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TÜV NORD
TÜV UK Limited

European Approval for Materials
Data Sheet
EAM-0879-04

This data sheet has been raised in accordance with the requirements of Article 15 of the Pressure Equipment Directive 2014/68/EU. The material described within is not included in a standard which has been harmonised to the afore mentioned directive.

Pure Nickel With Low Carbon For Pressure Equipment
EAM Nickel 201 – Seamless Tubes

1	Material Designation	1.1	Classification:	EAM-0879-04
		1.2	Name:	Nickel 201
		1.3	Material Ref. No.:	2.4068
		1.4	UNS Ref. No.:	N02201
		1.5	ISO/TR 15608:2000	Group 41
2	Standards to which consideration and or reference has been given.	This EAM incorporates by dated or undated reference provisions from other publications. These references are cited in the text and in the following list. For dated references, subsequent amendments to, or revisions of any of these publications apply to this EAM only when incorporated in an amendment or revision to this EAM. For undated references the latest edition of the publication applies (including amendments).		
		2.1	LC-Ni 99 VdTÜV 345 – 06/1999 (Origin)	
		2.2	EN 10002-1:2001	
		2.3	EN 10002-5:1992	
		2.4	EN 10204:1991	
		2.5	EN 10233:1994	
		2.6	EN 10234:1994	
		2.7	EN 10236:1994	
		2.8	EN 10237:1994	
		2.9	EN 10246-2:2000	
		2.10	EN 10246-6:2000	
		2.11	EN 10246-7:1996	
		2.12	EN 10246-17:2000	
		2.13	EN 473:2000	
		2.14	DIN 2413:1972	
		2.15	EN 10003-1:1995	
		2.16	EN ISO 6507-1:1998	

3	Limiting Dimensions	Dimensions									
		Thickness (mm)						Diameter (mm)			
		Up to and including 25mm						Up to and including 200mm			
4	Melting Method	4.1 Electric Arc Process 4.2 Induction Furnace Process									
5	Production Method / Delivery Condition	5.1 Hot Rolled 5.2 Cold Rolled 5.3 Extruded } Soft Annealed (see section 10)									
		The products shall be free from surface and internal defects which might impair their usability									
6	Application Temp.	6.1 -10° to 600°C 6.2 The material is also suitable for use below -10°C. For such cases, impact values and verification procedures shall be agreed at the time of ordering.									
7	Chemical Composition		% Composition by Weight								
			Ni	C	Si	Mn	S	P	Fe	Cu	Mg	Ti
	Ladle	Minimum	99.0									
		Maximum		0.020	0.20	0.35	0.010	0.015	0.40	0.25	0.15	0.10
	Product	Minimum	98.4									
		Maximum		0.025	0.23	0.38	0.013	0.018	0.47	0.28	0.18	0.13
8	Mechanical and Technological Requirements	8.1 Tensile Properties at Room Temperature									
		Rp0.2 N/mm²		Rp1.0 N/mm²			Rm N/mm²			A %	
		Min 80		Min 105			340/540			Min 40 (both 5d and 5.65√So)	
	Verification Test Direction	8.2 Longitudinal (see section 9)									
	Tensile Properties	8.3 Minimum proof and tensile strength values at Elevated Temperature °C[1)]									
		100	200	300	400	500	600				
		Requirement N/mm²									
	Rp0.2	70	65	60	55	(50)	(40)				
	Rp1.0	95	90	85	(80)	(75)	(65)				
	Rm[2)]	290	275	260	240	210	150				
		1) For design calculations no interpolation between stated values is permitted (unless the design code explicitly provides for it). The values at the higher temperature shall be used. 2) Rm values for reference only. The values in brackets are above the intersection with the calculated creep properties for 100,000 hours (see section 15). The property values are taken from VdTÜV 345-06.99									

<table>
<tr><td>8</td><td>Other Properties</td><td>
<table>
<tr><td>8.4</td><td>Minimum Impact Properties at room temperature (Charpy V) EN 10045-1</td></tr>
<tr><td></td><td>Longitudinal direction: = KV 120 J
Transverse direction : = KV 80 J</td></tr>
<tr><td>8.5</td><td>Hardness Brinell HB – EN 10003-1
Or Hardness Vickers HV – EN ISO 6507-1</td></tr>
<tr><td></td><td>Both HB and HV: 130 max</td></tr>
<tr><td>8.6</td><td>Modulus of Elasticity KN/mm^2</td></tr>
</table>
<table>
<tr><td>Temperature ^oC</td><td>20</td><td>100</td><td>200</td><td>300</td><td>400</td><td>500</td><td>600</td></tr>
<tr><td>E-Modulus</td><td>196</td><td>192</td><td>188</td><td>180</td><td>172</td><td>162</td><td>150</td></tr>
</table>
Reproduced from VdTÜV 345 06/99 (with mistake in source document regarding order of units corrected.
<table>
<tr><td>8.7</td><td>Technological Requirements</td></tr>
</table>
<table>
<tr><td rowspan="2">Outside Dia. D (mm)</td><td colspan="3">Wall Thickness T (mm)</td></tr>
<tr><td>< 2</td><td>≥ 2 ≤ 16</td><td>> 16 ≤ 25</td></tr>
<tr><td>≤ 18</td><td>Flattening test</td><td>Flattening test[1)]</td><td>-</td></tr>
<tr><td>> 18 ≤ 150</td><td>Flattening test</td><td>Ring Expanding test[1)]</td><td>Flattening test</td></tr>
<tr><td>> 150 ≤ 200</td><td>-</td><td>Ring Tensile test</td><td>Ring Tensile test</td></tr>
</table>
1) The test may, at the discretion of the manufacturer, be replaced by a drift test or ring tensile test.

