ABSTRACTS

MATHEMATICAL MODELLING IN NATURAL SCIENCES AND INFORMATION TECHNOLOGIES

MODERN MEANS OF HARDWARE AND SOFTWARE SUPPORT FOR THE IEEE STANDARD

Zhulkovska I.I., Zhulkovskii O.A.

Abstract

Rounding floating-point numbers is a very important problem of the existing computer arithmetic. Numbers are rounded when you enter initial values and after each arithmetic operation. Uniform standard for binary representation of floating point numbers was developed and implemented by the Association *IEEE* (*Institute of Electrical and Electronics Engineers*). The *IEEE* 754 introduces the following required for realization rounded floating-point operations: addition, multiplication, subtraction, division, calculating the remainder of the division, square root, format conversion.

Problem is improving the reliability of simulation results based on the evaluation of modern, most commonly used, hardware and software tools for obtaining the highest accuracy of computations and reducing errors due to the representation of actual data in computer memory.

Improving the accuracy of arithmetic operations by increasing the bit numbers is the main means performing calculations critical to rounding. Modern general-purpose processors and high level language compilers maintain, as a rule, only formats single and double precision, as well as not defined standard double extended precision format in which the mantissa consists of 64 bits. Arithmetic increased accuracy is costly, and therefore implemented in software.

The constant presence of rounding errors when working with the machine arithmetic imposes special requirements to computer algorithms and requires additional analysis of the problem being solved. Almost all numbers are represented in the computer memory with an error, so you need to know how the decision sensitive to changes in the parameters of the task.

The study shows the capabilities of modern general-purpose processors and high-level language compilers to support high-precision formats and modern streaming processing technologies to improve the efficiency of mathematical modeling.

References

[1] IEEE Standard for Floating-Point Arithmetic, New York, 2008, 70p.

[2] Hanrot G., Lefevre V., Muller J.-M., Revol N. and other. Some Notes for a Proposal for Elementary Function Implementation in Floating-Point Arithmetic, Proc. of Workshop IEEE 754 and Arithmetic Standardization, in ARITH-15, 2001.

[3] Defour D., Hanrot G., Lefevre V., Muller J.-M. and other. Proposal for a standardization of mathematical function implementation in floating-point arithmetic. Numerical Algorithms, 2004, no.37(1–4), pp. 367–375.

[4] Aharoni M., Asaf S., Fournier L., Koifman A. and other. A Test Generation Framework for Datapath Floating-Point Verification. IEEE International High Level Design Validation and Test Workshop, 2003, pp. 17–22.

[5] Stehle D., Lefevre V., Zimmermann P. Searching Worst Cases of a One-Variable Function Using Lattice Reduction. IEEE Transactions on Computers, 2005, no.54(3), pp. 340–346.

[6] Nikonov O.Ya, Mnushka O.V., Savchenko V.M. “Otsenka tochnosti vychisleniy spetsial'nykh funktsiy pri razrabotke kompyuternykh programm matematicheskogo modelirovaniya”. *Visnyk NTU «KHPI»* [Bulletin of the NTU "KhPI"],2011, no.17, pp. 115–121 (in Russian).

[7] Zhulkovska I.I., Zhulkovskii O.O., Shaganenko R.G. Vychisleniye granichnykh znacheniy subnormalnykh chisel v IEEE-standarte. *Matematychne modelyuvannya – Mathematical modeling*, 2015, no.1 (32), pp. 41–44 (in Russian).

[8] Zhulkovska I.I., Zhulkovskii O.O., Nikolayenko Yu.V. “Vychisleniye granichnykh znacheniy deystvitelnykh chislovykh dannykh v IEEE-standarte”. *Zbirnyk naukovykh prats DDTU (tekhnichni nauky)* [Collection of sciences works of DSTU (technical sciences)], 2015, no.1 (26), pp. 240–245 (in Russian).

[9] Goldberg D. What Every Computer Scientist Should Know about Floating-Point Arithmetic. ACM Computing Surveys, 1991, no.23(1), pp. 5–48.

[10] Zhulkovska I.I., Zhulkovskii O.O. Vychisleniye maksimalnykh absolyutnykh pogreshnostey okrugleniya chisel v IEEE-standarte. *Matematychne modelyuvannya – Mathematical modeling*, 2015, no.2 (33), pp. 33–36 (in Russian).

ON THE CHOICE OF THE PARAMETERS OF THE EM ALGORITHM FOR THE SEPARATION OF THE MIXTURE OF DISTRIBUTIONS.

Shumeiko A.A, Iskandarova-Mala A.

Abstract

The paper considers one of the types of non-hierarchical clustering - the EM-algorithm. This methd is traditionally the most used tool for separating a mixture of distributions with a known number of components. Determining the number of components (clusters) is a non-trivial problem. As a rule, this parameter is chosen by the researcher from some a priori assumptions. Nevertheless, the problem of the automatic choice of this parameter was investigated in many papers.

Existing approaches, as a rule, differ in the complexity of implementation, intuitive approaches or approximate methods for solving complex analytical problems, it is often not clear how they are generally related to this task.

The EM-algorithm for separating the mixture of normal distributions is in fact a reconstruction of the existing histogram by a linear combination of Gaussian functions, so, naturally, having the value of the specified error of reconstruction, describe the available histogram by a depleted histogram with free nodes, which is best (ie, with a minimum number nodes). The resulting number of nodes is an estimate of the number of components of the mixture, which is reconstructed by a linear combination of Gaussian functions with a given error. Moreover, the values of free nodes make it possible to obtain a starting estimate of the remaining parameters of the mixture.

References

[1]. McLachlan G.J. The EM algorithm and extensions / G. J. McLachlan, T. Krishnan.-New York: John Wiley & Sons, Inc., 1997 .– 288 p.

[2]. Korolev V.Yu. EM-algorithm, its modifications and their application to the problem of separation of mixtures of probability distributions. / V.Yu.Korolev; Theoretical review .– M: IPI RAS, 2007 .– 94 p.

[3]. Shumeiko A.A. Intelligent Data Analysis (Introduction to Data Mining) / A.A. Shumeiko, S.L.Sotnik .– Dnepropetrovsk: Belaya EA, 2012.– 212 pp.

[4]. Optimal Histograms with Quality Guarantees / H.Jagadish, N.Koudas, S.Multhukrishan та ін. .– Access mode: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.36.769&rep=rep1&type=ps

[5]. Vetrov, D.P. Automatic determination of the number of components in the EM-algorithm for recovering a mixture of normal distributions / D.P.Vetrov, D.A.Kropotov, A.A.Asokin // Zh. Vychisl. Math. and Math. fiz. .– 2010 .– No. 4 (50).–P.770–783.

[6]. Ligun AA Asymptotic methods for reconstructing curves / AA Ligun, AA Shumeiko .– K .: Naukova dumka, 1997 .– 358 pp.

ALGORITHMIC PROVIDING OF THE METHOD FOR FORECASTING OF THE ELECTRICITY CONSUMPTION VOLUME WITH THE USE OF A RECURRENT NEURAL NETWORK

Kosukhina O., Tonkonog S.E.

Abstract

The urgency of the topic of this work lies in the fact that the prediction of electric load is one of the main parameters that determine the mode of power systems operation. The forecasting errors necessarily lead to unreasonable costs in the energy sector. This is due to the fact that the reassessment of future consumption leads to unreasonable over-consumption of all types fuels, and its underestimation to a decrease in the quality of energy supply to consumers.

The purpose of this work is to improve the quality of the forecast of hourly electricity consumption by developing algorithmic and software method using recurrent neural network.

The following tasks were set in the work:

- to analyze the existing methods of time series forecasting;
- to construct the algorithm and software of the forecasting method using the recurrent neural network;

- apply the developed algorithmic and software for forecasting of hourly electricity consumption.

As a result of the work, the algorithmic and software of the method of forecasting of time series using the recurrent neural network was developed.

The developed software was used to forecast hourly electricity consumption. It is proved that the prediction error is valid and does not exceed the error of studying.

References

[1] Tzafestas S. Computational intelligence techniques for short-term electric load forecasting / S. Tzafestas, E. Tzafestas // Journal of Intelligent and Robotic Systems. – 2001. – 31. – P. 7–68.
[2] Mandic D.P. Recurrent Neural Networks for Prediction/ D.P. Mandic, J.A. Chambers. – Chichester: John Wiley&Sons, 2001. – 285 p.
[3] Williams R.J. A Learning Algorithm for Continually Running Fully Recurrent Neural Networks / R.J. Williams,D. Zipser // Neural Computation. – 1989. – 1. – P. 270–280.
[4] Elman J.L. Finding structure in time / J.L. Elman //Cognitive Science. – 1990. – 14. – P. 179–211.
[5] Jordan M. Constrained supervised learning /M. Jordan // Journal of Mathematical Psychology. – 1992. – 36. – P. 396–452.
[6] Vikko N., Lautala, P. Short-term electric power production scheduling using simulated annealing algorithm: Proc. of the IASTED Inter. Sym / N. Vikko, P. Lautala // ACTA Press, Anaheim, CA, USA, 1990.
[7] Chumachenko E. I. Algorithm for solving the problem of forecasting / E. I. Chumachenko, V. S. Horbatuk // Artificial Intelligence. – 2012. – № 2. – p.p. 24–30 (in Russian).

THE METHOD OF INCREASING THE ACCURACY OF ACCOUNTING AND THE INFORMATION PROTECTION FUNCTION OF THE AUTOMATED SYSTEM FOR COMMERCIAL ACCOUNTING OF NATURAL GAS FROM COAL DEPOSITS (ACS PG)

Stasevich R.K.

Abstract

According to the results of the IHTM researches of the NASU of 2017, the gas reserves of coal deposits in Donbass exceed 3 trillion m3. This is one of the foundations of Ukraine's energy independence.

IGTM NASU works out the developed scientific and technical foundations for the extraction, transportation and utilization of gases from coal deposits with the help of coal-mining cogeneration power complexes. The construction of such complexes will ensure the reliability of electricity and heat supply to coal-mining enterprises, as well as adjacent residential areas and enterprises. At the same time, the consumption of imported natural gas will be substantially reduced by replacing it with mine methane in heating gas boiler houses and there will be no need to purchase electricity from the mine. To solve the above-mentioned urgent problems, it will be necessary to create a single information and control complex for underground and surface gas extraction of coal deposits and shchakht, their transportation and disposal in real time. Therefore, the scientific and technical problems of increasing the accuracy of technological and commercial accounting for the gases of coal deposits and mines during its extraction, transportation and utilization are topical.

The aim of the work is to improve the accuracy of measuring and accounting for gas costs of a single dynamic technological process of degassing, transporting, disposing and supplying them to the gas transportation system of Ukraine.

Flowmeters for differential pressure on narrowing devices remain the most acceptable for accounting for methane consumption of coal deposits for the following reasons:

– proven reliability with proper installation and application;
– excellent reproducibility of measurement results;
– the possibility of metrological certifications without the use of exemplary high-precision wind tunnels;
– ease of detection of faults and errors in measurements;
– world-wide industrial metrological standards, as well as theoretical and empirical dependencies;
– the cost of measuring instruments depends little on the diameter of the pipeline for gaseous and liquid media.

The results of research and development of a method for increasing the accuracy of commercial gas metering with diaphragm flow devices are described by dividing the entire gas flow measurement range into three sub-ranges. The description of the device, information support and protection functions from unauthorized adjustment of the information of the automated system for commercial accounting of natural gas and a structural

solution for its application at compressor stations for gas preparation of coal deposits for transportation to consumers through the gas transportation system of Ukraine are described.

Conclusions

1. A technique has been developed to increase the accuracy of commercial accounting for natural gas from coal deposits, which consists of dividing the entire range of gas flow measurements into 3 sub-ranges used to create an automated gas metering device based on the measuring complex "DIA"

2. The structure, the principle of operation, the method for calculating the consumption of natural gases and gases of coal deposits, and industrial tests of the ASU PG at gas distribution station No. 2 in Dnprodzerzhinsk have been developed.

3. New functions of automated systems for commercial accounting of natural gas and coal gas gases are required to provide reliable information in the event of mutual settlements between suppliers and consumers and to protect it against unauthorized adjustments.

The method of increasing the accuracy of accounting and the information protection function of the automated system for the commercial accounting of natural gas from coal deposits are designed for information management complexes for the surface extraction of these gases, for their transportation and utilization, as well as for automated systems for the commercial recording of these gases when supplied to the gas transportation system of Ukraine .

References

[1] "The rules for the submission of natural gas in the People's State of Ukraine and the normative materials for effective natural gas".
[2] The program and methodology of the State metrological certification of devices for automated metering of natural gas consumption based on the MEASUREMENT "DIA" COMPLEX (PMA 081 / 24.021-97)
[3] DBN B.2.5-20-2001 "Gas supply".
[4] DNAPP 0.00-1.20-98 "Safety rules for gas supply systems in Ukraine".
[5] The procedure for admission to the gas transmission system of NAK Naftogaz of Ukraine (Order No. 79 of 26.03.01).

