Chapter 16
Linear Electromechanical Transducer in the Systems of Welded Joints of Electrodynamic Processing

Andrii Zhyltsov
National University of Life and Environmental Sciences of Ukraine, Ukraine

Igor Kondratenko
National Academy of Sciences of Ukraine, Ukraine

Vyacheslav Vasyuk
National University of Life and Environmental Sciences of Ukraine, Ukraine

ABSTRACT

This chapter is dedicated to establishing characteristics relationships between the induction type impact electromechanical transducer and parameters and quality indicators of electrodynamic effects on the welded joints. The authors developed two-dimensional circle-field mathematical model of transient discharge capacity at the branched electrical circuit with the coil inductance which changes dynamically, allowing by adjusting the parameters of the electromechanical transducer to achieve the necessary technological requirements for the characteristics of electrodynamic processing. Based on mathematical modeling of electrophysical processes in electromechanical transducers, induction type for electrodynamic processing of welded joints, reasonably geometrical parameters massive disk, and the contact area, the necessary conditions are created to reduce residual stresses in the weld joints.

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INTRODUCTION

Welding is one of the most common methods of metal bonding, which, in comparison with other types of integral joints, has significant advantages. However, the welding process also has drawbacks, one of which is the emergence of residual stresses and deformations, which can adversely affect the quality of the welded structure.

Residual or technological ones are called stresses that exist in the design or in its individual elements in the absence of external power, heat or other influences. In technology, for the purpose of designating residual stresses, the names of technological processes are used, after which they are found: welding stresses, deformation stresses, stresses of hardening, stresses of processing.

The presence of welding residual stresses is one of the reasons for reducing the resource of metal structures by influencing their characteristics of fatigue strength, corrosion resistance and residual molding. The reason for this is the uneven linear or volumetric deformations of adjacent volumes of metal. In the weld and in the zone around it there is a tensile stress, which is close to the threshold of the fluidity of the metal and even exceeds it. In some cases, welding stresses and deformations lead to the destruction of the welded structure, and as a consequence, affect the reliability and durability of the process equipment.

The objective of reducing welding residual stress can be solved in different ways processing: rolling, forging, heat processing, vibration processing, ultrasonic processing, and the shock and explosive load and others. Listed weld processing methods have certain disadvantages, which include the need to create energy and metal-intensive technological equipment, restrictions during processing large structures and significant energy costs.

A promising way to increase the life of welded joints is the method of electrodynamic processing based on the use of effect electroplastic deformation, which is characterized by ease of implementation, reducing process time by several times, the possibility of local action, low energy costs and leads to a decrease in residual stresses by 50-65%. Thus, provided that the current density in the metal reaches a value more than 10^9 A/m^2 and upon application of compressive forces at the level of 20 kN, the effect of electroplasticity is manifested, which consists in the relaxation stress-strain state of metallic materials.

However, despite the widespread use of the phenomenon of electroplastic deformation, the mechanisms that govern this phenomenon are not yet fully known. We can assume that in the process of local elastic discharge, the determining contribution belongs to the intensive dislocation interactions that are caused by the flow of electric current. These interactions depend on the parameters of the current pulse: the shape of the pulse, the amplitude, the duration of the front, and others.

The realization of this pulsed electromagnetic effect can be achieved by electrodynamic processing, which is the simultaneous action of electrodynamic force and current. During the passage of the current through the metal being processed and the action of the pulsed electromagnetic force, deformation processes are initiated, the interaction of which with the welding stress causes residual plastic deformation. The consequence of such interaction is to reduce the level of residual tensile stresses or their transformation into compression stresses, which positively affects the lengthening of the resource of welded joints. The advantages of using this processing are the possibility of a local action, which will enable the processing of objects of any shape and size at low energy costs.

The electrotechnical system for the implementation of electrodynamic processing can be constructively performed as a linear electromechanical converter of induction type of percussion action, which allows you to simultaneously provide both a force effect and transmit a current pulse through a contact electrode