



Cladding-Technology-Shanxi-Co.,-Ltd- CLADDING-MPS-011-TIG-Cladding- Process-Specification

TIG 堆焊工艺参数管理规范

TIG Welding Process Parameter Management Specification

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1. 目的 Purpose

本规范旨在建立科雷丁技术（山西）有限公司 TIG 堆焊工艺参数的标准化管理体系，确保法兰堆焊、管件堆焊、钢管堆焊、轴套管堆焊及模具堆焊修复等项目中，电流、电压、焊接速度、保护气体流量等关键工艺参数得到有效控制，保证堆焊层质量的一致性和可追溯性，满足客户对精密堆焊产品的技术要求。

This specification aims to establish a standardized management for TIG welding process parameters of CLADDING-Technology-Shanxi-Co.,-Ltd, ensuring that key process parameters such



as current, voltage, welding speed, and shielding gas flow rate are effectively controlled in projects including flange cladding, pipe fitting cladding, steel pipe cladding, shaft sleeve cladding, and mold cladding repair, guaranteeing consistency and traceability of cladding layer quality, and meeting customer technical requirements for precision cladding products.

2. 适用范围 Scope

本规范适用于公司所有采用 TIG（钨极惰性气体保护焊）工艺进行的堆焊作业，包括但不限于：

- 法兰密封面堆焊修复（Cr13 系、Cr26 系等合金钢堆焊）
- 管件及钢管内壁/外壁堆焊强化
- 轴套管耐磨层堆焊
- 模具型腔表面堆焊修复
- 基于 TIG 工艺的金属零部件增材制造

This specification applies to all cladding operations using TIG (Tungsten Inert Gas) welding process in the company, including but not limited to:

- Flange sealing surface cladding repair (Cr13 series, Cr26 series and other alloy steel cladding)
- Internal/external wall cladding strengthening of pipe fittings and steel pipes
- Wear-resistant layer cladding of shaft sleeves
- Mold cavity surface cladding repair
- Metal component additive manufacturing based on TIG process

3. 职责 Responsibilities

3.1 工艺技术部 Process Technology Department

负责 TIG 堆焊工艺参数的制定、评审与批准，编制焊接工艺规程（WPS），组织工艺验证试验，对工艺参数变更进行技术评估。

Responsible for the formulation, review and approval of TIG cladding process parameters, preparation of Welding Procedure Specifications (WPS), organization of process verification tests, and technical evaluation of process parameter changes.

3.2 生产部 Production Department

负责按照批准的工艺参数执行堆焊作业，确保设备参数设置准确，操作过程符合规范要求，记录实际工艺参数。



Responsible for executing cladding operations according to approved process parameters, ensuring accurate equipment parameter settings, compliance with specification requirements during operation, and recording actual process parameters.

3.3 质量部 Quality Department

负责工艺参数执行情况的监督检查，对堆焊层质量进行检验验证，审核工艺参数记录的完整性和准确性。

Responsible for supervising and inspecting the implementation of process parameters, inspecting and verifying cladding layer quality, and reviewing the completeness and accuracy of process parameter records.

3.4 设备部 Equipment Department

负责 TIG 焊接设备的维护保养，确保设备性能满足工艺参数控制要求，定期校验设备参数显示精度。

Responsible for maintenance of TIG welding equipment, ensuring equipment performance meets process parameter control requirements, and regular calibration of equipment parameter display accuracy.

4. 管理内容与程序 Management Content and Procedures

4.1 工艺参数分类 Process Parameter Classification

TIG 堆焊工艺参数分为关键参数和一般参数两类：

关键参数 Critical Parameters:

参数名称 Parameter	符号 Symbol	单位 Unit	控制要求 Control Requirement
焊接电流 Welding Current	I	A	直接影响熔深和稀释率，必须严格控制
电弧电压 Arc Voltage	U	V	影响熔宽和焊缝成形，需精确调节
焊接速度 Welding Speed	v	mm/min	决定熔敷效率和热输入，按 WPS 执行
保护气体流量 Shielding Gas Flow Rate	Q	L/min	保证保护效果，防止氧化，需稳定控制

一般参数 General Parameters:

