



Cladding-Technology-Shanxi-Co.,-Ltd- CLADDING-ITP-007-Cladding-Nipple- ITP

ITP-007 堆焊管牙螺纹堆焊、硬度检验与密封试验程序

ITP-007 Thread Cladding, Hardness Testing and Seal Test Procedure for Cladded Pipe Threads

| 文件编号 Document No. | CLADDING-ITP-007 |

| 版本号 Revision | A/0 |

| 发布日期 Issue Date | 2024-01-15 |

| 生效日期 Effective Date | 2024-02-01 |

| 编制 Prepared by | 质量管理部 Quality Management Dept. |

| 审核 Reviewed by | 技术部 Technical Dept. |

| 批准 Approved by | 总经理 General Manager |



1. 目的 Purpose

本程序规定了科雷丁技术（山西）有限公司在堆焊管牙产品制造过程中，螺纹堆焊、硬度检验与密封试验的质量控制要求与作业程序，确保堆焊管牙产品的螺纹成型质量、表面硬度及密封性能满足技术协议与相关标准要求。

This procedure specifies the quality control requirements and work instructions for thread cladding, hardness testing and seal testing during the manufacturing of cladded pipe thread products at CLADDING-Technology-Shanxi-Co.,-Ltd, ensuring that the thread forming quality, surface hardness and sealing performance of cladded pipe thread products meet the requirements of technical agreements and relevant standards.

2. 适用范围 Scope

本程序适用于公司生产的各类堆焊管牙产品，包括但不限于：

This procedure applies to various cladded pipe thread products manufactured by the company, including but not limited to:

- 法兰堆焊管牙 Flanged cladded pipe threads
- 管件堆焊管牙 Pipe fitting cladded pipe threads
- 钢管堆焊管牙 Steel pipe cladded pipe threads
- 轴套管堆焊管牙 Shaft sleeve cladded pipe threads

涉及工艺包括 TIG 精密堆焊、MIG 高效堆焊及电弧增材制造工艺。

The processes involved include TIG precision cladding, MIG high-efficiency cladding and arc additive manufacturing processes.

3. 职责 Responsibilities

| 部门/岗位 Department/Position | 职责 Responsibilities |

| 生产部 Production Dept. | 按本程序执行螺纹堆焊作业，记录工艺参数 | Execute thread cladding operations according to this procedure, record process parameters |

| 技术部 Technical Dept. | 编制工艺文件，确定堆焊参数与检验标准 | Prepare process documents, determine cladding parameters and inspection standards |

| 质量部 Quality Dept. | 执行硬度检验与密封试验，出具检验报告 | Execute hardness testing and seal testing, issue inspection reports |

| 设备部 Equipment Dept. | 维护堆焊设备，确保设备状态满足工艺要求 | Maintain cladding equipment, ensure equipment status meets process requirements |



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

4.1 螺纹堆焊 Thread Cladding

4.1.1 焊前准备 Pre-welding Preparation

- 母材表面清理：去除油污、氧化皮、锈迹等杂质，露出金属光泽
- Base material surface cleaning: Remove oil, oxide scale, rust and other impurities, expose metallic luster
- 坡口加工：按图纸要求加工螺纹坡口，坡口角度 $30^{\circ}\pm 2^{\circ}$ ，钝边 1-2mm
- Groove machining: Machine thread groove according to drawing requirements, groove angle $30^{\circ}\pm 2^{\circ}$, root face 1-2mm
- 预热处理：当母材厚度大于 25mm 时，预热至 100-150°C
- Preheating: When base material thickness exceeds 25mm, preheat to 100-150°C

