength tests have shown that the limit of the composite strength after HIP at ~ 11% higher than in sample ICP-1 (non-alloy particles) and 2 times higher than the yield strength of the M2 brand copper. The thermal conductivity of the composite sample of the test was 289 W / m • K, which is ~ 20% higher than the thermal conductivity of the traditionally used BrH08 bronze (239 W / m • K). These results demonstrate the fundamental possibility of producing a copper composite material reinforced with nano-sized particles of carbon - CNT by mechanical alloying, however, there is need to clarify the technology of its receipt

Key words: nanocomposite copper, mechanical properties, heat treatment

References

1. Chu K., Qingying W. Fabrication and effective thermal conductivity of multi-walled carbon nanotubes reinforced Cu matrix composites for heat sink applications. // Composites Science and Technology. – 2010. – vol. 70. – pp. 298–304.

2. Marcos-Gómez J., Ching-Lloyd M.R., Elizalde W.J., Clegg J.M., Molina-Aldareguia. Predicting the thermal conductivity of composite materials with imperfect interfaces. // Composites Science and Technology. – 2010. – vol. 70. – pp. 2276–2283.

3. Vaganov V.E., Zaharov A.D., Reshetnyak V.V. Uglerodosoderzhashie nanocomposite na osnove medi funkcionalnogo I konctrukcionnogo naznasheniya [Containing carbon nanocomposites on the basis of copper of functional and constructional purpose] // Materials science. – 2013. - No. 3. –25-32 p.

4. GOST 4960-75. Poroshok mednyi elektroliticheskiyi. Texnicheskie usloviya [Electrolytic copper powder. Specifications]. 1977-01-01. – M.: Standards Publishing House, 1998. – 12 p.

5. GOST 1497-84. Metally. Metody ispytanii na ractyazhenie [Metals. Test methods Tensile]. – 1984-07-16. – M.: Standartinform, 2008. – 24 p.

6. GOST 21073.1-75 Metally tsetnye. Opredelenie velichiny zerna metodom cravneniya co shkaloy mikroctruktur [Non-ferrous metals. Determination of the grain size by comparison with the scale microstructures]. – 1976-07-01. – M.: Standards Publishing House, 2008. – 24 p.

STRUCTURE, ELECTRICAL AND OPTICAL PROPERTIES
FILMS $(SnO_2)_X \cdot (ZnO)_{1-X}$ FOR x = 0,3; 0,5

S.A. Belousov, Postgraduate, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: heroy777@mail.ru

N.N. Kosheleva, Candidate of Technical Sciences, Associate Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: vstu-ppe@yandex.ru

A.A. Nosov, Student, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: sir.baters@yandex.ru

T.G. Menshikova, Candidate of Technical Sciences, Associate Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: menshikova.vrn@mail.ru

S.I. Rembeza, Doctor of Physico-Mathematical Sciences, Full Professor, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: rembeza@yandex.ru

Metal oxide film composition $(SnO_2)_x \cdot (ZnO)_{1-x}$ for x = 0,3; 0,5, which corresponds to the ZnO and SnO2 ratio of 2: 1 (x = 0,3) ZTO2 and 1:1 (x = 0,5) ZTO1, made by ion beam sputtering in Ar atmosphere. The elemental and phase composition, the structure of the films are studied, electrical and optical properties in the amorphous state are measured. The properties of amorphous films ZTO1 and ZTO2 allow to use them in transparent electronics as channel (ZTO1) or as a transparent conductive source, drain and gate contacts (ZTO2). After heat treatment at 580 ° C for 6 hours ZTO1 film is not crystallized, as the film is a ZTO2 have crystalline phase Zn_2SnO_4. The possibility of using films ZTO1 and ZTO2 in transparent electronics and gas sensorics discussed

Key words: thin films, ion-beam sputtering, elemental and phase composition, electric and optical properties

References

1. Wager, J.F. Transparent electronics [Text] / J.F. Wager // Science. - 2003. - Vol. 300. - P. 1245-1246.

2. Jung, J. Solar Cell [Text] / J. Jung, D.L. Kim, S.N. Oh, H.J. Kim // Solar Energy Mater. - 2012. - Vol. 102. - P. 103-108.

3. Lampe, V. Thin film oxygen sensors made of reactively sputtered ZnO [Text] / V. Lampe, J. Mulle // Sens. and Actuators. - 1989. - Vol. 18. - P. 269-284.

4. Hoffman, K.L. ZnO based transparend thin film transistor [Text] / K.L. Hoffman, B.I. Norris, J.F. Wager // Appl. Phys. Lett.. - 2003. - Vol. 82. - P. 733-735.

