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Fabrication and Performance Analyses of 45# Steel Supports using Liquid Forging

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Keywords: 45# steel; Liquid forging; Numerical simulation; Mechanical properties; Wear resistance; Fracture behavior.

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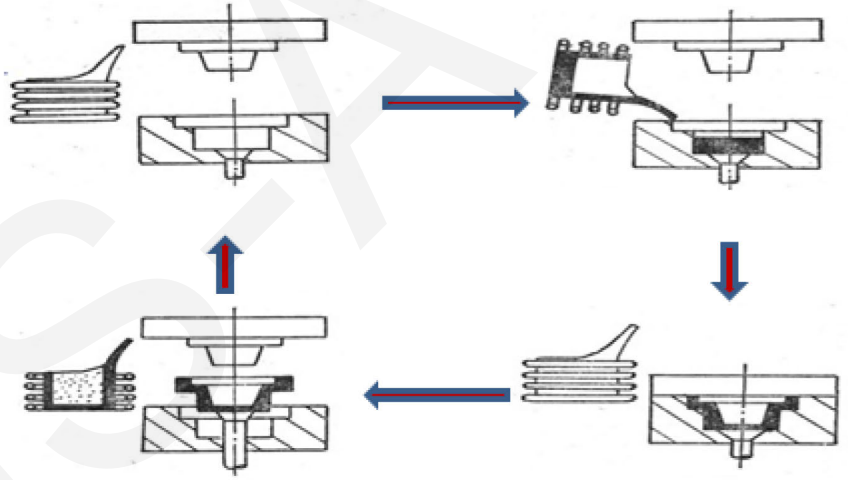
The problems

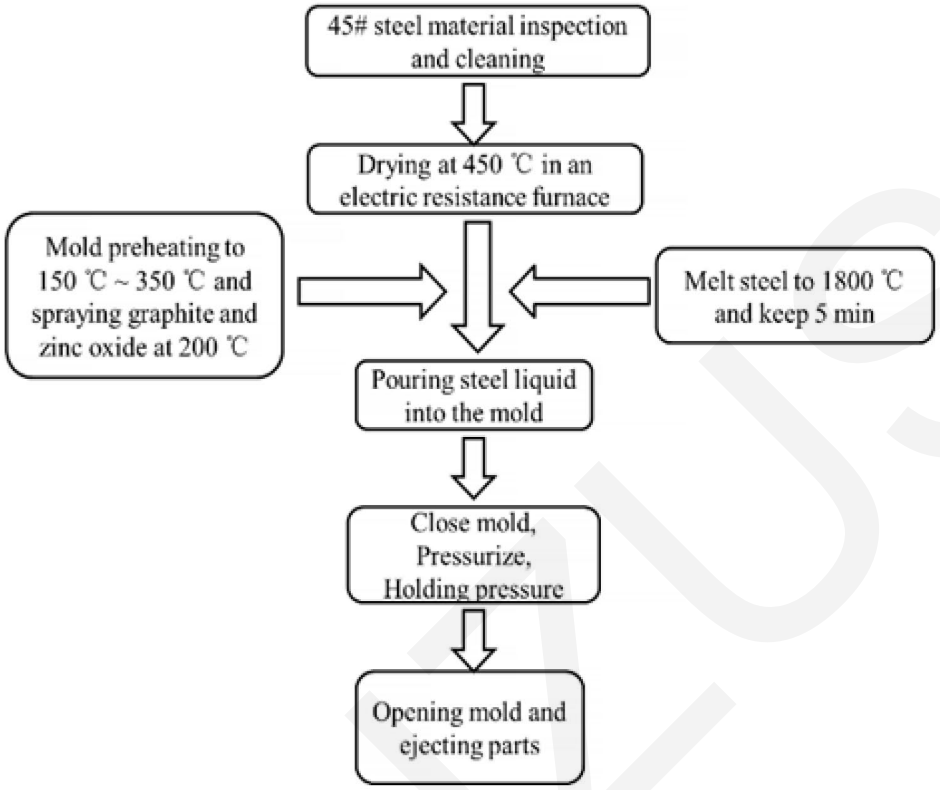


Liquid forged steel is widely used in the automotive industry, for military supplies, and in aerospace technology.

