PLASTICITY OF A DOUBLE LAYER FILTERING MATERIAL AND REASONS FOR THE OCCURRENCE OF MICROCRACKS IN CORRUGATING OF IT

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It is economically desirable to produce modern precision fine cleaning filters for various branches of industry of corrugated construction. The production of such filters is laborious and they are more effective in service and have less volume and weight.

High-strength powder materials with capillary structures, which are normally used for the production of filters, are characterized by low production plasticity; bending with a radius of 500 μm is accompanied by the occurrence of cracks at the tips of the corrugations. The most promising materials for corrugated filters are double layer ones obtained by spraying a powder on wire gauze and fiber ones. Material prepared from Bransmet type fibers using a nonwoven method is highly plastic and corrugates without the formation of microcracks. However, at the present time fibers of the necessary diameter (5–10 μm) are not available in the necessary quantities.

We have developed a double layer filtering material with a high production plasticity based on No. 80/720 serge weave nickel gauze with a 20–30-μm-thick sprayed layer of nickel powder [1]. Two-stage heat treatment of the double layer sheets in hydrogen and vacuum under the optimum conditions provided the material with the required physicomechanical and hydraulic properties.

The adhesion strength of the sprayed powder layer to the gauze and the interparticle cohesion strength of the bond, according to the data of electron microscopic autoradiography, are sufficiently high. This is the result of the coherent bond of the lattice and the sufficiently complete occurrence of the process of self-diffusion of nickel in the two-stage heat treatment of the sheets. The high adhesion strength of the sprayed layer to the gauze and the production plasticity of the material are proven by the results of backward-and-forward bending tests.

The production plasticity of the double layer material and its defect-free corrugatability are determined by the following basic mechanical and structural factors: the adhesion strength of the sprayed powder layer to the gauze and the interparticle adhesion strength, the recrystallized structure, the presence of hydrogen, the amount of residual stresses at the tips of the corrugations, and the thickness of the sprayed powder layer. The mechanical properties of samples not having special clamping portions for clamping of the double-layer porous material in tension were determined on a machine using an original method developed in the Institute of Strength Problems of the Academy of Sciences of the Ukrainian SSR [2–4]. The samples were tested at a strain rate of 1.5·10^{-1} sec^{-1}. The stress-strain curves were recorded on a PDP4-002 two-coordinate plotting potentiometer.

On the basis of analysis of the test results, materials with the optimum combination of strength and plasticity properties were selected and the heat-treatment cycles were determined. The mechanical properties (σ₁, σ₀₂, δ) of the material are dissimilar in different directions (Fig. 1). Samples cut from the sheet at an angle of 15–30° possess the greatest plasticity. The double layer material heat treated in hydrogen and vacuum differs significantly in mechanical properties from the original gauze. The increased values of σ₁ and σ₀₂ are caused by the treatment texture of the original wire of the gauze, which recrystallizes in sintering of the filtering material. The higher the sintering temperature, the more completely the recrystallization softening processes of the gauze wire occur and more the strength of the material drops to lower values. The increase in cohesion interparticle strength of the sprayed powder layer does not influence the general strength of the material. With an increase in treatment temperature to 900–950°C the plasticity of the double-layer material increases. Heat treatment at higher temperatures with longer holds is accompanied by a reduction in plasticity as the result of recrystallization grain growth of the sprayed layer, observed coagulation of the particles, and especially grain growth of the textured gauze wire (Fig. 2).

Moscow. Translated from Poroshkovaya Metallurgiya, No. 6(258), pp. 73-76, June, 1984. Original article submitted February 18, 1983.
Fig. 1. Mechanical properties of material sintered at 500 (1), 700 (2), and 800 (3) °C in relation to test direction (4 is the original gauze).

Fig. 2. Relationship of mechanical properties of the material to sintering temperature in hydrogen: 1, 4) δ; 2, 5) σ_t; 3, 6) σ_0.2. Samples cut along the weft (1-3) and the warp (4-6).

Fig. 3. Structure in tension (failure cracks) of material sintered at 500 (a), 900 (b), and 1200 (c) °C. a, b) 300×; c) 500×.