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# HYDROGENIUS DATABASE

## — Microstructures —

No. A61

Microstructures of JIS-SCM435 Low-Alloy Steel

2015

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

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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 <sup>1)</sup>	Hot-rolled	Plate	Length: 280 mm Width: 110 mm Thickness: 25 mm
K <sup>1)</sup>	Hot-forged	Cylinder	Length: 3800 mm Outer diameter: 357 mm Inner diameter: 306.6 mm Thickness: 25.2 mm
T <sup>1)</sup>	Hot-forged	Cylinder	Length: 7530 mm Outer diameter: 270 mm Inner diameter: 210 mm Thickness: 30 mm

<sup>1)</sup> As reported by the manufacturer.

Table 2. Chemical composition of SCM435.

	Heat	Element (mass%)						
		C	Si	Mn	P	S	Cr	Mo
Product Analysis	J <sup>1)</sup>	0.36	0.18	0.78	0.013	0.005	1.04	0.20
	K <sup>2)</sup>	0.37	0.22	0.84	0.012	0.005	1.15	0.24
	T <sup>2)</sup>	0.37	0.21	0.77	0.012	0.007	1.07	0.28
Ladle Analysis	J <sup>3)</sup>	0.34	0.19	0.76	0.014	0.005	1.06	0.20
	J <sup>3)</sup>	0.33	0.21	0.74	0.014	0.004	1.05	0.20
	Requirements <sup>4)</sup>	Max.	0.38	0.35	0.85	0.030	0.030	1.20
Min.		0.33	0.15	0.60			0.90	0.15

<sup>1)</sup> As recorded by JPEC.

<sup>2)</sup> As conducted by HYDROGENIUS.

<sup>3)</sup> As reported by the manufacturer.

<sup>4)</sup> As per JIS G 3441:2012, "Alloy steel tubes for machine purposes", and JIS G 4053:2008, "Low-alloyed steels for machine structural use".

Table 3. Heat-treatment conditions of SCM435.

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

<sup>1)</sup> As reported by the manufacturer.

<sup>2)</sup> As conducted by HYDROGENIUS.

<sup>3)</sup> See Table 1.

<sup>4)</sup> 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, $\sigma_B$ (MPa)	Fracture Elongation, $\epsilon_f$ (%)	Reduction of Area, $\phi$ (%)	
Large-sized, heat-treated material	J <sup>1)</sup>	Plate <sup>3)</sup>	600	681	838	23	73	258
	K <sup>2)</sup>	Hollow cylinder <sup>3)</sup>	630	687	824	20	71	256
	T <sup>2)</sup>	Hollow cylinder <sup>3)</sup>	560	782	947	15	66	289
Small-sized, heat-treated material	K <sup>2)</sup>	Near net shape of specimen <sup>4)</sup>	650	800	903	20	70	284
			T <sup>2)</sup>	Near net shape of specimen <sup>4)</sup>	550	1044	1127	19
	T <sup>2)</sup>	Near net shape of specimen <sup>4)</sup>	600	911	1002	21	68	319
			650	772	875	24	72	276
Requirements <sup>5)</sup>			Max.					
			Min.	785	930	15	50	

<sup>1)</sup> As reported by the manufacturer.

<sup>2)</sup> As performed by HYDROGENIUS.

<sup>3)</sup> See Table 1.

<sup>4)</sup> See Table 5.

<sup>5)</sup> 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