MODELLING AND OPTIMIZATION IN MATERIAL CONSTRUCTION TECHNOLOGY

PHYSICO-CHEMICAL MODELING OF PRODUCTION UNDER CONDITIONS SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS WEAR-RESISTANT COATINGS

Beigyl O.A., Sereda D.B.

Abstract

There are many methods for hardening the surface of steels, some of them are used in several versions. Surface saturation of steel with aluminum, chromium, zinc and other elements is called diffusion saturation with metals. The product, the surface of which is enriched with these elements, acquires valuable properties, including high heat resistance, corrosion resistance, increased wear resistance and hardness.

In this regard, the actual application of technologies that allows to receive coatings with limited or minimal time of their formation. One of such technologies is the method of self-propagating high-temperature synthesis.

The development of IFOR as a research direction related to the synthesis of materials has supplemented the arsenal of combustion chemistry with new inorganic reactions, the range of which is continuously expanding. The main interest at the present time is represented by reactions in multicomponent systems conducted with the aim of obtaining complex single-phase compounds or heterogeneous materials with a given ratio of phase components.

The application of protective layers was carried out in a pilot plant including the following functional systems: reaction equipment, gas supply system and a system for monitoring and regulating technological parameters.

On the surface of samples made of boron-doped steel 50, the protective coating consists of phases $(FeCr)_{23}C_6$, $(FeCr)_7C_3$, $(FeCrAl)_2B$, Fe_2Al_5 and α-solid solution of Cr, Al and B in Fe. A thin pearlitic layer is located under the layer. On steel 50, a layer consisting of a solid solution of chromium, aluminum and silicon in α-iron with inclusions of carbides is formed. Under the layer is located the decarburized zone.

The coatings were applied to the details of the crank mechanism and the gas distributing mechanism of the GAZ-322132 and BOGDAN A092 (city) cars. The conducted studies show that the SHS technology for obtaining borized coatings allows obtaining high-quality protective coatings with limited time of their formation

Toughness tests were carried out on a SMT-1 friction machine, the test time was 5 hours. Borized layers doped with chromium have a wear resistance of 1.8-2.1 times than uncoated samples.

References

[1] Merzhanov A.G. Processy goreniya i sintez materialov / Pod red. V.T. Telepy, A.V. Xachoyana. Chernogolovka: ISMAN, 1998. 512 s.

[2] Merzhanov A.G., Yuxvid V.I., Borovinskaya I.P. Samorasprostranyayushhijsya vysokotemperaturnyj sintez lityx tugoplavkix neorganicheskix soedinenij. Dokl. AN SSSR, 1980, t.255, №1, s. 120–124 (in Russian).

[3] Merzhanov A.G., Yukhvid V.I. The self-propagating high-temperature synthesis in the field centrifugal forces. In:Proc. Of the First US-Japan. Workshop on Combust. Synth., Jan. 11–12, 1990. Tokyo: Nat. Res. Inst. Metals Publ., 1990, p. 1–21(in English).

[4] Kogan Ya.D., Sereda B.P., Shtessel E.A. Vysokointensivnyj sposob polucheniya pokrytij v usloviyax SVS//Metallovedenie i termicheskaya obrabotka metallov. – 1991. – №6. – s. 39–40(in Russian).

[5] Sereda B.P., Skachkov V.O., Ivanov V.I., Usenko Yu.I. Xromuvannya stalej metodom gazotransportnix SVS-reakcij //Metaloznavstvo ta obrobka metaliv. – 1999. – № 4. s. 25–27.

[6] Sereda B.P., Kruglyak I.V. Modelirovanie processov xromirovaniya i silicirovaniya v usloviyax samorasprostranyayushhegosya vysokotemperaturnogo sinteza //Metallovedenie i termicheskaya obrabotka metallov –2002, № 4–s.29–33(in Russian).

[7] Sereda D.B. Poluchenie xromoalitirovannyx pokrytij na uglerodistyx materialax v usloviyax samorasprastranyayushhegosya vysokotemperaturnogo sinteza / Sereda B.P., Sereda D.B.., Belokon Yu.A., Kruglyak I.V. // Stroitelstvo, materialovedenie, mashinostroenie: Sb. nauch. trudov. Vyp. 80 – Dnvsk.,GVUZ PGASA, 2015. – 380 s., S. 296–301(in Russian).

[8] Sereda D.B. Povyshenie iznosostojkosti detalej gazoturbinnyx dvigatelej v usloviyax samorasprostranyayushhegosya vysokotemperaturnogo sinteza XIII mezhdunarodnaya nauchno texnicheskaya konferenciya „AVIA-2015". – K.: NAU, 2015. – S. 1172–1175.

[9] Sereda B., Sereda D. Advanced Chromoaluminizing Coatings for Wear and Heat-resistance on Composite Materials under SHS. Material science and technology- 2015.. Columbus, OH,USA. – 1821 p., P. 229–232.
[10] Sereda B., Sereda D. Aluminized Multifunctional Coating on Steel in SHS Condition. Material science and technology –2014. Pittsburgh. Pennsylvania USA. 2224 p. P. 482–486.
[11] Sereda B., Sereda D. Obtaining of Boride Coatings under SHS Conditions for Car Parts. Material science and technology- 2016. Salt Lake City, Utah USA 2016–1339 p. – P. 945–948.

RESEARCH OF THE ALGORITHM OF TRANSVERSE WALL THICKNESS DEVIATION OF PIPE WHICH HAS BEEN ROLLED ON THE TRP (TUBE ROLLING PLANT) WITH AUTOMATIC MILL

Sokurenko V.P., Drozhzha P.V., Bikovec K.M.

Abstract

Seamless steel tubes have been widely used in various applications such as boiler tubes, oil drilling, oil pipelines, automobile and aircraft pipelines, etc. Over time, the requirements for the accuracy of the cross section of the pipes are constantly increasing. The accuracy of the cross-section is determined by the accuracy of the diameter and the accuracy of the thickness of the wall. In the production of pipes the most difficult is to produce a pipe with the required level of transverse wall thickness deviation.

The high requirements as to accuracy of the wall thickness are due not only to necessity of assuring the reliability and serviceability of equipment, but also to the trend towards the continuous decrease of metal capacity. In this situation assuring observing of the given parameter is the most difficult affair. The cross wall thickness deviation can be presented in the form of two components: eccentric and symmetric deviation. Wall-thickness eccentricity and symmetric cross wall thickness deviation are the main problems of deviation from the size of the wall thickness in the production of pipes. Eccentricity is caused mainly by abnormal conditions of the process in the states of cross-screw rolling. Symmetric discrepancy is conditioned by conditions of longitudinal rolling of pipes.

The paper presents the study of the change in the proportion of the eccentric component of the transverse wall thickness deviation of the tubes during rolled on TRP-350 with the automatic mill. Analysis of research results allowed concluding that the highest percentage of eccentric wall thickness variation is found in pipes rolled in the piercing mill, after then the importance of this component is being reduced. The most significant reduction is observed when rolling the sleeve into a pipe in the automatic mill.

References

[1] Danchenko V.M. Tekhnolohiya trubnoho vyrobnytstva: Pidruchnyk dlya vuziv / V.M. Danchenko, A.P. Kolikiv, B.A. Romantsev, S.V. Samusev – M .: Yntermet Inzhynirynh, 2002. – 640 s.
[2] H.A. Orlov, Rozrobka matematychnykh modeley i sposobiv pidvyshchennya tochnosti i deformovanosti trub pry kholodnoyi prokatky. Avtoreferat dysertatsiyi na zdobuttya vchenoho stupeniv kand. tekhn. nauk, UPI, 2005.
[3] Kearns W.H. "Minimizing Wall Thickness Variation in Seamless Tubing," [The Fabricator The global pharmaceutical industry]. Available at: www.TheFabricator.com/TubePipeProduction/ TubePipeProduction_Article.cfm?ID=678 (accessed 23.11.2017).
[4] Kara F. Effect of thickness variation on collapse pressure of seamless pipes / F. Kara, J. Navarro, R. L. Allwood // Ocean Engineering – 2010. – № 37 – S. 998–1006.
[5] Crappsa J. Internal state variable plasticity-damage modeling of the copper tee-shaped tube hydroforming process Author links open overlay panel / J. Crappsa, E.B. Marinb, M.F. Horstemeyerab, R.Yassarc, P.T.Wang// Journal of Materials Processing Technology. – 2010. – № 13. – r. 1726–1737.
[6] Kolykov A.P. Mashyny ta ahrehaty trubnoho vyrobnytstva: Navchal'nyy posibnyk dlya vuziv / A.P. Kolikiv, V.B. Romanenko, S.V. Samusev i. in – M .: MISIS, 1998. – 536 s.
[7] Limonchenko E. O. Statystychnyy doslidzhennya riznostinnosti trub, prokatanikh na ahrehati z Bezperervna opravochnoho stanom / Limonchenko E. O., Drozhzha P. V., Pylypenko S. V. // Plastychna deformatsiya metaliv: Kolektyvna monohrafiya. – 2017. – S. 130–133. – ISBN 978-966-291-124-8.
[8] W. Guo, R. Chen, and J. J. Jin, "Online eccentricity monitoring of seamless tubes in cross-roll piercing mill," J. Manuf. Sci. Eng. 137 (2), 021007 (2015).
[9] R.K. Pattanayak, P. Manogharan, K. Balasubramaniam, and P. Rajagopa «Low frequency axisymmetric longitudinal guided waves in eccentric annular cylinders» J. Acoust. Soc. Am. 137 (6), r. 3253–3262
[10] Chuyev A.A. Modelyuvannya protsesu pozdovzhn'oyi prokatky z metoyu pidvyshchennya tochnosti trub / A.A. Chuyev // Obrobka materialiv tyskom. – 2011. – № 3 (28) – S. 59–65.

[11] Stolitniy M.F. Tochnist' trub / M.F. Stolitniy, E.D. Klempert – M .: Metalurhiya, 1975. – 239 s.
[12] Chekmar'ov A.P. Osnovy prokatky trub v kruhlykh kalibrakh / A.P. Chekmar'ov, YA.L. Vatkin – M .: Metallurhyzdat, 1962. – 222 S.
[13] A.A. Korsakov, Udoskonalennya tekhnolohiyi hvyntovoyi prokatky bezperervnolytoyi zahotovky z metoyu zmenshennya diametra chornovyy truby. Avtoreferat dysertatsiyi na zdobuttya vchenoho stupeniv kand. tekhn. nauk, PIVDNYU, 2015.
[14] Khanin M.I. Rezhymy proshyvky, shcho zabezpechuyut' znyzhennya pozdovzhn'oyi raznostennost' trub na ahrehatakh z korotkoopravochnymi stanamy / M.I. Khanin // Metalurhiyna ta hirnychorudna promyslovist'. – 2013. – №2. – S. 49 – 50.
[15] Khanin M.I. Tekhnolohiya prokatky trub pidvyshchenoyi tochnosti na ahrehati z naavtomat·stane z vykorystannyam nestatsionarnykh rezhymiv deformatsiyi pry proshyvtsi / M.I. Khanin // Metalurhiyna ta hirnychorudna promyslovist'. – 2002. – №8–9. – S. 361 – 369.

EXPERIMENTAL RESEARCH AND MATHEMATICAL MODEL OF THE WALL THICKNESS VARIATION IN COLD ROLLING OF PIPES OF HIGH PRECISION

Sokurenko V.P., Markevich I.V.

Abstract

The question of calculating the accuracy of pipes is very important in the manufacture of pipes with high accuracy in the existing rolling routes. The influence of modern multi-zone calibrations on the variation of the difference during the rolling process is not sufficiently investigated.

In the given work authors presents the results of experimental research and suggests a mathematical model for describing the wall thickness variation along the length of the working cone of the tubes with a small initial value of wall thickness variation. Such a process is characterized by a small reduction in diameter. Here the deformation tends to perform mainly on the tube wall. It is of interest to change the small wall thickness variation (4-5%) during the cold rolling of pipes to achieve the possibility of obtaining a finite transverse wall thickness variation from one to two percent. The experiment was carried out at the HPT-90 mill. Pipes were rolled by the route 64×8.0 mm → 42.4×5.0 mm. Material of pipes is steel 35.

The coefficients obtained from the processing of the experimental data are used in the mathematical model. This allows using the model for designing the parameters of the process of rolling high-precision tubes, deformation conditions and investigated the steel grade.

The production of pipes with small values of the transverse difference will reduce the resource costs and losses of metal during production. In addition, pipes with such a low transverse difference index will meet the requirements of modern standards.

