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SURFACE ROUGHNESS DIAGNOSTICS DURING ELECTROLYTIC PLASMA POLISHING OF STAINLESS STEEL

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Electrolytic plasma polishing (EPP) is advanced atmospheric plasma assisted electrochemical process which is used for polishing of stainless and low-carbon steels, titanium and nickel superalloys. The benefits of the EPP are environmental safety and high performance. The drawbacks are phenomena non-linearity and increased power consumption. To overcome the drawbacks, a diagnostic approach providing estimation of the surface properties during the treatment is proposed. Realization of this approach increases the polishing accuracy, and it contributes to the reduction of the power consumption and improvement of the workpiece rejection rate.
An experimental study dedicated to the electrolytic plasma polishing of stainless steel BS420S29 was carried out according to a full-factorial design with four factors: treatment time 3-5 min, voltage 250-350 V, temperature 70-90 °C and initial surface roughness Ra 0.3-0.6 μm. The evolution of the resultant surface roughness Ra and geometric size change h was adequately approximated by exponential and linear functions, respectively. Relations between the coefficients of the functions, and input and process parameters were uncovered. As a result, diagnostic models providing estimation of the surface roughness and geometric size change were developed. The simplest model is of a linear regression type; it takes into account the voltage, temperature, current density and initial roughness. The advanced model is a neural network also taking into account the in-situ impedance spectra and providing more accurate estimates.
Finally, the diagnostic mathematical models which evaluate the surface roughness and geometric size change during the EPP treatment were implemented into software. The models provide high accuracy (R^2 = 0,95..0,98) of the surface properties estimation, reduce the workpiece rejection rate twice, and they constitute a key element of a smart automated process control system for the EPP treatments.

Keywords
electrolytic plasma polishing
surface properties estimation
diagnostic mathematical model
reduction of workpiece reiection rate
environmental safety