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HYDROGENIUS DATABASE
— Hydrogen Transport Properties —

No. B32

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

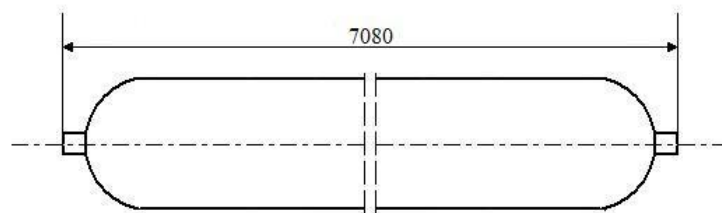


Table 2. Chemical composition of SCM435.

		Element (mass%)							
		C	Si	Mn	P	S	Cr	Mo	
Product Analysis	Present Material ¹⁾	0.35	0.25	0.74	0.011	0.004	1.08	0.26	
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.7: 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

	Tensile properties					Hydrogen content
	$\sigma_{0.2}$ (MPa)	σ_B (MPa)	ε_u (%)	ε_f (%)	φ (%)	C_H (mass ppm)
Uncharged	-	920	5.7	15.2	65.8	0.0
	717	878	5.4	14.5	64.8	0.0
Hydrogen-charged	723	875	5.0	12.7	60.9	0.3
	717	873	5.2	12.3	57.7	0.3
	736	891	5.5	13.9	60.2	0.3

(b) Longitudinal direction

	Tensile properties					Hydrogen content
	$\sigma_{0.2}$ (MPa)	σ_B (MPa)	ε_u (%)	ε_f (%)	φ (%)	C_H (mass ppm)
Uncharged	743	890	4.6	-	70.0	0.0
	733	885	6.0	15.7	68.9	0.0
Hydrogen-charged	733	892	5.9	14.1	62.5	0.4
	731	899	6.5	14.6	61.4	0.4
	750	895	5.5	13.7	64.3	0.4

Table 5. Average value of Vickers hardness.

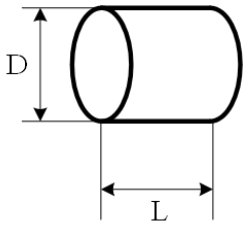
Vickers hardness
\overline{HV}
275

It should be noted that the following data are identical to those featured in HYDROGENIUS DATABASE No.7: 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 97 ~ 99 MPa
Hydrogen-gas purity	99.999%
Hydrogen-gas temperature & holding time	358 ~ 359 K, Over 200 h
Specimens ^{1), 2)}	 <p style="text-align: center;">$D = L = 19 \text{ mm}, 7 \text{ mm}$</p>

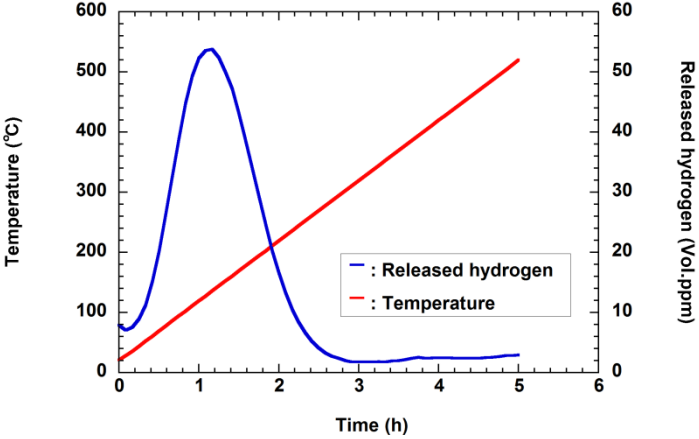
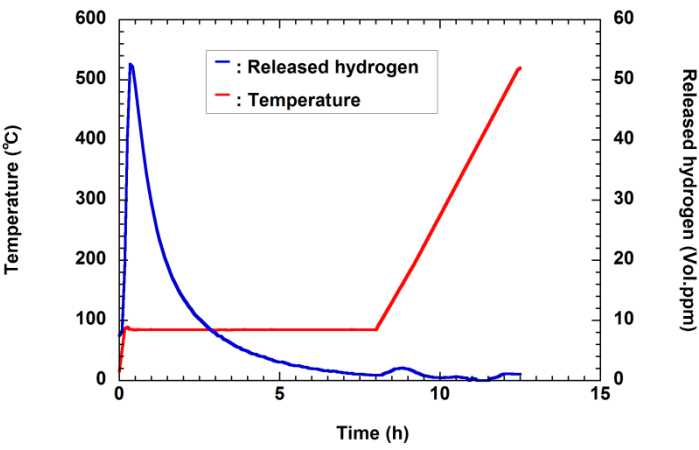
¹⁾ The specimens were cut so as to be equal in diameter and in length.

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.

<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 conditions: 100°C/h from 20°C ~ 520°C</p>  <p>(b) Single-specimen measurement method. Measurement conditions: 100°C /h; starting from 20°C, maintenance at 50°C, 70°C or 85°C, then up to 520°C.</p> </div>