



NESSteel Inc.

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Tool, Mold & Die Steel AISI O-1

O-1 is an oil-hardening steel with high surface hardness after hardening, resistance to shrinking and warping and outstanding machinability. Typical analysis is shown in the chart below:

Carbon	Silicon	Manganese	Chromium	Tungsten	Vanadium
0.9% -1.0%	0.2%- 0.35%	1.0% - 1.15%	0.40% - 0.60%	0.45% - 0.60%	0.8% - 0.15%

O-1 is used in applications requiring sharp cutting edges, wear resistance and machinability. Typical applications are

- Reamers
- Forming/Blanking Dies
- Trimming Dies
- Milling & Form Cutters
- Gages
- Rim & Seaming Rolls
- Feeding Rolls
- Jigs & Fixtures

Heat Treatment

Forging:

- Heat slowly to 1850° - 1950° F
- Allow steel to heat through before forging.
- DO NOT hot work O-1 below 1500° F.
- After forging, allow O-1 to cool slowly, buried in ashes, lime, etc.
- Anneal as soon as possible.

Annealing

- Slowly heat O-1 to 1400° - 1450°
- Allow to cool at rate of 20°/hour to 900° F.
- Surface protection - Anneal in controlled atmosphere furnace or pack in an inert material.
- Annealed hardness ranges between 170 - 210 Brinell.

Hardening:

- Pre-heat slowly to 1200°F-1250°F, then soak steel thoroughly. Increase heat more rapidly to quenching temperature of 1450°F-1500°F.
- Hold steel at quenching temperature for one half hour per inch of greatest cross section.
- Surface protection: pack hardening or controlled atmosphere furnaces.
- Quench in oil-bath (Oil temperature should be 150°F.

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

Martempering

In general, martempering is not recommended unless the tool has an intricate shape. Martempering may reduce the danger of hardening cracks and distortion by using the quench method below:

- Heat for quenching in normal fashion.
- Quench in saltwater or oil bath at 400 °F-425°F.
- Leave tool in bath long enough for temperature to equalize (no longer than 10-15 minutes).
- Air-cool to 150°F.
- Temper immediately.

Tempering

- Temper immediately after tool reaches 150°F after quenching. See chart for tempering temperatures. Steel required for general purposes are normally tempered at 350°F. Broaches and reamers are tempered between 390°F-450°F, coining and jewelry dies between 425°F-450°F. Large dies are tempered at 425°F-450°F for maximum shock resistance.

O-1 Oil-Quenched from 1470°F

Tempering Temperature, °F	Rockwell C
300	65
400	62-64
500	58-60
600	55-57
700	52-54
800	48-50
900	45-47
1000	42-44

Physical & Mechanical Properties

- Density, lb per cu in: .2831
- Specific gravity: 7.835
- Critical points:
 Heating (Ac) 100°/hr - begins 1350°F; ends 1400°F
 Cooling (Ac) 50°/hr - begins 1295°F; ends 1240°F

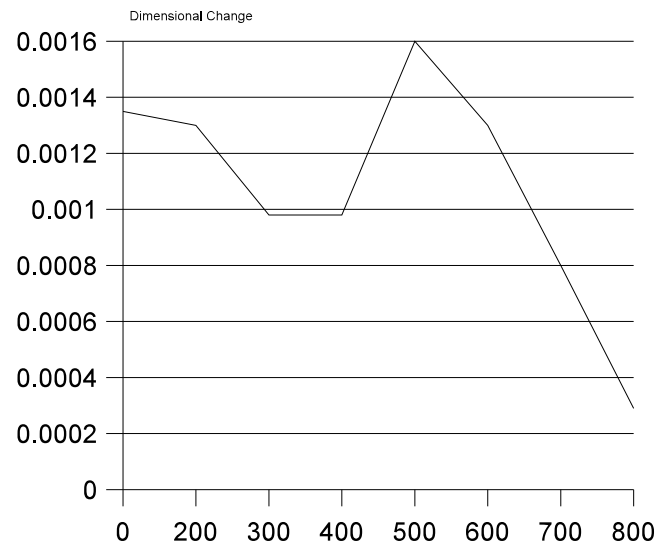
Grinding

A soft, coarse wheel is recommended. Take only light cuts. If wet grinding is used, provide plenty of coolant to stop localized overheating. Consult grinding manufacturers' catalogs and instruction books for further information.

Mean Thermal Coefficient of Expansion

Range °F	Coefficient x10 ⁻⁶ in/in/°F	Range °F	Coefficient x 10 ⁻⁶ in./in./°F
70-200	6.92	70-900	7.83
70-300	6.96	70-1000	8.06
70-400	6.97	70-1100	8.25
70-500	7.21	70-1200	8.36
70-600	7.36	70-1300	8.37
70-700	7.62	70-1350	8.37
70-800	7.67		

Dimensional Changes on Hardening, in/in. Tempering Temperature °F



IZOD Impact Properties

- Test samples prepared from 1/2 inch square annealed bars. Samples were oil-quenched after soaking for 15 minutes in 1475°F.
- Samples were tempered for 1 hour at indicated temperatures.
- Samples were wet-ground to .394 inch square, and were tested in a 120 ft-lb machine. Each value is an average of 4 individual tests.

Tempering Temperature, °F	Energy Absorbed, Ft-lb	Hardness, Rockwell C
None	22.5	64-1/2
300	64.0	62-1/2
400	Past machine limits	60
500	109.0	58-1/2
600	98.0	56
800	109.0	50-1/2
1000	Past machine limits	43

Compression Properties

Heat Treatment	Hardness, Rc	Ultimate compressive Strength, psi
1450°F-oil quench temper 350°F	62.0	404,000
1450°F-oil quench temper 400°F	60.5	382,000
1450°F-oil quench temper 500°F	58-1/2-59	366,500

Samples were .505 inch diameter, preheated at 1100°F, oil-quenched from 1450°F, tempered 2 hours to indicated temperatures. Samples were compressed in 100,000 lb capacity test machine.