HYDROGENIUS
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HYDROGENIUS DATABASE

— Microstructures —

No. A61

Microstructures of JIS-SCM435 Low-Alloy Steel

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Research Center for Hydrogen Industrial Use and Storage (HYDROGENIUS)
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Microstructures of JIS-SCM435 Low-Alloy Steel

1. MATERIALS

Table 1. Details of processing and related data of SCM435.

Heat	Production Process	Product Format	Dimensions (mm)
J[1)]	Hot-rolled	Plate	Length: 280 mm Width: 110 mm Thickness: 25 mm
K[1)]	Hot-forged	Cylinder	Length: 3800 mm Outer diameter: 357 mm Inner diameter: 306.6 mm Thickness: 25.2 mm
T[1)]	Hot-forged	Cylinder	Length: 7530 mm Outer diameter: 270 mm Inner diameter: 210 mm Thickness: 30 mm

[1)] As reported by the manufacturer.

Table 2. Chemical composition of SCM435.

	Heat		Element (mass%)						
			C	Si	Mn	P	S	Cr	Mo
Product Analysis	J[1)]		0.36	0.18	0.78	0.013	0.005	1.04	0.20
	K[2)]		0.37	0.22	0.84	0.012	0.005	1.15	0.24
	T[2)]		0.37	0.21	0.77	0.012	0.007	1.07	0.28
Ladle Analysis	J[3)]		0.34	0.19	0.76	0.014	0.005	1.06	0.20
	J'[3)]		0.33	0.21	0.74	0.014	0.004	1.05	0.20
	Requirements[4)]	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 recorded by JPEC.
[2)] As conducted by HYDROGENIUS.
[3)] As reported by the manufacturer.
[4)] As per JIS G 3441:2012, *"Alloy steel tubes for machine purposes",* and JIS G 4053:2008, *"Low-alloyed steels for machine structural use"*.

The data on this page are identical to those featured in HYDROGENIUS DATABASE No. A57.

Table 3. Heat-treatment conditions of SCM435.

Material	Heat	Shape	Quenching	Tempering
Large-sized, heat-treated material	J[1)]	Plate[3)]	900°C/60 min, Oil-quenching	600°C/100 min, Air-cooling
	K[1)]	Hollow cylinder[3)]	860°C, Water-spraying	630°C, Air-cooling
	T[1)]	Hollow cylinder[3)]	900°C, Oil-quenching	560°C, Air-cooling
Small-sized, heat-treated material	K[2)]	Near net shape of specimen[4)]	860°C/60 min, Oil-quenching	650°C/90 min, Water-cooling
	T[2)]	Near net shape of specimen[4)]	855°C/30 min, Oil-quenching	550°C/60 min, Water-cooling
				600°C/60 min, Water-cooling
				650°C/60 min, Water-cooling

[1)] As reported by the manufacturer.
[2)] As conducted by HYDROGENIUS.
[3)] See Table 1.
[4)] See Table 5.

2. MECHANICAL PROPERTIES

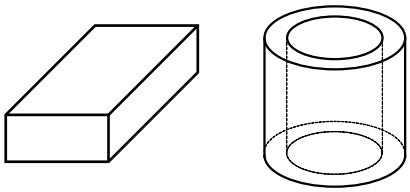
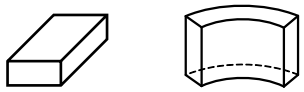
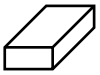
Table 4. Mechanical properties of SCM435.

Material	Heat	Shape	Tempering Temperature (°C)	Tensile Properties				Vickers Hardness *HV*
				0.2% Proof Stress, $\sigma_{0.2}$ (MPa)	Tensile Strength, σ_B (MPa)	Fracture Elongation, ε_f (%)	Reduction of Area, φ (%)	
Large-sized, heat-treated material	J[1)]	Plate[3)]	600	681	838	23	73	258
	K[2)]	Hollow cylinder[3)]	630	687	824	20	71	256
	T[2)]	Hollow cylinder[3)]	560	782	947	15	66	289
Small-sized, heat-treated material	K[2)]	Near net shape of specimen[4)]	650	800	903	20	70	284
	T[2)]	Near net shape of specimen[4)]	550	1044	1127	19	64	338
			600	911	1002	21	68	319
			650	772	875	24	72	276
Requirements[5)]			Max.					
			Min.	785	930	15	50	

[1)] As reported by the manufacturer.
[2)] As performed by HYDROGENIUS.
[3)] See Table 1.
[4)] See Table 5.
[5)] As per JIS G 3441:2012, *"Alloy steel tubes for machine purposes"*, and JIS G 4053:2008, *"Low-alloyed steels for machine structural use"*.

3. MICROSTRUCTURES

Table 5. Microstructural observation conditions.

Surface preparation	Optical	Etching with 3% nital solution Etching with ethanol-saturated picric acid
	SEM	Etching with 3% nital solution
	EBSD (Electron Backscatter Diffraction)	OPS (Colloidal silica solution) Acceleration voltage: 15 kV
Sampling	 Heat-treatment of large-sized material  Heat-treatment of small-sized material  Specimen for microstructural observation	