NESSteel Inc

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A-11 Powder Metal Tool Steel

Typical Analysis

C	Cr	Mo	V	Mn	Si
2.45%	5.30%	1.30%	9.80%	0.50%	0.90%

A-11 is a high wear tool steel made by the powder metallurgy process. It has very high wear resistance while still having good toughness and strength. The powder metallurgy manufacturing process gives it a very fine grain which contributes to toughness and improves grindability.

A-11 is used primarily for cold and warm work applications. Due to its extremely high wear resistance it often can replace carbide, particularly where carbide has a tendency to chip or break.

TYPICAL APPLICATIONS

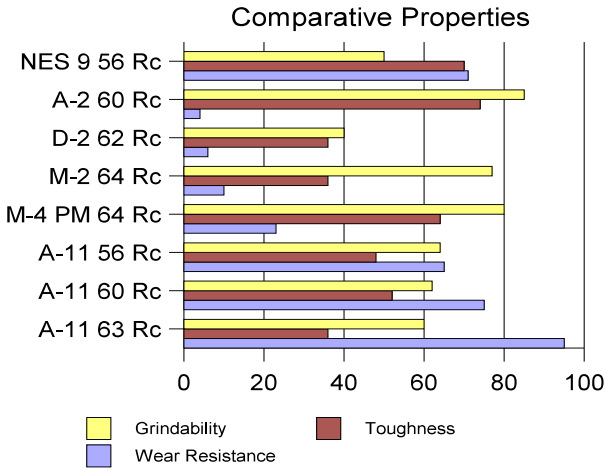
Punches and dies for:
Blanking, Piercing, Forming, Cold extrusion, Cold heading
Industrial knives for:
Slitting, Shearing, Trimming, Granulating, Wood Working
Nozzles, screw tips, barrel liners for plastic injection molding machines.
Powder compaction tools.
Roll forming Tools
Wear Parts

PHYSICAL PROPERTIES

Density: 0.267 lbs/in^3

Specific Gravity: 7.41
Modulus of Elasticity: 32 X 10^6 psi (221 GPa)
Machinability: 35-40% of 1% carbon steel
Critical Temperature: 1540° F (838° C)
Coefficient of Thermal Expansion:

Temp °F	in/in/°F X 10^{-6}
70-212	5.96
70-300	6.10
70-400	6.20
70-500	6.39
70-800	6.55
70-1000	6.85



HEAT TREATMENT

Annealing

Heat at a rate of 400° F per hour or less to 1600-1650° F and hold at temperature for 1 hour per inch of maximum section with a minimum of 2 hours. Cool slowly with the furnace at a rate of 40° F per hour or less to 1000° F. Cool to room temperature in the furnace or in air. The annealed hardness should be 255-285 HB.

Hardening

Critical Temperatures: Ac_1 1540° F Ms 330° F

Preheat: Heat to 1500-1550° F and allow to equalize.

Austenitize: Heat rapidly from the preheat to 1950-2150° F (depending on desired properties) either in the same or a different furnace.

For optimum toughness and minimum distortion in heat treat: Soak for 30-60 minutes at 1975° F for furnace and 1950° F for salt bath.

For optimum wear resistance: Soak for 5-15 minutes at 2150° F (furnace or salt bath). For a balance of wear resistance and toughness soak for 15-30 minutes at 2050° F (furnace or salt bath).

Quench: Parts may be quenched in air, pressurized gas, warm oil, or salt. Adequate quench rate is essential to obtain desired properties. Sections of less than 3" may be air quenched while still obtaining maximum hardness. Sections 3" or more must be quenched using a faster quench process as noted below:

Pressurized Gas may be used if the furnace has a minimum quench pressure of 4 bars. The rate of quench is critical down to 1000° F to obtain optimum properties.

Oil quench until black (about 900° F) then cool in still air to 125-150° F

Salt quench in a pot maintained at 1000-1100° F, equalize in the salt then cool in still air to 125-150° F.

Temper: Temper immediately after quenching and cooling down to below 125° F (parts can be held comfortably in hand). A-11 is normally tempered in the range of 1000-1100° F and should not be tempered below 1000° F. Parts should be brought to tempering temperature and held at temperature for 2 hours before air cooling to room temperature. Double or triple tempering is required. If the parts are austenitized at 2100° F or higher triple tempering is required. Parts must be cooled to room temperature between tempers.

Cryogenic treatment: Cryogenic treatment (deep freezing at -100° F or colder) is optional . It can be used to reduce the amount of retained austenite, particularly when austenitized from 2100-2150° F. Cryogenic treatment should be performed between the first and second tempers.

Size change in heat treatment: A-11 will grow approximately +0.0004 in/in upon heat treatment from annealed to hardened and tempered.

Heat Treat Response

As Oil Quenched From	HRC
1950° F, 45 minutes	65
2050° F, 20 minutes	65
2100° F, 15 minutes	64
2150° F, 5 minutes	63