References

[1] Grigorenko V.U., Klimenko P.L., Khanín M.Í. Rasche-ty kalibrovki i usiliy v stanakh kholodnoy prokat-ki trub s primeneniyem EVM: Uchebnoye posobiye. – Dnepropetrovsk «NMetaU», 2000. – 22 s.
[2] Khaustov G.Y. Issledovaniye tochnosti prokatki kho-lodnokatanykh trub: Avtoreferat dis. na soiska-niye stepeni kand. tekh. nauk: spets. 324 «Obrabotka metallov davleniyem» / Khaustov G.Y.. – Dnepropet-rovsk, 1971. – 20 s.
[3] Mishchenko A.V. Rezul'taty dannykh komp'yuternogo modelirovaniya i eksperimenta po izmeneniyu eks-tsentrichnoy raznotolshchinnosti pri kholodnoy de-formatsii na opravke / A.V.Mishchenko, V.U.Grigo-renko, A.Stefanek // Plasticheskaya deformatsiya me-tallov: sb. nauchn. trudov v 2-kh tomakh. Dnepropet-rovsk : Aktsept PP. – 2014. – T. 2. – St. 295–299.
[4] Henryk Dyja. Development of forecasting method of change of transverse variation in wall thickness in case of cold rolling of pipes made of titanium alloys / Hen-ryk Dyja, Vladimir Grigorenko, Oleksii Mishchenko // Metallurgical and Mining Industry. – Dnipro, 2017 – No.1 – Pp.401–404.
[5] 20. Danchenko V.N. Prodol'naya prokatka trub /Danchenko V.N., Chus A.V. –M.: Metallurgiya, 1984. – 137 s.
[6] 18. Gulyayev YU.G. Promyshlennaya aprobatsiya spo-soba volocheniya trub povyshennoy tochnosti na ko-rotkoy opravke / YU.G. Gulyayev, Ye.I. Shifrin, D.YU. Garmashev, A.V. Semichev // Metallurgicheskaya i gornorudnaya promyshlennost'. – 2004. – №1. – S.29-30.
[7] Kuznetsov Ye.V. Neravnomernost' deformatsii pri prokatke sloistykh polos / Ye.V. Kuznetsov, V.G. Pavlov // Metallurgicheskaya i gornorudnaya pro-myshlennost': Truby V Mezhdunarodnoy nauchno-tekhnicheskoy konferentsii. - Dnepropetrovsk, 2010 - S. 362 – 364.

[8] Míshchenko O.V. Do poyasnennya mekhanízmu zmenshennya poperechnoï ríznostínností trub pri kholodníy pro-kattsí na opravtsí / Míshchenko O.V., Grigorenko V.U. // Obrabotka materialov davleniyem. Sbornik nauch-nykh trudov. – Kramatorsk. DGMA, 2011. – №3(28). – S. 216–219.

MODELING OF THE MAIN REGULARITIES OF FORMATION OF CHROMEPLATED AND TITANIUM-CHROMATED COATINGS ON STEELS AT NON-STATIONARY TEMPERATURE CONDITIONS

Sereda B.P., Palehova I.V., Kruglyak I.V.

Abstract

In the complex operating conditions of machine parts, aggregates, equipment and tools, the physical and mechanical properties of their surface layer, its hardness, wear resistance and corrosion resistance are of great importance. The most widely used for surface hardening have been various methods and methods of chemical-thermal treatment (HTO). One of the effective methods of HTO, used to increase the surface hardness, corrosion and wear resistance of iron-carbon alloys, is diffusion saturation with one or more carbide-forming elements. At the same time, known methods of saturation are characterized by a considerable duration of the technological process (up to 10-16 hours) and energy intensity. In this regard, the actual development of technologies that allow to apply coatings with a minimum time of their formation. One of such technologies is the method of self-propagating high-temperature synthesis (SHS) using gas-transport chemical reactions.

The essence of the SHS method is the implementation of exothermic reactions in the propagation mode of combustion waves. The process is characterized by intensive application of coatings due to the presence of a temperature gradient in the product-powder medium system, which allows mass transfer of saturating elements to the product surface. Coatings consist of a film of deposited product and a transition diffusion gradient zone.

The aim of this work is to simulate the processes of chrome and titanium chromium in the conditions of SHS, to develop compositions of powder SHS-burden for the application of wear-resistant coatings, to compare and optimize the technological parameters of the SHS process.

As a result of the studies, it was found that with a simultaneous processing method, the main factor affecting the thickness of the coatings is the concentration of saturating elements in the reaction mixture. At the same time, in the case of titanochromination by the SHS method, the supplier of active chromium atoms is both metallic chromium and the chromium component (XC). When saturated in mixtures containing cholesterol and titanium or cholesterol, titanium, chromium (provided that the total amount of chromium in the mixture is identical), a greater thickness of the coating will be obtained when chromium is present in the mixture in an unbound state.

Gas-transported SHS-technology allows to obtain high-quality chrome and titanium-chromated coatings on iron-carbon alloys. At complex saturation by several carbide-forming elements on the thickness of coatings, their phase and chemical composition is significantly affected by the saturation method (sequential or simultaneous).

To obtain coatings of considerable thickness and increase their performance characteristics, a two-stage SHS-technology can be recommended. Sequential saturation with titanium and chromium ensures high concentrations of these elements in the surface layer. At the same time, even with a two-stage processing method, the duration of the SHS process is approximately 4 times lower than with traditional HTO methods.

References

[1] Ximiko-termicheskaya obrabotka metallov i splavov: spravochnik / pod red. Lyaxovicha L.S. – M.: Metallurgiya, 1981. – 424 s.
[2] Filonenko B.A. Kompleksnye diffuzionnye pokrytiya. – M.: Mashinostroenie, 1981. – 13: ISMAN, 1998. – 512 s.
[3] Merzhanov A.G. Processy goreniya i sintez materialov/ pod red. V.T. Telepy, A.V. Xachoyana. – Chernogolovka: ISMAN, 1998. – 512 s.
[4] Sereda B.P. Metaloznavstvo ta termichna obrobka chornix ta kolorovix metaliv. Pidruchnik. – Zaporizhzhya: Vid-vo ZDIA, 2008. – 302 s..
[5] Sereda B., Sereda D. Obtaining of Boride Coatings under SHS Conditions for Car Parts. Material science and technology- 2016. Salt Lake City, Utah USA 2016-1339p.-P.945-948.
[6] Sereda B.P., Kalinina N.Є., Kruglyak I.V. Poverxneve zmicnennya materialiv. Monografiya.- Zaporizhzhya: Vid-vo ZDIA, 2004. – 230 s.
[7] Kogan Ya.D., Sereda B.P., Shtessel E.A. Vysokointensivnyj sposob polucheniya pokrytij v usloviyax SVS / Metallovedenie i termicheskaya obrabotka metallov, 1991, №6. – s. 39-40 (in Russian).

[8] Zemskov G.V., Kogan R.L. Mnogokomponentnye diffuzionnoe nasyshhenie metallov i splavov.- M.: Metallurgiya, 1978.- 208 s.
[9] Mnogokomponentnye diffuzionnye pokrytiya/ pod red. Lyaxovicha L.S. – Minsk: Nauka i texnika, 1974.- 289 s.
[10] Bekkert M., Klemm X. Spravochnik po metallograficheskomu travleniyu. – M.: Metallurgiya, 1979.- 336 s.
[11] Sinyarev G. B., Vatolin N. A., Trusov B .G., Moiseev R. K. Primenenie EVM dlya termodinamicheskix raschetov metallurgicheskix processov .- M.: Nauka, 1982. – 263s.
[12] Shatinskij V.F., Nesterenko A.I. Zashhitnye diffuzionnye pokrytiya. – K.: Nauk. dumka, 1988. – 272 s.

SOLUTION OF THE PROBLEM FOR CONVECTIVE RADIATION HEATING (COOLING) OF BODIES WITH SIMPLE GEOMETRIC FORM BY THE METHOD OF FINITE DIFFERENCES

Gorbunov A.D., Ukleina S.V.

Abstract

The heating or cooling of bodies under the influence of convection and radiation is, at the same time, the most common and often treatment encountered in the practice of of materials heating. The development of a simple and sufficiently accurate technique for calculating temperature fields and thermal stresses in bodies of different geometric shapes is an actual problem in the context of continuous intensification of heat exchange processes in aggregate setups.

The aim of the paper is to obtain the improved schemes of finite-difference approximation of the boundary conditions for numerical integration.

A finite-difference method for temperature fields and thermal stresses calculation for heating (cooling) simple bodies in the form of a plate, cylinder, or ball is simulated simultaneously by convection and radiation. Using the expansion of the function of the temperature field in the Taylor series, the Lopital rule for uncovering uncertainties, the method of Newton's tangents, the solution of the fourth-degree equation, the idea of the fictitious layer and the elementary balance method of Vanichev, we obtained improved formulas for temperatures calculation at the center and the surface of the body .According to this algorithm, a program was developed using Fortran-77 language.The testing of was carried out by comparison of the results with exact analytical solutions for the case of convective heating of bodies of simple form at Bi = const and Sk = 0. Test calculations showed that the maximal errors occur both at the initial stage and in the determination of surface temperatures. The application of the improved approximation formulas resulted in errors reduction from 5% to 2%. It was found that the circuit choice depends essentially on the value of the heat transfer coefficients - the Stark and Bio numbers. A formula for calculation of the maximum-large heat transfer coefficients was obtained, when the "direct" approximation scheme for the boundary condition on the surface could be efficiently applied. By calculations, the equality of two variants was established: Sk = ∞, Bi = 0 and Bi = ∞, Sk = 0. This fact confirmed the earlier conclusion that in the case of intense nonlinear thermal loading, the determination of the temperature field can be carried out by the linear theory of convective heating (cooling) bodies for Bi = ∞.

This technique can be used for thermal calculations, heat engineering equipment, in power metallurgical and other industries.

References

[1] Vidin Yu.V., Ivanov V.V. *Raschet temperaturnykh poley v tverdykh telakh, progrevayemykh konvektsiyey i radiatsiyey odnovremenno* [Calculation of temperature fields in solids heated by convection and radion at the same time] Krasnoyarsk: KPU, 1965, 144 p. (In Russ.)
[2] A.V. Kavaderov Samoilovich Yu.A. *Utochneniye zakonomernostey neogranichennoy plastiny* [Refinement of the regularities of an unbounded plate] IFJ, 1960. - t. III, - no. 2. - pp. 57-60. (In Russ.)
[3] Gorbunov A.D. *K analiticheskomu raschetu termicheskikh napryazheniy pri konvektivnom nagreve tel prostoy formy* [To the analytical calculation of thermal stresses in the convective heating of bodies of simple form] *Matematica moduluvannya*, Dniprodzerginsk: DDTU, 2012, no 1(26), pp. 39-45. (In Russ.)
[4] Gol'dfarb E. M. *Teplotekhnika metallurgicheskikh protsessov* [Heat metallurgical processes]- M.: Metallurgiya, 1967.- 439 p. (In Russian)
[5] Samarsky A.A. *Vvedeniye v teoriyu raznostnykh skhem* [Introduction to the theory of difference schemes] - Moscow: Nauka, 1971. - 552 p. (In Russ.)
[6] Ogurtsov AP, Mamaev L. M, Karimov I.K. *Matematicheskiye metody i modeli v raschetakh na EVM* [Mathematical methods and models in computer calculations] - K .: ISMO, 1997. – 192 p. (In Russ.)

[7] Gorbunov A.D. *Analiticheskiy raschet protsessov radiatsionnogo nagreva (okhlazhdeniya) tel na nachal'noy stadii* [Analytical calculation of objects radiant heating (cooling) processes at the initial stage]. *Matematichne modelyuvannya*, 2012, no. 2(27), pp. 90–94. (In Russian)
[8] Gorbunov A.D, Ukleina S.V. Analiticheskoye issledovaniye nagreva tverdykh tel radiatsiyey [Analytical study of the heating of solids by radiation] Message 3. *Matematichne modelyuvannya*, 2015, no 2 (33), pp. 65 - 68. (In Russian)

MATHEMATICAL MODEL OF A PROCESS TO TRANSPORT AEROSOLS WITHIN UNDERGROUND MINE WORKINGS

Ikonnikova N.A., Yurchenko A.A., Ikonnikov M.Y., Litvinenko A.A.

Abstract

Topicality of the studies is in the following: solution of problems concerning dust prevention within underground mine workings should involve disperse control of the dust, sizes of constantly floating fine fractions, and boundaries of coarse dust fractions deposition.

Objective of the studies is to develop mathematical model concerning transport of aerosols by means of air current within underground mine workings.

As a result of the task execution, analytical dependence of dust particle deposition velocity on air flow velocity within a mine working, density of dust particles and their diameter and viscosity of deposition medium has been obtained. Engineering method has been developed to calculate dynamic parameters of both deposition and transport of coal dust represented by analytical dependences of aerosol deposition velocity, distance of the particles transport upon their density and deposition medium density, fractional composition of the particles, and air velocity in the context of turbulent condition of the air current motion. The developed technique makes it possible to determine diameters of dust particles, being suspended constantly, for certain aerodynamic parameters of a mine working as well as boundary of different dust fractions deposition on the floor.

