SPECIFICATION FOR GENERAL REQUIREMENTS OF HEAT TREATMENT OFALLOY STEELS FOR USE IN WELL HEAD RELATED EQUIPMENT

Rev	Reason of Change	Date	Prepared By	Reviewed By	Approved By	Status
0	Initial Release	05.02.2024	PK	USR	JG	Released

1.0 PURPOSE

1.1 It is the purpose of this specification to list in a concise form the Heat Treatment of alloy Steels used in well head, Christmas Tree, Manifold and related equipment used oil field services.

1.2 This material specification is intended to aid the PPC / Product Manager/ purchasing department in out sourcing and the vendor to comply the requirements of heat treatment of a material which needs to meet its intended use, and the quality control department in the inspection and release of incoming material.

2.0 SCOPE

2.1 This specification covers requirements of heat treatment of alloy steels used for Well Head, Christmas Tree, Manifold and related equipment /die-forgings and ring rolling's (where applicable) to meet requirements of the relevant specification.

3.0 APPLICABLE DOCUMENTS

3.1 API Spec 6A - 21st Edition- Specification for Wellhead and Christmas Tree Equipment

4.0 CONDITION

4.1 Heat Treated products shall be supplied clean, free from scale meeting the requirements of this specification, the purchase order and the relevant forging drawing.

5.0 HEAT TREATMENT:

5.1 Prior to outsourcing the process, prospective vendors shall be assessed for their capabilities for heat treatment.

5.2 Prior to HT of bulk the prospective vendor shall submit first off samples of the product duly Heat treated as per procedure for evaluation & approval.

5.3 After approval vendor shall make no changes in process without the written permission of CPC and re-approval of first article sample, if desired by CPC

6.0 GENERAL REQUIREMENTS

6.1 Spacing: Material to be heat treated should be racked / stacked such to allow circulation of heating and quenching media, to ensure all surfaces of the product are exposed to heating & quenching media and to minimize warpage during heating & quenching.

6.2 Carburization and Nitriding - The heating media in furnaces used for heating

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material shall be controlled to preclude carburization & nitriding.

6.3 Temperature Uniformity / Calibration of Furnace - The design and construction of the furnace (heat treatment equipment) shall be such that the temperature at any point in the furnace working zone or work load shall comply requirements of Annex 'M' of the 21st Ed. of API 6A or AMSH-6875 and AMS2750E.

7.0 EQUIPMENT CALIBRATION

7.1 Furnaces shall meet the calibration and survey frequency requirements of Annex M of the 21st edition of API 6A.

7.2 Uniformity surveys shall be made once per year minimum and shall be made at temperatures that are representative of the operations intended for the furnace. For solution annealing, annealing, austenitizing and normalizing, the uniformity shall be +/- 25°F (14°C) or better. For tempering, stress relieving and aging the uniformity shall be +/-15°F (8°C) or better. Furnace survey records shall be available to CPC upon request.

7.3 Temperature controlling and recording instruments used for the heat-treatment processes shall be calibrated at least once in three months with ± 1 % accuracy of their full-scale range.

7.4 Equipment used to calibrate the production equipment shall be accurate to ± 0.25 % of full-scale range

8.0 TEMPERATURE UNIFORMITY SURVEY FREQUENCY

8.1 The temperatures within each batch-type furnace shall be surveyed within 1 year prior to use of the furnace for heat-treatment in accordance with Annex M of the 21st edition of API 6A.

9.0 TEMPERATURE SURVEY METHOD FOR BATCH-TYPE FURNACES

9.1 The furnace working zone shall be defined by the manufacturer. A temperature survey within the furnace working zone(s) shall be performed on each furnace at the maximum and minimum temperatures for which each furnace is being used.

9.2 For furnaces having a working zone less than or equal to 0.3 m^3 (10 ft^3), a minimum of three thermocouples located either at the front, center and rear,

or at the top, center and bottom of the furnace working zone shall be used.

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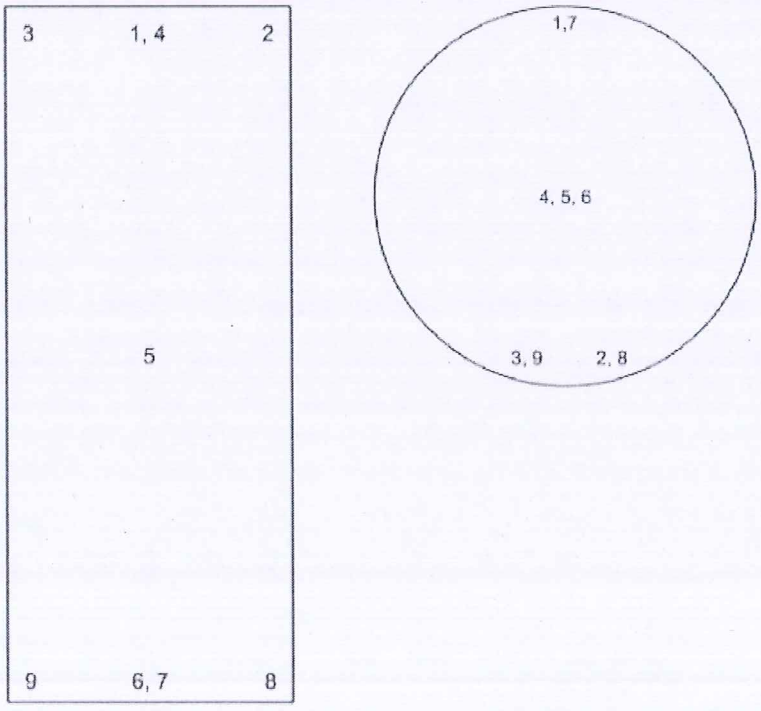
9.3 For furnaces having a working zone greater than 0.3 m^3 (10 ft^3) and not greater than 31.5 m^3 (1125 ft^3), a minimum of nine thermocouples shall be used. For each additional 3.5 m^3 (125 ft^3) beyond 31.5 m^3 (1125 ft^3) of furnace working zone surveyed, at least one additional thermocouple shall be used, up to a total of 40 thermocouples. The first nine thermocouples shall be located as per Figure M.1 and Figure M.2. Each additional thermocouple location shall be equally spaced in the central additional working zone volume.

