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Void closure and the sensitivity analysis of the process parameters during forging of large steel ingot

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ABSTRACT

In this paper, numerical and factory tests were performed for the investigation of void closure and the sensitivity analysis of the process parameters during forging in a 17-tons steel ingot using Deform-3D software. Recent results show that the effective strain and hydrostatic stress are the determining factors for evaluating the void closure. The effects of process parameters during forging on the effective strain and hydrostatic stress distributions were investigated by the orthogonal simulation design. Results show that increasing the deformation degree, the deformation rate in the range from 0.01 to 0.05 s^{-1}, lowering the height–diameter ratio from 1.4 to 2.0 and increasing the value of from 0° to 8° are all beneficial to the void closure and deformation uniformity. The deformation degree is remarkable regarding the effective strain in the core. The remarkable factors that affect the hydrostatic stress in the core are as follows according to the response degree from high to low: deformation degree, height–diameter ratio, and deformation temperature. The order regarding the effective strain in the contact surface is as follows: angle of inclination, deformation rate, and deformation degree. The order regarding the hydrostatic stress in the contact surface is as follows: deformation degree, deformation rate, deformation temperature, and height–diameter ratio. The upsetting process were set as follows: the deformation degree 60%; the deformation temperature 1200°C; the deformation rate 0.05 s^{-1}; the height–diameter ratio 1.7. After forging, the grade for inspected was 4. The microstructures are uniform.

KEYWORDS: void closure, microstructure, effective strain, hydrostatic stress, upsetting