

TECHNICAL BULLETIN

AISI S-1 Oil Hardening Shock Steel ^{Annealed}

Typical Analysis:	Carbon	Chromium	Tungsten	Mang.	Silicon	Vanadium
	0.50	1.15	2.50	0.30	0.75	0.20

Color Code: Brown

HEAT TREATMENT

Forging	2000 to 2100°F, stop at 1600°F
Annealing	1475°F, cool slowly, Brinell 212 max
Preheating	1200°F prior to hardening
Hardening	1750°F, oil-quench
Tempering	300 to 500°F, for cold work, hardness Rockwell C 57; 1000 to 1200°F, for hot work, hardness Rockwell C 45

CHARACTERISTICS

Machinability — In the annealed condition S-1 has a machinability rating of 75 as compared with a rating of 100 for a 1% carbon tool steel.

Dimensional Stability — When oil-hardened, S-1 can be expected to expand approximately 0.002 in./in. of greatest cross section.

Critical Points — Critical points obtained by dilatometer test when heating and cooling at a rate of 400°F per hour are as follows:

Heating — Ac range 1470 to 1545°F

Cooling — Ar range 1415 to 1350°F

Impact Properties — In determining the resistance to impact of S-1, Charpy impact specimens were machined oversize, heat-treated, and finish-ground to standard size. Specimens used were of the unnotched type, 0.250 in. by 0.375 in. by 2.165 in. Heat treatment consisted of a 1750°F oil-quench. The quenched specimens were tempered at temperatures ranging from 300 to 1300°F at 100-degree intervals. The results obtained are shown in Figure 1.

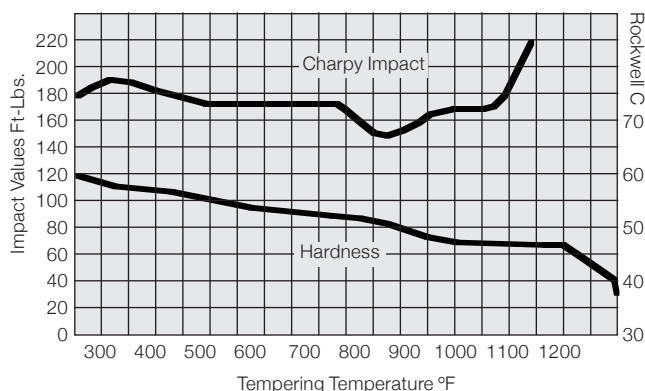


FIGURE 1.

INSTRUCTIONS FOR WORKING

Hardening — Preheat to 1200°F. Then heat to 1750°F for quenching and hold at temperature for a half-hour for each inch of greatest thickness. Tungsten chisel steels are susceptible to decarburization on hardening and, therefore, precautions should be taken to minimize surface deterioration. It is advisable to protect the surface by using vacuum heating. Preheating at approximately 1200°F serves to minimize the subsequent time at hardening temperature which also helps to reduce decarburization.

S-1 is one of the most commonly used grades for master hob applications. Master hobs require a steel that has a very high toughness and, at the same time, a surface of almost file hardness. This can be achieved by carburizing and hardening from 1750°F. Aim for a case depth of .010 in. Avoid deep carburized cases (.015 in. or greater) which could cause brittle failures. Oil quenching can be conducted directly from the carburizing temperature. Temper at 350°F immediately after oil quenching. This carburizing treatment should result in a shallow file hard case of approximately Rockwell C 61 and a tough core of approximately Rockwell C 57.

Tempering — The tempering temperature of S-1 varies with the intended use of the steel. For hot-work tools the range may be within 1000 to 1200°F; for cold-work tools, between 300 and 500°F. Hold at temperature a minimum of one hour for each inch of thickness.

Specimens 1 in. diameter by 5 in. long were quenched in oil from 1750°F and tempered at 100-degree intervals from 300 to 1200°F for one hour. Hardness results are shown in Figure 2.

Tempering Temperature-°F	Brinell Hardness
None	61
300	57.5
400	56.5
500	54
600	53
700	52
800	50
900	48
1000	47
1100	47
1200	42

FIGURE 2.

(over)

These results may be used as a guide in tempering tools to desired hardness. However, since 1 in. diameter specimens were used in this test, tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.



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