

# NACE – Material requirements for Badotherm products

## Description

NACE International has developed two significant standards relative to the use of materials in hydrogen sulfide bearing environments. One is titled ISO 15156 / MR0175, *Petroleum and Natural Gas Industries - Materials for use in H<sub>2</sub>S-containing Environments in Oil and Gas Production*; and the other is MR0103/ISO 17945, *Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments*. Hydrogen sulfide is not only a poisonous gas, but can also cause stress corrosion cracking in steels and alloys. These standards define material conditions that are suitable for use in given hydrogen sulfide service conditions.

## ISO 15156 (MR0175)

Basis for this document is the ISO 15156 / MR0175. This standard specifies the selection of proper materials, their conditions and strength required to provide a good service life in sour gas and oil environments. It can be applied to help to avoid costly corrosion damage to the equipment itself. It supplements, but does not replace, the material requirements given in the appropriate design codes, standards or regulations. Most materials that are used in Badotherm products are in line with the metallurgical requirements of the NACE ISO 15156/MR0175

## ISO 17945 (MR0103)

For downstream processes the ISO 17945 / NACE MR0103 Petroleum, petrochemical and natural gas industries - Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments was developed. However this datasheet is based on the ISO 15156 / MR0175 the additional restriction per material(group) are given.

## Classification

ISO 15156 / MR0175 describes for various material groups the requirements. These material groups are categories by application. Badotherm products are categorized in the application "Instrumentation and control devices" and "Any equipment or component". The requirements from those applications are used for the further categorization.

## Responsibility

The ISO 15156 / MR0175 emphasizes that the responsibility of the selection of materials and the if the materials are satisfactory in the intended environment is the end user's responsibility. It is Badotherm's responsibility to ensure that the materials are meeting the metallurgical requirements mentioned in the ISO 15156 / MR0175. In this datasheet the metallurgical condition of commonly used materials in Badotherm products are highlighted.

## Materials

### 300 series stainless steel

Austenitic (300 series) stainless steels of this material type shall contain the following elements in the following proportions, expressed as mass fractions: C, 0,08 % max; Cr, 16 % min; Ni, 8 % min; P, 0,045 % max; S, 0,04 % max; Mn, 2,0 % max; and Si, 2,0 % max. Other alloying elements are permitted. It is common industry practice to dual certify 300 series stainless steels as standard grade and low carbon grade such as S31600 (316) and S31603 (316L). The environmental limits given for low carbon 300 series stainless steels are acceptable for the dual certified grades. Other restrictions given are:

- In the solution annealed and quenched, or annealed and stabilized heat treatment condition;
- Free of cold work intended to enhance their mechanical properties;
- Have a maximum hardness of 22HRC

The ISO 17945 / NACE MR0103 does not have any additional restrictions or requirements on top of the ISO 15156 / MR0175 for the austenitic 300 series stainless steels.

### Highly Alloyed Austenitic Stainless steels

Some materials are defined as highly alloyed austenitic stainless steel. There are two categories. The first are N08904 (AISI904L) and S31254 (254SMO) with a restriction of  $(Ni+2*Mo)>30$  where the  $Mo>2\%$ . The second is N08367 (AL-6XN®) with restriction having a restriction of  $PREN>40$

Process limitations given according the ISO 15156 / MR0175 for both materials N08904 & S31254

Temperature (max)	Partial pressure H2S (max)	Chlorides (max)	Sulfur resistant
60°C	100 kPa	no remarks	no
60°C	no remarks	50 mg/l	no

Values given by application table A8.

Process limitations given according the NACE MR0175/ISO 15156 for material N08367.

Temperature (max)	Partial pressure H2S (max)	Chlorides (max)	Sulfur resistant
121°C	700 kPa	5000 mg/l	no
149°C	310 kPa	5000 mg/l	no
171°C	100 kPa	5000 mg/l	

Values given by application table A8.