Flattening test: specimens shall be flattened until the distance between the platens “H” is achieved using:

$H = \frac{(1+c)\,T}{c + T/D}$ Where T = wall thickness (mm)
D = outside diameter (mm)
c = constant 0.1

Ring expanding test specimens shall be expanded until fracture occurs. The fracture shall be of a clean ductile nature. If a 40% expansion is reached the test may be discontinued.

Drift Expanding test: The diameter of the specimen shall be increased by 30% and when examined shall shown no signs of cracking without the use of magnifying aids.

Ring Tensile test: Specimens shall have a clean ductile fracture.

Flattening and expanding tests shall show no signs of cracking without the use of magnifying aids.
</td></tr>
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<tr><td>9</td><td>Testing</td><td>
<table>
<tr><td colspan="3">9.1 Type of Inspection and Test</td></tr>
<tr><td>Test / Inspection</td><td>Frequency</td><td>Reference</td></tr>
<tr><td>Cast Analysis</td><td>One per cast</td><td>Section 7</td></tr>
<tr><td>Product Analysis</td><td>One per cast (if required and agreed at the time of ordering by the purchaser).</td><td>Section 7</td></tr>
<tr><td>Positive Material I/D</td><td>All items</td><td>Section 7</td></tr>
<tr><td colspan="3">9.2 Tensile Test at Room Temperature</td></tr>
<tr><td rowspan="2"></td><td>Frequency</td><td>Reference</td></tr>
<tr><td>1 Longitudinal test per cast size per heat treatment lot for every 100 tubes or part thereof.</td><td>Section 8.1 and EN 10002-1</td></tr>
<tr><td colspan="3">9.3 Elevated Temperature Tensile Tests</td></tr>
<tr><td rowspan="2">For tubes with operating temperatures ≥ 100°C</td><td>Frequency</td><td>Reference</td></tr>
<tr><td>1 test per cast from the product with the largest thickness.</td><td>Section 8.3 and EN 10002-5</td></tr>
<tr><td colspan="3">9.4 Impact Testing</td></tr>
<tr><td colspan="2" rowspan="2">Verification of impact properties is only required when specified by the purchaser at the time of ordering.
The values stated in section 8.4 shall be the minimum average of 3 specimens, with only one individual specimen value allowed up to a maximum of 30% lower.</td><td>Reference</td></tr>
<tr><td>Section 8.4 and EN 10045-1</td></tr>
<tr><td colspan="3">9.5 Hardness Test</td></tr>
<tr><td rowspan="2"></td><td>Frequency</td><td>Reference</td></tr>
<tr><td>All Mechanical Test Samples / Coupons</td><td>Section 8.5</td></tr>
</table>
</td></tr>
</table>

9	Testing	9.6 Leak Tightness

Test Method	Frequency	Reference
Hydraulic pressure test with water at 80 bar[1], duration 5 sec minimum. Alternatively Eddy Current Testing may be employed.	All Tubes	EN 10246-2

1) Pressures greater than 80 Bar may be used, where agreed. However under no circumstances shall the test pressure be such as to result in the stress exceeding the Rp0.2 or Rp1.0 proof strength.

Using: P = 20 x S x T/D

Where:
P = Test pressure in bar
S = 86% of the minimum specified Rp0.2 proof strength in N/mm^2 (Reference the formula from DIN 2413 with a 1.1 safety factor)
T = Minimum wall thickness in mm
D = Outside diameter in mm

9.7 Non-destructive Tests

Test	Frequency	Reference
Ultrasonic Test[2) 3)]	All tubes	EN 473 or equivalent EN 10246-6, 7 or 17

2) The ultrasonic test shall be performed in accordance with EN 10246-7 (longitudinal imperfections), and the acceptance criteria shall be Level U2 subcategory C. This test may be dispensed with where the tube is being used inside a pressure vessel (internal tubes). The order shall specify whether internal use is intended.
3) Ultrasonic testing for transverse or laminar imperfections, if required, shall be agreed at the time of ordering.

9.8 Visual Inspection [4)]

	Frequency	Reference
	All bars	

9.9 Dimensional Inspection [4)]

	Frequency	Reference
	All bars	

4) 100% inspection of all tubes by the manufacturer. Dimensional tolerances shall be agreed between the manufacturer and purchaser at the time of ordering.

