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EFFECT OF THE AVERAGE VELOCITY OF THE FREE PART OF THE SEMIFINISHED PRODUCT ON THE PROCESS OF PNEUMOTHERMAL FORMING IN THE SUPERPLASTIC REGIME

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Results are presented from two experiments involving the pneumothermal forming of a cellular product of alloy OT4-1 in the superplastic regime. It was determined that the average velocity of the free part of the semifinished product must be taken into account when using a model in which the stresses depend directly on the deformation rate.

Keywords: *pneumothermal forming of disk-shaped parts, superplastic effect, temperature-speed conditions for deformation.*

The process of pneumothermal forming in the superplastic regime cannot be carried out without strictly adhering to the parameters specified for the forming operation. Those parameters are determined by modeling the process and constructing a graph which describes the change in pressure over time with allowance for the constancy of the deformation rate. The graph is usually calculated and plotted by using a model of the material in which the stresses depend directly on deformation rate [1]:

$$\sigma = K\dot{\varepsilon}^m,$$

where K is a proportionality factor; $\dot{\varepsilon}$ is the deformation rate; m is the strain-hardening modulus; and σ is the stress.

The behavior of the material during pneumothermal forming in the superplastic regime is described fairly simply by this model, but many factors are not accounted for. We chose a cellular 1-mm-thick part of alloy OT4-1 (Fig. 1) to study the effect of one of those factors – the average velocity of the free part of the semifinished product.

The first stage of the investigation is the creation of a finite-element model of the semifinished product and the fixture. The model was constructed and the geometry of the elements in the forming operation (Fig. 2) was determined by using the CAD system Siemens NX.

The software package PAM-STAMP 2G, created by the French company ESI Group, was used as the CAE system for modeling pneumothermal forming in the superplastic regime. In accordance with the aforementioned model, material OT4-1 was assigned the following parameters to perform the modeling operation in this software:

- Young's modulus – 112 GPa;

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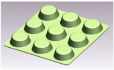

Fig. 1. The part being studied.

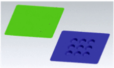

Fig. 2. Semifinished product and fixture for obtaining the part.

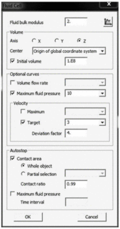

Fig. 3. Specifying the parameters of the liquid cell.

- Poisson's ratio – 0.333;
- density – $4.5 \cdot 10^{-6}$ kg/mm^3;
- proportionality factor 0.114116 GPa;
- deformation rate – 0.004 sec^{-1} [2]; and
- strain-hardening modulus – 0.38 [2].