科雷丁技术（山西）有限公司
Cladding Technology (Shanxi) Co., Ltd.
增材制造 · TIG 堆焊 · MIG 堆焊 · 精密焊接 · 表面强化 · 再制造修复

Cladding-Technology-Shanxi-Co.,-Ltd-CLADDING-MPS-012-MIG-Cladding-Process-Specification

科雷丁技术（山西）有限公司

Cladding-Technology-Shanxi-Co.,-Ltd

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1 目的 Purpose

本规范旨在统一科雷丁技术（山西）有限公司 MIG 堆焊工艺参数标准，确保法兰堆焊、管件堆焊、钢管堆焊、轴套管堆焊、模具堆焊修复等产品的焊接质量稳定性和工艺一致性，为生产现场提供可执行的技术依据。

This specification aims to standardize the MIG welding process parameters of Cladding-Technology-Shanxi-Co.,-Ltd, ensuring the stability and consistency of welding quality for flange cladding, pipe fitting cladding, steel pipe cladding, shaft sleeve cladding, and mold cladding repair products, providing executable technical basis for production sites.

2 适用范围 Scope

本规范适用于公司所有采用 MIG（熔化极气体保护焊）工艺进行的堆焊作业，包括但不限于：

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

- 法兰密封面 MIG 堆焊强化
- 管件内壁 MIG 堆焊防腐
- 钢管外壁 MIG 堆焊耐磨
- 轴套管 MIG 堆焊修复
- 模具型腔 MIG 堆焊再制造
- 梯度材料 MIG 增材制造

  Flange sealing surface MIG cladding strengthening

  Pipe fitting inner wall MIG cladding anti-corrosion

  Steel pipe outer wall MIG cladding wear resistance

  Shaft sleeve MIG cladding repair

  Mold cavity MIG cladding remanufacturing

  Gradient material MIG additive manufacturing

3 职责 Responsibilities

3.1 工艺技术部 Process Technology Department

- 负责本规范的编制、修订与解释

- 负责 MIG 堆焊工艺参数的制定与优化
- 负责新工艺参数的试验验证
- 负责操作人员的技术培训

Responsible for the preparation, revision and interpretation of this specification

Responsible for the formulation and optimization of MIG cladding process parameters

Responsible for the test verification of new process parameters

Responsible for technical training of operators

3.2 生产部 Production Department

- 负责按本规范执行 MIG 堆焊作业
- 负责工艺参数的现场记录与反馈
- 负责设备日常维护与保养

Responsible for executing MIG cladding operations according to this specification

Responsible for on-site recording and feedback of process parameters

Responsible for daily maintenance of equipment

3.3 质量部 Quality Department

- 负责工艺参数执行情况的监督检查
- 负责堆焊质量检验与评定
- 负责不合格品的处理与追溯

Responsible for supervision and inspection of process parameter implementation

Responsible for cladding quality inspection and evaluation

Responsible for handling and traceability of non-conforming products

4 管理内容与程序 Management Content and Procedures

4.1 MIG 堆焊设备配置 Equipment Configuration

4.1.1 焊接电源 Welding Power Source

项目 Item	技术要求 Technical Requirement
电源类型 Power Type	直流逆变式 MIG/MAG 焊机
额定输出 Rated Output	300A/32V

工作周期 Duty Cycle	100%（40℃）
调节精度 Adjustment Accuracy	电流±2A，电压±0.2V

DC inverter MIG/MAG welding machine

300A/32V

100% (40℃)

Current ±2A, Voltage ±0.2V

4.1.2 送丝系统 Wire Feeding

项目 Item	技术要求 Technical Requirement
送丝方式 Feeding Method	双驱动伺服送丝
送丝精度 Feeding Accuracy	±1%
送丝速度范围 Speed Range	2-20 m/min
焊丝直径 Wire Diameter	φ1.0mm、φ1.2mm、φ1.6mm

Dual-drive servo wire feeding

±1%

2-20 m/min

φ1.0mm, φ1.2mm, φ1.6mm

4.1.3 保护气体系统 Shielding Gas

项目 Item	技术要求 Technical Requirement
气体类型 Gas Type	Ar+CO_2混合气或纯 Ar
气体纯度 Gas Purity	≥99.99%
流量控制 Flow Control	电磁流量计，精度±2%
流量范围 Flow Range	10-30 L/min

Ar+CO_2 mixture or pure Ar

≥99.99%

Electromagnetic flow meter, accuracy ±2%

10-30 L/min

4.2 MIG 堆焊工艺参数规范 Process Parameter Specification

4.2.1 法兰堆焊工艺参数 Flange Cladding Parameters

法兰堆焊主要用于密封面强化，要求焊缝成型美观、稀释率低、表面平整度好。

Flange cladding is mainly used for sealing surface strengthening, requiring beautiful weld formation, low dilution rate, and good surface flatness.