参数名称 Parameter	符号 Symbol	单位 Unit	控制要求 Control Requirement
钨极直径 Tungsten Diameter	d	mm	根据电流大小选择，确保引弧稳定
钨极伸出长度 Tungsten Extension	L	mm	影响电弧稳定性，按规范设定
焊丝直径 Wire Diameter	φ	mm	根据堆焊层厚度选择



| 焊丝送进速度 Wire Feed Speed | v_w | mm/min | 与焊接速度匹配，保证熔敷量 |

4.2 典型工艺参数范围 Typical Process Parameter Ranges

4.2.1 法兰堆焊工艺参数 Flange Cladding Process Parameters

| 基材 Base Material | 堆焊材料 Cladding Material | 电流 I (A) | 电压 U (V) | 速度 v (mm/min) | 气体流量 Q (L/min) | 钨极直径 (mm) |

| Q235B | Cr13 系合金 | 80-120 | 12-16 | 80-150 | 8-12 | 2.4-3.2 |

| Q235B | Cr26 系合金 | 100-140 | 13-17 | 70-120 | 10-14 | 3.2-4.0 |

| 16MnR | Cr13 系合金 | 90-130 | 13-17 | 80-140 | 8-12 | 2.4-3.2 |

| 16MnR | Cr26 系合金 | 110-150 | 14-18 | 70-130 | 10-14 | 3.2-4.0 |

4.2.2 管件及钢管堆焊工艺参数 Pipe and Steel Pipe Cladding Process Parameters

| 管径范围 Pipe Diameter | 堆焊位置 Position | 电流 I (A) | 电压 U (V) | 速度 v (mm/min) | 气体流量 Q (L/min) |

| $\Phi 50$ - $\Phi 100$ | 内壁 Internal | 60-90 | 11-14 | 60-100 | 6-10 |

| $\Phi 50$ - $\Phi 100$ | 外壁 External | 80-110 | 12-15 | 80-120 | 8-12 |

| $\Phi 100$ - $\Phi 200$ | 内壁 Internal | 80-120 | 12-15 | 80-130 | 8-12 |

| $\Phi 100$ - $\Phi 200$ | 外壁 External | 100-140 | 13-16 | 100-150 | 10-14 |

| $\Phi 200$ 以上 | 内壁 Internal | 100-140 | 13-16 | 100-150 | 10-14 |

| $\Phi 200$ 以上 | 外壁 External | 120-160 | 14-18 | 120-180 | 12-16 |

4.2.3 轴套管堆焊工艺参数 Shaft Sleeve Cladding Process Parameters

| 轴径范围 Shaft Diameter | 堆焊材料 Cladding Material | 电流 I (A) | 电压 U (V) | 速度 v (mm/min) | 气体流量 Q (L/min) |

| $\Phi 30$ - $\Phi 80$ | Stellite 6 | 70-100 | 12-15 | 70-110 | 8-12 |

| $\Phi 30$ - $\Phi 80$ | Co 基合金 | 80-110 | 13-16 | 70-110 | 10-14 |

| $\Phi 80$ - $\Phi 150$ | Stellite 6 | 90-130 | 13-16 | 80-130 | 10-14 |

| $\Phi 80$ - $\Phi 150$ | Co 基合金 | 100-140 | 14-17 | 80-130 | 12-16 |

| $\Phi 150$ 以上 | Stellite 6 | 110-150 | 14-17 | 100-150 | 12-16 |

| $\Phi 150$ 以上 | Co 基合金 | 120-160 | 15-18 | 100-150 | 14-18 |



4.2.4 模具堆焊修复工艺参数 Mold Cladding Repair Process Parameters

| 模具材料 Mold Material | 堆焊材料 Cladding Material | 电流 I (A) | 电压 U (V) | 速度 v (mm/min) | 气体流量 Q (L/min) |

| H13 | Cr12MoV | 60-90 | 11-14 | 60-100 | 8-12 |

| H13 | 硬质合金 | 50-80 | 10-13 | 50-90 | 8-12 |

| Cr12MoV | H13 | 70-100 | 12-15 | 70-110 | 8-12 |

| Cr12MoV | 硬质合金 | 60-90 | 11-14 | 60-100 | 8-12 |

4.3 工艺参数确定程序 Process Parameter Determination Procedure

4.3.1 新项目工艺参数制定 New Project Process Parameter Development

1. 技术评审 Technical Review

工艺技术部根据客户技术要求、基材特性、堆焊材料性能，结合公司设备能力，初步确定工艺参数范围。

Process Technology Department shall preliminarily determine the process parameter range based on customer technical requirements, base material characteristics, cladding material properties, and company equipment capabilities.

2. 工艺试验 Process Trial

在正式生产前，使用相同或相近的基材和堆焊材料进行工艺试验，验证工艺参数的可行性。

Before formal production, process trials shall be conducted using the same or similar base materials and cladding materials to verify the feasibility of process parameters.