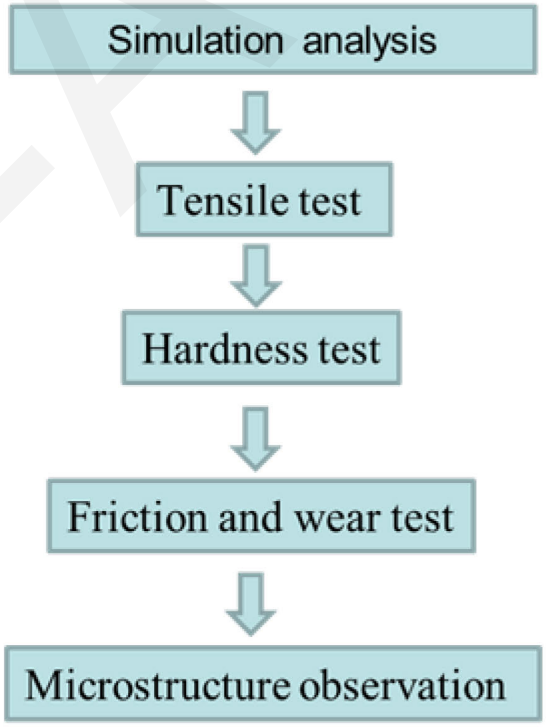
The process of liquid forging is relatively complex, however, as it encompasses fluidics, heat conduction, and some plastic deformation.

It is of vital importance to fabricate the liquid-forged steel parts with excellent properties by optimizing process parameters.