参数 Parameter	数值 Value	备注 Remarks
焊接电流 Welding Current	140-180A	根据板厚调整
电弧电压 Arc Voltage	22-26V	匹配电流使用
焊接速度 Welding Speed	150-250 mm/min	保证成型质量
送丝速度 Wire Feeding Speed	5.5-7.5 m/min	与电流匹配
气体流量 Gas Flow Rate	15-20 L/min	Ar+20%CO_2
干伸长 Dry Extension	10-15mm	保持稳定
摆动幅度 Oscillation Width	8-12mm	根据焊缝宽度
摆动频率 Oscillation Frequency	3-5 次/min	均匀过渡

Adjust according to plate thickness

Match with current

Ensure formation quality

Match with current

Ar+20%CO_2

Keep stable

According to weld width

Uniform transition

4.2.2 管件堆焊工艺参数 Pipe Fitting Cladding Parameters

管件堆焊分为内壁防腐堆焊和外壁耐磨堆焊，工艺参数有所区别。

Pipe fitting cladding is divided into inner wall anti-corrosion cladding and outer wall wear-resistant cladding, with different process parameters.

内壁防腐堆焊 Inner Wall Anti-corrosion Cladding

参数 Parameter	数值 Value	备注 Remarks

焊接电流 Welding Current	120-160A	低稀释率要求
电弧电压 Arc Voltage	20-24V	短弧焊接
焊接速度 Welding Speed	100-180 mm/min	保证熔敷均匀
送丝速度 Wire Feeding Speed	4.8-6.5 m/min	匹配电流
气体流量 Gas Flow Rate	18-25 L/min	内壁保护要求高
焊枪角度 Torch Angle	前倾 10°-15°	利于熔池观察
层间温度 Interpass Temperature	≤150℃	防止组织恶化

Low dilution rate requirement

Short arc welding

Ensure uniform deposition

Match with current

High protection requirement for inner wall

Facilitate molten pool observation

Prevent structure deterioration

外壁耐磨堆焊 Outer Wall Wear-resistant Cladding

参数 Parameter	数值 Value	备注 Remarks
焊接电流 Welding Current	160-220A	高熔敷效率
电弧电压 Arc Voltage	24-28V	匹配大电流
焊接速度 Welding Speed	200-350 mm/min	提高效率
送丝速度 Wire Feeding Speed	6.5-9.0 m/min	匹配电流
气体流量 Gas Flow Rate	15-20 L/min	常规保护
焊枪角度 Torch Angle	垂直或后倾 5°	保证熔深
层间温度 Interpass Temperature	≤200℃	控制热输入

High deposition efficiency

Match with high current

Improve efficiency

Match with current

Normal protection

Ensure penetration

Control heat input

4.2.3 钢管堆焊工艺参数 Steel Pipe Cladding Parameters

钢管堆焊主要用于长距离管道外壁耐磨防腐，要求连续性好、效率高。

Steel pipe cladding is mainly used for wear-resistant and anti-corrosion of long-distance pipeline outer wall, requiring good continuity and high efficiency.

参数 Parameter	数值 Value	备注 Remarks
焊接电流 Welding Current	180-250A	根据管径调整
电弧电压 Arc Voltage	25-30V	匹配电流
焊接速度 Welding Speed	250-400 mm/min	自动化作业
送丝速度 Wire Feeding Speed	7.5-10.5 m/min	匹配电流
气体流量 Gas Flow Rate	15-20 L/min	Ar+20%CO_2
干伸长 Dry Extension	12-18mm	自动化送丝
焊枪角度 Torch Angle	垂直±5°	保证对称性
道间清理 Interpass Cleaning	钢丝刷清理	去除氧化皮

Adjust according to pipe diameter

Match with current

Automated operation

Match with current

Ar+20%CO_2

Automated wire feeding

Ensure symmetry

Remove oxide scale

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

轴套管堆焊用于修复磨损部位，要求尺寸精度高、表面质量好。

Shaft sleeve cladding is used for repairing worn parts, requiring high dimensional accuracy and good surface quality.

