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TECHNICAL BULLETIN

AISI A11 TOOL STEEL

Typical Analysis:	Carbon	Mang.	Silicon	Chromium	Moly.	Vanadium	Sulphur
	2.40/2.50	0.35/0.60	0.75/1.10	4.75/5.75	1.10/1.50	9.25/10.25	0.05/0.09

Color Code: Black/White Stripe

DESCRIPTION

AISI A11 tool steel is a high vanadium tool steel produced using the powder metal process. This grade possesses wear resistance superior to most other tool steels, including the high speed steels, along with good strength and toughness characteristics.

Many of the benefits realized in the use of powdered metals are a direct result of the refined microstructure (smaller, more uniformly distributed carbide particles and a finer grain size) and the lack of segregation in the powder metallurgy product. These advantages include ease of grinding, improved response to heat treatment, greater wear resistance, and increased toughness of the finished tool.

SIZE CHANGE IN HARDENING — AISI A11 tool steel changes size only slightly after hardening. An expansion of about .0004 inches/inch is typical. Tools will open up slightly in the ID and expand on OD.

CHARACTERISTICS

MACHINABILITY — The machinability of AISI A11 tool steel in the annealed condition may be rated between 35 to 40% of 1% carbon tool steel. Tooling provider's recommendations for cutting fluids should be followed.

Due to the presence of the fine, uniformly distributed carbides, the grindability of AISI A11 tool steel is relatively good. Grinding wheel supplier's recommendations should be followed. Grinding wheels containing ceramic particles may provide improved performance.

One can easily EDM AISI A11 tool steel using proper precautions to prevent and/or remove the "white layer".

THERMAL PROCESSING

DECARBURIZATION — Like all high carbon steels, AISI A11 tool steel is somewhat susceptible to decarburization in hardening. Means of preventing decarburization are well known. Modern furnaces which employ protective environments, such as protective atmosphere furnaces, salt pots, fluidized bed furnaces and vacuum furnaces, should present no difficulty with decarburization of this alloy.

FORGING — Heat slowly to 2000/2100ºF (1093/1149ºC). Do not work below 1700ºF (927ºC). Reheat as necessary. Cool forgings slowly and anneal immediately upon cooling.

NORMALIZING — Normalizing is not recommended.

ANNEALING — Heat slowly to 1600/1650ºF (871/889ºC), hold for 2 hours, cool slowly at a rate of 20/40ºF (11/22ºC) per hour to 1000ºF (538ºC), then air cool. Typical annealed hardness will be 255 to 277 Brinell.

STRESS RELIEVING — To relieve machining stresses for greater accuracy in hardening, first, rough machine, then heat to a temperature of 1150/1250ºF (621/677ºC), equalize, and cool slowly in still air.

HARDENING — AISI A11 tool steel should be heat treated using proper precautions to prevent decarburization. First, preheat to 1500/1550ºF (816/843ºC), equalize and transfer to a furnace maintained at the desired hardening temperature.

TOUGH TREATMENT — Austenitize at 1950ºF (1066ºC) for 30 to 60 minutes then air cool. Temper immediately to Rockwell HRC 58/61.

INTERMEDIATE TREATMENT — Austenitize at 2050ºF (1121ºC) for 15 to 30 minutes, fan air cool, quench in oil or step quench in salt. Temper immediately to Rockwell HRC 60/62.

WEAR TREATMENT — Austenitize at 2150ºF (1177ºC) for 5 to 10 minutes, oil quench. If vacuum quench is desired, furnaces should have 4 bar minimum capability. Temper immediately to Rockwell HRC 63/65.

TEMPERING — Tools should be tempered immediately after completion of the hardening treatment. The tempering temperature may be adjusted according to the hardness desired. Tempering usually performed in the temperature range of 1000/1100ºF (538/593ºC).

Triple tempering and/or refrigeration at -100ºF (-73ºC) is suggested when hardening is performed above 2100ºF (1149ºC). If refrigeration is used, tools should be refrigerated immediately after the first temper.

The effects of various hardening and tempering temperatures are shown in the following chart.

Average Rockwell C Hardness

Tempering Temp ºF/ºC	Austenitized 1950ºF (1066ºC)	Austenitized 2050ºF (1121ºC)	Austenitized 2150ºF (1177ºC)
As Quenched	64.5	64.0	62.5
1000/538	60.0	61.0	64.0
1025/551	59.0	60.0	62.0
1050/566	55.0	58.0	60.0
1100/593	50.0	52.0	54.0
1150/621	44.0	45.0	46.0