The calculations have shown that in the context of Western Donbas mines, coal dust particles with 5μ size and less are almost constantly in a suspended state on a ventilation drift. Boundaries of coal dust of different fractions on a ventilation drift of a site after their transport out of longwall have been determined. In the context of dust particles, which diameter is 10 μ, distance of transport by means of air current is 773 m; if their diameter is 25 μ, then transportation distance is 125 m; if their diameter is 50 μ, then transportation distance is 27 m.

References

[1] Zhuravlov V.P., Demisheva Ye.F., Spirin L(1988), A. *Aerodinamicheskiye metody bor'by s ugol'noy pyl'yu.* [Aerodynamic methods of fight against a braize], Iz-vo Rostovskogo universiteta, Rostov, Russia.
[2] Romanenko S.B. (2007), *Apparatno-programmnyy kompleks kontrolya urovney zapylonnosti na baze datchikov novogo pokoleniya.* [Hardwarily-programmatic complex of control of levels of dustiness on the base of sensors of new generation], Gornyy informatsionno - analiticheskiy byulleten', s. 273–279.
[3] Mednikov Ye.P. (1981), *Turbulentnyy perenos i osazhdeniye aerozoley*, [Turbulent transfer and besieging of aerosols].: Nauka, Moscow, Russia.
[4] Burchakov, A.S., Moskalenko, E.M. *Dinamika aerozoley v gornykh vyrabotkakh* [Aerosol dynamics in mine workings].-M. Publishing House *Nauka*, 1965.– 65pp.
[5] *Bor'ba s pyl'yu v ochistnykh zaboyakh* / Grodel' G.S., Gubskiy YU.N., Krivokhizha B.M., Shpak A.F.(1983), [Fight against a dust in cleansing coalfaces] Tekhníka, Kyiv, Ukraine
[6] Aerologiya gornykh prepriyatiy [. Aerology of mountain enterprises] /V.I. Golin'ko, YA.YA. Lebedev, A.A. Litvinenko, O.A. Mukha, (2015), []; M-vo obrazovaniya i nauki Ukrainy, Nats. gorn. un-tyu. – Dnepropetrovsk, NGU, Ukraine.
[7] *Rudnichnaia ventiljatsiia* [Mine ventilation]: reference book / Grashchenkov, N.F., Petrosian, A.E., Frolov, M.A. et al. – M. *Nedra*, 1988. – 440 pp.
[8] Bradshow, P. *Vvedenie v turbukentnost' i ejo izmerenie* [An Introduction to Turbulence and its Measurement]. – M.: *Mir*, 1974. – 280 pp.

THE MODELING THE PROCESS OF SELF-REGULATION DURING ROLLING IN A WIRE BLOCK OF A MILL 400/200 PJSC «DMK»

Maksimenko O.P., Kuzmin E.V., Loboiko D.I., Lysak V.O.

Abstract

The work is relevant, because is aimed at reducing the downtime and stoppage of rolling equipment as a result of partial and complete slipping of metal in the deformation zones of a continuous mill with considerable tension of the strip.

The aim of the research is to develop a theory and a method for estimating the longitudinal weariness of a metal during the rolling of wire rod in a wire block, and also to study the possibilities for self-regulation of the process when the dimensions of the rolled stock fluctuate.

The task of the paper is to analyze the force interaction of a metal with rolls during continuous rolling taking into account the condition of constancy of the second volumes and longitudinal forces of a plastically deformable metal.

Conclusions, the conducted research allows to establish theoretically the boundaries of process self-regulation under external disturbance in the form of changing the size of the roll, the wear of the rolls, the tension of the strip.

In the future, the results of the study are expected to be used on a medium-grade mill 400/200 in a wire block.

References

[1] Hrudev A. P. *Zahvatyivayuschaya sposobnost prokatnyih valkov* [Exciting ability rolling rolls]. Moscow, 1998. 283 p.

[2] Prokofev V. Y. [Maximum gripping angles with a steady rolling process]. *Trudy DMetY «Obrabotka metallov davlenyem»* [Proc. of the *DMetY* "Metal forming"], 1962, no. XLVIII, pp. 234–239. (In Russian).

[3] Maksymenko O. P., Loboiko D. Y., Romaniuk R. Ia., Metallurgical and mining industry. *Metallurgicheskaya i gornorudnaya promyishlennost*, 2013, no.6, pp. 47–49 (in Russian).

[4] Maksymenko O. P., Yzmailova M. K., Loboiko D. Y., Metallurgical and mining industry. *Metallurgicheskaya i gornorudnaya promyishlennost*, 2015, no.1, pp. 59–62 (in Russian).

[5] Maksymenko O. P., Loboiko D. Y., Yzmailova M. K., *Prodolnaya ustoychivost polosyi v valkah s analizom kontaktnyih usloviy: Monografiya* [Longitudinal stability of a strip in rolls with the analysis of contact conditions: Monograph]. Dneprodzerzhinsk, 2016. 212 p.

[6] Hrudev A. P. *Teoriya prokatki* [Theory of rolling]. Moscow, 2001. 280 p.

[7] Shtoda M. N., Ershov S. V., Heimur K. H., Samokhval V. M., Havrylyn S. Iu. [Bulletin of the NTU "KhPI". Series Innovative Technologies and Materials Processing Equipment for Mechanical Engineering and Metallurgy]. *Visnik NTU «HPI». Seriya Innovatsiyni tehnologiyi ta obladnannya obrobki materialIv u mashinobuduvanni ta metalurgiyi*, 2016, no. 30(1202), pp. 79–87.

CALCULATION OF VIRGINITY OF DETERMINATION OF DEFECTS OF DETAILS BY NON-GOVERNMENTAL CONTROL METHODS

Shmatko D.Z, Kochneva E.V.

Abstract

Non-destructive methods of control or defectoscopy are a generic name for methods of control of materials or products used to find defects, homogeneity of the macrostructure, deviations in the chemical composition and other purposes that do not require the destruction of samples of the material or article as a whole. The widespread application of non-destructive methods of control avoids large losses of time and material costs, provides partial or complete automation of control operations while significantly improving the quality and reliability of products and parts. In the next time, no technological process of obtaining responsible products will be introduced into the industry without an appropriate system of non-destructive testing.

The main areas of application of non-destructive types of control are defectoscopy of critical parts and devices, defectoscopy of parts and appliances for prolonged operation, continuous defectoscopy of particularly responsible units and devices, conducting studies on the structure of metals and defects in products and parts, in order to improve their manufacturing technology.

For researches of parts or products by methods of non-destructive testing, it is necessary to select the equipment that will meet the task, that is, such devices, which with a sufficient degree of certainty will reveal the most dangerous and characteristic defects in the controlled product or component. The second condition is the problem of reliability, which is required to identify defects that are dangerous for the operation of a part or product. And the third condition is the setting up of control equipment, namely the selection of sensitivity and resolving its ability in such a way as to satisfy the second condition.

When measuring, measuring instruments of higher accuracy are used and more modern measurement methods are used. However, due to the inevitable presence of any measure of random errors, the true value of the measured value remains unknown and instead of it takes some average arithmetic value and consider it, taking into account the theory of probability and mathematical statistics, the most appropriate approximation to the true value. The accuracy of the measurement is influenced by systematic errors. But measurements must be made in such a way that there are no systematic errors. The theory of random errors is based on two axioms: randomness and distribution.

Rederences

[1] Bocharov P.P., Pechenkin A.V. Theory of probabilities. Mathematical Statistics – 2nd ed. – Moscow: Fizmatlit, 2005 – 296 pp.
[2] Venttsel E.S., Ovcharov L.A. Probability theory and its engineering applications. Educational manual for high schools. – 2nd ed. – M .: Vyssh.shk., 2000 – 480 p.
[3] Gutter R.S., Ovchinsky B.V. Elements of numerical analysis and mathematical processing of the results of experience. – Moscow: Fizmatlit, 1986 – 356 pp.
[4] Sukhov AN Mathematical processing of measurement results. Tutorial. – M .: MISI, 1982 – 89 p.
[5] Chkalova O.N. Fundamentals of scientific research. – Kiev Higher school, 1978 – 120 p.
[6] Kanevsky I.N. Non-destructive methods of control: study. allowance / I.N.Kanevsky, E.N.Salnikova. – Vladivostok: DVSTU, 2007 – 243s.
[7] Bronshtein IN, Semendyaev K.A. Manual for maths for engineers – 3rd ed. corrected – Moscow: Nauka, 1986 – 544 pp.
[8] Non-destructive testing: Cases / Ed. R.MackMaster. Kn.1 – ML: Energy. 1965. – 504 pp.
[9] Novokschenova SM Defects in steel: Cases – Moscow: Metallurgy, 1984. – 200 p.
[10] Belokur I.P. Defectology and non-destructive testing. – Kyiv: Higher School 1990. – 207 pp.
[11] Non-destructive control of metals and products: Issues / Ed. G.Samoilovich. – Moscow: Mechanical engineering, 1976. – 456 p.

THE OPTIMIZATION OF THE COMPOSITION INTERMETALLIC CATALYST FOR THE OXIDATION OF CARBON MONOXIDE AND HYDROCARBONS

Sereda B.P.,Belokon K.V., Belokon Y.A.

Abstract

The paper presents the results of optimization composition intermetallic catalyst in the processes of neutralization carbon-containing components of gas emissions. The second-order orthogonal plan with the nucleus 2^3 was used to establish the regularities of the influence of the mixture composition on the catalytic properties and the derivation of the quadratic coefficients of the regression equation. Optimization parameters are: Y_1 — specific surface area of the catalyst (S_{sp}), m^2/g; Y_2 — total porosity of the catalyst (P),%; Y_3 — activity of the catalyst during oxidation of CO at 200°C ($\alpha_{CO,\%}$),%;Y_4 — activity of the catalyst during oxidation of C_3H_8 at 200°C ($\alpha_{C_3H_8,\%}$),%. As independent variables were chosen: the content of the mixture of cobalt (X_1), the content of the mixture of manganese (X_2), the content of the mixture of copper (X_3). As the initial components were used pure powders of nickel, aluminum, cobalt, manganese oxide and copper.

A number of the equations were obtained in the results of regression analysis, which show the dependence of the catalytic properties and porosity of the catalyst on the content of the alloying elements. As a result of mathematical planning, it was found that the optimal composition of the catalyst is, mass %: nickel — 30%, cobalt — 10%, manganese — 11%, copper — 2%, aluminum — the rest.

For obtaining comparative data tests of the famous structure of the catalyst which have received in the conditions of burning were in parallel carried out. The catalytic activity and the specific surface of the received catalyst were estimated with the famous structure. The obtained catalysts were used in the processes of neutralization of carbon monoxide and hydrocarbons. As a result of the study it was found that using the obtained intermetallic catalyst, the conversion of CO is 100%, and the conversion of C_3H_8 is 95%. When using

the known catalyst the conversion of CO is 85%, and the conversion of C_3H_8 is 75%. The specific surface area of the obtained catalyst was 110 m^2/g, and for the known composition it was 65 m^2/g.

References

[1] Sereda B.P., Kozhemyakin G.B., Ryzhkov V.G., Savela K.V., Belokon Y.A. Vliyanie sostava nikel'-alyuminievogo splava s dobavkami Co, Mn i Cu na strukturu i udel'nuyu aktivnost' katalizatora na ikh osnove [The effect of the composition of a nickel-aluminum alloy with Co, Mn and Cu additives on the structure and specific activity of a catalyst based on them]. Stroitel'stvo, materialovedenie, mashinostroenie: sb. nauch. trudov, 2009, no. 48, pp. 101–104 (in Russian).

[2] Grigoryan E.A., Merzhanov A.G. Katalizatory XXI veka [Catalysts of the XXI century]. Nauka proizvodstvu, 1998, no. 3 (5), pp. 30–41 (in Russian).

[3] Sereda B.P., Kozhemyakin G.B., Savela K.V., Belokon Y.A., Ryzhkov V.G. Issledovanie vliyaniya fazovogo sostava Ni-Al splavov na fizikohimicheskie svoystva skeletnyih nikelevyih katalizatorovda [Investigation of the influence of the phase composition of Ni-Al alloys on the physicochemical properties of skeleton nickel catalysts], Metallurgiya, 2009, no. 20, pp. 112–117 (in Russian).

[4] Sereda B., Belokon' Y., Zherebtsov A. and Sereda D. "The researching and modeling of physical-chemical properties of Ni-base alloys in SHS conditions", Materials Science and Technology, vol. 1, pp. 494–498, October 2012. *(references)*

[5] Sereda B., Belokon Y., Belokon K., Sereda D. Issledovanie fiziko-mehanicheskih svoystv intermetallidnyih katalizatorov, poluchennyih v usloviyah SVS [Investigation of the physico-mechanical properties of intermetallic catalysts obtained under SHS conditions]. Metaloznavstvo ta termichna obrobka metaliv, 2015, no. 2 (69), pp. 19–23 (in Russian).

[6] Novik F.S., Arsov Ya.B. Optimizatsiya protsessov tehnologii metallov metodami planirovaniya eksperimentov [Optimization of metal technology processes by experiment planning methods], Moscow: Mashinostroenie, 1980, 304 p (in Russian).

