hydrogen in solid compounds. Ti-Fe is one of these alloys. Ti-Fe alloys are able to absorb and desorb hydrogen under favorable conditions, and they are capable of reversibly absorbing hydrogen up to 1.9 wt. %.

It was established that carbides, in addition to the strengthening effect, are also useful in terms of hydrogen trapping ability. Since diffusible hydrogen may be sufficient to cause failure, well-designed hydrogen trapping sites may be an appropriate strategy to increase resistance to hydrogen embrittlement (HE). Pure iron has the high sensitivity to HE, which is explained by its high diffusion of hydrogen. When studying steels, both carbides and other microstructural features, such as grain boundaries, dislocations, vacancies, etc., can absorb hydrogen in the reversible or irreversible way. The hydrogen trapping behavior of TiC changed according to its coherent or incoherent interfacial character. The semi-coherent interfaces of the TiC precipitate did not trap hydrogen during annealing, but trapped hydrogen during cathodic charging at ambient temperature, for which the desorption activation energy (Ea) is 55.8 kJ/mol. Incoherent TiC was unable to internally trap hydrogen during cathodic charging at ambient temperature, but absorbed hydrogen during thermal treatment. Ea is 116 kJ/mol for coarse incoherent TiC particles in 0.42C-0.30Ti steel annealed at 700 ºC, which decreased to 68 kJ/mol when the material was annealed at 500 ºC. For coherent TiC in steel Ea is from 46 to 59 kJ/mol depending on annealing.

Therefore, it is assumed that the carbides are effective as hydrogen scavengers and contribute to increased resistance to hydrogen-induced property degradation.

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SOLUTION OF THE PROBLEM OF STATIONARY HEAT CONDUCTION FOR A LAYERED PLATE

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Elements of engineering structures are operated in conditions of a wide range of temperature changes [1, 2]. This leads to the need to take into account the influence of the temperature field when calculating their stress-strain state, but first it is necessary to solve the corresponding problems of thermal conductivity. For objects with a layered structure, problems of thermal conductivity with ideal thermal contact between layers are mainly solved [3, 4]. In reality, there may be a thin intermediate layer of some material between the contacting layers, therefore, among the boundary value problems of thermal conductivity and thermoelasticity, the problems for layered structures with non-ideal thermal contact between the layers are of significant interest. Plates are important elements of various engineering structures, therefore, the study of their deformation characteristics under the influence of thermal loads is an urgent task.

The work considers a three-dimensional stationary heat conduction problem for a layered plate with non-ideal thermal contact between the layers, for which an exact analytical solution is constructed. Temperature distributions are given on the upper and lower surfaces of the plate. The problem is solved using a double integral Fourier transform. The temperature in the layers is represented as a linear combination of two auxiliary functions. The solution of the problem is obtained in a form convenient for numerical implementation. The obtained temperature distributions were compared with the results obtained by other methods. In the future, it is planned to apply the specified method to solving the problem of thermoelasticity [5] for a layered plate with non-ideal thermal contact.

References:

1. Smetankina N., Semenets O., Merkulova A., Merkulov D., Misura S. Two-stage optimization of laminated composite elements with minimal mass. Smart Technologies in Urban Engineering. STUE-2022. Lecture Notes in Networks and Systems. Springer, Cham, 2023. Vol. 536. P. 456–465. https://doi.org/10.1007/978-3-031-20141-7_42

2. Smetankina N.V., Postnyi O.V., Misura S.Yu., Merkulova A.I., Merkulov D.O. Optimal design of layered cylindrical shells with minimum weight under impulse loading. In: 2021 IEEE 2nd KhPI Week on Advanced Technology (KhPIWeek). 2021. P. 506–509. https://doi.org/10.1109/KhPIWeek53812.2021.9569982

3. Malykhina A. I., Merkulov D. O., Postnyi O. V., Smetankina N. V. Stationary problem of heat conductivity for complex-shape multilayer plates. Bulletin of V.N.

Karazin Kharkiv National University. Series "Mathematical modeling. Information technology. Automated control system". 2019. Vol. 41. P. 46–54. https://doi.org/10.26565/2304-6201-2019-41-05

4. Smetankina N., Postnyi O. Nonstationary heat conduction in multilayer glazing subjected to distributed sources. Informatyka, Automatyka, Pomiary w Gospodarce i Ochronie Środowiska. 2020. Vol. 10, No 2. P. 28–31. https://doi.org/10.35784/iapgos.930

5. Smetankina N., Merkulova A., Merkulov D., Misura S., Misiura Ie. Modelling thermal stresses in laminated aircraft elements of a complex form with account of heat sources. ICoRSE 2022. Lecture Notes in Networks and Systems. 2023. Vol. 534. Springer, Cham. P. 233–246. https://doi.org/10.1007/978-3-031-15944-2_22

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APPLICATION OF COMPLEX NUMBERS IN ENGINEERING CALCULATIONS

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This study examines the use of complex numbers in calculations, knowledge of which is very useful for studying and better understanding processes in electrical and electronic engineering. Complex numbers are a universal tool in engineering, for example, in the transmission, transformation and use of energy in large electrical networks and the creation of various units with electrical circuits. The basis of this engineering lies in the properties of potential difference and electric current. Thus, the key factors of research, analysis and calculations depend on the approach:

– theoretical, from the point of view of physics, which involves understanding the processes in electrical circuits;

– practical, from the point of view of mathematics, which takes into account knowledge of complex numbers and the ability to solve complex mathematical problems.

Complex numbers are widely used in most industries, such as engineering physics, especially in computing and electrical operations.