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Optimum field shaper design for electromagnetic forming by balancing trade-off among energy efficiency, field distribution, and thermo-mechanical loadings

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Field shaper is a powerful supplement for the magnetic field generator (namely, the driving coil) in electromagnetic forming (a high velocity manufacturing technology), which utilizes the magnetic shielding effect of deticated-shaped electrical-conductor to alter the path of the pulsed magnetic field, so as to obtain the desired spatial distribution for the magnetic field as well as the pulsed Lorentz force induced on the metal workpiece, thus shaping the metal workpiece into targeted geometry. In addition, the introduction of the field shaper may also essentially relieve the mechanical and thermal loadings on the driving coil, which is a critical issue for high performance life for the field generator.
This paper shall give an overview for the design and utilization of the field shaper. Adopting one type of most commonly-used field shaper, namely, the field shaper for tubular metal workpiece, as example, we shall discuss how to balance the trade-off of the energy efficiency, the targeted magnetic field distribution, and the thermal-mechanical loadings on the coil, thus targeting an optimum performance. And we shall validate our deduction by a combinations of experiment and simulation. While the paper is mainly focused on the applications of pulsed magnetic field in manufacturing industries, we think the content may stimulate a wide interest for the researchers in other area, especially for research area needing a flexible spatial pattern for the high pulsed magnetic field.

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