HYDROGENIUS
水素材料先端科学研究センター

DOI: 10.48708/4756029

HYDROGENIUS DATABASE

— Hydrogen Transport Properties —

No. B31

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

August 2011

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

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Year of publication: 2011

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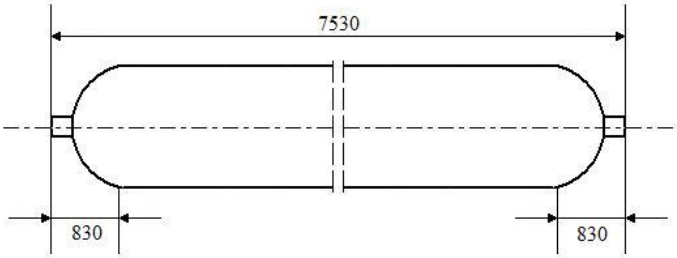
1. MATERIAL

Table 1. Processing details and related properties.



Hot-forged cylinder → Cold-forming of head and tail → Quenching-tempering → Shot-blasting → Screw-processing → Inspection of inner and outer surfaces → Pressure proof-testing → 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	0.21	0.77	0.012	0.007	1.07	0.28
		Inside	0.34	0.21	0.77	0.012	0.005	1.08	0.28
Ladle Analysis	Requirements[2)]	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 per JIS G 3441:1988, *“Alloy Steel Tubes for Machine Purpose”*.

Table 3. Heat-treatment.

Quenching	Tempering
Truck-furnace	Combination car-furnace
900°C, Oil-cooling	560°C, Air-cooling
3.50～3.70 BHD (Target hardness)	

It should be noted that the following data were reproduced from HYDROGENIUS DATABASE No.6: 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	808	943	6.0	14.2	56.0	0.0
	769	945	6.0	14.7	58.9	0.0
Hydrogen-charged	800	957	6.2	13.6	51.6	0.4
	792	950	5.9	12.0	49.5	0.4
	800	955	6.5	15.1	58.7	0.4

(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	785	951	6.6	16.6	65.3	0.0
	779	943	6.7	17.1	66.3	0.0
	777	936	6.4	18.4	65.0	-
Hydrogen-charged	767	937	9.1	21.7	61.5	0.4
	770	926	6.9	16.3	61.9	0.4
	767	929	6.6	16.2	63.9	0.4

Table 5. Average value of Vickers hardness.

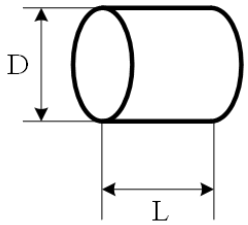
Vickers hardness
$\overline{HV}$
289

It should be noted that the following data were reproduced from HYDROGENIUS DATABASE No.6: Tables 1, 2, 3, 4 and 5.

3. HYDROGEN TRANSPORT PROPERTIES

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

(a) Hydrogen-charging conditions.

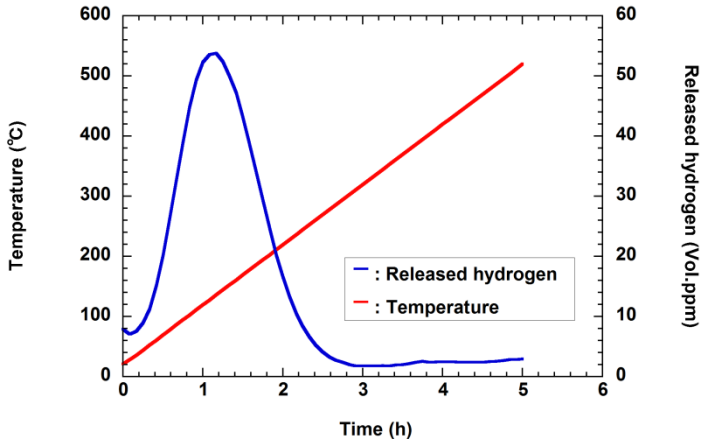
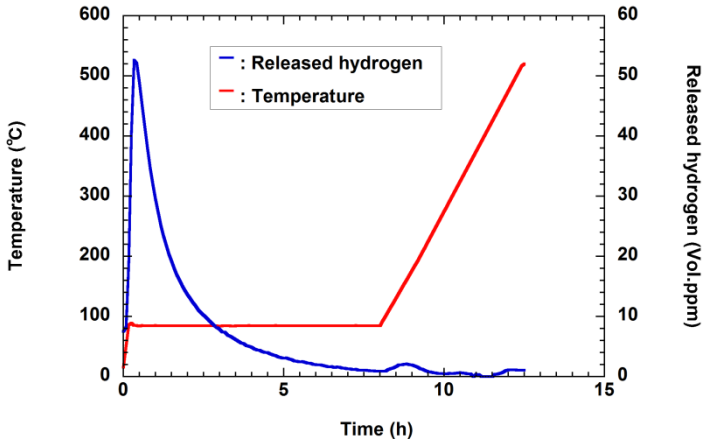
Type of hydrogen-charging	Exposure to hydrogen gas at pressures of 99 ～ 100 MPa
Hydrogen-gas purity	99.999%
Hydrogen-gas temperature & holding time	358 ～ 359 K, Over 200 h
Specimens[1), 2)]	 *D* = *L* = 19 mm, 18 mm, 7 mm

[1)] Specimens were cut so as to ensure equal measurements 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 from 20°C, maintaining 50°C, 70°C or 85°C, then up to 520°C.