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基于有限元模拟的空拔铜管拉拔参数的优化

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摘 要： 为研究拉拔参数对铜管空拔变形的影响，运用非线性有限元分析软件对铜管空拔过程进行仿真，分析空拔过程中铜管与模具的轴向及径向应力分布规律，并以此阐述空拔铜管的缩径缺陷。利用正交实验法模拟研究拉拔参数(工作锥半角α、过渡圆弧半径R、定径带长度L、摩擦因数μ、拉拔速度v)对铜管空拔的影响，并采用极差分析和方差分析对模拟结果进行分析，得到铜管一定减面率条件下的最佳拉拔参数(α=9°，R=5 mm，L=2 mm，μ=0.05，v=100 m/min)及各因素对分析指标的影响。在此基础上对优化方案进行数值模拟，模拟结果表明了正交实验对铜管空拔参数优化的有效性。这对实际中提高铜管空拔质量，延长模具寿命有重要的指导意义。

关键字： 空拔；铜管；拉拔参数；有限元；正交实验法

Optimization of drawing parameters for copper tubes withhollow sinking based on FEM simulation

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Abstract: In order to investigate the influence of drawing parameters on the deformation of copper tubes in hollow sinking, the nonlinear finite element software was used to simulate the whole copper tube hollow sinking process. The distributions of the axial stress and radial stress were analyzed, and the mechanism of drawn copper tubes diameter shrinking was explained. The influences of drawing parameters (the semi-angle of drawing dies α, the transition arc radius R, the length of bearing part L, the friction coefficient μ, the drawing velocity v) on copper tubes hollow sinking were investigated by using orthogonal experiment. The optimal drawing parameters (α=9°, R=5 mm, L=2 mm, μ=0.05, v=100 m/min) under certain reduction of area and the influence of factors on analysis indexes were obtained according to the simulation results by range analysis and

variance analysis. Furthermore, the optimal drawing parameters were simulated by FEM, and the simulation results confirmed the effectiveness of the orthogonal experiment in optimizing tubes drawing in hollow sinking. It is of great significant for improving the quality of drawn copper tubes and prolonging the lifetime of drawing dies.

Key words: hollow sinking; copper tube; drawing parameter; finite element; orthogonal experiment

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