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I. Yakovleva, head of a chair, d.t.s
A. Cheylitko, doctoral candidate, c.t.s.
Yu. Belokon′, doctoral candidate, c.t.s.
M. Nosov, graduate student

DEVELOPMENT OF STRUCTURE FOR NEW HEAT ISOLATION ON BASE METALLIC PERFORATED PLASTINS

Zaporozhe state engineering academy

Analytical researches of heat isolation are executed on base metallic perforated plastins with varying of size of pores and distance between them. The optimal geometrical parameters of component plastins are certain for their practical use. The coefficient of heat conductivity and tensile strength is found on the compression of the got material. The worked out metallic thermal isolation can be used in aircraft building; rocket production; and also of motor and nuclear industry. Application of this material instead of monolithic parts will result in diminishing: gross weight of construction; thermal losses and expenses of material.

Keywords: metallic perforated plates, heat isolation, effective heat conductivity, tensile strength on a compression

Introdfuction. Porous metallic materials differ in unique combination of properties which was repeatedly examined by the scientists of different countries [1,2]. They already found the application in aerospace (titan and aluminium sandwich panels); shipbuilding (carcass of passenger ships); in motor-car (structural elements) and railway industry (dampers), and also medicine (implants in the organism of man).

For further development it is necessary to work out new porous metallic material which is simple in making that allows to arrive at the identity of all pores, dispose pores in the necessary order and use combination of different alloys without application of costly equipment.

Problem formulation. Development of heat isolation on the base of set of the perforated metallic plastins, which is simplicity in making and has optimal thermophysical descriptions, that will allow to use structural elements both from one material and combinations of different components.

Main material. The offered variant of the worked out porous metallic material consists in connection related of the perforated plastins. Perforation in plates it is possible to execute thus, that during their connection a pore is formed had a necessary form and location. Connection of plastins inter se it is possible to carry out by sintering force-feed, by agglutination or by means of screw-bolts. At the cold method of connection as a dielectric in pores it is possible to apply a dielectric paper. Because pin heat resistance between plates will considerably diminish a heat stream, plates must be collected thus, that lines of their connection were athwart to the heat stream.

For being of dependence of durability and effective heat-conducting from the qualificatory sizes d and b the method of planning of experiment was used. Entry parameters of model: d – a maximal diameter of openings in plastins (X_1); b – distance between the edges of pores in one row (X_2); s – distance between the foci's of rows of perforation (X_3). The initial parameters of model are Y_1 – a coefficient of heat-conducting of the collected plastins, W/(m·K) and Y_2 – a border of durability on a compression, MPa.

In an experiment we used carbon construction steel of ordinary quality of brand ST3sm with the border of durability on the compression 137 MPa and coefficient of heat-conducting 55.0 W/(m·K). Through every six plastins in pores inlaid a dielectric paper in a form petal. The perforated plates were clamped by the point causing of epoxy glue the «Cold welding» and welding of butt ends of sample by electrodes. For the making of quadratic coefficients of equation of regression, the orthogonal plan of the second order, with a nucleus 2^3, with two «star» points was select.

According to work [10], for a plan with a nucleus 2_3, elect next coefficients: $\alpha = 1,215$; $\beta = 0,730$; $c_0 = 0,067$; $c_1 = 0,091$; $c_2 = 0,230$; $c_3 = 0,125$. After the calculations of all coefficients of equation of regression and being of unmeaningful coefficients on t -criterion of Student next equations are got

$$Y_1 = 20,979 - 1,9X_3 + 8,592X_1^2 + 3,985X_2^2 + 4,29X_3^2 + 3,45X_1 \cdot X_2; \quad (1)$$

$$Y_2 = 100,284 - 8,375X_1 + 0,955X_2 + 1,01X_3^2 + 1,385X_1 \cdot X_2. \quad (2)$$

For determination of the optimal mode of thermal treatment composed Langrangian function. As an objective function which is subject to optimization, used a function

$$F(X) = 20,979 - 1,9x_3 + 8,592x_1^2 + 3,985x_2^2 + 4,29x_3^2 + 3,45x_1 \cdot x_2 \,. \quad (3)$$

Decide the system of equations

$$\begin{aligned} &17,184x_1 + 3,45x_2 + \mu \cdot \ -1,385x_2 + 8,375 \ = 0; \\ &3,45x_1 + 7,97x_2 + \mu \cdot \ -1,385x_1 - 0,955 \ = 0; \\ &-2,02x_3 \cdot \mu + 8,58x_3 - 1,9 = 0. \end{aligned} \quad (9)$$

We examine two variants:

– $\mu \neq 0$, $X_1 = \ 0,037, -0,024, 0,218 \ $, $\mu = -0,065$;

– $\mu = 0$, $X_1 = \ 0, 0, 0,221 \ $.

A point $X_1 = \ 0, 0, 0,221 \ $. satisfies to all conditions. The value of function in this point composed 20,769. For the function of $L(X,\lambda,\mu)$ the Hesse matrix HL is found.

The Hesse matrix has a next kind

$$G \ X \ = \begin{pmatrix} 17,184 & 3,45 & 0 \\ 3,45 & 7,97 & 0 \\ 0 & 0 & 8,58 \end{pmatrix}. \quad (15)$$

Get diagonal minors: $D_1 = a_{11} = 17,184$; $D_2 = a_{11} \cdot a_{22} - a_{21} \cdot a_{12} = 125,054$; $D_3 = 1072,963$.

As diagonal minors are positive, then G_f is a positively certain matrix. From swims out here, that a function is protuberant. Moreover, a function is strictly protuberant and has an only point of minimum $X_0 = (0,\ 0,\ 0{,}221)$. Coming from the got sizes, the optimal sizes of the collected metallic perforated plastins compose *d* = 15 mm; *b* = 5 mm; s = 31.1 mm. The coefficient of heat-conducting at these optimal parameters presents 20.7686 W/(m·K), and border of durability on a compression – 100.235 MPa.

Conclusions. A heat isolation which consists of the perforated metallic folias permanent brands of ST3sm is worked out. The optimal sizes of perforation of metallic plastins are got, their coefficient of heat-conducting and border of durability on a clench. Technology of production of such isolation is to the outage and allows to minimize financial charges on purchased of technological equipment. The offered isolation in an aggregate with the used methods of analysis can be applied in further researches, namely during realization of experiments with plates, which compose from different metals. Similarly on the base of the executed research creation of heat-insulation composite material is possible, where part of plastins will be executed from non-metal material.

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