

锥形方管无模拉伸断面形状变化的实验

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摘 要: 对锥形方管进行无模拉伸基础实验研究. 探讨各种工艺参数对锥形方管外形、断面形状和锥度变化的影响, 分析方管无模拉伸时断面圆化程度的影响因素及影响规律, 并提出减轻断面圆化程度的具体方法. 研究表明, 采用无模拉伸的方法可以加工带有一定锥度的锥形方管, 锥管角精度在 1.0% 以内, 加工后锥形方管的轮廓与控制曲线的计算结果一致性很好; 方管拉伸断面形状膨胀率随着拉伸变形区宽度增大而减小; 壁厚较大, 断面形状膨胀率较小, 当壁厚和变形区宽度都比较大时, 几乎不产生膨胀现象.

关 键 词: 无模拉伸; 锥形方管; 锥管角精度; 断面形状膨胀率; 变形区宽度

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Experiment Study on Section Shape Variations During Tapered Square Pipe Dieless Drawing

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Abstract: Dieless drawing of tapered square pipe was carried out. The influences of process parameters on the variation of pipe profile, section shape and conical degree were studied. The influence factors and law on the section rounding of square pipe were analyzed and the methods of alleviating rounding factor were given out. In the experiments, square section steel pipes were mainly used, and tapered pipes with large angles were obtained. The drawing precise can be conducted within an error of 1.0% in taper angle. The tapered pipe profile drawn by dieless drawing is in good agrees with the calculated ones. The expansion rate of section shape decreases with the increase of deformation width. The thicker the wall, the larger the expansion rate. When the wall thickness and width are all relatively large, the expansion is relatively little.

Key words: dieless drawing; tapered square pipe; cone angle precision; section shape expansion rate; deformation width

锥形方管是由板料冲压成形后焊接而成的, 其生产效率低, 成品尺寸精度差^[1-2]. 在本实验中, 讨论用无模拉伸方法加工锥形方管, 主要研究变形区域宽度等工艺参数对方管断面形状、表面质量和锥形方管锥度等影响规律.

1 实验方法

锥形方管无模拉伸方法如图 1 所示. 无模拉

伸时拉伸速度 v_1 与冷热源移动速度 v_2 的比值决定断面减缩率 R_s 的大小, 拉伸中 v_1 (或 v_2) 一定, 使 v_2 (或 v_1) 发生变化, 都可以加工锥形方管^[3-6].

在实验中使用的是 20 mm × 20 mm, 壁厚 1.2 ~ 2.3 mm 的普通碳素方形钢管. 拉伸速度 v_1 为 5.0 ~ 2.5 mm/min, 加热线圈移动速度 v_2 为 40 ~ 75 mm/min, 加工温度为 800 ℃, 实验在无模拉伸试验机上进行.

20% ,边长减少率随着变形区宽度的增加而增加,变形区宽度越大,边长减少率也越大. 断面减缩率为 20% ,变形区宽度 W 对方管壁厚减少率 ν 的影响如图 6 所示,随着变形区宽度 W 减小,壁厚减少率 ν 增大.

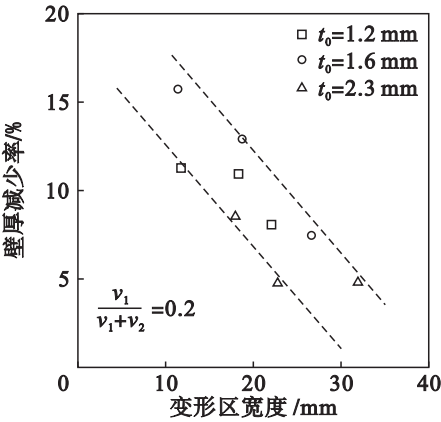


图 6 壁厚减少率与变形区宽度的关系
Fig. 6 Relationships between reduction rate of wall thickness and deformation width

由实验结果可知,变形区宽度 W 较小时,壁厚减少率 ν 增大,主要是管的壁厚减小. 变形区宽度 W 较大时,边长减少率增大,主要是管的边长减小.

当断面减缩率为 20% 时,变形区宽度 W 对方管断面形状缺陷膨胀率 η 的影响如图 7 所示. 对于各种不同的壁厚 t_0 ,变形区宽度增大,断面形状缺陷膨胀率减小. 壁厚增大,也会使断面形状缺陷膨胀率减小. 例如,当 $t_0 = 2.3 \text{ mm}$, $W = 33 \text{ mm}$,即壁厚和变形区宽度都比较大时,则几乎不产生膨胀现象.