3. 参数优化 Parameter Optimization

根据试验结果，对工艺参数进行调整优化，确定最佳参数组合，编制焊接工艺规程（WPS）。

Based on trial results, process parameters shall be adjusted and optimized to determine the optimal parameter combination, and Welding Procedure Specifications (WPS) shall be prepared.

4. 工艺验证 Process Qualification

按照批准的 WPS 进行工艺验证，检验堆焊层质量（外观、硬度、结合强度、稀释率等），确认工艺参数满足技术要求。

Process qualification shall be conducted according to the approved WPS, inspecting cladding layer quality (appearance, hardness, bond strength, dilution rate, etc.) to confirm that process parameters meet technical requirements.



4.3.2 工艺参数变更 Process Parameter Change

5. 变更申请 Change Application

因设备调整、材料更换、质量改进等原因需要变更工艺参数时，由相关部门提出变更申请，说明变更原因和预期效果。

When process parameter changes are required due to equipment adjustment, material replacement, quality improvement, etc., relevant departments shall submit change applications, explaining the reasons for change and expected effects.

6. 技术评估 Technical Evaluation

工艺技术部对变更申请进行技术评估，分析变更对产品质量的影响，必要时进行工艺试验验证。

Process Technology Department shall conduct technical evaluation of change applications, analyzing the impact of changes on product quality, and conducting process trial verification when necessary.

7. 变更批准 Change Approval

经技术评估确认变更可行后，由工艺技术部负责人批准，更新 WPS 和相关工艺文件。

After technical evaluation confirms the change is feasible, it shall be approved by the head of Process Technology Department, and WPS and related process documents shall be updated.

8. 变更实施 Change Implementation

生产部按照更新后的工艺参数执行堆焊作业，质量部加强变更后的质量监控。

Production Department shall execute cladding operations according to updated process parameters, and Quality Department shall strengthen quality monitoring after changes.

4.4 工艺参数控制要求 Process Parameter Control Requirements

4.4.1 设备参数设置 Equipment Parameter Setting

9. 焊接设备开机后，操作人员应按照 WPS 要求设置各项工艺参数，设置完成后进行确认。

After equipment startup, operators shall set various process parameters according to WPS requirements, and confirm after setting.

10. 设备参数显示精度要求：

- 电流显示精度：±2A
- 电压显示精度：±0.5V
- 速度显示精度：±5mm/min
- 气体流量显示精度：±1L/min

Equipment parameter display accuracy requirements:



- Current display accuracy: $\pm 2A$
- Voltage display accuracy: $\pm 0.5V$
- Speed display accuracy: $\pm 5mm/min$
- Gas flow rate display accuracy: $\pm 1L/min$

11. 设备参数设置完成后，由班组长或质检员进行复核确认，确保参数设置正确。

After equipment parameter setting is completed, it shall be reviewed and confirmed by team leader or quality inspector to ensure correct parameter setting.

4.4.2 工艺参数监控 Process Parameter Monitoring

12. 堆焊作业过程中，操作人员应密切关注设备参数显示，确保参数在 WPS 规定的范围内。

During cladding operations, operators shall closely monitor equipment parameter displays to ensure parameters are within the range specified in WPS.

13. 当参数偏差超过允许范围时，应立即停止作业，调整参数至规定范围后方可继续。

When parameter deviation exceeds the allowable range, operations shall be stopped immediately, and parameters shall be adjusted to the specified range before continuing.

14. 关键参数（电流、电压、速度、气体流量）的监控记录应每道焊缝至少记录一次。

Monitoring records of critical parameters (current, voltage, speed, gas flow rate) shall be recorded at least once per weld seam.

4.4.3 工艺参数记录 Process Parameter Recording

15. 每道堆焊焊缝完成后，操作人员应填写《TIG 堆焊工艺参数记录表》，记录实际使用的工艺参数。

After each cladding weld seam is completed, operators shall fill in the "TIG Cladding Process Parameter Record Form", recording the actual process parameters used.

16. 记录内容应包括：

- 工件编号/名称
- 堆焊位置
- 基材材质
- 堆焊材料
- 实际电流、电压、速度、气体流量
- 操作者
- 记录时间

Record content shall include:

- Workpiece number/name
- Cladding position
- Base material



- Cladding material
- Actual current, voltage, speed, gas flow rate
- Operator
- Record time

17. 工艺参数记录应随产品流转，作为质量追溯的依据。

Process parameter records shall accompany product flow as the basis for quality traceability.

