FORGINGS STAINLESS STEEL ASTM A182-F6NM API 75K H2S AND CO2 SERVICE

Rev	Reason of Change	Date	Made By	Reviewed By	Approved By	Status
0		09-05-2013	USR	J Gulati	KKD	Released

Summary:

This specification covers martensitic stainless steel forgings and mill shapes to meet API material designation 75K for mechanical properties. Material is acceptable for chlorides <20,000 PPM (no oxygen).

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1.0 SCOPE

1.1 This specification covers martensitic stainless steel forgings and mill shapes to meet API material designation 75K for mechanical properties. Material can be used for H2S, CO2 and low temperature.

2.0 APPLICABLE SPECIFICATIONS

2.1 ASTM A182-F6NM (chemistry only);

2.2 NACE MR-01-75 / ISO 15156

2.3 ASTM A370

3.0 CHEMICAL REQUIREMENTS

3.1 The chemical composition of the material shall conform to the following limit:

Element	Wt. Percentage (%)
Carbon, max	0.03
Nitrogen, max	0.03
Carbon + Nitrogen, max	0.05
Manganese, max	0.50-1.00
Sulfur, max	0.025
Phosphorus, max	0.025
Silicon, max	0.30-0.60
Chromium	12.00 -14.00
Nickel	3.50-4.50
Molybdenum	0.30-0.70

3.2 It has been found that a lower carbon content, lower nitrogen content, and lower percentages of Mo, Ni, Cu, and Cr are helpful in meeting the 241 HBW maximum hardness. It is thus recommended to aim for 0.02% Carbon, 12.50% Cr, 4.00% Ni, 0.30/0.50% Mo, and Cu as low as possible in the melt chemistry to assist the vendor in meeting the maximum hardness requirements after heat treatment.

Note: Rounding is permitted per ASTM E29 (Standard Practice for Significant Digits in Test Data to Determine Conformance with Specification). For example,a carbon plus nitrogen content of 0.054 may be rounded down to 0.05.

4.0 MECHANICAL PROPERTIES

4.1 Determine the size of the coupon or test block to certify the material for the appropriate product specification (API 6A, 14D or 16A) and PSL levels (PSL 1, 2, 3 or PSL 4).

Table 1: Required Mechanical Properties

Tensile Strength, min	95,000 psi (655 Mpa)
Yield Strength, min	75,000 psi (517 Mpa)
Elongation in 2" or 4D gage length, min	17%
Reduction of area, min	35%
Brinell Hardness of Raw material (forgings, bar stock, mill shapes) and QTC after heat treatment*	197-241 HBW
Brinell Hardness of components in the semi finished and finished condition*	197-255HBW, 23 HRC, max
Hotwork (Reduction) of QTC	n)
* See section 6.0 for more information	

4.2 Other mechanical properties such as impact values may be required. These would be specified by the particular part number specification/Drg. and are in addition to the requirements above.

5.0 HEAT TREATMENT

All QTC's, if not prolongations, shall be placed on top of their respective production parts in the furnace.

Furnace charts to document all heating cycles (example - steps 5.1, 5.3, 5.5) shall be retained by the vendor. Copies are to be supplied upon request by Sara Sae. Strip or circle charts to document the cooling cycles are not required (reference - steps 5.2 and 5.4). The material certificate shall include heat treatment certification that notes the actual recorded temperature and times for all heat soak cycles.

The following is a recommended heat treatment procedure that has been successful in meeting the specified hardness of 241 HBN maximum. Modifications to this procedure that still meet heat treatment requirements of NACE MR0175 are allowed and at the vendor's discretion providing the requirements of section 3.0, 4.0, and the first two paragraphs of 5.0 are also met.

5.1 Heat to 1875° +/- 25°F (1024° +/- 14°C).

T (thickness) shall be determined to calculate soak time for heat treatment. T shall be calculated as follows:

For parts with geometrical/ dimensional variations: consider the greatest "T" for soak time calculations. The greatest T for such a part shall be determined by

calculating the diameter of the largest circle or sphere than can be placed inside the heaviest cross section of the part.

