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AISI A2

Air Hardening Tool Steel

AISI A2 is an air-hardening tool steel containing 5 pct chromium. It replaces O1 when safer hardening, better dimensional stability, and increased wear-resistance are required. Use for dies, punches, and similar forming and blanking tools as recommended for Type O1, but where less distortion in heat-treatment or better wear-resistance is required.

Machinability - If properly annealed to Brinell 212 max, A2 has a machinability of 65, as compared with a 1-pct carbon tool steel, rated at 100.

Dimensional Stability - When air-quenchedfrom the proper hardening temperature, this grade generally expands 0.001 in./in. of cross-section.

Typical Analysis

Carbon 1.00	Molybdenum 1.10
Vanadium 0.25	Chromium 5.25
Silicon 0.60	Manganese 0.60

Annealing

A2 should always be annealed after forging. To prevent decarburization use a controlled-atmosphere furnace or pack in a sealed container using some inert material. To anneal for lowest hardness, heat slowly to 1650°F and hold at this temperature for about two hours per inch of greatest cross-section. Cool at a rate of 20 degrees per hour to 1150°F and reheat to 1350°F; hold three hours per inch of greatest cross-section; furnace cool at 20 degrees per hour to 1100°F; then furnace-cool to 900°F and air-cool. A hardness of Brinell 212 max will result from this treatment.

Hardening

To prevent decarburization, pack in some inert material; or the treatment can be carried out in a salt bath or controlled-atmosphere furnace. Preheat to 1200°F and hold at this temperature until thoroughly soaked. Heat to 1750 to 1800°F and hold for one hour per inch of greatest cross-section. Remove from the furnace and cool in air. Although A2 is primarily an air-hardening grade, flash oil-quenching is occasionally used on large sections; but tools must be removed from the oil when they reach 1000°F, and air-cooled to 1500°F. Temper immediately to minimize the possibility of cracking.

The fracture grain size and Rockwell C hardness of specimens 1in. square X 4 in. long, quenched in air and quenched in oil, after holding 1 hour at temperatures ranging from 1600 to 1900°F are:

	Still-Air Cooled				Oil-Quenched	
Quenching	Fracture	Rockwell		Quenching	Fracture	Rockwell
temp - °F	grain size	C		temp - °F	grain size	C
1600	7	48		1600	9-3/4	54
1650	9-1/2	54		1650	9-3/4	55
1700	9-3/4	59.5		1700	9-3/4	62
1750	9-3/4	64		1750	9-3/4	65
1775	10	64		1800	9-3/4	64
1800	10	64		1850	9-1/2	63.5
1850	9-1/2	63		1900	9-3/4	62
1900	9-1/4	62				

Tempering

After the pieces have cooled in the quench to about 150°F they should be tempered immediately. For most applications A2 should be tempered at 350 to 400°F. A minimum holding time of two hours per inch of greatest cross-section should be used.

The Rockwell C hardness obtained on specimens 1 in. square when quenched in air from 1775°F, and quenched in oil from 1750°F, and tempered at various temperatures, are as follows:

Rockwell C		
Tempering	1775°F	1750°F
temperature - °F	Air-quench	Oil-quench
None	64	65
300	62	62.5
400	60	61
500	56	57.5
600	56	56
700	56	56
800	56	56
900	56	56
1000	56	55
1100	50	50
1200	43	45
1300	34	34

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.
