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AISI O1

Oil Hardening Tool Steel

AISI 01 is one of the most well respected oil-hardening tool and die steels. It is easy to machine. Normal care in treatment gives good results in hardening and produces small dimensional changes. It has good abrasion-resistance, and sufficient toughness for normal tool-and-die applications. When it is essential to have a safer hardening tool-and-die steel, O1 is used for the majority of applications too sensitive for carbon tool steels.

Recommended applications include cold-forming, blanking and bending dies, forming rolls, broaches, knurling tools, and gages.

Machinability - Annealed to Brinell 202 max, O1 machines easily and approaches the machinability of straight-carbon water-hardening tool steel. Where a 1 pct carbon steel is rated at 100, O1 has a rating of 90.

Dimensional Stability - When quenched from the proper hardening temperature this grade normally expands .0015 in./in. plus. In many instances a slight scaling will occur during heat treatment which tends to counteract this expansion. Like all tool steels, hardening of 01 to insure minimum size change necessitates careful study of the die or tool and the furnace equipment used for heat treatment.

Typical Analysis

Carbon	0.90	Manganese	1.20
Tungsten	0.50	Chromium	0.50
Vanadium	0.20		

Annealing

The recommended annealing practice is to use controlled-atmosphere furnaces. If these are not available, pack-anneal in an inert material. For a quick annealing cycle to develop fair machining properties, heat slowly to 1375 to 1425°F. and cool slowly in the furnace. To develop the lowest hardness and best spheroidization for optimum machinability, heat slowly to 1450°F. and furnace cool at 20 degrees per hour to 900°F. The piece may then be removed from the furnace and cooled in air. Hardness after this cycle will be Brinell 202 max.

Hardening

If pack-hardening cannot be used or is not essential, a slight oxidizing atmosphere should be used in heating to the hardening temperature of 1450to 1475°F. This will give a minimum of decarburization and distortion. On large parts, pack-hardening and pre-heating at approximately 1200°F,with a thorough soaking before raising to the quenching temperature of 1475 to 1500°F, are recommended. Hold at the quenching temperature for one half hour per inch of greatest cross-section. Follow by quenching in oil to 150°F and temper immediately.

A series of oil-quenched samples were tested. Here are the resulting hardness and fracture ratings from different quenching temperatures:

Quenching temperature - °F	Fracture grain size	Rockwell C
1400	9	60
1425	9	62
1450	9-1/2	63
1475	9-1/2	65
1500	9-1/2	65
1525	9-1/4	65
1550	9-1/4	65

Tempering

The tempering temperature generally employed may vary from 300 to 450°F, depending on size and properties required. For all general purposes tempering at 350°F is satisfactory. Temperatures above 450°F are rarely used on 01. The hardness levels produced by tempering above 450°F can also be produced in shock-resisting grades. Therefore, where greater toughness is required than 01 provides after tempering at 450°F, it is customary to change to a shock-resisting steel. Small tools should be held at the tempering temperature for at least one hour, and larger tools for two hours, per inch of greatest thickness. If a second temper is used, it should be 25 degrees lower than the first.

Tempering temperatures and resulting Rockwell hardness, based on 1-in. round samples oil-quenched from 1475 °F and tempered for two hours, are as follows:

Tempering temperature - °F	Rockwell C
None	65
300	63
350	62.5
400	62
450	61
500	60
600	57
700	53
800	50
900	47
1000	44
1100	39
1200	31
1300	22

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