INTENSIFICATION OF ELECTROCHEMICAL RESTORATION OF AGRICULTURAL MACHINERY PARTS THROUGH MASS TRANSFER CONTROL

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Abstract: *This paper examines the main mechanisms of mass transfer during the electrochemical restoration of worn agricultural machinery parts. The influence of diffusion, migration, and convection on the supply of ions to the cathode surface and the formation of the restoration layer is demonstrated. The relationship between the hydrodynamic regime, current density, temperature, and electrolyte concentration with the stability of electrodeposition is established. The feasibility of mass transfer control for improving coating uniformity and the productivity of restoration is substantiated.*

Key words: *electrochemical restoration; worn parts of agricultural machinery; mass transfer; electrodeposition; diffusion; migration; convection; hydrodynamic regime; current density; electrolyte; restorative coating.*

Under intensive use conditions of machinery and tractors in the agro-industrial complex, a significant proportion of failures are due to wear on the working surfaces of components. Electrochemical restoration allows for the formation of a metal layer directly on the worn surface, restoring the geometric dimensions and operational properties of the component. The effectiveness of the process is determined not only by the electrochemical reaction but also by the conditions under which the substance is supplied to the cathode.

The electrode process involves the movement of particles from the bulk of the electrolyte to the electrode surface, electrochemical conversion, and incorporation of the resulting substance into the growing layer. Mass transfer is achieved through the combined action of diffusion, migration, and convection. Diffusion is driven by the

concentration gradient, migration by the action of the electric field on charged particles, and convection by the movement of the electrolyte. The coordination of these mechanisms determines the rate at which reacting ions reach the surface.

Gas formation and thermal processes also influence mass transfer. Hydrogen evolution at the electrode can generate circulating electrolyte flows, while Joule heating alters the temperature and density of the solution and can enhance natural convection. However, excessive mixing is not an end in itself: a rational regime must ensure a uniform flow of ions to the surface without disrupting the formation of the metal layer.

Thus, it is appropriate to consider electrochemical restoration of agricultural machinery parts as a controlled electrochemical- hydrodynamic process. Optimizing the electrolyte flow rate, current density, temperature, and solution concentration helps stabilize mass transfer and improve deposition uniformity. This approach is of practical interest in restoring shafts, bushings, seats, and other working surfaces subject to abrasive wear and variable loads.

A promising area for further research is to determine a rational combination of electrical and hydrodynamic parameters for specific component materials and electrolyte compositions. This will improve the productivity of repair and restoration operations, reduce material consumption, and ensure more consistent performance of restored components.

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INCREASING THE DURABILITY OF AGRICULTURAL MACHINERY PARTS UNDER ABRASIVE WEAR BY SURFACE HARDENING

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Abstract. *This article examines the wear characteristics of agricultural machinery components operating under intense abrasive conditions. The influence of hard mineral particles, contact pressure, relative displacement, impact loads, and surface condition on damage formation is analyzed. The need for a comprehensive*