For simple shapes, the soak time shall be determined based on T as follows:

- height (for hollow and solid discs), thickness
- (for hollow forgings and rings), diameter (for
- round bars) and
- side (for square bars).

Maximum holding time shall not exceed five times (5X) the minimum holding time. The 5X rule does not apply to the separate QTC (e.g. API 6A 5 inch round or 4x4x8 coupon).

Opening of the furnace door to retrieve individual pieces during heat treatment is permitted, as long as the holding time for all pieces in the load meet the minimum hold time requirements prior to removal of the first piece. Following removal of the first piece, the furnace door shall be closed and the furnace shall be permitted to return to a stable temperature within the specified range for that grade. Additional pieces shall be removed after a time sufficient to have stable furnace and metal temperatures.

5.2 Still air quench to ambient temperature. Parts must be allowed to cool to ambient temperature, preferably less than 90°F (32°C), throughout the parts cross section for sufficient time to ensure complete transformation. Complete cooling will assist in staying under the maximum hardness requirement. Oil quenching may also be used if the material shape allows.

5.3 Temper at 1235° - 1275°F (668° - 690°C). The minimum soak times shall be per 5.1. Maximum soak times may be left to vendor's discretion (to meet requirements of section 4.0).

5.4 Air cool to ambient temperature. Parts must be allowed to cool to ambient temperature, preferably less than 90°F (32°C), throughout the parts cross section for sufficient time to ensure complete transformation. Cooling below ambient between tempering cycles has been shown to assist in final hardness reduction. A simple cooling unit can be used to accelerate normal air cooling once the part is around 122°-176°F (50°-80°C) and would reduce the time delay between steps 5.3 and 5.5. See note below.

5.5 Temper to 1100°-1150°F (593°-620°C). The minimum soak times shall be per 5.1 Maximum soak times may be left to vendor's discretion (to meet requirements of section 4.0).

5.6 Air cool to ambient temperature.

Note: On all cooling steps 5.2, 5.4 and 5.6 any quenching medium may be used to accelerate full cooling once the production part is cooled through its core to less than 400°F (204°C).

6.0 Hardness Testing

6.1 Table 1 requires a lower maximum hardness for raw material when compared to finished components. The maximum hardness of 241 HBW on raw material is imposed by Sara Sae to ensure cold work induced during machining does not cause the part to measure > 255 HBW when checked on finish machined surfaces. The potential for hardness increases due to machining and post weld heat treatment is unique to this material.

6.2 Hardness testing methodology & hardness testing location(s) for finished components shall be in accordance with particular part number specification / Drg.

6.3 The requirements for hardness testing of pipe bends shall be in accordance with particular part number specification / Drg.

6.4 To certify hardness of raw material, the following shall apply:

6.4.1 For forged blocks or other mill shapes less than 5000 pounds or straight sections of thin walled hollow sections (tubulars) less than 36-inches in length refer to particular part number specification / Drg. for hardness test locations.

6.4.2 For forged blocks or other mill shapes > 5000 pounds or straight sections of thin walled hollow sections (tubulars) > 36-inches in length: a minimum of three readings should be taken on each end and the mid section (if possible). If the average hardness is 241 HBW or lower with no reading greater than 248 HBW, then the raw material is approved for production. If the average hardness is greater than 241 HBW, the vendor shall contact Sara Sae for disposition.

6.5 The raw material limits of 197-241 HBW per Table 1 shall apply for hardness acceptance of raw materials following heat treatment and prior to welding and machining.

6.6 The hardness range of 197-255 HBW shall apply to any semi finished or finished component.

7.0 MARKINGS

7.1 Each piece shall be identified with the heat number marked with stenciled letters or marked with low stress or interrupted dot stamps on the exterior surface. Please refer to the part specification and purchase order for additional marking requirements.

8.0 INSPECTION

8.1 Forgings shall be inspected and free of laps, seams, cracks or other injurious indications.