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Simulation-Based Parametric Study for the Hybrid Superplastic Forming of AZ31

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Abstract : As the lightest constructional metal on earth, magnesium alloys offer excellent potential for weight reduction in the transportation industry, and it was observed that some magnesium alloys exhibit superior ductility and superplastic behavior at high temperatures. The main limitation of the superplastic forming (SPF) includes the low production rate since it needs a long forming time for each part. Through this study, an SPF process that starts with a mechanical pre-forming stage is developed to promote formability and reduce forming time. A two-dimensional finite element model is used to simulate the process. The forming process consists of two steps. At the pre-forming step (deep drawing), the sheet is drawn into the die to a preselected level, using a mechanical punch, and at the second step (SPF) a pressurized gas is applied at a controlled rate. It is shown that a significant reduction in forming time and improved final thickness uniformity can be achieved when the hybrid forming technique is used, where the process achieved a fully formed part at 400°C. Investigation for the impact of different forming process parameters achieved by comparing forming time and the distribution of final thickness that were obtained from the simulation analysis. Maximum thinning decreased from over 67% to less than 55% and forming time significantly decreased by more than 6 minutes, and the required gas pressure profile was predicted for optimum forming process parameters based on the 0.001/sec target constant strain rate within the sheet.

Keywords : magnesium, plasticity, superplastic forming, finite element analysis
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