The experiments

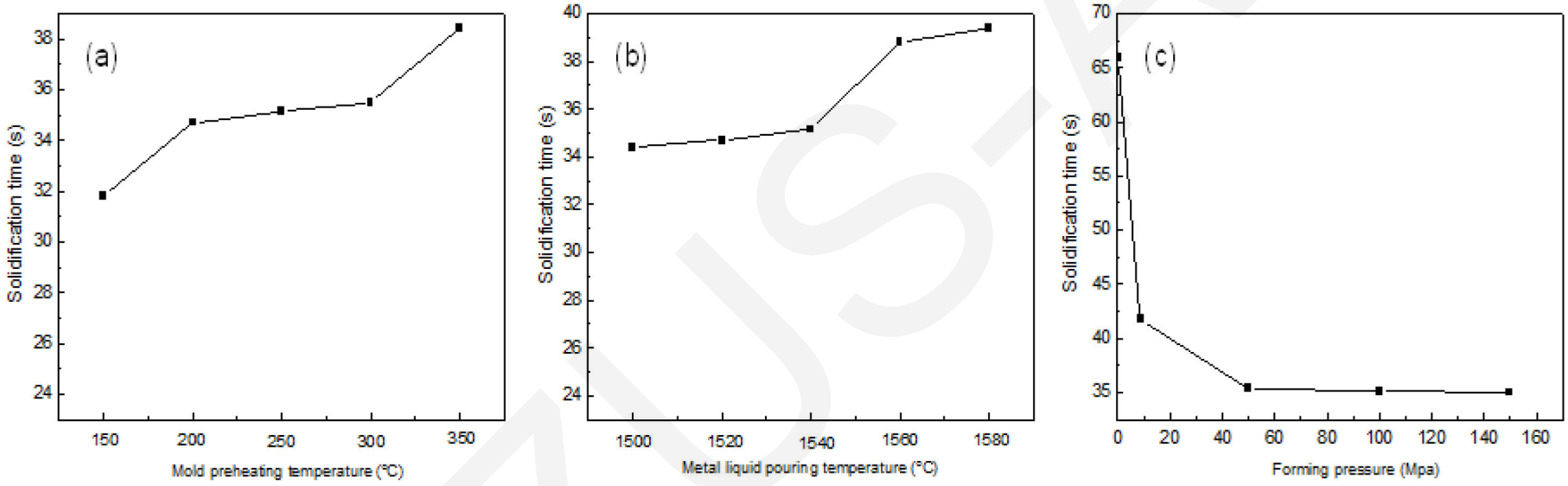


Liquid forging process



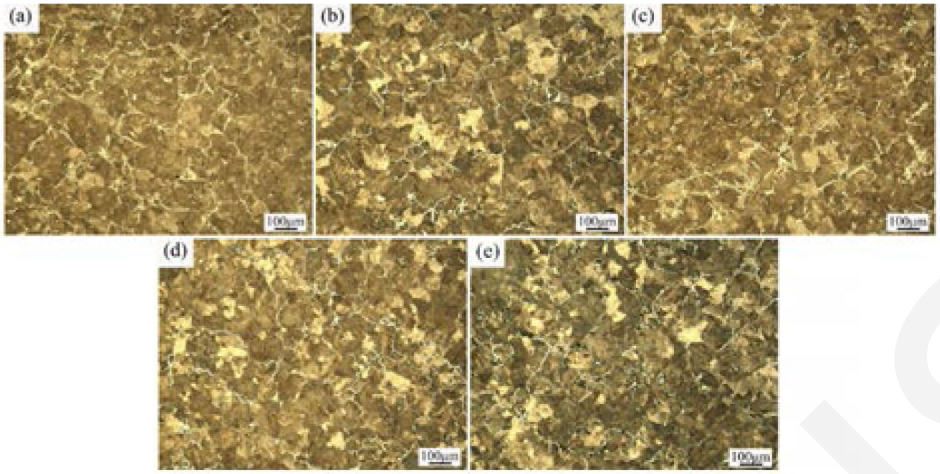
Performance analyses

The main results



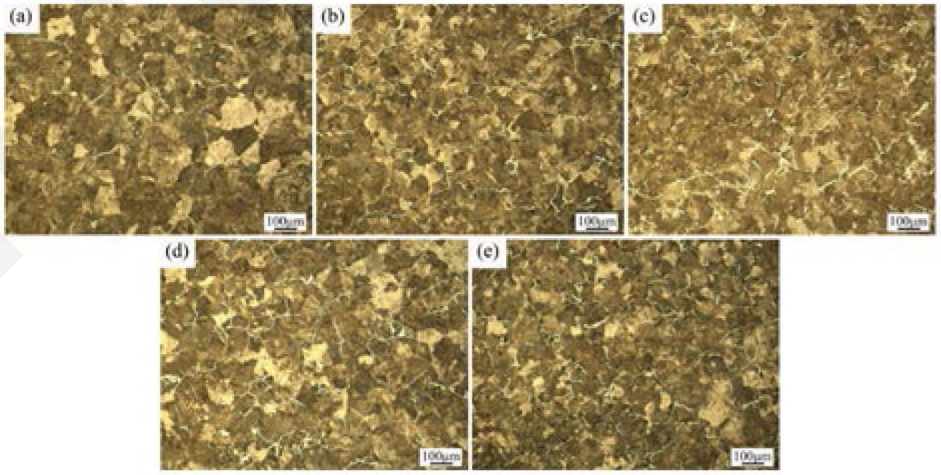
Solidification time varies with:
(a) mold preheating temperature; (b) metal liquid pouring temperature, and; (c) forming pressure.

The main results

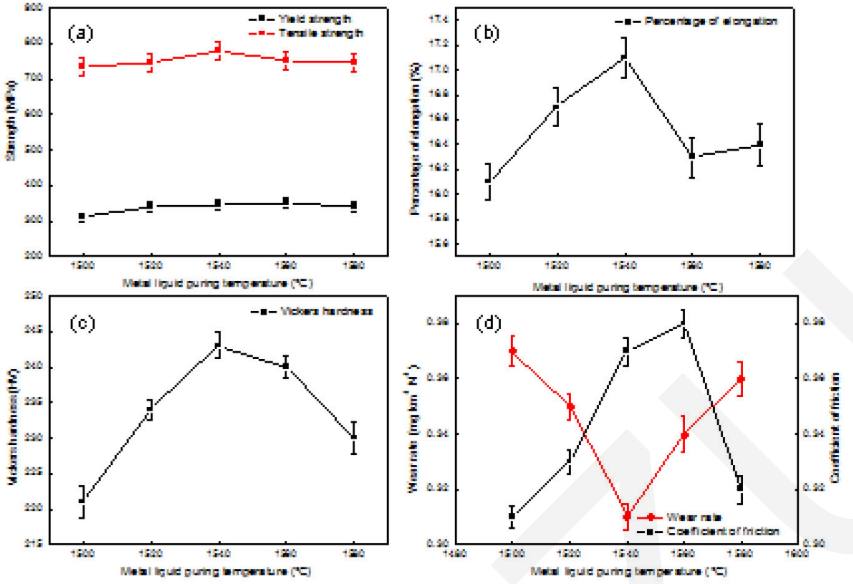


Edge optical micrographs at different pouring temperatures:
(a) 1500 °C; (b) 1520 °C; (c) 1540 °C; (d) 1560 °C; (e) 1580 °C.

