

Heuristic design of U-shaped die cooling channel for producing ultra-high strength steel using hot press forming

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ABSTRACT

This paper proposes an optimised cooling channel design for a U-shaped die in the hot sheet metal forming process using a heuristic method. Unlike in previous works, the parameters used in this study for optimising the cooling channel design not only consider the pitch between and diameter of cooling channels but also their distance from the tool surface and wall tool. The cooling channel design is optimised by coupling the heuristic method with finite element thermal and static analyses. The main factors to be considered in the optimisation include the highest heat transfer and the lowest stress that can be achieved by the optimum cooling channel die design. The optimum design was determined by conducting a simulation and was validated by conducting an experiment. The temperature distribution of the FEA model was at most 5% different from the experimental results. The optimum cooling channel design of hot press sheet metal forming can produce ultra-high strength steels which tensile strength and hardness are 51 and 83% greater than those of original boron steels. The heuristic method can also be applied to optimise the cooling channel die design for the production of ultra-high strength steels in the automotive manufacturing industry.

KEYWORDS:

Hot press forming; Cooling channel design; Heuristic optimization; Ultra-high strength steels; Finite element analysis