The NACE MR0103 / ISO 17945 gives an additional maximum hardness value of 35 HRC on top of above restrictions for all materials.

### Nickel-Base Alloys

Commonly used materials are Nickel-Base alloys are they have very good resistance to cracking in sour, chloride containing environment. Badotherm is using Solid-solution nickel-based alloys for their products. Materials in this material group are N10276, N06625, N08825, and N04400. Materials with below chemical composition does not have any hardness limit.

- 19.0% Cr minimum, 29.5% Ni+Co minimum, and 2.5% Mo minimum (N06625, N08825)
- 14.5% Cr minimum, 52% Ni+Co minimum, and 12.0% Mo minimum (N10276 - 4b)

N04400 has been integrated in the NACE MR0175/ISO 15156 and is categorized in the same group with a hardness restriction of <35 HRC.

The ISO 17945 / NACE MR0103 does not have any additional restrictions or requirements on top of the ISO 15156 / MR0175 for the nickel base alloys described above.

### Duplex Stainless Steel

In the Duplex stainless steel there are 2 categories. The standard duplex and the super duplex category. The duplex alloys are having  $30\leq PREN\leq 40$  and 1.5% Mo, and the super duplex alloys are having  $PREN\geq 40$ . The PREN is calculated based on the composition of the material. The ISO 15156 / MR0175 uses the PREN calculation formula:  $PREN = Cr\% + 3.3(Mo\% + 0.5W\%) + 16N\%$

For standard duplex (S31803 and S32205)

Temperature (max)	Partial pressure H2S (max)	Chlorides (max)	Sulfur resistant
232°C	10 kPa	no remarks	NDS
232°C	no remarks	50 mg/l	NDS

Values given by application table A24.

For super duplex (S32750)

Temperature (max)	Partial pressure H2S (max)	Chlorides (max)	Sulfur resistant
232°C	20 kPa	no remarks	NDS
232°C	no remarks	50 mg/l	NDS

The ISO 17945 / NACE MR0103 gives an additional maximum hardness value of 28 HRC on top of above restrictions when the value for  $PREN\leq 40$  and when  $PREN>40$  a max value of 32HRC.

### Tantalum, Titanium and Zirconium

Tantalum R05200 shall have a maximum hardness of 55 HRB  
 Titanium gr2 R50400 shall have a maximum hardness of 100 HRB.  
 Zirconium Zr702 is not mentioned in the ISO 15156 or ISO 17945.

### Bolting

ISO 15156 / MR0175 distinct two types of applications; the exposed and non-exposed application. Grade ASTM A193 B7 bolts or ASSTM A194 2H nuts are allowed in the non-exposed situation. For exposed bolting the bolts B7M and 2HM nuts (<22 HRC) or B8A cl.1A and B8M cl.1A are acceptable together with 8A or 8MA nuts.

### Coating

ISO 15156 / MR0175 and ISO 17945 / NACE MR0103 both allow linings, coating and plating. Applying gold plating on diaphragm seals is allowed in NACE environments, however are not acceptable for preventing cracking or to prevent the SSC. This means that the underlying (base) material should meet the restrictions of both the ISO 15156 / MR0175 and ISO 17945 / NACE MR0103.

Holland – Romania – India – Thailand – Dubai – USA

To our knowledge, the information contained herein is accurate as of the date of this document. However neither Badotherm, nor its affiliates makes any warranty, express or limited, or accepts any liability in connection with this information or its use. This information is for technical skilled persons at their own discretion and risk and does not relate to the use of this product in combination with any other product. The user alone finally determines suitability of any information or material in contemplated use, the manner of use and whether any patents are infringed. This information gives typical properties only. Badotherm reserves the right to make changes to the specifications any materials without prior notice. The latest version of the datasheet can be found on [www.badotherm.com](http://www.badotherm.com).

© 2015 Badotherm, all rights reserved. Trademarks and/or other products referenced herein are either trademarks or registered trademarks of Badotherm.