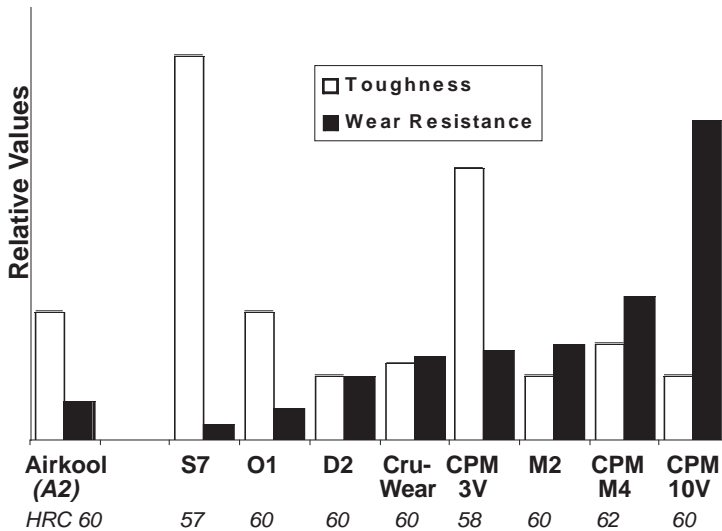


CRUCIBLE

Airkool (AISI A2) is an air-hardening medium alloy tool steel which is heat treatable to HRC 60-62. It has wear resistance intermediate between the oil hardening tool steels (O1) and the high carbon chromium tool steels (D2). Because it offers a combination of good toughness along with moderate wear resistance, it has been widely used for many years in variety of cold work applications which require fairly high abrasion resistance but where the higher carbon/ high chromium steels are prone to chipping and cracking. Airkool is quite easily machined in the annealed condition and, like other air-hardening tool steels, exhibits minimal distortion on hardening, making it an excellent choice for dies of complicated design.

Tool Steel Comparagraph



Typical Applications

- | | |
|-------------------|----------------------------|
| Punches and Dies | Wear Parts |
| Blanking Dies | Shear Blades |
| Coining Dies | Industrial Knives/Slitters |
| Forming Dies | Scrap Choppers |
| Fineblanking Dies | Gauges |
| Lamination Dies | Tablet Compression Tooling |
| Trim Dies | Mold Inserts |

Note: These are some typical applications. Your specific application should not be undertaken without independent study and evaluation for suitability.

Crucible Industries LLC

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DATA SHEET

AIRKOOL® (AISI A2)

Issue #1

Carbon	1.00%
Manganese	0.85%
Chromium	5.25%
Molybdenum	1.10%
Vanadium	0.25%

Physical Properties

Elastic Modulus	30 X 10 ⁶ psi	(207 GPa)
Density	0.284 lbs./in ³	(7.86 g/cm ³)
Thermal Conductivity		
at 200° F (95° C)	BTU/hr-ft-°F 15	W/m-°K 26 cal/cm-s-°C 0.062
Coefficient of Thermal Expansion		
	in/in/°F	mm/mm/°C
70-500° F (20-260° C)	5.91 X10 ⁻⁶	(10.6 X10 ⁻⁶)
70-800° F (20-425° C)	7.19 X10 ⁻⁶	(12.9 X10 ⁻⁶)
70-1000° F (20-540° C)	7.76 X10 ⁻⁶	(14.0 X10 ⁻⁶)
70-1200° F (20-650° C)	7.91 X10 ⁻⁶	(14.2 X10 ⁻⁶)

Mechanical Properties

	Heat Treatment ⁽¹⁾ Austenitizing Temperature	HRC	Impact Toughness ⁽²⁾ ft.-lb. (J)	Wear Resistance ⁽³⁾ Adhesive
Airkool	1750°F (955°C)	60	40 (53)	2-3
S7	1750°F (955°C)	57	125 (165)	1
D2	1850°F (1010°C)	60	21 (28)	3-4
Cru-Wear	1950°F (1065°C)	62	30 (40)	5-6
CPM 3V	1950°F (1065°C)	60	70 (95)	7
M2	2050°F (1120°C)	62	20 (27)	8-10
CPM M4	2050°F (1120°C)	62	32 (43)	20-25
CPM 10V	2150°F (1175°C)	63	14 (19)	90

(1) Heat Treatment: Austenitized as indicated and tempered to hardness.

