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Abstract
Hexagonal bolts are mostly formed by cold heading process. Cold heading is a kind of open-die forging process and its die design is relatively simple, however there is an additional trimming process required after the mushroom head is formed in cold heading. The amount of the trimmed scrap can be significant in forming with short bolts. Therefore reducing the scrap has become demanding when the bolts are to be produced of high alloys. This work adopted the concept of near-net-shape forging in the forming process of hexagonal bolts. FE software DEFORM 3D was applied in verifying the validity of the proposed near-net-shape die designs.
By successive trials, there were four die designs tested with the simulation. The effect of the taper angle of the first forming stage on the overfill and forming load was investigated. It was found that the optimum taper angle was 12° in obtaining minimum overfill and forming load. The effect of the friction factor of the fourth die design was also investigated. It shows that with the control over the friction factor, near-net-shape forming of hexagonal bolts can be achieved.
Backward extrusion and heading with counterpressure were applied in pursuit of near-net-shape forming of hexagonal bolts. The simulation showed that by controlling the counterpressure along the six faces of the bolt head, metal flow toward both the diagonals and the bolt faces can be adjusted. The forming load is the minimum when the counterpressure is 30 % of the yield strength of the workpiece. Additionally, forming load of heading with counterpressure is less than that of backward extrusion with counterpressure. The results can be used as the die design guide for near-net-shape forming of hexagonal bolts.
Keywords: hexagonal bolts, cold heading, near-net-shape, counter-pressure forging.
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