9.4 After insertion of the temperature-sensing devices, readings shall be taken at least once every three minutes to determine when the temperature of the furnace working zone approaches the bottom of the temperature range being surveyed.

9.5 Once the furnace temperature has reached the set-point temperature, the temperature of all test locations shall be recorded at two-minute intervals, maximum, for at least 10 min. Then, readings shall be taken at five-minute intervals, maximum, for sufficient time (at least 30 min) to determine the recurrent temperature pattern of the furnace working-zone.

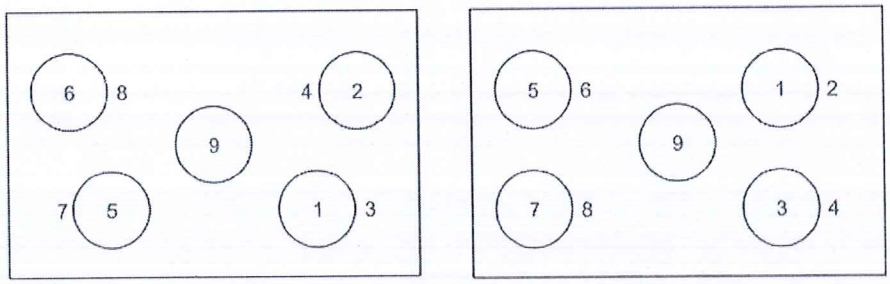
10.0 Temperature Survey Method for Continuous-type Furnaces

10.1 Furnaces used for continuous heat-treatment shall be validated in accordance with SAE AMS2750 or SAE AMS-H-6875.



a) Side view b) Top view

Figure M.2—Thermocouple Locations—Cylindrical Furnace (Working Zone)



a) Top view b) Side view

Figure M.1—Thermocouple Locations—Rectangular Furnace (Working Zone)

11.0 HOLDING TIME

Table -1: Holding Time for Annealing / Austenizing / Normalizing and tempering of Class A, B, C, and D Steels

Material	Annealing /Austenizing/Normalizing		Tempering & Aging
	Furnace Thermocouples	Contact Thermocouples	Furnace or Contact Thermocouples
Class A & B steels	30 minutes/ inch of T + one hour: 1-hour min.	15 minutes/ inch of T 15 minutes min	Up to 8" T 1 hr. / inch min. + 30 min/ inch for additional T
Class C steels	As per table -1C, AMSH-6875		
Class D steels	As per table -1C, AMSH-6875		

1- These times are suitable for the simple solid shapes heated from -all-surfaces
2- For simple shapes, thickness 'T' shall be defined as follows:

Billets for forgings may be heated by induction or electric or oil-fired furnace

11.1 Heating shall not produce internal oxidation, sigma phase or grain growth exceeding Grain Size of 5 as per ASTM E112.

11.2 Billet pre-heat temperature shall depend upon the material used.

11.3 Forgings shall be struck/ rolled so that the longitudinal axis of the starting billet coincides with the centerline of the forging / ring.

11.4 Finished forgings / rings shall be hot trimmed.

11.5 A min forging ratio of 4:1 shall be maintained for all die/free forgings and rings produced from bars/billets with predetermined forging ratio of min 4:1.

12.0 When specified on the PO, forgings shall be supplied in normalized or normalized and tempered condition as required.

13.0 FINISHED FORGING REQUIREMENTS

13.1 Forgings shall conform to the dimensions and tolerances specified on the relevant drawing referenced on the purchase order.

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13.2 Finished forgings shall be clean, scale free, free of laps, seams, cracks, fins, scabs, excessive flash or other surface / injurious defects.

13.3 Forging surfaces shall be capable of meeting the requirements of MPT / LPT as applicable.

14.0 ACCCEPTANCE

14.1 A lot shall consist of one-part number forgings produced from one heat of respective material and forged (heat treated, if require) in identical conditions.

14.2 CPC may inspect random samples from each lot to verify any or all the above requirements.

14.3 An AQL of 4 with an acceptance / rejection number as per CPC QA Plan to be used for lot acceptance. Any non-conforming lot shall be rejected.

14.4 Individual forgings may also be rejected for non-conformance if any.

15.0 PACKING

15.1 Forgings shall be supplied in packages that protect against damages during shipment.

16.0 DOCUMENTATION REQUIRED

16.1 Each shipment shall be accompanied by material certifications for each lot of material, the certifications must be positively relatable to the lot of material represented.

a) Mill certificate of raw material.

b) Chemical certificate for each lot of forging.

16.2 Mechanical properties certification as per spec

16.3 Impact testing certification

16.4 Certification of heat treatment including cycle time, temperature, cooling media, hardness and graphs.

16.5 Calibration certificate of furnace.

16.6 Ultrasonic test report -- certification of raw material.

16.7 **Suppliers shall retain heat treat charts in a secure area for a period of no less than 10 years (e.g. electronic or paper)**

17.0 TESTING TO BE CARRIED OUT BY CPC

17.1 At the time of lifting forgings re-verification of chemical properties.

17.2 Recheck of tensile strength, yield strength, elongation, reduction in area, hardness, impact testing and UT testing as per applicable spec.

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