4.5 特殊工况工艺参数调整 Special Condition Process Parameter Adjustment

4.5.1 厚壁工件堆焊 Thick-walled Workpiece Cladding

对于壁厚大于 50mm 的工件，应采用多层多道堆焊，各层工艺参数可略有调整：

- 打底焊：电流降低 10-15%，电压降低 1-2V，速度降低 10-20%
- 填充焊：采用标准工艺参数
- 盖面焊：电流降低 5-10%，电压降低 0.5-1V，速度提高 5-10%

For workpieces with wall thickness greater than 50mm, multi-layer multi-pass cladding shall be used, and process parameters for each layer may be slightly adjusted:

- Root pass: Current reduced by 10-15%, voltage reduced by 1-2V, speed reduced by 10-20%
- Fill pass: Standard process parameters
- Cap pass: Current reduced by 5-10%, voltage reduced by 0.5-1V, speed increased by 5-10%

4.5.2 薄壁工件堆焊 Thin-walled Workpiece Cladding

对于壁厚小于 10mm 的工件，为防止烧穿，应采用较小的工艺参数：

- 电流降低 20-30%
- 电压降低 2-3V
- 速度提高 20-30%
- 气体流量降低 1-2L/min

For workpieces with wall thickness less than 10mm, to prevent burn-through, smaller process parameters shall be used:

- Current reduced by 20-30%
- Voltage reduced by 2-3V
- Speed increased by 20-30%
- Gas flow rate reduced by 1-2L/min

4.5.3 高稀释率要求 High Dilution Rate Requirement

当客户对稀释率有特殊要求时（如稀释率 $\leq 15\%$ ），应采用以下工艺措施：

- 降低焊接电流 10-20%



- 提高焊接速度 15-25%
- 减小钨极伸出长度至 3-5mm
- 采用较小的焊丝直径

When customers have special requirements for dilution rate (e.g., dilution rate $\leq 15\%$), the following process measures shall be adopted:

- Reduce welding current by 10-20%
- Increase welding speed by 15-25%
- Reduce tungsten extension length to 3-5mm
- Use smaller wire diameter

5. 监督考核 Supervision and Assessment

5.1 监督检查 Supervision and Inspection

18. 质量部每月对 TIG 堆焊工艺参数执行情况进行检查，检查内容包括：

- 工艺参数设置是否符合 WPS 要求
- 工艺参数记录是否完整、准确
- 操作人员是否按规范执行

Quality Department shall conduct monthly inspections of TIG cladding process parameter implementation, including:

- Whether process parameter settings comply with WPS requirements
- Whether process parameter records are complete and accurate
- Whether operators execute according to specifications

19. 工艺技术部每季度对工艺参数的合理性进行评审，根据产品质量数据和客户反馈，必要时调整工艺参数范围。

Process Technology Department shall conduct quarterly reviews of process parameter rationality, and adjust process parameter ranges when necessary based on product quality data and customer feedback.

5.2 考核标准 Assessment Criteria

考核项目 Assessment Item	考核标准 Assessment Criteria	扣分标准 Deduction Criteria
工艺参数设置准确率	100%	每发现 1 次错误扣 5 分
工艺参数记录完整率	$\geq 95\%$	每发现 1 次缺失扣 3 分
工艺参数记录准确率	$\geq 98\%$	每发现 1 次错误扣 3 分
工艺参数执行符合率	$\geq 95\%$	每发现 1 次不符合扣 5 分



5.3 纠正措施 Corrective Actions

20. 对监督检查中发现的问题，责任部门应在 3 个工作日内制定纠正措施并实施。

For problems found during supervision and inspection, responsible departments shall develop and implement corrective actions within 3 working days.

21. 对重复出现的问题，应分析根本原因，采取系统性纠正措施，防止问题再次发生。

For recurring problems, root causes shall be analyzed, and systematic corrective actions shall be taken to prevent recurrence.

6. 附则 Supplementary Provisions

6.1 相关文件 Related Documents

- CLADDING-WPS-001 《TIG 堆焊焊接工艺规程》
- CLADDING-QC-005 《堆焊层质量检验规范》
- CLADDING-TR-003 《工艺参数记录表》

6.2 记录表格 Record Forms

- CLADDING-FORM-011 《TIG 堆焊工艺参数记录表》
- CLADDING-FORM-012 《工艺参数变更申请单》
- CLADDING-FORM-013 《工艺参数监督检查记录表》

6.3 修订历史 Revision History

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