4.1.2 堆焊工艺参数 Cladding Process Parameters

| 工艺参数 Process Parameter | TIG 堆焊 TIG Cladding | MIG 堆焊 MIG Cladding |

| 焊接电流 Welding Current | 80-120A | 180-260A |

| 电弧电压 Arc Voltage | 12-16V | 22-28V |

| 焊接速度 Welding Speed | 40-80mm/min | 200-400mm/min |

| 送丝速度 Wire Feeding Speed | 手动控制 Manual Control | 4-8m/min |

| 保护气体 Shielding Gas | Ar 99.99% | Ar+CO₂(80:20) |

| 气体流量 Gas Flow Rate | 10-15L/min | 15-20L/min |

4.1.3 堆焊操作要求 Cladding Operation Requirements

- 采用多层多道焊工艺，每层厚度控制在 2-3mm
- Adopt multi-layer multi-pass welding process, control each layer thickness at 2-3mm
- 层间温度控制在 150-250°C，避免过高温度导致稀释率增大
- Control interpass temperature at 150-250°C, avoid excessive temperature causing increased dilution rate
- 螺纹牙型成型要求：牙顶圆角 $R\leq 0.5\text{mm}$ ，牙底圆角 $R\leq 1.0\text{mm}$
- Thread profile forming requirements: crest radius $R\leq 0.5\text{mm}$, root radius $R\leq 1.0\text{mm}$
- 堆焊层与母材过渡区应平滑，无咬边、未熔合等缺陷
- The transition zone between cladding layer and base material should be smooth, without undercut, lack of fusion and other defects



4.2 硬度检验 Hardness Testing

4.2.1 检验时机 Inspection Timing

- 堆焊完成后冷却至室温进行硬度检验
- Perform hardness testing after cladding and cooling to room temperature
- 每批次产品至少检验 3 个点，单件产品不少于 2 个点
- Inspect at least 3 points per batch, no less than 2 points per single product

4.2.2 检验方法 Inspection Method

- 采用洛氏硬度计（HRC）或维氏硬度计（HV）进行测量
- Use Rockwell hardness tester (HRC) or Vickers hardness tester (HV) for measurement
- 测试点位置：螺纹牙顶及牙侧各取 1 个点
- Test point location: Take 1 point each at thread crest and flank
- 加载时间：洛氏硬度 10-15 秒，维氏硬度 10-15 秒
- Loading time: Rockwell hardness 10-15 seconds, Vickers hardness 10-15 seconds

4.2.3 合格标准 Acceptance Criteria

材料类型 Material Type	硬度要求 Hardness Requirement
不锈钢堆焊层 Stainless Steel Cladding Layer	HRC 25-35 或 HV 250-350
镍基合金堆焊层 Nickel-based Alloy Cladding Layer	HRC 20-30 或 HV 200-300
钴基合金堆焊层 Cobalt-based Alloy Cladding Layer	HRC 30-40 或 HV 300-400

4.3 密封试验 Seal Testing

4.3.1 试验准备 Test Preparation

- 堆焊管牙产品经硬度检验合格后，进行密封试验
- After passing hardness testing, cladded pipe thread products undergo seal testing
- 试验前检查螺纹表面无裂纹、气孔等缺陷
- Check thread surface for cracks, porosity and other defects before testing

4.3.2 试验方法 Test Method

- 气压试验：试验压力 0.6MPa，保压时间 5 分钟，无泄漏为合格
- Air pressure test: Test pressure 0.6MPa, holding time 5 minutes, no leakage is qualified
- 水压试验：试验压力 1.0MPa，保压时间 10 分钟，无渗漏为合格
- Hydrostatic test: Test pressure 1.0MPa, holding time 10 minutes, no seepage is qualified
- 煤油渗漏试验：适用于精密密封要求的产品，观察时间 15 分钟
- Kerosene seepage test: Applicable to products with precision sealing requirements, observation time 15 minutes



4.3.3 不合格处理 Non-conforming Treatment

- 发现泄漏点，标记位置后重新堆焊修复
- Mark the leakage position and re-clad for repair when leakage is found
- 修复后重新进行硬度检验与密封试验
- Re-perform hardness testing and seal testing after repair

5. 监督考核 Supervision and Assessment

- 质量部每月对堆焊管牙产品进行抽检，抽检比例不低于 10%
- Quality Department conducts sampling inspection of cladded pipe thread products monthly, sampling ratio not less than 10%
- 对硬度不合格或密封试验不合格的产品，追溯生产记录，分析原因
- For products with unqualified hardness or seal test, trace production records and analyze causes
- 连续 3 批次出现同类质量问题，暂停生产，组织工艺评审
- If similar quality problems occur in 3 consecutive batches, suspend production and organize process review

6. 附则 Supplementary Provisions

- 本程序由质量部负责解释和修订
- This procedure is interpreted and revised by Quality Department
- 本程序自发布之日起生效，原有相关规定同时废止
- This procedure takes effect from the date of release, and previous relevant regulations are simultaneously abolished
- 本程序每年评审一次，必要时进行修订
- This procedure is reviewed annually, and revised when necessary

| 文件编号 Document No. | CLADDING-ITP-007 | 第 1 页 / 共 1 页 |

| 版本 Version | A/0 | 发布日期 Issue Date | 2024-01-15 |