5. Abdulaziz, A. Sh. Al – Shahrani, Preparation and characterisatron of ceramic and thin film Zn_2SnO_4 [Text] / A. Abdulaziz, Sh. Al – Shahrani // E-Theses, Diorham Un. - 1993. - Vol. 32. - P. 467-471.

6. Rembeza, S.I. Sintez mnogokomponentnyh metallooksidnyh plenok razlichnogo sostava $(SnO_2)_x(ZnO)_{1-x}$ (x=1-0.5) [Synthe-sis of multi-component metal oxide films of various compositions $(SnO_2)_x(ZnO)_{1-x}$ (x=1-0.5)] / S.I. Rembeza, N.N. Kosheleva, E.S. Rembeza, T.V. Svistova, E.Ju. Plotnikova, E. Suvaci, E. Ozel, G. Tuncolu, C. Aciksari // Fizika i tehnika poluprovodnikov. - 2014. - T. 48. - № 8. - S. 1147-1151.

7. Fizicheskie metody issledovanija materialov tverdotel'noj jelektroniki [Physical methods of materials research of solid-state electronics] / S.I. Rembeza, B.M. Sinel'nikov, E.S. Rembeza, N.I. Kargin – Stavropol': SevKavGTU, 2002. - 432 s.

8. Govindappa, C.K. Electrochemical generation of cubic shaped nano Zn_2SnO_4 photocatalysts [Text] / C.K. Govindappa, V.T. Venkatarangaiah, S.B. Abd Hamid // Nano-micro Letters. - 2013. - Vol. 5. - №2. - P. 101-110.

9. Rumjanceva, M.N. Vlijanie mikrostruktury poluprovodnikovyh sensornyh materialov na hemosorbciju kisloroda na ih poverhnosti [Influence of microstructure on the semiconductor sensor materials oxygen chemisorption on the surface] / M.N. Rumjanceva, E.A. Makeeva, A.M. Gas'kov // Rossijskij Himicheskij Zhurnal (ZhRHO im. D.I.Mendeleeva). - 2008. - T. 52. - №2. - S. 122-129.

MATHEMATICAL MODELING OF TECHNOLOGICAL PROCESSES OF AUTOMATED CALCULATIONS OF EXPERIMENTAL SAMPLES POLYMER COMPOSITE MATERIALS

A.V. Gaganov, Director of the scientific-educational center "Innovative technologies in aircraft engineering", Voronezh State Technical University, Voronezh, Russian Federation, e-mail: avg036@mail.ru **O.V. Karaeva**, Candidate of Physico-Mathematical Sciences, Junior researcher of scientific and implementation laboratory «Composite material», Voronezh State Technical University, Voronezh, Russian Federation, e-mail: olgakaraeva9@mail.ru

A.M. Kudrin, Candidate of Physico-Mathematical Sciences Managing scientific and implementation laboratory «Composite material» Voronezh State Technical University, Voronezh, Russian Federation, e-mail: kudrin.ru@gmail.com

Ya.V. Darneva, Student, Voronezh State Technical University, Voronezh, Russian Federation, e-mail: dti73@mail.ru

Results of technological process mathematical simulation of aviation products production of polymeric composite materials are given. Results of technological process multiple-factor research of the automated calculation of polymeric composite material experimental samples with the set operational characteristics by means of specialized computer means for parametrical researches and nonlinear optimization are presented. The complex of the operating parameters making the greatest impact on results of the studied technological process regarding mechanical properties of the received samples is determined. The adaptive neural network models providing forecasting of technological process results of the automated calculation, allowing carrying out an assessment of the operating parameters influence on strength characteristics of samples are created. Introduction in production of the developed techniques of the multiple-factor analysis will allow receiving material with the set operational characteristics and to lower financial and time expenditure at production of products from polymeric composite materials

Key words: technological processes, modeling, optimization

References

1. Kryzhanovsky V. K. Tekhnologiya polimernykh materialov [Technology of polymeric materials]. Sankt-Petersburg: Profession, 2008

2. Alent'yev A.Yu. Svyazuyushchie dlya polimernykh kompozitsionnykh materialov [Binding for polymeric composite materials]. Moscow, MGU, 2010. 69 p.

3. Borovikov V. STATISTICA. Iskusstvo analiza dannykh na komp'yutere: Dlya professionalov. [Art of the analysis of data on the computer: For professionals.] Second edition, Sankt-Petersburg,2003.688.

4. Terekhov V.A., Efimov D.V., Tyukin I.Yu.,Antonov V.N. Neyrosetevye sistemy upravleniya [Neural network control systems]. Sankt-Petersburg: Publishing house of the St. Petersburg university,1999.265