[7] Adler Y.P., Markova E.V., Granovskiy Y.V. Planirovanie eksperimenta pri poiske optimalnyih usloviy [Planning an experiment when searching for optimal conditions], Moscow: Nauka, 1976, 320 p.

[8] Sereda B., Sheyko S., Kruglyak I. and Belokon' Y. "Application of activation of substrate by aluminium and copper for increase of adhesive durability of sheetings received in self-propagating high-temperature synthesis conditions", 10th International Conference on the Science and Technology of Adhesion and Adhesives, Oxford, UK, pp. 437–439, 2008.

[9] Belokon K., Belokon Y., Kozhemyakin G. and Matukhno E. "Environmental assessment of the intermetallic catalysts utilization efficiency for deactivation of the pollutants emitted by electrode production enterprises", Scientific bulletin of National Mining University, № 3 (153), pp. 87–94, 2016.

[10] Rumiantsev V., Yakubin N., Bielokon K., Matukhno E. and Leventsova C. "Ecological aspects of the neutralization of gas emissions leaving from the resin storehouse of joint – stock company «Zaporozhkoks»", Metallurgical and Mining Industry, №.4, pp. 105–109, 2015.

MODELING OF THE MEDIUM-WEIGHTED FINENESS SOLID IN THE LOADING OF THE BALL MILL OF THE ORE AND THE SAND OF THE CLASSIFIER

Matsui A.N., Kondratets V.A.

Abstract

One of the key issues to improve the efficiency of ore preparation is the optimization of pulp liquefaction in a ball mill. Since this problem can not be solved without a model of the weighted average particle size of a solid ball mill, this work is actual.

The purpose of this publication is to simulate the weighted average particle size of a solid in the ball mill loading ore and classifier sands, aimed to find a mathematical model of the technological parameter.

To achieve this goal, the following tasks were accomplished: a closed cycle test procedure was developed; it was tested in industrial conditions; a mathematical model for determining the weighted average size of a solid was developed.

First of all, a technique for testing a closed grinding cycle was developed, which basically consisted of determining the technological points of the test, establishing the minimum value of the material samples and the number of samples to ensure the accuracy of the results obtained. Selected samples of material were dried, mixed, reduced to the minimum value of mass. Reduced samples were scattered. As a result of the dispersion of the samples, the characteristics of the size of the material were obtained by the size classes. According to cuts and mill productivity, the productivity of the sands of the classifier was calculated. The weighted average size of

the initial ore and sands of the classifier was also determined. A total of four cycle tests were carried out for different ore sizes and conveyor weights. According to the test data and the recalculations performed, the weighted average size of the material at the entrance of the ball mill was determined. The same data, obtained from the average values of the size and productivity of the initial ore and sands, coincided with great accuracy with the earlier traditional approach. On the basis of this, a mathematical model is established to determine the weighted average particle size of a ball mill at the input of a ball mill by parameters that can be automatically measured.

Tests of the closed cycle of ore grinding in industrial conditions according to the developed technique gave the results, which became the basis for its modeling. As a result, a mathematical model is obtained for finding the weighted average particle size of a solid ball at the entrance of a ball mill for certain productivity and the average size of the crushing and grinding particles in the initial ore and sands of the classifier.

The prospect of further development is the creation of a more progressive automatic control system for grinding ore in closed cycles.

References

[1] Pivnjak G. G., Vajsberg L. A., Kirichenko V. I., Pilov P. I., Kirichenko V. V. *Izmel'chenie. Jenergetika i tehnologija* [Grinding. Energy and technology]. Moscow, 2007. 296 p. (in Russian).

[2] Zverevich V. V., Perov V. A. *Osnovy obogashhenija poleznyh iskopaemyh* [Basics of mineral processing]. Moscow, 1971. 216 p. (in Russian).

[3] Kozin V. Z., Trop A. E., Komarov A. Ja. *Avtomatizacija proizvodstvennyh processov na obogatitel'nyh fabrikah* [Automation of production processes in concentrating plants]. Moscow, 1980. 333 p. (in Russian).

[4] Goncharov Ju. G., Davidkovich A. S., Gejzenblazen B. E., Gulenko G. V. *Avtomaticheskij kontrol' i regulirovanie tehnologicheskih processov na zhelezorudnyh obogatitel'nyh fabrikah* [Automatic control and regulation of technological processes in iron ore beneficiation factories]. Moscow, 1968. 227 p. (in Russian).

[5] Kosharskij B. D., Sitkovskij A. Ja., Krasnomovec A. V. *Avtomatizacija upravlenija obogatitel'nymi fabrikami* [Automation of management of concentrating factories]. Moscow, 1977. 525 p. (in Russian).

[6] Kononenko G. G. e.a. *Sposob regulirovanija sootnoshenija rashodov potokov tverdoj i zhidkoj faz v zagruzke mel'nicy* [Method for controlling the ratio of flow rates of solid and liquid phases in mill loading]. Patent SSSR, no. 1563757, 1990.

[7] Savilov A. P. e.a. *Sposob avtomaticheskogo upravlenija sootnosheniem rashodov zhidkoj i tverdoj faz potokov v zagruzke mel'nic* [The method of automatic control of the ratio of flow rates of liquid and solid phases of flows in the loading of mills]. Patent SSSR, no. 1526829, 1989.

[8] Dmitriev V. I. e.a. *Sposob upravlenija plotnost'ju pul'py v potoke na slive barabana mel'nicy* [A method for controlling the pulp density in a flow on a mill drum discharge]. Patent SSSR, no. 1688920, 1991.

[9] Morkun V. S., Cokurenko A. A., Lucenko I. A. *Adaptivnye sistemy optimal'nogo upravlenija tehnologicheskimi processami* [Adaptive systems for optimal control of technological processes]. Krivoj Rog, 2005. 261 p. (in Russian).

[10] Kupin A. I. *Intelektual'na identyfikacija ta keruvannja v umovah procesiv zbagachuval'noi' tehnologii'* [Intelligent identification and control in the processes of enrichment technology]. Kryvyj Rig, 2008. 204 p. (in Ukanian).

[11] Porkujan O. V. *Keruvannja nelinijnymy dynamichnymy ob'jektamy zbagachuval'nyh vyrobnyctv na osnovi gibrydnyh modelej Gamershtejna.* Avtoref. dys. na zdobuttja nauk. stupenja dokt. tehn. nauk [Management of Nonlinear Dynamic Objects of Enrichment Production on the Basis of the Gamerstein Hybrid Models]. Kryvyj Rig, 2009. 36 p.

[12] Herbst J. A. and Oblad A. E. "Modern Control Theory Applied to Crushing. Part 1: Development of a Dynamic Model for Cone Crusher and Optimal Estimation of Crusher Operating Variables", Proc. of the Jst JFAC Symposium on Automation for Mineral Resourse Development. Pergamon Press, Oxford, 1986. – pp. 301–307.

[13] Herbst J.A., Alba F.A., Pate W.T. and Oblad A.E. "Optimal Control of Communition Operations", Int. Jour. of Miner. Proc, Vol.22, №1-4, pp. 275–296, 1988.

[14] Herbst J. A., Pate W.T. and Oblad A.E. "Model-bassed control of mineral processing operations", Pow. Techn., Vol.69, pp. 21–32, 1992.

[15] *SCADA TRACE MODE v ASUTP obogashhenija rudy Severnogo GOKa* [SCADA TRACE MODE in the process control system for ore beneficiation at Severnoye GOK] at: http://www.tracemode.ua.

[16] Morozov V. V., Topchaev V. P., Ulitenko K. Ja. *Razrabotka i primenenie avtomatizirovannyh sistem upravlenija processami obogashhenija poleznyh iskopaemyh* [Development and application of automated control systems for the processes of mineral processing]. Moscow, 2013. 512 p. (in Russian).

[17] Ivanov A. B., Kuvaev V. N., Kuvaev Ja. G. Perspektivnye napravlenija avtomatizacii processov droblenija i izmel'chenija rudy [Prospective directions of automation of processes of crushing and grinding of ore]. *Gornyj zhurnal*, 2010, no.11, pp.74–76. (in Russian).
[18] Ulitenko K. Ja. Upravlenie vodnymi rezhimami izmel'chenija i klassifikacii v sovremennyh ASUTP [Management of water regimes of grinding and classification in modern process control systems]. *Obogashhenie rud*, 2008, no.1, pp.35–42. (in Russian).
[19] Kondratec' V. O., Macuj A. M. Optymizacija prognozuvannja rozridzhennja pul'py u kul'ovyh mlynah pry zminnij vytrati vody v pisky klasyfikatora [Optimization of prediction of dilution of pulp in ball mills with variable water consumption in sand grade classifier]. *Visnyk Zhytomyrs'kogo derzhavnogo tehnichnogo universytetu. Serija: Tehnichni nauky*, 2017, no.1(79), pp. 171–181. (in Ukrainian).
[20] Kozin V. Z. *Oprobovanie mineral'nogo syr'ja* [Testing of mineral raw materials]. Ekaterinburg, 2011. 316 p. (in Russian).
[21] Klejn M. S., Vahonina M. S. *Oprobovanie i kontrol' tehnologicheskih processov obogashhenija* [Testing and control of enrichment technological processes]. Kemerovo, 2012. 131 p. (in Russian).
[22] Mladec'kyj I. K., Pilov P. I. *Vyprobuvannja i kontrol' v procesah zbagachennja korysnyh kopalyn* [Tests and control in the processes of enrichment of minerals]. Dnipropetrovs'k, 2005. 155 p. (in Ukrainian).
[23] Kozin V. Z. *Issledovanie rud na obogatimost'* [Research of ores for concentratability]. Ekaterinburg, 2008. 312 p. (in Russian).

INFLUENCE OF FREQUENCY AND INDUCTION OF LONG-MOVED MAGNETIC FIELD FOR ELECTRIC METAL LOSS AND ITS DISCHARGE IN MAG-WELDING

Nosov D. G., Peremitko V. V.

Abstract

Mechanized welding method in active shielding gas by solid cross-section wire — MAG-welding – certainly has a number of advantages over the manual arc welding process. However, along with the advantages this method has drawbacks that reduce the effectiveness of its use: the low productivity compared to the automatic welding methods; quality dependence of the welded joint on the skill of the welder; significant metal loss on spattering, which constitutes up to 10…15% of welding wire weight.

Spattering is accompanied by the ejection from arc zone the sprays of molten metal of various size, which come into physical and chemical interaction with the surface layers of the weld metal. The protection of metal surface from spray sticking and / or its cleaning leads to the need of additional works in a volume of 20…40% of the overall complexity of the welding operations.

Among the main reasons of metal droplets ejection from the welding zone the following are pointed out: unstable metal transfer, when the power which separetes a drop from the electrode is directed away from the bath and a drop is ejected beyond its bounds; local explosive gases expelling in the volume of metal of welded bath caused by metallurgical reactions; destruction of molten metal bridge formed during metal transfer with the short circuits as a result of a sharp increase in current density under narrowing of the tie plate (pinch effect).

It is possible to increase the MAG-welding efficiency by controlling the electrode metal mass transfer at the reduction of discharge coefficient on spattering by influence of longitudinal magnetic field on the arc. The paper identifies a range of longitudinal magnetic field frequencies and induction which provide the discharge coefficient reduction of the electrode metal; it has also been found the characteristics of their mutual influence on electrode metal mass transfer process; mathematical models correlating the frequency and induction of longitudinal magnetic field length with loss coefficient of electrode metal on spattering are presented; technological recommendations, the implementation of which will allow to improve the efficiency of MAG-welding in industrial environments, are given.

References

[1] Potap'yevsky A.G. Spattering at welding CO2 with a wire Sv-08G2S A.G.Potapevsky, V.Ya.Lavrischev *Automatic welding* 1972 no 8 p 39-42.
[2] Fedko V.T., Tomas K.I. and Sapozhkov S.B., Protecting the surfaces welded components against molten metal splashes in CO_2 welding// *Welding International*. 1998. no 1. S. 58-62/
[3] Chinakhov D A Calculation of Gas-dynamic Impact of the Active Shielding Gas on the Electrode Metal Drop in Gas Jet Shielded Welding *Applied Mechanics and Materials* Vol. 379 (2013) p 188-194
[4] Chinakhov D A Zuev A V Filimonenko A G Gas-dynamic Impact of a Shielding Gas Jet on the Drop Transfer When Welding with a Consumable Electrode *Advanced Materials Research* Vol. 1040 (2014) p 850-853

[5] Nosov D G Maltsev V V The influence of magnetic fields by a melting rate of wire for arc surfacing under flux *Applied Mechanics and Materials* Vol. 379 (2013) p 178-182.
[6] Razmyshlyaev A D Magnetic control of rollers and weld formation in arc surfcing and welding A D Razmyshlyaev, M V Mironov Mariupol: Publishing Priazovsky State Technical University 2009 p 242/
[7] Nosov D.G. Power source of electromagnetic system for arc welding using external magnetic fields control D. G. Nosov *Welder* 2010 no 4 p 18-19.
[8] Nosov D.G. The influence of the frequency of the external electromagnetic field on the geometric parameters of the roller submerged under flux / D.G. Nosov, VV Klimenko, V.V. Maltsev / Collection of scientific works of DSTU: (technical sciences) / Dneprodzerzhinsk: DSTU
[9] Peremitko V.V. Influenza sag parti del telaio indossare macchine stradali / V.V.Peremit`ko, V.D.Kuznetsov, I.O.Cherednyk // Italian Science Review. – 2014. – no 8 (17). – PP. 93– 96.
[10] Patskevitch I R Longitudinal magnetic field influence on the surfacing and transfer of electrode metal I.R.Paskevich, A.V.Zernov, V.S.Serafimov *Welding production* 1973 no 7 pp 8-10.

