



NESSteel Inc.

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Die Steel AISI A-2

A-2 is an air-hardening die steel with excellent non-deforming properties. Typical analysis is shown in the chart below:

Carbon	Silicon	Manganese	Chromium	Molybdenum	Vanadium
1%	0.2%	0.6%	5.3%	1.1%	0.2%

A-2 is used in applications requiring toughness, wear resistance and machinability. Typical applications are

- Blanking Dies
- Coining Dies
- Cams
- Drawing Dies
- Forming Dies
- Gages
- Plastic Molds
- Slitting cutters

Heat Treatment

Forging:

- Heat slowly to 1800° - 2000° F
- Allow steel to heat through before forging.
- DO NOT hot work A-2 below 1500 F.
- After forging, allow A-2 to cool slowly, buried in ashes, lime, etc.
- Anneal as soon as possible.

Annealing

- Slowly heat A-2 to 1500° - 1600°
- Allow to cool at rate no greater than 50°/hour while in temp range of 1450°F and 1300°F.
- Surface protection - pack in tubes/containers with cinders, spent carburizing compound, or other slightly carbonaceous substance.
- Annealed hardness ranges between 202 - 248 Brinell.

Hardening:

- Pre-heat slowly to 1300°F - 1400°F, then increase heat more rapidly to hardening temperature of 1700°F-1800°F (best results obtained at higher end of hardening range).
- Hold steel at hardening temperature until workpiece is thoroughly heated through.
Surface protection: pack hardening or controlled atmosphere furnaces (Pack mat'l should be slightly

carbonaceous; furnace atmosphere should be at least 10% CO).

- Cool to room temp or in dry, mild air blast.
- Full hardness:
 - Salt pack: quench piece into salt at 1000°F-1100°F and air-cool.
 - Oil quench piece until almost black and air cool.
- As-hardened hardness should be about 63-65 Rockwell C.

Tempering

For tools intended for working on medium to light gage material, normal tempering temperatures vary from 300°F to 500°F.

Double tempering treatment at 900°F-1000°F is recommended, particularly for tools to be subject to shock. Allow 1 hour per inch of thickness, but not less than 1 hour for very thin sections.

Sub-Zero Treatment

- More complete austenite transformation can be achieved by chilling workpiece to -60°F after cooling from hardening temperature.
- Hardness: 66-68 Rc
- Dimensional change: expansion of .003" per inch
- Re-tempering: at 300°F, steel hardness of approx 65 Rc is produced; at 400°F, a hardness of approx 64 Rc.

Physical & Mechanical Properties

- Density, lb per cu in: .2825
- Specific gravity 7.82
- Critical points:
Heating (Ac) 100°/hr - begins 1427°F; ends 1481°F
Cooling (Ar) 50°/hr - begins 1373°F; ends 1328°F

EDM

EDMing produces a recast (melted and rehardened) layer on the steel. EDM'd pieces should be retempered at 50F under the final tempering temperature to prevent cracking due to stress caused by the recast layer.

Mean Thermal Coefficient of Expansion

Range °F	Coefficien in./in./°F	Range °F	Coefficien in./in./°F
70-200	6.54 x 10 ⁻⁶	70-900	7.65
70-300	6.74	70-1000	7.74
70-400	6.82	70-1100	7.81
70-500	6.87	70-1200	7.92
70-600	7.17	70-1300	8.05
70-700	7.38	70-1400	8.08
70-800	7.47	70-1427	8.09

Hardening

Hardening Temperature, °F	Hardness, Rockwell	Shepard Fracture Rating
1600	46 - 47	8
1650	54 - 55	9.5
1700	60	10
1750	64	9.75
1800	63	9.5
1850	62	9.5
1900	59 - 60	9

Data based on 2" x 1" round samples, preheated at 1200°F, heated to indicated temp, held for 30 minutes in atmosphere of 10% CO, cooled in still air. After being fractured, sample hardness was tested. Full hardness is developed in sections as large as 4" cubes by cooling in still air from 1750°F.

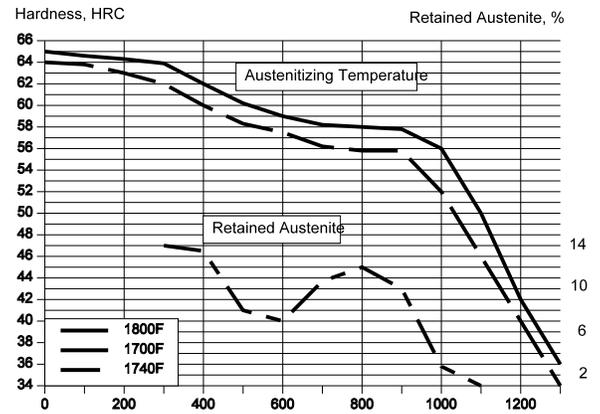
Dimensional Changes on Hardening, in/in.

A 1" x 4" x 4" piece, hardened at 1740F and air-quenched, will undergo dimensional changes, such as:

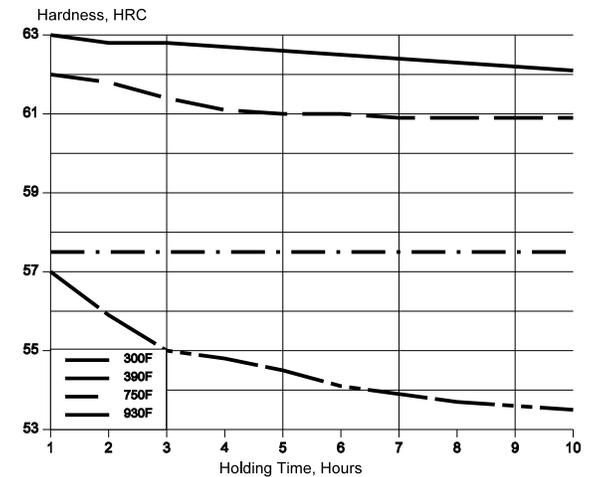
- Width: +0.0008/+0.0014, inch/per inch
- Length: +0.0013/+0.0015, inch/per inch
- Thickness: +0.0004 min, inch/per inch

These values are only guidelines and can vary depending on other heat treat variables.

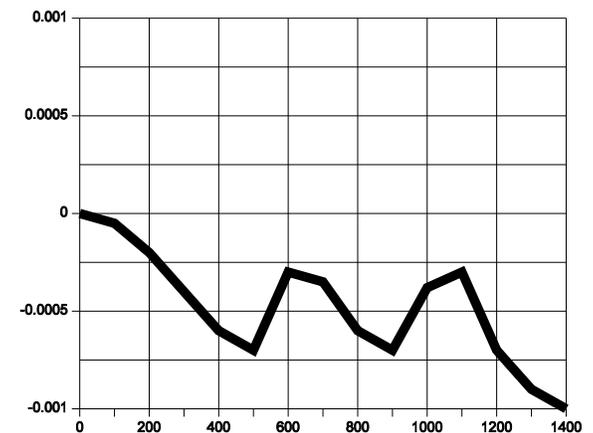
Tempering Graph



Time Effects on Hardness during Tempering



Dimensional Changes on Tempering, in/in.



Total distortion in heat treat can be estimated by adding the distortion on hardness to the distortion on tempering.

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