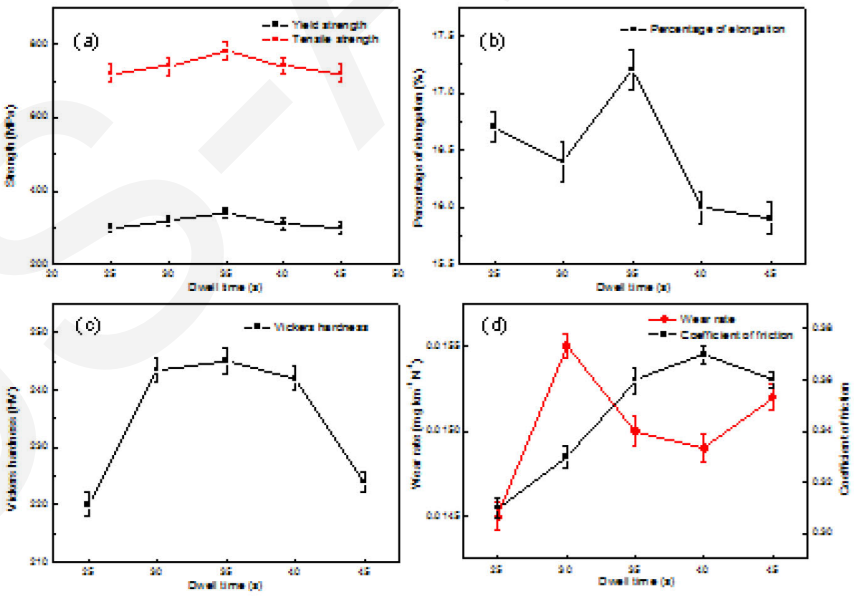
Edge optical micrographs under different dwell times:
(a) 25 s; (b) 30 s; (c) 35 s; (d) 40 s, and; (e) 45 s.



The main results

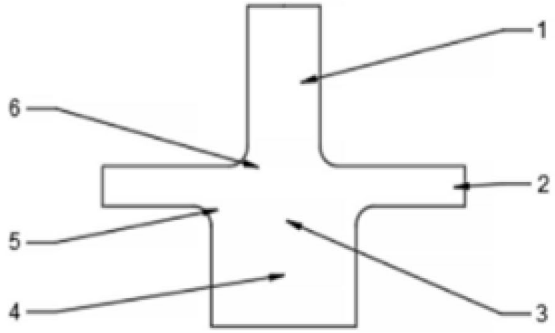


Edge properties at different pouring temperatures:
(a) strength; (b) percentage of elongation; (c) hardness, and; (d) wear properties.

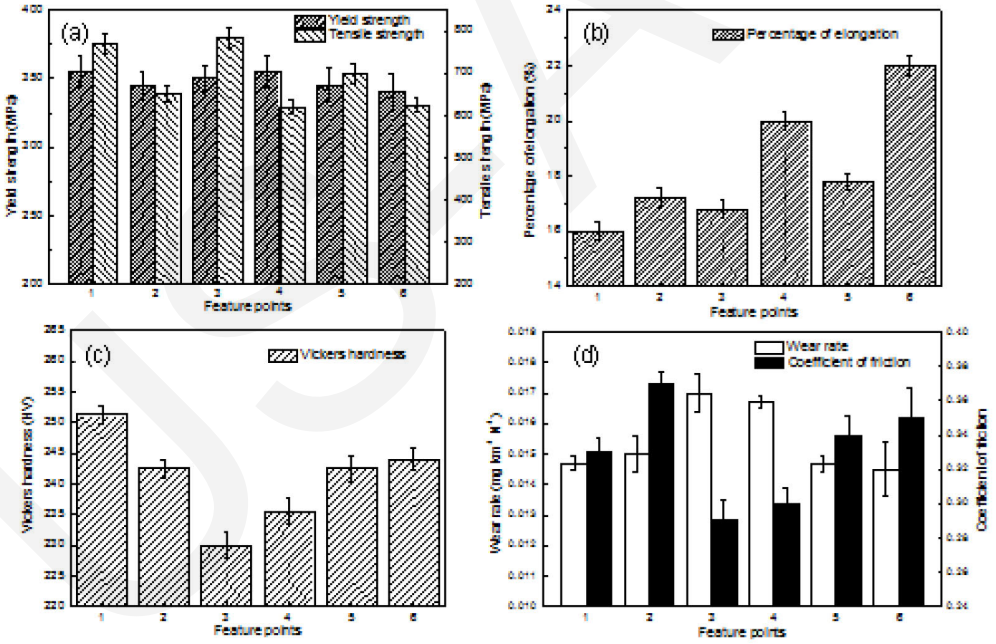


Edge properties under different dwell times:
(a) strength; (b) percentage of elongation; (c) hardness, and; (d) wear properties.

