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Assessment of coil design and pulse unit parameters for the optimization in the electromagnetic forming process of metal sheet

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Electromagnetic forming (EMF) is a high-speed forming process that has recently been explored in modern industrial applications to extend the forming limits of magnesium alloy or aluminum metal sheets. In this study, an experimental and statistical approach using analysis of variance (ANOVA) and response surface methodology (RSM) techniques is used to find the significant main and interaction effects to verify the relationship between controllable factors of the process and achieved displacement of the metal sheet. An experimental investigation is proposed using controllable factors involving the design of the actuator coil and the pulse unit parameters, such as capacitance, electrical potential, number of windings and pitch of the coil. The statistical software Design Expert is used to aid experimenters in selecting and constructing the experimental design, aiming randomization, replication, and blocking. Further, the design of the experiment is carried out using a factorial design method to study the joint effect of the controllable factors on the metal sheet displacement. The Matlab commercial software is also used to perform the ANOVA to verify the statistical significance of the main and interaction effects of controllable factors. The major aim of this paper is to conduct a factorial experimental design to find factor settings that maximize the free bulging displacement of metal sheets by the EMF process using a proposed and adequate regression equation. In addition, the combination of analyzed parameters for maximizing displacement of metal sheets is established according to desired criteria. Finally, design principles for the free bulging of metal sheets by EMF are outlined based on experimental and statistical methods. These results can contribute for spreading industrial applications of EMF process by introducing statistical approaches for the optimization of it.

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