HYDROGENIUS
水素材料先端科学研究センター

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HYDROGENIUS DATABASE

— Hydrogen Transport Properties —

No. B29

Database of Hydrogen Transport Properties of JIS-SCM435 Low-Alloy Steel for Use in a Storage Cylinder at a 35-MPa-Hydrogen Type "A" Station

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Research Center for Hydrogen Industrial Use and Storage (HYDROGENIUS)
Kyushu University - JAPAN

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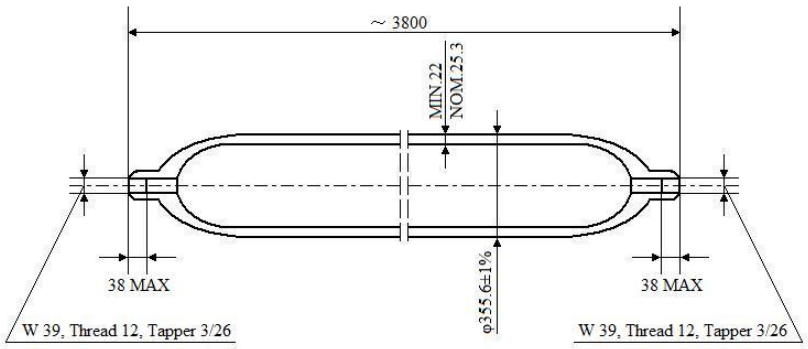
1. MATERIAL

Table 1. Processing details and related properties.



Hot-forged cylinder → Cold-forming of head and tail → Quenching-tempering → Hardness measurement → Screw processing →Shot-blasting → Inspection of inner and outer surfaces → Pressure proof-test → Stamping → Painting

Table 2. Chemical composition of SCM435.

			Element (mass%)						
			C	Si	Mn	P	S	Cr	Mo
Product Analysis	Present Material[1)]	Center	0.37	0.22	0.84	0.012	0.005	1.15	0.24
		Inside	0.38	0.22	0.79	0.006	0.004	1.1	0.23
Ladle Analysis	Present Material[2)]		0.35	0.20	0.77	0.008	0.003	1.05	0.20
	Requirements[3)]	Max.	0.38	0.35	0.85	0.030	0.030	1.20	0.30
		Min.	0.33	0.15	0.60			0.90	0.15

[1)] As performed at HYDROGENIUS.
[2)] As reported by the manufacturer.
[3)] As per JIS G 3441:1988, *"Alloy Steel Tubes for Machine Purpose"*.

Table 3. Heat treatment.

Quenching	Tempering
Barrel-furnace	Truck-furnace
860°C, Water-spraying	630°C, Air-cooling
3.60～3.95 BHD (Target hardness)	

It should be noted that the following data are identical to those featured in HYDROGENIUS DATABASE No.4: Tables 1, 2, 3, 4 and 5.

2. MECHANICAL PROPERTIES

Table 4. Tensile properties.

$\sigma_{0.2}$: 0.2% Proof strength
σ_B : Tensile strength
ε_u : Uniform elongation
ε_f : Total elongation
φ : Reduction of area
C_H : Hydrogen content

(a) Circumferential direction (C-specimens)

	Tensile properties					Hydrogen content
	$\sigma_{0.2}$ (MPa)	σ_B (MPa)	ε_u (%)	ε_f (%)	φ (%)	C_H (mass ppm)
Uncharged	671	824	7.9	20.4	71.6	0.0
Hydrogen-charged	682	823	7.9	21.0	66.6	0.3
	665	803	7.0	18.8	71.6	0.3
	680	815	7.0	18.0	68.3	0.3

(b) Longitudinal direction (L-specimens)

	Tensile properties					Hydrogen content
	$\sigma_{0.2}$ (MPa)	σ_B (MPa)	ε_u (%)	ε_f (%)	φ (%)	C_H (mass ppm)
Uncharged	687	824	6.9	20.3	71.0	-
	679	815	7.5	23.6	73.0	-
Hydrogen-charged	719	827	8.2	19.5	71.3	0.4
	707	838	7.5	19.5	68.9	0.3
	667	829	7.5	19.7	67.0	0.3

Table 5. Average value of Vickers hardness.