The main results

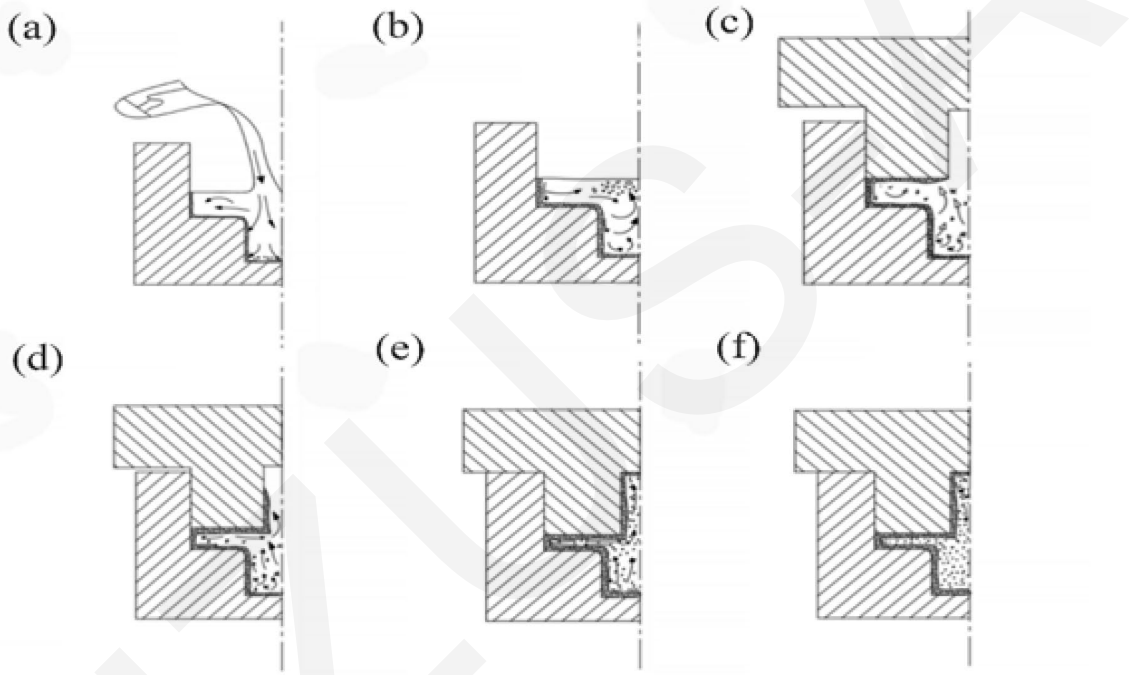


Optical micrograph sampling positions



Properties of different support positions:
(a) strength; (b) percentage of elongation; (c) hardness, and; (d) wear properties.

The main results



Schematic to show the liquid forged forming process of 45# steel supports:
(a) mechanical scouring; (b) free convection of metal liquid; (c) complex free convection;
(d) inter-dendritic convection; (e) plastic deformation, and (f) reverse convection.

The conclusions

- 1. Optimal pouring temperature of the molten metal and pressure-holding time were between 1540 ℃ and 1560 ℃ and 35 s and 40 s, respectively.
- 2. 45# steel supports prepared by liquid forging at a pouring temperature of 1540 ℃ and dwell time of 35 s had the optimum combination of properties. Tensile strength, percentage of elongation, Vickers hardness, and friction coefficient of the middle disc edge were 783.4 MPa, 17.1%, 242.7 HV, and 0.36, respectively.
- 3. Performance of different positions in the support did not vary significantly; the central position performed better than the edge because of plastic deformation.
- 4. The liquid forging process of 45# steel supports was complex and contained some special metal liquid convection and several plastic deformation stages. The properties of these supports are therefore excellent.