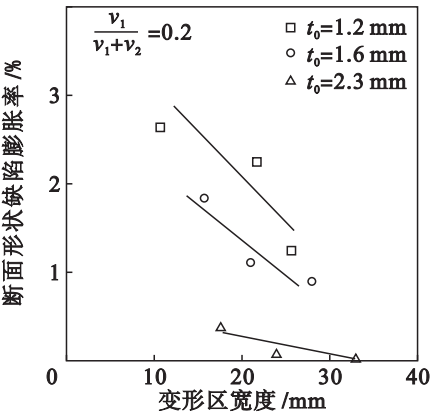


图 7 断面形状膨胀率与变形区宽度的关系
Fig. 7 Relationships between section shape expansion rate and deformation width

锥形方管拉伸断面膨胀率随断面减缩率的变化规律如图 8 所示. 3 圈线圈加热时断面膨胀率最小. 同时,断面减缩率增大时,断面膨胀率相应增大,断面减缩率减小时,断面膨胀率也减小.

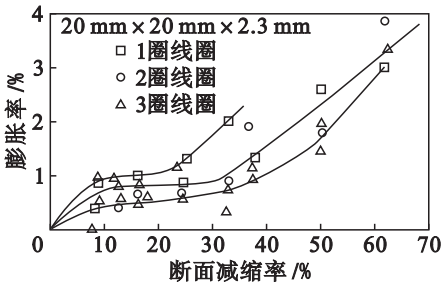


图 8 断面膨胀率随断面减缩率的变化
Fig. 8 Relationships between expansion rate and reduction rate

如上所述,要得到较高的锥角加工精度,需要采用较小的变形区宽度;考虑抑制膨胀现象,则应采用较大的变形区宽度. 提高锥角加工精度与抑制断面形状膨胀对变形区宽度要求不同.

2.2 锥形方管锥度

锥形方管加工后边长与轴向尺寸的关系如图 9 所示. 实验中采用的加热线圈为 2 圈, ν_1 按 5—10—15—20—25 mm/min 阶梯变化,时间间隔 40 s, ν_2 保持定值 40 mm/mim,最终的工件加工轮廓与计算结果一致性很好.

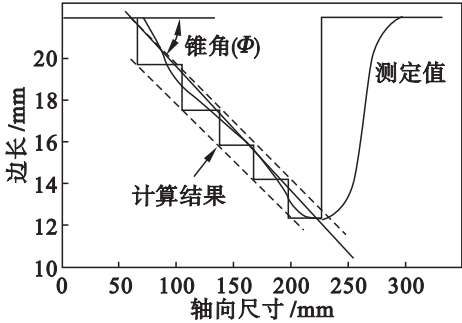


图 9 拉伸后边长相对轴向尺寸变化
Fig. 9 Variation of side length along longitudinal direction of pipe after drawing

工件加工后锥角 Φ' 与设计锥角 Φ 的关系如图 10 所示. 采用 1 圈或 2 圈加热线圈时,加工件

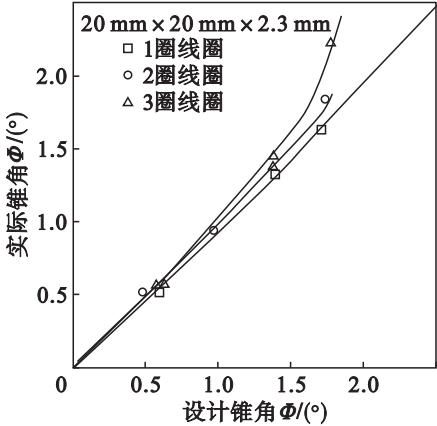


图 10 成品锥角与设计锥角的关系
Fig. 10 Relationship between experimental taper angle of products and calculated ones

的锥角与设计锥角相对一致,加工件的锥角与设计锥角的误差在 $\pm 1.0\%$ 以内.采用3圈加热线圈时加工件锥角较设计值偏大.

3 结 论

1) 在断面减缩率一定的条件下,方管边长的变化由无模拉伸变形区宽度(加热宽度)决定,变形区宽度 W 越大,边长减少率 ξ 也越大;同样,方管壁厚变化也由无模拉伸变形区宽度决定,方管变形区宽度 W 越大,则壁厚减少率 ν 越小.

2) 无模拉伸方管断面形状膨胀率 η 随着拉伸变形区宽度 W 增大而减小,壁厚对断面形状膨胀率也有影响,壁厚较大,断面形状膨胀率较小;当壁厚和变形宽度都比较大时,几乎不产生膨胀现象.

3) 锥型方管拉伸采用1圈或2圈加热线圈时,加工件的锥角与设计锥角相对一致,采用3圈线圈锥角较设计值偏大,锥型方管拉伸如果需要得到较高的锥角加工精度,应采用较小的变形区宽度.

4) 采用无模拉伸的方法可以加工带有一定锥度的锥形方管,锥管角精度在 1.0% 以内,加工后锥形方管的轮廓与控制曲线的计算结果一致性很好.

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