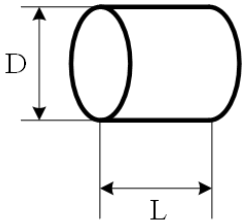
Vickers hardness
$\overline{HV}$
256

It should be noted that the following data are identical to those featured in HYDROGENIUS DATABASE No.4: Tables 1, 2, 3, 4 and 5.

3. HYDROGEN TRANSPORT PROPERTIES

Table 6. Hydrogen-charging and hydrogen-measurement conditions.

(a) Hydrogen-charging conditions.

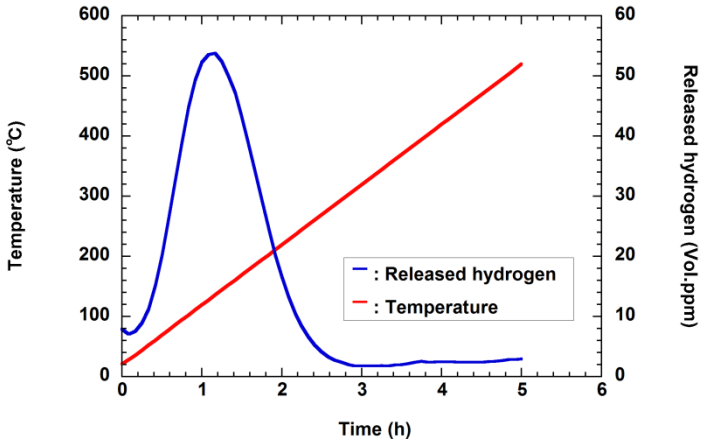
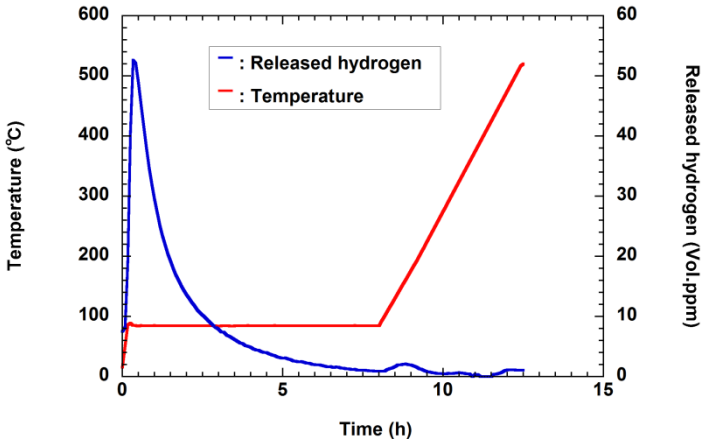
Type of hydrogen-charging	Exposure to hydrogen gas at pressures of 94 ～ 100 MPa
Hydrogen-gas purity	99.999%
Hydrogen-gas temperature & holding time	358 ～ 359 K, Over 200 h
Specimens[1), 2)]	 *D* = *L* = 19 mm, 7 mm

[1)] Specimens were cut so as to be equal in diameter and in length.
[2)] Surface-finishing was performed by circumferential-polishing using 2000-grade silicon-carbide paper.

(Table continues on the following page)

Table 6. Hydrogen-charging and hydrogen-measurement conditions. (Continued)

(b) Hydrogen-measurement conditions.

Type of spectroscope	TDA (Thermal Desorption Analysis) Hydrogen detection accuracy : 0.3 Vol. ppm Amount of hydrogen molecule detection : 6.1×10^{-10} mol/min
Measurement methods and conditions	 (a) Multiple-specimen measurement method. Measurement conditions: 100°C /h, 20°C ~ 520°C  (b) Single-specimen measurement method. Measurement conditions: 100°C /h, starting at 20°C, maintenance at 50°C, 70°C or 85°C, then increasing to 520°C.