MATHEMATICAL MODEL OF THE THERMAL PERFORMANCE OF THE LINING OF THE CONVERTER'S WALLS, WHICH IS COVERED WITH SLAG, AT ITS INTERACTION WITH THE MELT DURING OXYGEN BLOWING

Panteikov S.P., Panteikova E.S.

The oxygen converter process (LD-process in European or BOP process in American terminology) have gained rapid and widespread due to its relative simplicity and high performance, therefore, at present, is the leading steel-making process in the world. Due to the fact that is now widely used technology the hot refractory repairs units by applying to it a protective slag skull, is important to study the thermal state of lining of the converter when the unit is operating as a covering slag of the lining, and without with the aim of studying the influence of various factors on the resistance of the slag skull and the refractory lining of the converters when they are covering slag.

The purpose of this article is to describe the developed mathematical model with thermal state of the lining of the walls of the converter at its interaction with melt during the purge, taking into account the presence on the walls of the unit layer of frozen slag skull with simulation of its thickness and properties.

The task of the article is to carry out with the help of this mathematical model numerical studies of the dependence of the temperature of the working surface of the lining of 250-ton converter at the end of the purge the thickness of the slag skull at different coefficients of thermal conductivity and its coefficient of thermal conductivity of slag skull in its various thicknesses.

The specified mathematical model allowed us to determine the conditions for reducing the temperature gradient arising in the lining of the walls of the unit. With increasing thickness of the slag skull covering the lining of the walls of the converter, the temperature on the outer surface of the lining (i.e. on the border "slag skull"-"the lining") will decrease, which in turn will reduce the temperature gradient across the thickness of the lining of the walls of the unit. The decrease in conductivity nabryzgivanii slag will help to reduce the temperature of the working surface of the lining and, consequently, to reduce temperature gradient in the refractory material lining the walls of the converter.

The data obtained can be used further for the calculation of thermal stresses in the refractory lining of the walls of the BOF with a view to their reduction, which will lead to a significant increase in the resistance of the lining.

References

[1] Strielov K.K. Tieorietichieskiie osnovy tiekhnologii ognieupornykh matierialov [Theoretical bases of technology of refractory materials].– M.: Mietallurgiia, 1985.– 480 p.
[2] Strielov K.K., Kashchieiev I.D., Мамукін P.S. Tiekhnologiia ognieuporov [Refractory technology].– M.: Mietallyrgiia, 1988.– 528 p.
[3] Panteikov S.P. Analiz mirovogo razvitiia i sovriemiennoie sostoianiie tiekhnologii oshlakovaniia futierovki kislorodnykh konviertierov [Analysis of world development and the current state of slagging technologies for the lining of oxygen converters] // Chiornaia metallurgiia. Bullietien' NTiEI.– 2013.– № 6 (1362).– P.65–78.
[4] Oku Susumu, Mimura Mitsutosi, Akamatsu Setuo. Development of a method for coating slag coatings for an oxygen converter // Taikabutsu, Refractories.– 1983.– Vol. 35.– № 300.– P.17–21.
[5] Panteikov S.P., Panteikova Ye.S. Matiematichieskaia model' tieplovogo sostoianiia dnishcha kislorodnogo konviertiera s uchiotom sloia zashchitnogo shlakovogo pokrytiia [Mathematical model of the thermal state of the bottom of the oxygen converter taking into account the layer of protective slag coating] //

«Sovriemiennaia mietallurgiia novogo tysiachielietiia»: Sb. nauch. tr. XI Miezhdunarodnoy nauchno-praktichieskoy konfierientsii (8–11 diekabria 2015g., g.Lipietsk, Rossiia).– Chast' 1.– Lipietsk: Izd-vo LGTU, 2015.– P.89–92.

[6] Panteikov S.P., Panteikova Ye.S. Chisliennyie issliedovaniia tieplovogo sostoianiia ognieuporov dnishcha kislorodnogo konviertiera s uchiotom yego oshlakovaniia [Numerical studies of the thermal state of the refractories of the bottom of the oxygen converter taking into account its slagging] // Problemy matematychnogo modeliuvannia: Materialy Vseukrains'koi naukovo-metodychnoi konferentsii, 25–27 travnia 2016r. m.Dniprodzerzhins'k.– Dnipropetrovs'k: Bila K.O., 2016.– P.51–53.

[7] Panteikov S.P., Panteikova Ye.S. O tiempieraturnom sostoianii ognieuporov dnishcha kislorodnogo konviertiera pri yego oshlakovanii [On the temperature state of the refractories of the bottom of the oxygen converter with its slagging] // Sbornik trudov XIV Miezhdunarodnogo Kongriessa stalieplavil'shchikov (g.Eliektrostal', Rossiia, 17–21 oktiabria 2016g.).– Moskva-Eliektrostal', 2016.– P.211–21

[8] Panteikov S.P., Panteikova Ye.S. Chisliennoie issliedovaniie dinamiki iznosa sloia zashchitnogo shlakovogo garnisazha na dnishchie kislorodnogo konviertiera pri produvkie rasplava [Numerical study of the wear dynamics of the protective slag layer on the bottom of the oxygen converter during melt blowing] // Univiersitietskaia nauka 2016: Sbornik tiezisov dokladov miezhdunarodnoy nauchno-tekhnichieskoy konfierientsii v 4-kh t.: T.1 – fakul'tiety: mietallurgichieskiy, yeniergietichieskiy.– Mariupol', GVUZ "PGTU", 2016.– P.148–150.

[9] Panteikov S.P., Panteikova Ye.S. Matiematichieskaia modiel' tiermonapriazhionnogo sostoianiia ognieuporov dnishcha kislorodnogo konviertiera s uchiotom ikh oshlakovaniia [Mathematical model of the thermally stressed state of the refractories of the bottom of the oxygen converter taking into account their slagging] // "Lit'ye. Mietallurgiia. 2016": Matierialy XII i V Miezhdunarodnykh nauchno-praktichieskikh konfierientsiy (24–26 maya 2016 g., g.Zaporozh'ie) / Pod obshch. ried. d.t.n., prof. Ponomarienko O.I. – Zaporozh'ie, ZTPP, 2016.– P.393–395.

[10] Panteikov S.P., Panteikova Ye.S. Chisliennyie issliedovaniia tiermichieskikh napriazhienii, voznikaiushchikh v ognieuporakh dnishcha kislorodnogo konviertiera pri yego oshlakovanii [Numerical studies of thermal stresses occurring in refractories of the bottom of an oxygen converter with its slagging] // "Strategy of Quality in Industry and Education": Proceedings XII International Conference (May 30 – June 1 2016, Varna, Bulgaria).– Dnepropetrovsk-Varna, 2016.– P.209–212.

[11] Panteikov S.P., Panteikova Ye.S. O tiermichieskikh napriazhieniiakh, voznikaiushchikh v ognieuporakh dnishcha kislorodnogo konviertiera pri yego oshlakovanii [About thermal stresses arising in refractories of the bottom of the oxygen converter with its slagging] // Zbiór artykułów naukowych. Konferencji Miedzynarodowej Naukowo-Praktycznej "Inżynieria i technologia. Współczesne problemy i perspektywy rozwoju" (Warszawa (PL), 30.01.2017–31.01.2017).– Warszawa: Wydawca: Sp. z o.o. «Diamond trading tour», 2017.– Str.21–24.

[12] Mikhieiev M.A., Mikhieieva I.M. Osnovy tieplopieriedachi [Fundamentals of heat transfer].– M.: Eniergiia, 1979.– 344 p.

[13] Kreyt F., Blek U. Osnovy tieplopieriedachi [Fundamentals of heat transfer].– M: Mir, 1983.– 512 p.

[14] Radl R.U. Zatvierdievaniie otlivok [Solidification of castings].– M.: Mashgiz, 1960.– 391 p.

[15] Tieploobmien i tieplovyie riezhimy v promyshliennykh piechakh [Heat transfer and thermal conditions in industrial furnaces] / V.I.Timoshpol'skiy, I.A.Trusova, A.B.Stieblov, I.A.Pavliuchienkov // Pod obshch. ried. V.I.Timoshpol'skogo.– Minsk: Vysheyshaia shkola, 1992.– 217 p.

[16] Samarskii A.A. Vviedieniie v tieoriiu raznosnykh sistem [Introduction to the theory of dissimilar systems].– M.: Nauka, 1971.– 552 p.

[17] Samarskii A.A., Gulin A.V. Chisliennyie mietody: Uchiebnoie posobiie dlia vuzov [Numerical methods: Textbook for high schools].– M.: Nauka. Gl. ried. fiz-mat. lit., 1989.– 432 p.

[18] Akio I. The behavior of carbon-containing refractories at high temperatures // Taikabutsu = Refractories.– 1988.– 40, № 10.– P.605.

[19] Refractories for converters with combined blowdown / E.Todataka, S.Hirashi, Y.Hirashi, I.Akio // Taika dzairio = Refrac. Mater..– 1990.– № 138.– P.69–85.

RESEARCH OF THE TENSE STATE OF CONVEYER RIBBON IS WITH THE ROPES OF DIFFERENT INFLEXIBILITY

Belmas I,V., Bilous O.I., Kolosov D.L., Vorobjova O.M

Abstract

Conveyor belts are used in a variety of conveyor systems, convex drums, and can have damaged ropes and cables of varying rigidity. Determination of the strained state of the tape is an actual task, it is aimed at creating safe conditions for the conveyor.

The purpose of the study is to develop an algorithm for determining the stress state of the tape, both damaged and cables of different rigidity, interacts with the curvilinear drum. The stress-strain state of the tape is determined by the equal weight of its ropes.

Having solved a system of equilibrium equations for a tape of cables of different stiffness given as a Dirac function on a segment of a discrete axis of rope numbers, it has been established that the laws of the distribution of forces, movements of ropes have the character of local perturbations. Reducing the stiffness of the cable leads to a decrease in the relative loads of adjacent ropes at their gusts and gusts of cable less rigidity. Obtained expressions for calculating the strained state of the tape, taking into account the presence of ropes in it less rigidity, wire ropes, the interaction of the tape with a non-cylindrical drum. The determined voltage state of the tape during its use allows to determine the loss of its attractive ability, to ensure safe and safe operating conditions of the conveyor belt. The use of the obtained results allows to increase the safety level of the conveyor. The obtained results are quite reliable and can be extended to composite materials of layered construction with hard layers.

References

[1] Volotkovskij V.S., Nohrin E.G., Gerasimova M.F. Isnos I dolgovethnost konveernih lent [Wear and longevity of conveyer ribbons] – Moscow, 1976. – 176 p.

[2] Kartavij A.N. Obosnovanie osnovnih parametrov kruto naklonnogo konveera s prijimnoj lentoj dlj karerov s boltsimi grusopotokavi [Basis of the main parameters of a steeply bent conveyor with a clamping belt for quarries with large cargo flows Kand tehn. sci. diss.]. Moscow, 2000. 211 p.

[3] Averthinkov V.I., Davidov S,V, Dunaev V.P., Ivanthenko V,N. Konveeri s podvesnoj kentoj Conveyors with hanging tape.Moscow, 2004. –255c.

[4] Belmas I.V., Kolosov D.L. The stress-strain state of a flat rope is due to grip of traction elements and the construction of a lifting machine.*Zbirnik naukovih praz nazionalnoho hirnitcoho universitetu – Collection of scientific works of national mountain university*, 2017, no. 50, pp. 163–170/ (in Ukrainian).

[5] Belmas I.V., Kolosov D.L., Kolosov O.L. Investigation of the stress-strain state of the rubber-rubber rope at the transition to the tubular form. *Vestnik PNIPU geologij. Naftegazovoe I gornoe delo – Announcer PNIPU. Geology. Oil and gas and mountain business,* 2014, no. 12. pp. 48–55.(in Russian)

[6] Belmas I.V., Bilous O.I. The tense state of гумовотросової ribbon is at loading. – *Zbornik nauthnih trudov Dneprodzerzhinskjho hosudarstvennogo tehnitheskogj unsversiteta (tehnitheskie nauki), jbilejnij vipusk (1999–2000) – Collection of scientific works of Dneprodzerzhinsk State Technical University (technical science), anniversary issue (1999–2000),* no. 2, pp. 331–333. (in Ukrainian).

