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HYDROGENIUS DATABASE
— Hydrogen Transport Properties —

No. B30

Database of Hydrogen Transport Properties of JIS-SCM435 Low-Alloy
Steel for Use in a 20-MPa-Hydrogen Storage Cylinder

August 2011

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

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Database of Hydrogen Transport Properties of JIS-SCM435 Low-Alloy Steel for Use in a 20-MPa-Hydrogen Storage Cylinder

1. MATERIAL

Table 1. Related properties.

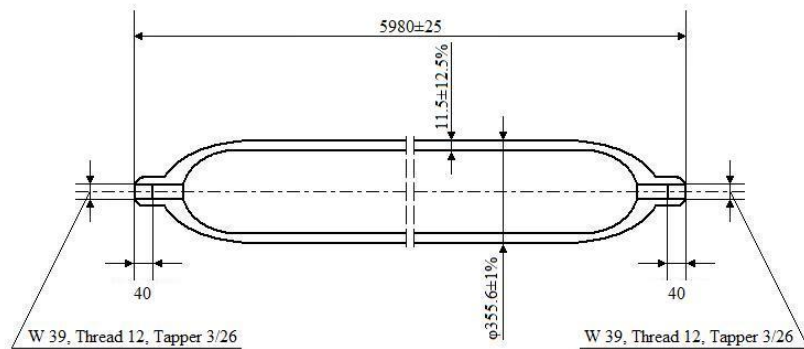


Table 2. Chemical composition of SCM435.

		Element (mass%)							
		C	Si	Mn	P	S	Cr	Mo	
Product Analysis	Present Material ¹⁾	0.30	0.32	0.62	0.029	0.011	0.91	0.19	
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

It should be noted that the following data are identical to those featured in HYDROGENIUS DATABASE No.5: 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	650	807	7.1	17.3	60.9	0.0
Hydrogen-charged	646	802	7.4	17.1	54.6	0.3
	649	801	6.8	14.8	54.8	0.3
	652	803	6.4	13.8	54.0	0.3
	630	783	6.4	13.9	53.9	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	655	801	6.5	17.1	66.1	0.0
Hydrogen-charged	668	818	7.3	16.1	59.2	0.3
	650	806	7.0	16.2	57.6	0.4
	659	808	7.0	16.7	58.6	0.3

Table 5. Average value of Vickers hardness.

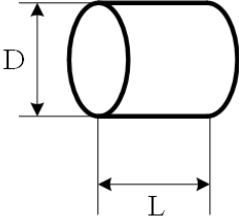
Vickers hardness
\overline{HV}
272

It should be noted that the following data are identical to those featured in HYDROGENIUS DATABASE No.5: 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 a pressure of 100 MPa
Hydrogen-gas purity	99.999%
Hydrogen-gas temperature & holding time	358 K, Over 200 h
Specimens ^{1), 2)}	 <p style="text-align: center;">$D = L = 11 \text{ mm}, 7 \text{ mm}$</p>

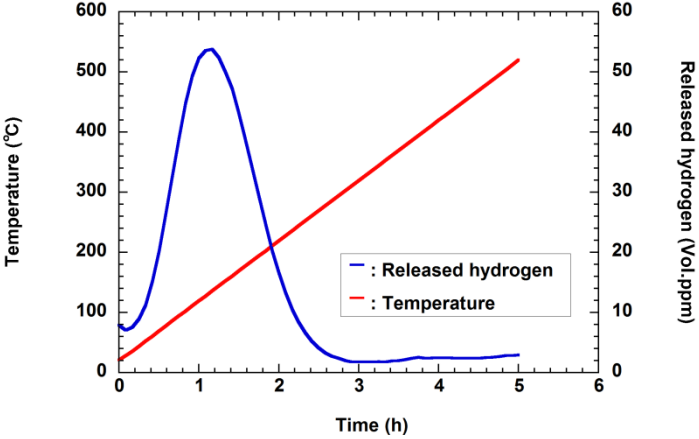
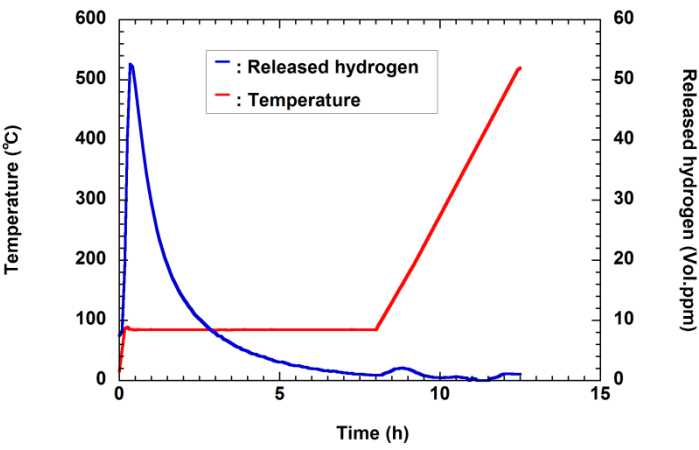
¹⁾ Specimens were cut so as to be equal in diameter and in length.

²⁾ Surface-finishing was performed by circumferential-polishing with 2000-grade silicon-carbide paper.

(Table continues on the following page)

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

(b) Hydrogen-measurement conditions.

<p>Type of spectroscope</p>	<p>TDA (Thermal Desorption Analysis) Hydrogen detection accuracy : 0.3 Vol. ppm Amount of hydrogen molecule detection : 6.1×10^{-10} mol/min</p>
<p>Measurement methods and conditions</p>	<div style="text-align: center;">  <p>(a) Multiple-specimen measurement method. Measurement condition : 100°C/h from 20°C to 520°C</p>  <p>(b) Single-specimen measurement method. Measurement condition: 100°C/h from 20°C, maintaining at 50°C, 70°C or 85°C, then increasing up to 520°C.</p> </div>