(2) Charpy C-Notch Impact Test

(3) Crossed cylinder adhesive wear test (higher number = better wear resistance)

Machinability

The machinability of Airkool (A2) as annealed is about 50% of W1 tool steel.

Surface Treatments

Airkool (A2) can be given standard surface treatments such as nitriding, TiN (titanium nitride) coating or hard chrome plating if desired. When using surface treatments, harden from the high side of the austenitizing range and temper at or above the process temperature of the treatment.

Thermal Treatments

Annealing: Heat to 1600°F (870°C), hold 2 hours, slow cool 50°F (30°C) per hour to 1200°F (650°C) then air cool. OR heat to 1600°F (870°C), hold 2 hrs., cool to 1400°F (760°C) hold 6 hrs. then air cool.

Annealed Hardness: About BHN197/241

Stress Relieving

Annealed Parts: Heat to 1200-1250°F (650-675°C), hold 2 hours, then cool in still air.

Hardened Parts: Heat to 25-50°F (15-25°C) below the original tempering temperature, hold 2 hours, then cool in still air.

Hardening

Preheat: Heat to 1100-1250°F (595-675°C), equalize, then to 1350-1450°F (730-790°C), equalize.

Austenitize: 1750-1800°F (955-980°C), Hold time at temperature 30-45 minutes.

Quench: Air or positive pressure quench (2 bar minimum) to below 150°F (65°C)

Temper: 400-1000°F (205-540°C).

Temper 2 hours minimum each time or at least 1 hour per inch (25mm) of thickness. Double Temper. Cool to room temperature in between tempers.

Cryogenic Treating: Refrigeration after the first temper may improve long term dimensional stability by transforming retained austenite. Any refrigeration treatment must be followed by a temper.

Size Change:

Hardening Temperature	Tempering Temperature	HRC	Longitudinal Size Change
1775°F (970°C)	400°F (205°C)	61	+0.07%
1775°F (970°C)	500°F (260°C)	59	+0.10%
1775°F (970°C)	600°F (315°C)	58	+0.09%

Note: Properties shown throughout this data sheet are typical values. Normal variations in chemistry, size and heat treat conditions may cause deviations from these values.

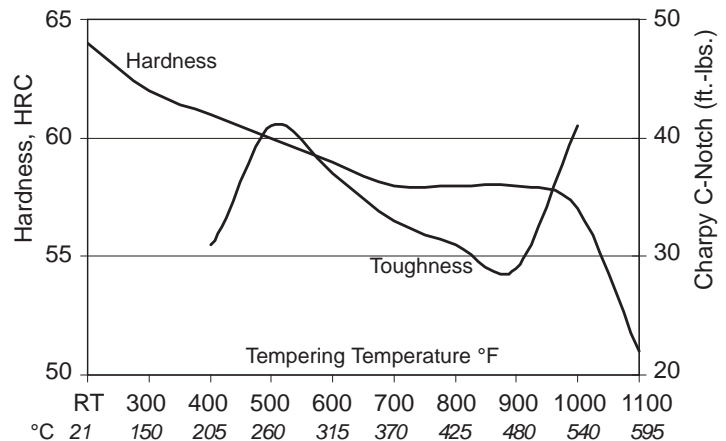
Heat Treat Response

Hardness and Impact Toughness Data

Austenitized 1775°F (970°C) Air Cool

Tempering Temperature	HRC	Ft. lbs.	Joules
As Air Quenched	64	---	---
300°F (150°C)	62	---	---
400°F (205°C)	61	31	42
500°F (260°C)	60	41	56
600°F (315°C)	59	37	50
700°F (370°C)	58	33	45
800°F (420°C)	58	31	42
900°F (480°C)	58	29	39
1000°F (540°C)	55	41	56
1100°F (595°C)	51	---	---

Results may vary with hardening method and section size. Vacuum or atmosphere cooling may result in up to 1-2 HRC points lower.



Welding

Use air hardening tool steel filler material.

Annealed Material: Preheat 700-900°F (370-480°C), maintain the temperature of the workpiece above 700°F (370°C) during welding. After welding, reanneal or temper at 1400°F (760°C) for 6 hours.

Hardened Material: Preheat 25-50°F (15-30°C) below original tempering temperature or 300°F (150°C) minimum. Maintain the temperature of the workpiece above 300°F (150°C) during welding. Cool to 150°F (65°C) after welding. Temper 25°F (15°C) below original tempering temperature.



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