HYDROGENIUS
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HYDROGENIUS DATABASE

— Hydrogen Diffusivity and Solubility —

No. B34

Database on Hydrogen Diffusivity and Solubility of
JIS-SUS 316 (Type 316, over 12 mass% Ni) Austenitic Stainless Steel

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Research Center for Hydrogen Industrial Use and Storage (HYDROGENIUS),
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Database on the Hydrogen Diffusivity and Solubility of JIS-SUS 316 (Type 316, over 12 mass% Ni) Austenitic Stainless Steel

1. MATERIALS

Table 1. Details of processing and related data of SUS316 (over 12 mass% Ni).

Heat	Production Process	Product Format	Diameter or Thickness (mm)	Date of Issue
A[1)]	Hot-rolling	Plate	t 45	2011
B[1)]	Hot-rolling	Plate	t 45	2011
D[2)]	Hot-rolling	Round bar	φ 25.4	2010

[1)] As reported by JPEC.
[2)] After issuance of the inspection certificate.

Table 2. Chemical composition of SUS316 (over 12 mass% Ni).

	Heat		Element (mass%)							
			C	Si	Mn	P	S	Ni	Cr	Mo
Product Analysis	A[1)]		0.048	0.39	1.43	0.024	0.002	12.46	17.06	2.33
	B[1)]		0.048	0.39	1.44	0.024	0.002	12.36	16.99	2.32
	D[2)]		0.04	0.54	1.74	0.019	0.021	12.15	17.42	2.38
Ladle Analysis	A[1)]		0.049	0.40	1.40	0.025	0.002	12.38	16.98	2.29
	B[1)]		0.048	0.40	1.39	0.025	0.002	12.39	16.94	2.30
	D[3)]		0.040	0.54	1.71	0.023	0.025	12.08	17.66	2.35
	Requirements[4)]	Max.	0.08	1.00	2.00	0.045	0.030	14.00	18.00	3.00
		Min.						10.00	16.00	2.00

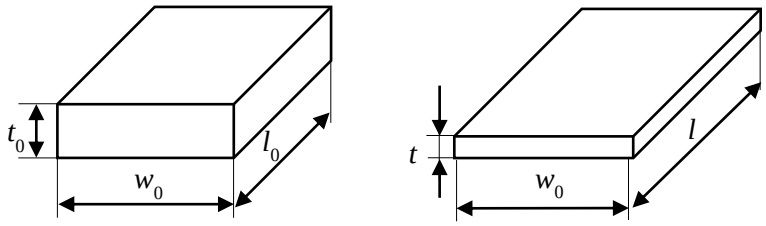
[1)] As reported by JPEC.
[2)] As performed at HYDROGENIUS.
[3)] After issuance of the inspection certificate.
[4)] As per JIS G 4304:2005, *"Hot-rolled Stainless Steel Plate, Sheet and Strip"* and JIS G 4303:2005, *"Stainless Steel Bars"*.

Table 3. Heat-treatment conditions of SUS316 (over 12 mass% Ni)[2)].

Heat	Heat-treatment	Conditions
A[1)]	Solution-treatment	1080°C, 1.1 h, water-quenching
B[1)]	Solution-treatment	1080°C, 1.1 h, water-quenching
D[2),3)]	Solution-treatment	1066°C, water-quenching

[1)] As reported by JPEC.
[2)] After issuance of the inspection certificate.
[3)] The material was heat-treated by the manufacturer.

Table 4. Cold-rolling process of SUS316 (over 12 mass% Ni).

Definition of cold-rolling reduction-ratio, CW (%)	$CW = \left((t_0 - t)/t_0\right) \times 100$  Before cold-rolling After cold-rolling	
True pre-strain, ε_{pre}	$\varepsilon_{pre} = \ln \frac{A_0}{A} = \ln \frac{1}{1-(CW/100)}$	
Heat	Cold-rolling reduction-ratio, CW (%)	True pre-strain, ε_{pre}
A	0	0
B	20	0.22
D	0	0

2. MECHANICAL PROPERTIES

Table 5. Mechanical properties of SUS316 (over 12 mass% Ni).

Heat	Cold-rolling Reduction-Ratio, *CW* (%)		Tensile Properties[2)]				Vickers Hardness (*HV*)
			0.2% Proof Stress, $\sigma_{0.2}$ (MPa)	Tensile Strength, σ_B (MPa)	Elongation, ε_f (%)	Reduction of Area, φ (%)	
A	0	1)	218	533	98	86	
		2)	234	520	74	82	127
			236	522	73	83	
B	20	1)	536	682	58	81	
		2)	590	670	43	79	238
			596	670	42	75	
D	0	1)					
		3)	274	570	72	83	
			274	568	76	83	
Requirements[4)]	Max.						200
	Min.		205	520	40		

[1)] As performed at HYDROGENIUS according to ASTM : G142-98 (Re-approved in 2004)
[2)] As reported by JPEC, per JIS Z 2241:2011, using a No. 14A-type specimen.
[3)] After issuance of the inspection certificate.
[4)] As per JIS G 4304:2005, *"Hot-Rolled Stainless Steel Plates, Sheets and Strip"*.

3. HYDROGEN DIFFUSIVITY AND SOLUBILITY (Determined by the hydrogen-entry method)

Table 6. Hydrogen-charging and hydrogen measurement.

Type of hydrogen-charging	Exposure to hydrogen gas at a pressure of 10-MPa
Hydrogen-gas purity	99.999%
Hydrogen-gas temperature & holding time	511 K/1 h, 478 K/2 h, 416 K/25 h and 383 K/95 h
Specimen shape	Circular disk with a diameter of 7 mm and a height of 0.11 - 1.31 mm.
Hydrogen-measurement method	Thermal desorption spectroscopy (TDS) using quadrupole mass spectrometer
Heating rate	20 K/min (0.33 K/s)
Error range of hydrogen-content measurement	±5% of the measured value