[7] Belmas I.V., Saburova I.T., Zadorohnj I.M. Prevention of the destruction of the traction unit of the steep slope of the hoist . *Zbornik nauthnih trudov Kerthenskogo morskogotehnologithnogo morskogo instituta. Mehanisatcij proizvodstvennih protsesov ribnogo hozajstva, promithlenih I agrarnih predprijtij – Collection of scientific works of the Kerch marine technological institute. Mechanization of productive processes of fish industry, industrial and agrarian enterprises*, 2008, no 9, pp. 132–136.(in Ukrainian).

[8]. Blohin S,.E., Kolosov D.L., Kolosov O.L., Stress-strain state of a flat rubber-rubber traction organ on a drum. *Visnik Gnipropetrovskogo natsionalnogo universitetu zaliznithnogo transportu im. Akad Lazapjna. = Bulletin of Dnipropetrovsk National University of Railway Transport named after. acad. V. Lazaryan,* 2009, no. 30, pp. 88–91. (in Russian).

[9] Tantsura G,I,. Hnuthki tjgovi orgahi. Stikovi sednannj konveehnih stritsok [Flexible hauling organs. Butt connections of conveyer ribbons]. – Dniprodzerzhynsk, 2010, 127 p.

[10] Pedthenko O.S. Mathematical model of the suspended conveyer ribbon on a conveyer with the bend of route in a vertical line -*Gornij informatsionno analititheskij bulleten – Mining Information Analytical Bulletin*, 2007, no. 1, pp. 322–324. (in Russian).

[11] Pruthak V.J. Numerical evaluation of the durability of joints of rubber-rubber conveyor belts. *Vestnik Belorusskoho natsionalmnogo tehnitheskogo universiteta – Bulletin of the Belarusian National Technical University*, 2008. no. 1, pp. 35–38. (in Russian).

[12] Levthenij J.B. Povishenie nadeshnosti stikovih soedinenij konveernih lent na gornodobivajshih predprsjtijh:

na primere RUP "PO "Belarus kalij" [Increase of reliability of butt connections of conveyer ribbons on mining enterprises: On the example of РУП "ON "Belarus kalij" Kand tehn. sci. diss.], Soligorsk, 2004, 152 p.

[13] Volhovskij V.J., Radin V.P., Rudjk M.B. Concentration of efforts in ropes and bearing strength of резинотросовых of conveyer ribbons with damages. *Buleten Moskovskogo energetitheskogo instituta – Bulletin of the Moscow Power Engineering Institute,* 2010, no 5, pp. 5–12. (in Russian).

[14] Belmas I.V., Saburova I.T., Model of Model of the stress-strain state of the rubber-fabric tape in the transitional section. – *Podjomno-transportnaj tehnika – Lifting-transport technique,* 2003, no. 3, pp. 93–99. (*in Ukrainian*).

[15] Ithenko R.V. Povishense nadejnosti bistroiznashivajsthihsj detalej lentothnih konveerov v vjsdushno-soljnoj srede [Increase of reliability of wear parts of belt conveyors in air-salt environment – Kand tehn. sci. diss.]. – Moscow, 2013? 204 p.

MODELING OF THE SHORT–RANGE ORDER AMORPHY ALLOYS OF METAL-METALOID

Gulivets A.N., Baskevich A.S.

Abstract

Amorphous metal alloys metal-metalloid possess a complex of unique physical-chemical properties and are a new class of promising materials of unquestionable theoretical and practical interest.

The purpose of this work is to develop and approbate the method of modeling short-range order in amorphous metal alloys on the basis of data from x-ray experiments. Description of the mechanisms of formation of the short-range order of the amorphous state is an important and urgent task necessary for a deeper understanding of the physical processes taking place at the initial stages of solid phase formation, in conditions far from equilibrium, and also for calculating properties, in order to optimize the experiments on obtaining alloys with a given complex of properties.

A method for studying the near atomic location in amorphous metal alloys of a metal-metalloid is proposed based on the results of X-ray and acoustic results. Nonequilibrium conditions for the crystallization of alloys are achieved by using extremely high cooling rates or overvoltages in the precipitation. Such conditions for the formation of a solid phase contribute to the fact that the crystal structure does not have time to form in the entire volume, but forms only in the regions of the ordered arrangement of atoms 2-6 nm in size. Numerous experiments have shown that in the amorphous state the short-range order of alloys contains regions of the ordered arrangement of atoms in the form of simple geometric structures similar to crystal structures of b.c.c. and f.c.c. The proposed method of joint modeling of the short-range order of metal-metalloid alloys using the radial arrangement of atoms, the approximation of the main peak of the structural factor, taking into account the speed of sound in the alloy, made it possible to establish the characteristics of the short-range order of alloys: the type of packing of atoms in regions of ordered arrangement of atoms (polyhedron type) the average size of these regions, the volume fraction that they occupy, and also the parameters of the unit cell based on these polyhedron.

It is shown that with the help of this technique it is possible to determine the dimensions and shape of the ROAA and also the size of the gaps between them, the parameters of the ROAA lattice, and also the volume fraction of their volume of metal. Simulation showed that in amorphous Cr-C alloys, ROAA are predominantly cuboctahedra, and the gaps between them are filled with amorphizing atoms forming a solid solution in the metal.

References

[1] Waseda Y. “The structure of liquids, amorphous solids and solid fast ion conductors”, Pergamon Press. Ltd. Progress in Materials Science, vol. 26, pp. 2–122, 1984.

[2] Suzuki K., Fujimori C., Hashimoto K. “Amorfnyye metally” [Amorphous metals]. Moskov, Metallurgy, 1987. 328 p.

[3] Kratky O., Pilz I., Schmidt P.I. “Absolute intensity measurement of small-angles X-rays scattering by means of standard sample”, J. Colloid and Interface Sci., vol. 24, pp. 211–215, №1. 1966.

[4] Baskevich A.S., Gulivetz A.N., Zabludovsky V.A. “Blizhniy poryadok rentgenovskikh amorfnykh splavov Ni-P i Co-P, poluchennykh impul'snym elektroosazhdeniyem” [Short-range order of X-ray amorphous Ni-P and Co-P alloys obtained by pulsed electrodeposition]. Metallofizika i noveyshiye tekhnologii – Physics of Metals and Advanced Technologies, 2004. Vol.26, no.9, pp. 1151–1161 (in Russian).

[5] Baskevich O.S., Gulivetz A.N., Zabludovsky V.O. “Modeling of short-range structure in Ni-P alloys”. Ukr.J.Phys., 2004. Vol.49, no.12., pp. 1196–1199.

[6] Ichikava T. “Electron Diffraction Study of the local Atomic Arrangement in Amorphous Iron and Nickel Films”, Phys. Stat.Sol., vol.19(a), pp.707–716, 1973.

[7] Mirkin L.I. “Spravochnik po rentgenostrukturnomu analizu polikristallov” [Handbook of X-ray diffraction analysis of polycrystals], Moscow, Phys.mat.lit., 1961. 864 p.

[8] Svergun D.I., Feigin L.A. “Rentgenovskoye i neytronnoye malouglovoye rasseyaniye” [X-ray and neutron small-angle scattering], Moscow, Phys.mat.lit., 1986. 280 p.

[9] Gin'ye A. “Rentgenografiya kristallov” [Radiography of crystals], Moscow, Phys.mat.giz., 1961. 604 p.

[10] Melnik A.B., Perekos A.E., Chuistov K.V. “Issledovaniye struktury amorfnykh splavov na osnove kobal'ta i zheleza” [Investigation of the structure of amorphous alloys based on cobalt and iron]. Metallophysics – Physics of Metals, 1989, vol. 11, no.6, pp. 93–95 (in Russian).

[11] Dutchak YA.I. “Rentgenografiya zhidkikh metallov” [Radiography of liquid metals]. Lviv, Vishcha school, 1977. 163 p.

[12] Chernov A.A., Givargizov I.E., Bagdasarov H.S. “Sovremennaya kristallografiya. Tom 3. Obrazovaniye kristallov” [Modern crystallography]. Vol.3. The formation of crystals]. Moscow, Nauka, 1980. 407 p.

MATHEMATICAL METHODS IN SOCIAL AND HUMANITARIAN SCIENCES

MULTI-MOMENTS FLOW MODEL PRODUCTION LINE

Pihnastyi O.M.

Abstract

The analysis of the system of balance equations for flow parameters of the production line is presented. The class of solutions of the system of balance equations for the parameters of the production line, represented by equilibrium functions, is investigated. Approximate methods based on perturbation theory were used to consider nonequilibrium states of flow line parameters. The derivation of equations of system dynamics for a network of materials of a production line based on balance equations is demonstrated. It is shown that the equations of system dynamics are determined as a result of integrating the system of balance equations. The method of constructing the equations of system dynamics for a network of materials is analyzed

References

[1] Azarenkov N.A. Kineticheskaja teorija kolebanij parametrov potochnoj linii / N. A. Azarenkov, O. M. Pihnastyi, V. D. Hodusov // Dopovidi Nacional'noï akademiï nauk Ukraïni. 2014. № 12. – S. 36 – 43.– Available at : https://goo.gl/M913ju (accessed 14.01.2018)

[2] Kempf K. Optimization models for production planning. Planning Production and Inventories in the Extended Enterprise: A State of the Art Handbook. / K.Kempf, P.Keskinocak, R.Uzsoy –Springer-Verlag, New York, 2010. – 587 p.

[3] Lefeber E. Modeling, Validation and Control of Manufacturing Systems. / E.Lefeber, R.A.Berg, J.E. Rooda – Proceeding of the 2004 American Control Conference, Massachusetts, 2004. – P. 4583 – 4588.

[4] Sinica L.M. Organizacija proizvodstva. / L.M. Sinica. – Mn.: UP IVC Minfin, 2003. – C. 512.

[5] Razumov I.M. Organizacija i planirovanie mashinostroitel'nogo proizvodstva./ I.M.Razumov, L.Ja.Shuhgalter – M.: Mashinostroenie, 1974. – C.592.

[6] Bogoljubov N. N. Asimptoticheskie metody v teorii nelinejnyh kolebanij. / N.N. Bogoljubov, Ju. A. Mitropol'skij. – M.: Fizmatgiz, 1963. – S. 412.

[7] Pihnastyi O.M. Stohasticheskoe opisanie jekonomiko-proizvodstvennyh sistem s massovym vypuskom produkcii / V.P.Demuckij, V.S Pihnasta, O.M. Pihnastyi // Dopovidi Nacional'noï akademiï nauk Ukraïni. – Kiïv: Vidavnichij dim "Akademperiodika". – 2005. – № 7. – S. 66–71. DOI: 10.13140/RG.2.2.31202.32968 –Available at: https://goo.gl/Cu6MXe (accessed 14.01.2018)

[8] Armbruster D.A model for the dynamics of large queuing networks and supply chains. / Armbruster D., Degond P., Ringhofer C. – SIAM Journal on Applied Mathematics 66(3), 2006. – P. 896–920.

[9] Armbruster D. Kinetic and fluid model hierarchies for supply chains. SIAM Multiscale Model Simul. / Armbruster D., Marthaler D., Ringhofer C. – 2004. – vol. 2 №1. – P. 43–61

[10] Jacobs I. S. and Bean C. P. “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[11] Vencel' E. S. Teorija verojatnostej i ee inzhenernye prilozhenija. / E. S. Vencel', L. A. Ovcharov. – M.: Vyssh. shk., 2000. – 2-e izd. – S. 480.

[12] Zubarev D.N. Statisticheskaja mehanika neravnovesnyh processov. / D.N.Zubarev, V.G.Morozov, G.Repke –M.: FIZMATLIT, 2002. – Tom 1. – C. 432.

[13] Tihonov A.N. Uravnenie matematicheskoj fiziki./ A.N.Tihonov, A.A.Samarskij. – M.: Nauka , 1972. – C. 736.

[14] Pihnastyj O.M. K voprosu podobija tehnologicheskih processov proizvodstvenno-tehnicheskih sistem / N.A.Azarenkov, O.M.Pihnastyj, V.D.Khodusov // Dopovidi Nacional'noï akademiï nauk Ukraïni. – Kiïv: Vidavnichij dim "Akademperiodika". – 2011. – №2 – S. 29–35. – Available at: https://goo.gl/0N1Sql (accessed 14.01.2018)

[15] Bogoljubov N. N. Problemy dinamicheskoj teorii v statisticheskoj fizike. / N.N. Bogoljubov. – M.: OGIZ, 1946. – S. 120.

[16] Gibbs D.V. Osnovnye principy statisticheskoj mehaniki. / D.V. Gibbs. – M.: Reguljarnaja i haoticheskaja dinamika, 2002. – C. 204.

