Technical Datasheet

CarTech® Micro-Melt® 420-CW Tool Steel

Type Analysis

Single figures are nominal except where noted.

Carbon	2.25 %	**Manganese (Maximum)**	0.50 %
Sulfur (Maximum)	0.030 %	**Silicon**	0.90 %
Chromium	12.80 %	**Molybdenum**	1.30 %
Vanadium	9.25 %	**Iron**	Balance

General Information

Description

CarTech Micro-Melt 420-CW tool steel is a corrosion-resistant, high vanadium wear-resistant tool steel produced using Carpenter's CarTech Micro-Melt powder process. The wear resistance of this grade is comparable to CarTech Micro-Melt A11-LVC alloy. CarTech Micro-Melt 420-CW alloy also is comparable in toughness to CarTech Micro-Melt A11 alloy. CarTech Micro-Melt 420-CW may be considered for those applications where 440C and D2 tool steels do not have adequate wear resistance or for applications where A11-LVC, A11, D2 or other tool steels do not have adequate corrosion resistance.

Many of the benefits realized in the use of CarTech Micro-Melt powder metals, such as CarTech Micro-Melt 420-CW alloy, are a direct result of the refined microstructure (small, uniformly distributed carbide particles and a fine 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.

Applications

CarTech Micro-Melt 420-CW alloy may be considered for:

- Plastic injection molds and inserts
- Plastic injection and extrusion feedscrews
- Non-return valve components
- Pelletizing equipment
- Pelletizer blades
- Nozzles
- Gate and nozzle inserts
- Industrial knives, slitters, and cutters
- Wear-resistant specialty cutlery
- Wear components for food and chemical processing
- Bearings, bushings, valves, rolls
- Gear pumps

Corrosion Resistance

Corrosion Rate – Micro-Melt® 420-CW Tool Steel

Heat Treatment	Hardness (HRC)	Corrosion Rate (mpm)(1)	
		Dilute Aqua Regia	Boiling 1% Acetic Acid
Austenitize 1950°F/30min + 1000°F Salt Quench + AC to RT + double temper 550°F/2hr+2hr(1)	57	411	0.5
Austenitize 2050°F/30min + 1000°F Salt Quench + AC to RT + double temper 550°F/2hr+2hr(1)	59	683	1.2
Austenitize 2150°F/30min + 1000°F Salt Quench + AC to RT + double temper 550°F/2hr+2hr(1)	60	842	0.0

(1) Dilute aqua regia was 5 volume % HNO_3 & 1 volume % HCL with a test duration of 1.5 hrs. The test duration for the boiling 1 volume % acetic acid test was 7 hrs.
Results are reported in mils per month (mpm). Lower numbers indicate better corrosion resistance.

Properties

Physical Properties

Specific Gravity	7.40	
Density	0.2700	lb/in³
Mean CTE		
70 to 400°F	6.13	x 10 $^{-6}$ in/in/°F
70 to 600°F	6.48	x 10 $^{-6}$ in/in/°F
Modulus of Elasticity (E)	31.0	x 10 ^{3} ksi

Typical Mechanical Properties

Unnotched Izod Longitudinal Impact Values – Micro-Melt® 420-CW Tool Steel Per ASTM E23

Heat Treatment	Hardness HRC	Impact Values ft/lb
Austenitize 1950ºF-30mins in salt, 1000ºF salt quench, AC to RT + double temper 550ºF-2hrs, AC to RT	57	42
Austenitize 2050ºF-30mins in salt, 1000ºF salt quench, AC to RT + double temper 550ºF-2hrs, AC to RT	59	37
Austenitize 2150ºF-30mins in salt, 1000ºF salt quench, AC to RT + double temper 550ºF-2hrs, AC to RT	60	30

Heat Treatment

Decarburization

Micro-Melt 420-CW tool steel, like all high carbon tool steels, is somewhat susceptible to decarburization in hardening. Means of preventing decarburization are well known. Modern furnaces that employ protective environments, such as protective atmospheres, salt pots, fluidized bed furnaces and vacuum furnaces, should present no difficulty with decarburization of this alloy.

Normalizing

Normalizing is not recommended.

Annealing

Heat slowly to 1650°F (899°C), hold for 2 hours, cool slowly at a rate of 25°F (14°C) maximum per hour to 1000°F (538°C), then either furnace cool or cool in still air to room temperature. Typical annealed hardness will be 277 Brinell.

Hardening

Micro-Melt 420-CW tool steel should be heat treated using proper precautions to prevent decarburization. First preheat to 1500/1550°F (816/843°C), equalize, and transfer to a furnace maintained at the desired hardening temperature. Austenitize: 1950-2150°F (1066-1175°C) and hold time at temperature for 20-30 minutes.

