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DETERMINATION OF THE DEFORMATION PARAMETERS OF THE STEEL REINFORCING PHASE INSIDE THE ALUMINUM MATRIX DURING HOT ROLLING

Purpose. Comparison of deformation parameters during rolling of reinforced composites based on aluminum alloy using braided and expanded steel meshes as a reinforcing phase.

Methodology. An experimental study on the effect of pressure on the deformation of the reinforcing phase during rolling of aluminum composites is carried out. A wire mesh and expanded mesh made of stainless steel was used as a reinforcing phase. The effect of deformation on the change in the lattice angle of the reinforcing phase is investigated.

Findings. In this work, experimental data on the parameters of deformation of the wire mesh and expanded mesh are obtained. A comparison is made of the shape change in such grids under hot rolling conditions between two aluminum plates, which play the role of a matrix. It is found that the elongation coefficients of the lattice for the experiment with a wire mesh μ_c is equal to 1.68–2.3, which is greater than the coefficient of elongation of the lattice in the expanded mesh of 1.55–2.2. Therefore, expanded sheets make the best reinforcing layer for aluminum-based composites produced by the roll-bonding process. Expanded mesh also reduces the risk of rupture at the intersection of wires.

Originality. In the work, for the first time, a comparison of the deformation parameters during roll bonding of composites based on an aluminum alloy, reinforced with a braided and expanded steel mesh, has been given. Obtaining composite materials by means of hot roll bonding requires an understanding of the flow of composite components during deformation and their influence on each other. These peculiarities have not been studied sufficiently. Currently, there is no reliable method for predicting the behavior of the material of a solid reinforcing phase of various shapes inside a composite.

Practical value. Advantages of using an expanded steel mesh for reinforcing aluminum-based composites have been confirmed. Scientific results can be used to refine calculating methods for metal flow at high hydrostatic pressure with variable components of the stress tensor and the major stresses.

Keywords: *roll bonding, aluminum matrix, steel mesh inlay, flat rolling, composite, deformation parameters*

Introduction. The article is aimed at research and development of effective technology of hot rolling of sheet aluminum composite reinforced with steel mesh. The development of technologies to produce composite materials by means of hot rolling requires detailed research, given that at present there is no reliable method for predicting the deformation of the solid inserts from the mesh within the package. In addition, an important condition determining the quality of the resulting material is that the pressure welding of the two layers of the aluminum matrix between each other must be ensured during rolling. The object of the research is the behavior of different types of grids in aluminum composite, considering the degree of deformation during roll-bonding of the product. A certain combination of these parameters during rolling provides an increase in the properties of the product, in particular a decrease in specific gravity, an increase in impact energy that can be absorbed, as well as fire resistance. The composites obtained in this way can be used as protective barriers, finishing elements, as well as a blank for further production of structural elements.

Literature review. The properties and characteristics of aluminum materials, including those obtained in metal forming processes, were first described in [1]. The characteristics of metal flow under the action of temperature and strain in this work are described using the dependencies given in [2].

The paper [3], which describes the roll-bonding process, defines the key process parameters and provides a detailed discussion of the scientific and technical aspects that influence the relationship between the microstructure and the mechanical behavior of the processed materials. In addition, the application, and advantages of the process in heterogeneous material joining technologies by hot rolling to produce titanium, stainless steel and carbon steel sheets are discussed. The paper concludes with a discussion of the mechanisms and engineering principles of roll-bonding and suggests possible applications for future research.

A new study [4] presents numerical and experimental studies on the change in the shape of the reinforcing insert in the aluminum-steel mesh-aluminum package during roll-bonding. The diameters of the rolls used during rolling, pressure and temperature affect the resulting mechanical properties, i.e., the energy absorbed. As a rule, reinforced products exhibit up to 20 % higher impact energy compared to unreinforced composites [4].

The research aimed at studying the rolling process of composite products described in [5]. The authors investigated composites based on alloys EN AW 6063 and EN AW 5056 with different orientation of the mesh fibers. It was found that aluminum plates reinforced with steel mesh at an angle of 45° to the rolling direction show the best mechanical properties compared to products with the arrangement of the reinforcing phase at a different angle to the rolling direction. In a study [6], the authors concluded that the wire mesh insert increases the tensile strength of the entire product if there is sufficient connection between the matrix and wire layers. A similar conclusion was obtained in [7], where a solid aluminum substrate (a compound of solid and liquid casting and rolling) was processed into a composite material by two-roll casting. In this case, the hardness of AA1060 aluminum was increased by almost 30 % by using an AISI 304 austenitic steel mesh.

The assumption of complete connection between the two layers of aluminum matrix was made based on a previous study [7], which found that diffusion adhesion between steel mesh and alu-