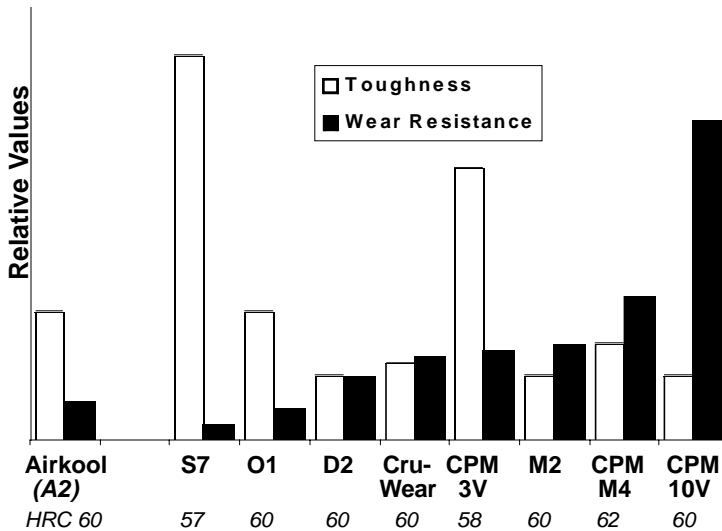


CRUCIBLE

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...
The Tool Steel Pros®

DATA SHEET

AIRKOOL® (AISI A2)

Issue #12

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)	15 BTU/hr-ft-°F	26 W/m-°K
		0.062 cal/cm-s-°C
Coefficient of Thermal Expansion		
70-500° F (20-260° C)	5.91 X10 ⁻⁶ in/in/°F	(10.6 X10 ⁻⁶ mm/mm/°C)
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.

The Crucible logo, Crucible, Airkool, CRU-WEAR, CPM, 3V, 10V and The Tool Steel Pros are trademarks of Crucible Materials Corporation.

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. For additional data or metallurgical engineering assistance, consult your local Crucible Service Center.

Service Center Locations

Location	Phone	Toll Free	FAX
Auburn, MA	508-832-5353	800-365-1101	508-832-2217
Charlotte, NC	704-372-3073	800-365-1160	704-342-0985
Chicago, IL	630-378-0093	800-365-1151	630-378-1965
Cincinnati, OH	513-771-1310	800-365-1163	513-771-0119
Cleveland, OH	330-562-3131	800-365-1132	330-562-7818
Columbus, OH	614-262-4959	800-365-1131	614-262-7850
Dallas, TX	817-649-2800	800-365-1168	817-633-8142
Detroit, MI	248-528-0332	800-365-1133	248-528-1977
Grand Rapids, MI	616-554-9699	800-365-1137	616-554-9328
Huntsville, AL	256-772-0201	800-365-1161	256-772-3361
Indianapolis, IN	317-638-4501	800-365-1146	317-634-7375
Los Angeles, CA	714-632-1131	800-365-1179	714-632-1181

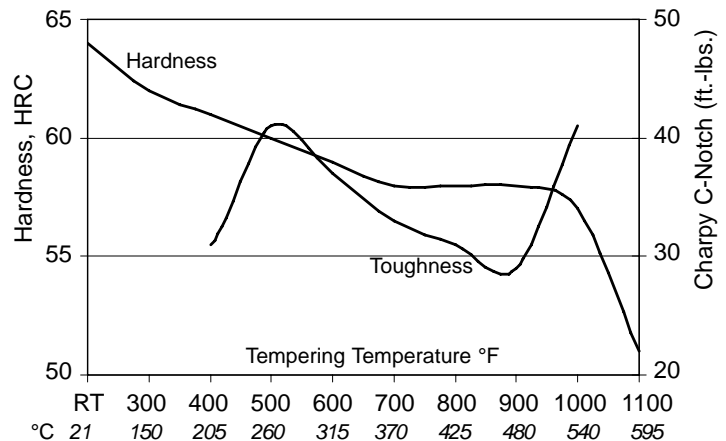
Heat Treat Response

Hardness and Impact Toughness Data

Austenitized 1775°F (970°C) Air Cool

Tempering Temperature	HRC	Charpy C-Notch 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.



A Division of Crucible Materials Corporation

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