Note: For larger section sizes, fan air cooling or step quenching in oil or salt may be used in order to obtain the optimum quench rate.

Deformation (Size Change) in Hardening

Micro-Melt 420-CW tool steel changes size only slightly after hardening. An expansion of about 0.0005 inches/inch is typical for a fully martensitic microstructure. Tools will open up slightly in the ID and expand on the OD.

The presence of retained austenite may reduce the net growth. When tempering at 400-750°F (200-400°C), a –100° F refrigeration freezing treatment may be necessary to minimize retained austenite.

Quenching

Salt quench, interrupted oil quench, positive pressure gas quench, or air cool at a minimum cooling rate of 150°F/min. (80°C/min.) to below 1000°F (540°C). Cool to below 125°F (50°C) before tempering. For optimum vacuum heat treatment response, a minimum 4 bar gas quench is recommended.

Stress Relieving

Annealed Parts: Heat to 1100-1300°F (593-705°C), hold 2 hours, then furnace cool or cool in still air.

Hardened Parts: Heat to 25-50°F (15-30°C) below original tempering temperature, hold 2 hours, then furnace cool or cool in still air.

Tempering

Tools should be tempered immediately after completion of the hardening treatment. The tempering temperature may be adjusted according to the final hardness desired. Double temper at 400-750°F (200-400°C). Hold for a minimum of 2 hrs. each temper. Tempering in this temperature range provides the best corrosion resistance and wear resistance.

Tempering between about 800 and 1000°F (427 and 538°C) is not recommended. All martensitic stainless steels suffer from embrittlement when tempered in this range.

For optimum stress relieving and dimensional stability, Micro-Melt 420-CW may be double tempered at 1025°F, but some loss of corrosion resistance may result.

A –100°F refrigeration treatment may be employed between the first and second tempers, if desired. Freezing treatments should always be followed by at least one temper.

The typical hardness of Micro-Melt 420-CW after hardening and tempering is 56-60 HRC.

Effect of Hardening and Tempering Temperatures on Hardness – Micro-Melt® 420-CW Tool Steel

Tempering Temperature		Hardness (HRC)		
		Hardening Temperature		
°F	°C	1950°F (1066°C)	2050°F (1121°C)	2150°F (1177°C)
As Quenched		60	62	63
500	538	56	59	60
550	551	57	59	60

All samples were hardened (austenitized) for 30 minutes in salt, quenched in 1000°F (538°C) salt and then air cooled to room temperature. Double Tempering (2 hrs + 2 hrs) was performed in an air furnace followed by air cooling to room temperature after each tempering.

Workability

Forging

Heat slowly to 2000/2100°F (1093/1149°C). Do not work below 1700°F (927°C). Reheat as necessary. Cool forgings slowly and anneal immediately upon cooling.

Machinability

The machinability of Micro-Melt 420-CW tool steel in the annealed condition may be rated between 35% and 40% of 1% carbon tool steel. Tooling providers' recommendations for cutting fluids should be followed.

Micro-Melt 420-CW tool steel can be easily EDM'd. Use proper precautions to prevent and/or remove the "white layer."

Other Information

Wear Resistance

Wear resistance is measured using the Dry Sand/Rubber Wheel wear test (ASTM G65, Method A). Volume loss of the test sample is determined after a 30-minute test time. A lower sample volume loss indicates better wear resistance.

Comparative Dry Sand/Rubber Wheel Abrasion Tests
Per ASTM G65 Method A Wear Test

Alloy/Treatment	Hardness (HRC)	Volume Loss (mm^3)
Micro-Melt 420-CW / 1950°F/30min + 550°F/2hr+2hr(1)	57	15.6
Micro-Melt 420-CW / 2050°F/30min + 550°F/2hr+2hr(1)	59	13.6
Micro-Melt 420-CW / 2150°F/30min + 550°F/2hr+2hr(1)	60	12.2
Micro-Melt A11-LVC / Wear Treatment(2)	55.0	14.4
Micro-Melt A11-LVC / Tough Treatment(2)	49.0	16.3
Micro-Melt A11 / Wear Treatment(2)	63.0	9.0
Micro-Melt A11 / Tough Treatment(2)	59.0	12.0
AISI M2 / Standard Treatment(2)	65.0	23.3
AISI D2 / Standard Treatment(2)	60.0	41.0
AISI A2 / Standard Treatment(2)	60.0	62.6
AISI H13 / Standard Treatment(2)	51.0	127.0

(1) Refer to Heat Treatment Section of this datasheet for details of heat treatment
(2) Standard treatment refers to standard hardening/tempering treatment for these grades.

Forms Manufactured

- Bar-Flats
- Bar-Squares
- Plate
- Wire
- Bar-Rounds
- Billet
- Powder

Technical Articles

- Blade Alloys 101: What You Need to Know About the Alloys Used for Knife Blades

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