GSI FAIR	Technical Guideline	Number	2.35e
B-MT	Steel Materials for Pressurised Cryogenic Components	Status	2011-04-04

Contents

1. Scope

1) This document defines steel materials to be used as wrought material for engineering and production of tubing and components operated at cryogenic temperatures for the use in
   - magnet cryostats
   - cryogenic supply systems
   - cryogenic transport systems
   - cryogenic current lead boxes
   - auxiliary cryogenic systems

   within particle accelerators.
2) This document is NOT related to
   - any materials in use for construction of beam vacuum chambers and related components
   - any materials for cryogenic compensation bellows
   - any super conductive magnet-, magnet coil- or cable applications
3) This document does NOT represent a replacement for any relevant technical standards in terms of 97/23/EC [1] or the AD2000 Code [2].
4) This document is NOT related to any other purpose as aforementioned.

2. Definitions

1) *Pressurised components* in terms of this document are components being identified as such according to the European pressure equipment directive 97/23/EC [1].
2) *Cryogenic temperatures* in terms of this document are any temperatures below 273K.
3) *Magnetic fields* in terms of this document are magnetic fields generated by any magnet system dedicated to ion optics.

3. Codes and Standards

1) The European pressure equipment directive 97/23/EC [1] defines the legal standards for components and assemblies being identified as pressure equipment.
2) The AD 2000 Code [2] defines the engineering, production and documentation standards in terms of pressure equipment.
3) The AD 2000-Technical Bulletin W 10 [3] defines the requirements for material to be applied for pressurised components at cryogenic temperatures.

4. Qualified materials for applications within magnetic field regions

1) As long as not specified, the necessity of low μ_R materials and the required μ_R value must be agreed with GSI.
2) Materials applied in regions close to components generating magnetic fields must show a $\mu_R \leq 1.01$, respectively $\mu_R \leq 1.005$ after solution annealing and at room temperature.
3) The μ_R value must be proven separately for each stainless steel component exposed to magnetic fields.
4) The applicable temperature range in dependence of the load cases according to [3] must be respected.

4.1. Materials with unrestricted temperature range

1) Qualified low μ_R materials with unrestricted usability at low temperatures in terms of [3] are
   - 1.4429 - X2CrNiMoN17-13-3 according to [4] and [5],
   - P506 - X2CrMnNiMoN 19 12 11 1 according to [6].
2) In case the material P506 is chosen for application, the applicability for pressure equipment in terms of [1] must be proven in detail; by the contracting entity; as defined by [2].

4.2. Materials with restricted temperature range

1) The temperature related restrictions on applicability as defined by [3] in dependence of load cases must be adhered.
2) Qualified low μ_R materials with restricted usability are
   - 1.4404 - X2CrNiMo17-12-2,
   - 1.4435 - X2CrNiMo18-14-3

   according to [4] and [5].

5. Qualified materials for applications far from magnetic field regions

1) Materials applied in regions far from magnetic fields, which means showing no significant influence on the magnetic field, do not have special requirements to μ_R.
2) As long as not specified, the applicability of materials without μ_R restrictions must be agreed with GSI.
3) Only stainless steel materials are qualified.

5.1. Materials with unrestricted temperature range

1) Qualified materials with unrestricted temperature range are
   - 1.4306 - X2CrNi19-11
   - 1.4311 - X2CrNiN18-10
   - 1.4406 - X2CrNiN17-11-2
   - 1.4541 - X6CrNiTi18-10
   - 1.4571 – X6CrNiMoTi17-12-2

   according to [4] and [5].

5.2. Materials with restricted temperature range

1) As long as not specified, all other stainless steel materials with lowest operation temperature < 73K (< -200°C) according to [3] with respect to the permitted operation temperature in relation to the relevant load case, are qualified.

6. Documents and certificates

1) All material related documents and certificates as defined by [3] must be delivered for any material in use for steel made cryogenic components independent of being pressure equipment.

7. References

[1] Directive 97/23/EC, European parliament and the council of the European Union, http://eur-lex.europa.eu; 1997

[2] AD 2000-Code; Verband der TÜV e. V.; Beuth Verlag GmbH; Berlin; Germany; 2009.

[3] AD 2000-Technical Bulletin W 10, Werkstoffe für tiefe Temperaturen - Eisenwerkstoffe; Verband der TÜV e. V.; Beuth Verlag GmbH; Berlin; Germany; 2009

[4] DIN EN 10088-2; Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes; German version EN 10088-2; Deutsches Institut für Normung e.V., Beuth Verlag GmbH; Berlin; Germany; 2005

[5] DIN EN 10088-3; Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes; German version EN 10088-3; Deutsches Institut für Normung e.V.; Beuth Verlag GmbH; Berlin; Germany; 2005

[6] Technical Guideline F-TG-V-2.28e: Stainless Steel for Beam Vacuum Chambers at Cryogenic Temperatures