9.10 Technological Tests

Test	Frequency	Reference
Flattening Test	1 test piece from 1 end of each tube or factory length	Section 8.7 and EN 10233 EN 10234 EN 10236 EN 10237
Ring Tensile Test		
Drift Expanding Test		
Ring Expanding Test		

<table>
<tr><td rowspan="3">10</td><td rowspan="3">Heat Treatment</td><td>Method</td><td>Temperatures</td><td>Holding Times</td><td>Cooling</td></tr>
<tr><td>Soft Annealing</td><td>700 to 850°C</td><td>2 to 4 min/mm of thickness</td><td rowspan="2">Air</td></tr>
<tr><td>Stress Relief Annealing</td><td>550 to 650°C</td><td>30 min to 3 hrs.</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Joining</td><td colspan="4">11.1 Welding</td></tr>
<tr><td colspan="4">This material has, historically, proven suitable for fusion welding by: the MMA (111) welding process with coated electrodes using the appropriate filler material, e.g. material No.:2.4156. Also the processes TIG (141) and MIG (131) using the appropriate filler material, e.g. No.:2.4155
Information supplied by the consumable manufacturer on the filler wires suitability must be considered, especially with regard to sulphur sensitivity and both low and elevated temperature properties.
The material does not normally require pre heat and should be welded in the soft annealed condition.
Stress relief annealing may take place after welding.
Where cold forming exceeds 5%, stress relief annealing shall be performed prior to welding.
Consultation with the material manufacturer’s technical department is recommended when choosing a filler wire or welding process.</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">Forming</td><td colspan="4">12.1 Hot and Cold</td></tr>
<tr><td colspan="4">The material is suitable for both hot and cold forming subject to the following provisions:
1) Hot forming shall occur between 800 to 1250°C followed by soft annealing (see section 10).
2) Where cold forming deformation exceeds 5% a stress relief anneal or soft anneal shall be performed (see section 10).
3) The material is sensitive to sulphur above 400°C, therefore the surface should be carefully cleaned before any welding or heat treatment.
4) It is important that the furnace atmospheres for processing are sulphur free.</td></tr>
<tr><td>13</td><td>Marking</td><td colspan="4">13.1 All Tubes
1) Manufacturer’s Identification Mark
2) Cast / Melt Number
3) Test or Manufacturing Batch Number
4) Material Grade
5) EAM Reference No.

Markings shall normally be by permanent ink marking or Vibro-etching.</td></tr>
</table>

14	Inspection Documents	14.1	Document Type
		1)	Material manufacturers shall supply documentation affirming compliance with this EMA. This document shall normally be in the form of an inspection certificate in accordance with EN 10204 3.1.B.
		Note: Where a material manufacturer has an appropriate quality assurance system, certified by a competent body, established with the community and having undergone a specific assessment for materials, certificates issued by the manufacturer are presumed to certify conformity with the requirements of section 4.3 of Annex 1 of the PED.	
		2)	If an inspection document in accordance with EN 10204 3.1.C or 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organisation or person who is to carry out the inspection and produce the inspection document. In the case of the inspection report 3.2 it shall be agreed which party shall issue the certificate.
		Note: The affirmation of the compliance of the delivery with this EMA is not a mandatory requirement of EN 10204. Such affirmation – as is required by the PED 2014/68/EU in Annex 1 4.3 first paragraph – can be added into the text of the material certificate, when it is signed by the manufacturer. It could also be provided in a separate document. In the case the material certificate is signed by a third party, the affirmation shall be contained in a document which is (also) signed by the manufacturer.	
		14.2	Contents of Inspection Documents
		1)	Details of the manufacturer
		2)	Details of the purchaser (if required)
		3)	Description and dimensions of the product
		4)	Supply conditions
		5)	Ladle analysis
		6)	Product analysis (if required)
		7)	Results from mechanical property tests
		8)	Heat treatment applied
		9)	Results from other applicable tests (e.g. NDT, Leak Test, PMI, Technological Tests)
		10)	Marking and identification
		11)	Affirmation of compliance with this EAM
		12)	Declaration of the status of the Manufacturer's Quality System (including the name of the competent body having certified the quality system, if applicable).

15	Calculated Creep Properties	Temperature	Calculated 1% creep strain strength characteristics (multiplied by factor 1.5)[1)] N/mm^2	
		^{o}C	10^4h	10^5h
		350	-	85
		360	-	80
		370	-	75
		380	85	70
		390	80	65
		400	75	60
		410	71	56
		420	67	52
		430	63	48
		440	59	44
		450	55	40
		460	51	36
		470	47	32
		480	43	29
		490	39	26
		500	35	23
		510	31	20
		520	28	17
		530	25	15
		540	22	13
		550	19	11
		560	17	9
		570	15	8
		580	13	7
		590	11	6.5
		600	10	6
		1) The figures above are calculated creep strain strength characteristics values which correspond to the lower scatter band of the 1% creep strain limit multiplied by 1.5. N.B. Between the 1% creep strain limit and the creep rupture strength there is a difference which is greater that 1.5 x 1% creep strain limit. In order to avoid unacceptable deformations the creep rupture strength cannot be used for calculation. For design calculations no interpolation between stated values is permitted (unless the design code explicitly provides for it). The values at the higher temperature shall be used.		

The characteristics in the table above are reproduced from VdTÜV 345 06/99