The representative office of the ESI Group (France), the internationally acclaimed developer of software for computer modeling, would like to direct your attention to a series of articles prepared for an ongoing section of the journal Metallurgist together with our partner in Russia – the PLM Ural – Delkam-Ural Company Group.
This series will be devoted to the mathematical modeling of production processes at modern industrial plants.
In these articles, we will describe examples of the use of software products developed by the ESI Group to solve engineering problems encountered in sheetmetal stamping (including elastic forming and superplastic deformation) and the casting, welding, and heat treatment of metals.
We hope that the material presented in the articles will broaden the potential of mathematical modeling for solving practical engineering problems and will show through practical examples that these software products are an effective tool for saving money and time in manufacturing operations.

FORMING OF TEE PARTS BY A PROCESS THAT COMBINES DIFFUSION WELDING AND PNEUMOTHERMAL FORMING IN THE SUPERPLASTIC REGIME

A. A. Cheslavskaya,[1] V. V. Mironenko,[1]
S. A. Bersenev,[1] and V. V. Kotov[2,3]

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An alternative method is described for making tees. The article discusses the main stages in the advanced method, which combines diffusion welding and pneumothermal forming in the superplastic regime. The process of superplastic pneumothermal forming is modeled and calculated results are reported. In the method, pneumothermal forming is preceded by diffusion welding.
Keywords: *pneumothermal forming of sheet metal parts, superplastic effect, tubular parts made from sheets.*

Parts called "tees" are commonly used in the systems of conduits in aircraft to separate flows of liquid or gas into two flows or to combine two such flows (Fig. 1).

To make such parts, a drop hammer or a rigid die is used to divide a flanged pipe into two symmetrical halves which are then welded. This standard tee-forming technology has several shortcomings:

1) a significant amount of material is lost because of the established tolerances;

2) the finishing operations, involving the stamping and welded of a flanged pipe, are labor-intensive; and

3) it is necessary to use several different types of equipment.

[1] Irkutsk State Technical University, Irkutsk, Russia.
[2] ESI Group, Russian Office.
[3] Yeltsin Ural Federal University (UrFU), Ekaterinburg, Russia; e-mail: viacheslav.kotov@esi-group.com.

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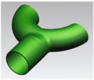

Fig. 1. A part of the tee type.

Fig. 2. Region of application of anti-welding coating.

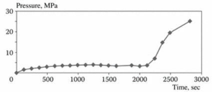

Fig. 3. Graph of the time dependence of pressure obtained from the results of the modeling.

Here, we examine an alternative method of making tees that resolves the above problems – *a process that combines diffusion welding with pneumothermal forming in the superplastic regime.* The part is made from two sheets, as in the traditional technology. However, the new method employs diffusion welding and the desired final shape is obtained by superplastic forming.

First, a template is used to apply an anti-welding coating to the parts of the semifinished product that are not to be welded, i.e., to the parts that will form the channel of the tee. The prepared semifinished product is then placed in a heated jig for diffusion welding and superplastic forming; pressure is created and maintained for the period of time needed to perform the welding operation.

After the welding has been completed, the jig and the accompanying packet of semifinished products is further heated to the temperature at which it becomes superplastic. Then enough pressure is created inside the cavity that is created in order to allow pneumothermal forming of the part while it is in the superplastic state.

Certain temperature conditions must be established in order to carry out the forming operation, the exact conditions depending on the material of the part and the pressure. The pressure is changed during the process to ensure that the defor-