[17] Khodusov V.D. Ispol'zovanie metodov fizicheskoj kinetiki dlja issledovanija kolebanija parametrov potochnoj linii / V.D.Hodusov, O.M.Pihnastyi// – Vostochno-evropejskij fizicheskij zhurnal. – Harkov: HNU. – 2014. – Vol. 1. – №4. – S. 88–95. – Available at: https://goo.gl/Sprxuh (accessed 14.01.2018)

[18] Pihnastyi O. M. Primenenie metodov statisticheskoj fiziki dlja opisanija stacionarnogo funkcionirovanija proizvodstvennyh sistem / V. P. Demuckij, O. M. Pihnastyi, V. D. Khodusov, M. N. Azarenkova // – Visnik Harkivs'kogo nacional'nogo universitetu. – Harkiv: HNU. – 2006. – N732. Ser. "Fizichna". – S.79–86.
[19] Pihnastyi O. M. Matematicheskaja model' makroskopicheskogo opisanija sistemy s massovym vypuskom produkcii / V.P.Demuckij, O.M. Pihnastyi , V.S. Pihnasta // Visnik Harkivs'kogo nacional'nogo universitetu. – Harkiv: HNU. –2005. – № 664. Ser. "Fizichna", vip. 2. – S. 107–112
[20] Pihnastyi O. M. Statisticheskaja teorija proizvodstvennyh sistem / O. M Pihnastyi. – Harkiv: HNU, 2007. – 388 s. –Available at: https://goo.gl/dzcEZk (accessed 14.01.2018)
[21] Armbruster D. Modeling production planning and transient clearing functions, Logistics Research. / Armbruster D., Fonteijn J., Wienke M. – 2012. – VOL 87 – №3. – P. 815 – 822.
[22] Pihnastyi O. M. Obzor modelej upravljaemyh proizvodstvennyh processov potochnyh linij proizvodstvennyh sistem / O.M. Pihnastyi // Nauchnye vedomosti Belgorodskogo gosudarstvennogo universiteta. Belgorod: BGU. – 2015. – № 34/1. S.137–152. – Available at: https://goo.gl/53P4hV (accessed 14.01.2018)
[23] Bigel' Dzh. Upravlenie proizvodstvom. / Dzh. Bigel'. – M.: Mir, 1973. – S. 420.
[24] Buslenko N.P. Matematicheskoe modelirovanie proizvodstvennyh processov. / Buslenko N. P. – M.: Nauka, 1964. – S. 363.
[25] Demuckij V.P. Teorija predprijatija: Ustojchivost' funkcionirovanija massovogo proizvodstva i prodvizhenija produkcii na rynok. / Demuckij V. P., Pihnasta V. S., Pihnastyi O. M. – H.: HNU, 2003. – C. 272.
[26] Forrester Dzh. Osnovy kibernetiki predprijatija. / Dzh. Forrester. – M.: Progress, 1961. – C. 341.
[27] Shkurba V.V. Planirovanie diskretnogo proizvodstva v uslovijah ASU. / V. V. Shkurba i dr. – K.: Tehnika, 1975. – C. 296.
[28] Mihajlenko V.G. Osobennosti modelirovanija tehnologicheskih processov proizvodstvennyh sistem. / V.G.Mihajlenko, V.D.Hodusov, Pihnastyj O.M. – Vestnik HNU, 2006. – N719 – S. 267–276.
[29] Pihnastyj O.M Funkcija Lagranzha proizvodstvennoj sistemy s massovym vypuskom produkcii. / O.M.Pihnastyj, V.D.Khodusov, V.G.Mihajlenko, – Sbornik nauchnyh trudov mezhdunarodnoj nauchno-prakticheskoj konferencii «Osobennosti social'no-jekonomicheskogo razvitija Ukrainy i regionov», Zaporozh'e, 11–12 oktjabrja 2007. – S. 189–190.
[30] Pihnastyj O. M. Stohasticheskaja model' perenosa tehnologicheskih resursov na predmet truda v rezul'tate vozdejstvija tehnologicheskogo oborudovanija. / O. M. Pihnastyj // Nauchnye vedomosti Belgorodskogo gosudarstvennogo universiteta. Belgorod: BGU. – 2016. – № 38/9. – S. 146–155
[31] Little J.D. A proof of the queuing formula l = λw. Operations Research,9:383 387, 1961.

ALGORITHM OF DEFINITION ECONOMIC RESULTS WORK OF THE ENTERPRISE

Levchuk K.O., Romaniuk R.Ja.

Abstract

Economic efficiency of activity is estimated by means groups of indicators. Set of indicators work which allows to receive to the head full enough representation about economic results activity of the enterprise, comprises more than 100 indicators.

The work purpose is working out of algorithm definition of economic results work of the enterprise which will allow to receive the generalised information about technical and economic and an enterprise financial position, dynamics of its development, definition of changes in a course of an estimation results of work and reserves improvement of activity.

For reception of a generalising estimation it is offered to carry out the analysis of industrial and financial activity of the enterprise on the basis of the indicators calculated by a matrix (tabular) method with use of the computer. Calculation of indicators which characterise it is industrial-economic activities the enterprises a matrix method, begins from selection of quality indicators of results activity the enterprise. The number of indicators can be differently, but is expedient use no more than 10 of major of them who provide the control of economic activities and is a basis for a substantiation of administrative decisions. Further the selected indicators are brought in the first line of the table-matrix, as results of manufacture, and in the first column, as factors which influence these results. On crossing of columns and lines of the table relative indicators by division ovalue of an indicator a column into value an indicator of a line pay off. Similar tables are considered according to the accounting and base period. Considering simplicity of calculations and presence of initial data in the current accounting reporting, the period calculation of indicators can be chosen, since 1 days. At last stage, relative changes of indicators by distribution indicators activity of the enterprise in accounting period on corresponding

indicators of the base period are defined and the total table of relative change indicators activity of the enterprise in accounting period is filled. On the basis of the calculated changes efficiency activity of the enterprise is analyzed.

Calculation indicators of economic activities of the enterprise by means this algorithm allows to see interrelations of economic processes and their indicators, provides presentation and efficiency of the analysis, clearness of perception, characterises quality results of the accepted administrative decisions, allows to carry out the constant operative control and monitoring.

References

[1] Bondar N.M. *Ekonomika pidpryiemstva: navch. posib.* [Factory economy: the manual]. Kiev, 2005. 400 p.

[2] Savickaja G.V. *Analiz hozjajstvennoj dejatel'nosti predprijatija* [The analysis economic activities of the enterprise]. Moscow, 2011. 288 p.

[3] Boichyk I.M *Ekonomika pidpryiemstva: pidruch.* [Factory economy: the textbook]. Kiev, 2016. 378 p.

[4] Levchuk E.A. [Methodical maintenance of strategic planning activity of the enterprise in conditions of the actable economic environment]. *Visnyk skhidnoukrainskoho natsionalnoho universytetu im. V. Dalia* [The bulletin of the East Ukrainian national university of V.Dalja]. Lugansk, 2010, no. 8(150), pp. 137–142 (in Russian).

[5] Fen' M.I., Romaniuk R.Ja. [The administrative analysis of economic results works of the enterprise]. *Problemy nedropol'zovanija: sb. nauk. trudov. Ch. II* [Problems of using of bowels: collection of proc. Part II]. Sankt Petersburg, 2010, pp. 55–57 (in Russian).

[6] Levchuk E.A. [Planning of outsourcing logistical strategy of the industrial factory]. *Modeli upravlinnja v rinkovij ekonomici: zb. nauk. prac'* [Running sample pieces in market economy: the collector of scientific works]. Donetsk, 2010, no. 13, pp. 76–82 (in Russian).

[7] Levchuk K.O. [Running integration by logistical processes into the general control system of expenses of the big industrial factory]. *Modeliuvannia rehionalnoi ekonomiky: zb. nauk. prats* [Modelling of regional economy: the collector of scientific works]. Ivano-Frankivsk, 2010, no. 2(16), pp. 115–121 (in Ukrainian).

[8] Fen' M.I., Romanjuk R.Ja. [Efficiency of work in modern conditions]. *Problemy nedropol'zovanija: sb. nauk. trudov. Ch. II* [Problems of using of bowels: collection of proc. Part II]. Sankt Petersburg, 2013, pp. 130–131 (in Russian).

[9] Fen' M.I., Romanjuk R.Ja. [Habits of planning of an over-all performance in modern conditions]. *Sovremennyj nauchnyj vestnik: jekonomicheskie nauki* [The modern scientific bulletin: economic sciences]. Belgorod, 2013, no. 33(172), pp. 44–50 (in Russian).

[10] Borodkina N.O., Levchuk K.O. [The complex assaying of logistical processes of metallurgical area within effective managing of the factories]. *Visnyk Zhytomyrskoho derzhavnoho tekhnolohichnoho universytetu. Seriia: Ekonomichni nauky* [The bulletin of Zhitomir state technological university. A series: Economic sciences]. Zhitomir, 2014, no. 2(68), pp. 90–94 (in Ukrainian).

IMPLEMENTATION OF IMPLICIT DIFFERENCE SCHEMES TO SOLVE THE MATHEMATICAL PHYSICS PROBLEMS USING MS EXCEL SPREADSHEET

Karimov I.K., Karimov G.I.

Abstract

The implementation of difference schemes is connected to the high volume of computations and is usually carried out on a PC using on a program written in one of the programming languages. For professionals whose main job is not related to programming, such an approach leads to some difficulties, which defines the necessity of finding alternative ways to implement difference schemes.

The purpose of the study is to research the specifics of using the MS Excel spreadsheet for the implementation of implicit difference schemes; the task is to develop and test the applicable algorithm using the example of solving the boundary value problem for a typical parabolic equation - the heat equation.

To solve the problem, an implicit difference scheme is used, which leads to the necessity of solving the system of linear algebraic equations of the three diagonal forms using the marching algorithm at each time step. A new approach to the implementation of the described algorithm, based on the use of MS Excel spreadsheet, is proposed. An algorithm and results of the solution of the boundary value of heat conduction based of the proposed approach are given. The data obtained in this way allows us to analyze the simulated process in all aspects of interest to the researcher: to answer a number of questions regarding the nature of the temperature

distribution in the investigated area, to determine the time of attaining one or another temperature at a given point, temperature differences, etc.

The most attractive features of the proposed approach should include the absence of direct programming, the simplicity of computer implementation, the ease and natural presentation of the results. Especially note the appeal of the application of the proposed approach in the learning process. Avoiding the programming allows students to reduce the component of modeling, not directly related to future professional activities, and to concentrate efforts on forming skills of mathematical modeling and analysis of the specifics of the investigated process. As a result, the learning process becomes more creative, theory is better absorbed, motivation and interest in application of methods of mathematical modeling is increased.

The specifics of the application of the proposed approach in some cases (nonlinear problems, two-dimensional problems, etc.) require further research.

References

[1] Samarsky A. A. Teoriya raznostnyh shem. [Theory of difference schemes] – Moscow: Nauka, 1983. – 616 p.
[2] Godunov S.K., Ryabenky V.S. Raznostnye shemy. Vvedenie v teoriyu. [Difference schemes. Introduction to the theory] – Moscow: Nauka, 1973. – 400 p.
[3] Feldman L.P., Petrenko A.I., Dmitrieva O.A. Chiselni metody v informatici. [Numerical methods in computer science] – K .: Publishing group VNV, 2006. – 480 p.
[4] Paskonov V.M., Polezhaev V.I., Chudov L.A. Chislennoe modelirovanie processov teplo- i massoperenosa. [Numerical simulation of heat and mass transfer processes] – Moscow: Nauka, 1984. – 288 p.
[5] Ogurtsov A.P., Samokhvalov S.E. Chislennye metody issledovaniya gidrodinamicheskih and teplomassoperemosnyh processov staleplavilnogo poizvodstva. [Numerical methods of the investigation of hydrodynamic and heat and mass transfer processes on steel production]– K .: Naukova Dumka, 1993. – 220 p.
[6] Ogurtsov A.P., Mamaev L.N., Karimov I.K. Matematicheskie metody i modeli v rasschetax ne EVM. [Mathematical methods and models in calculations on computers] – K .: ISMO, 1997. – 192 p.
[7] Kundrat A.M., Kundrat M.M. Naukovo-tehnichni obchislennya zasobami MathCAD i MS Excel. [Scientific and technical computing by means of MathCAD and MS Excel] – Rivne: NUVGP, 2014 – 252 p.
[8] Porshnev S.V., Belenkova I.V. Chislennye metody na baze MathCAD [Numerical methods based on MathCAD], – SPb .: BHV-Petersburg, 2005. – 464 p.
[9] Karimov I.K., Karimov G.I., Nuzhna S.A. Realizaciya riznecevyh shem zasobami tablichnogo processora MS Excel/Problemy matematichnogo modelyuvannya[Implementation of difference schemes using means of MS Excel spreadsheet/ Problems of mathematical modeling]: Materials Allukr. sci. method. conf., 24–26 May. 2017 – Dnepr: Bila K.O., 2017. – P.130–132.