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3D FE modelling of die stress and wear in non-isothermal forging of Ti–6Al–4V turbine blade

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ABSTRACT

Non-isothermal forging as one of the production methods is widely used in titanium alloy turbine blade forming operation. The efficiency of the forging process is tightly related to the tool service life, which is mainly limited by high stress and die wear. To predict die failure and enhance die service life of the blade forging process, first, a 3D coupled thermo-mechanical finite element (FE) approach using a modified Archard's wear model is employed to simulate the real movements and processing conditions of the turbine blade body. Second, the distributions of die stress and wear depth are numerically estimated. Finally, the effects of process parameters, including the forging velocity, friction factor, initial workpiece temperature, and die temperature, on the die stress and wear depth are investigated. The numerical results show that the high stress concentrates on the middle area of the lower die, the place where the slightest die wear occurs. Moreover, the forging parameters have multiple effects on die wear behavior. This work can be served as a basis for selecting reasonable forging variables, predicting die life, and reducing production cost in the hot forging operation of titanium alloy turbine blade.

KEYWORDS: blade forging, titanium alloys, die stress and wear, finite element method, process parameters