参数 Parameter	数值 Value	备注 Remarks
焊接电流 Welding Current	130-170A	精密控制
电弧电压 Arc Voltage	21-25V	短弧焊接
焊接速度 Welding Speed	120-200 mm/min	保证精度
送丝速度 Wire Feeding Speed	5.2-7.0 m/min	匹配电流
气体流量 Gas Flow Rate	15-20 L/min	充分保护
干伸长 Dry Extension	8-12mm	精密控制
摆动方式 Oscillation Mode	直线或小幅摆动	根据修复要求
层间温度 Interpass Temperature	≤120℃	防止变形

Precision control

Short arc welding

Ensure accuracy

Match with current

Full protection

Precision control

According to repair requirements

Prevent deformation

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

模具堆焊修复要求焊缝与基体结合牢固、硬度均匀、表面可加工。

Mold cladding repair requires firm bonding between weld and substrate, uniform hardness, and machinable surface.

参数 Parameter	数值 Value	备注 Remarks
焊接电流 Welding Current	110-150A	低热输入
电弧电压 Arc Voltage	19-23V	短弧焊接
焊接速度 Welding Speed	80-150 mm/min	控制热影响
送丝速度 Wire Feeding Speed	4.4-6.0 m/min	匹配电流
气体流量 Gas Flow Rate	15-20 L/min	Ar+15%CO_2

干伸长 Dry Extension	8-12mm	保持稳定
摆动幅度 Oscillation Width	6-10mm	均匀熔敷
层间温度 Interpass Temperature	≤100℃	防止开裂

Low heat input

Short arc welding

Control heat affected zone

Match with current

Ar+15%CO_2

Keep stable

Uniform deposition

Prevent cracking

4.2.6 梯度材料增材制造工艺参数 Gradient Material Additive Manufacturing Parameters

梯度材料增材制造用于制备性能梯度变化的功能部件，要求层间结合良好、成分过渡均匀。

Gradient material additive manufacturing is used for preparing functional parts with gradient performance variation, requiring good interlayer bonding and uniform composition transition.

参数 Parameter	数值 Value	备注 Remarks
焊接电流 Welding Current	150-200A	根据材料调整
电弧电压 Arc Voltage	23-27V	匹配电流
焊接速度 Welding Speed	150-250 mm/min	保证层间结合
送丝速度 Wire Feeding Speed	6.0-8.5 m/min	匹配电流
气体流量 Gas Flow Rate	15-20 L/min	Ar+20%CO_2
层厚 Layer Thickness	2-4mm	根据设计要求
层间温度 Interpass Temperature	150-250℃	保证冶金结合
送丝切换 Wire Switching	自动切换	梯度材料制备

Adjust according to material

Match with current

Ensure interlayer bonding

Match with current

Ar+20%CO_2

According to design requirements

Ensure metallurgical bonding

Automatic switching for gradient material

4.3 工艺参数调整原则 Parameter Adjustment Principles

4.3.1 电流调整原则 Current Adjustment Principles

- 板厚增加时，适当提高焊接电流
- 堆焊层数增加时，后续层电流可适当降低
- 高硬度材料堆焊时，采用较低电流防止开裂
- 薄壁件堆焊时，采用较低电流防止烧穿

Increase welding current appropriately when plate thickness increases

Subsequent layer current can be appropriately reduced when cladding layers increase

Use lower current to prevent cracking when cladding high hardness materials

Use lower current to prevent burn-through when cladding thin-walled parts

4.3.2 电压调整原则 Voltage Adjustment Principles

- 电压与电流匹配，一般电压=电流×0.15+12
- 电压过高时，焊缝变宽、飞溅增加
- 电压过低时，焊缝变窄、熔深增加
- 根据焊缝成型要求微调电压

Voltage matches current, generally voltage=current×0.15+12

When voltage is too high, weld becomes wider and spatter increases

When voltage is too low, weld becomes narrower and penetration increases

Fine-tune voltage according to weld formation requirements

4.3.3 速度调整原则 Speed Adjustment Principles

- 速度过快时，熔敷量不足、焊缝变窄
- 速度过慢时，熔敷量过大、稀释率增加
- 根据焊缝宽度要求调整速度
- 自动化作业时速度保持稳定

When speed is too fast, deposition is insufficient and weld becomes narrower

When speed is too slow, deposition is excessive and dilution rate increases

Adjust speed according to weld width requirements

Keep speed stable during automated operation

4.4 工艺参数记录与追溯 Parameter Recording and Traceability

4.4.1 记录要求 Recording Requirements

每批次 MIG 堆焊作业必须填写《MIG 堆焊工艺参数记录表》，内容包括：

Each batch of MIG cladding operations must fill in the "MIG Cladding Process Parameter Record Form", including:

记录项目 Recording Item	内容要求 Content Requirement
产品名称 Product Name	法兰/管件/钢管/轴套管/模具
产品编号 Product Number	唯一追溯编号
焊接日期 Welding Date	年/月/日
操作人员 Operator	持证焊工姓名
设备编号 Equipment Number	焊机编号
焊接电流 Welding Current	实际使用值
电弧电压 Arc Voltage	实际使用值
焊接速度 Welding Speed	实际使用值
送丝速度 Wire Feeding Speed	实际使用值
气体流量 Gas Flow Rate	实际使用值
保护气体 Shielding Gas	气体类型及配比
焊丝规格 Wire Specification	材质及直径
备注 Remarks	异常情况说明

Flange/Pipe fitting/Steel pipe/Shaft sleeve/Mold

Unique traceability number

Year/Month/Day

Certified welder name

Welding machine number

Actual used value

Actual used value

Actual used value

Actual used value

Actual used value

Gas type and ratio

Material and diameter

Abnormal situation description

4.4.2 追溯要求 Traceability Requirements

- 工艺参数记录保存期限不少于产品使用寿命
- 质量异常时，可根据记录追溯工艺参数
- 客户投诉时，提供相关批次工艺参数记录
- 定期分析工艺参数数据，持续改进

Process parameter records shall be retained for no less than the product service life

Process parameters can be traced according to records when quality abnormalities occur

Provide process parameter records of relevant batches when customer complaints occur

Regularly analyze process parameter data for continuous improvement

5 监督考核 Supervision and Assessment

5.1 监督检查 Supervision and Inspection

5.1.1 日常检查 Daily Inspection

质量部每日对 MIG 堆焊作业进行抽查，检查内容包括：

Quality Department conducts spot checks on MIG cladding operations daily, including:

- 工艺参数是否符合本规范要求
- 操作人员是否按规范执行
- 设备运行状态是否正常
- 记录填写是否及时完整

Whether process parameters comply with this specification

Whether operators execute according to specification

Whether equipment operation status is normal

Whether records are filled in timely and completely

5.1.2 专项检查 Special Inspection

工艺技术部每月对 MIG 堆焊工艺参数执行情况进行专项检查，内容包括：

Process Technology Department conducts special inspections on MIG cladding process parameter implementation monthly, including:

- 参数执行符合率统计
- 异常参数原因分析
- 改进措施制定与跟踪
- 操作人员技能评估

Statistics of parameter implementation compliance rate

Analysis of abnormal parameter causes

Formulation and tracking of improvement measures

Operator skill assessment

5.2 考核标准 Assessment Criteria

考核项目 Assessment Item	合格标准 Qualified Standard	不合格处理 Non-conforming Handling
参数执行符合率	≥95%	分析原因，制定纠正措施
记录填写完整率	100%	重新填写，培训教育
设备点检完成率	100%	立即整改，责任追究
培训考核合格率	≥90%	补训补考，直至合格

≥95%

Analyze causes, formulate corrective measures

100%

Re-fill, training and education

100%

Immediate rectification, accountability

≥90%

Supplementary training and examination until qualified

6 附则 Supplementary Provisions

6.1 文件管理 Document Management

- 本规范由工艺技术部负责解释
- 本规范每年评审一次，必要时及时修订
- 本规范修订时，版本号递增
- 本规范发放范围：工艺技术部、生产部、质量部

This specification is interpreted by Process Technology Department

This specification is reviewed annually, revised promptly when necessary

Version number increases when this specification is revised

Distribution scope: Process Technology Department, Production Department, Quality Department

6.2 相关文件 Related Documents

文件编号 Document Number	文件名称 Document Name
CLADDING-MPS-001	增材制造工艺管理规范
CLADDING-MPS-002	TIG 堆焊工艺参数规范
CLADDING-MPS-003	焊接设备操作规程
CLADDING-MPS-004	焊接材料管理规范
CLADDING-MPS-005	焊接质量检验规程

Additive Manufacturing Process Management Specification

TIG Cladding Process Parameter Specification

Welding Equipment Operating Procedure

Welding Material Management Specification

Welding Quality Inspection Procedure

6.3 修订记录 Revision History

版本 Version	修订日期 Revision Date	修订内容 Revision Content	修订人 Reviser

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