

CarTech® Ferrium® C64® Alloy

Identification

U.S. Patent Number

• 8,801,872 B2

UNS Number

• K92731

Type Analysis

Single figures are nominal except where noted.

Carbon	0.11 %	Chromium	3.50 %
Nickel	7.50 %	Molybdenum	1.75 %
Cobalt	16.30 %	Vanadium	0.02 %
Tungsten	0.20 %	Iron	Balance

General Information

Description

A premium quality carburizing steel that offers high core strength, high fatigue strength, high temperature resistance and high hardenability versus AISI 9310, X53 (AMS 6308), EN36 and other standard carburizable alloys. Benefits of using Ferrium C64 include light weighting of components and increasing power density.

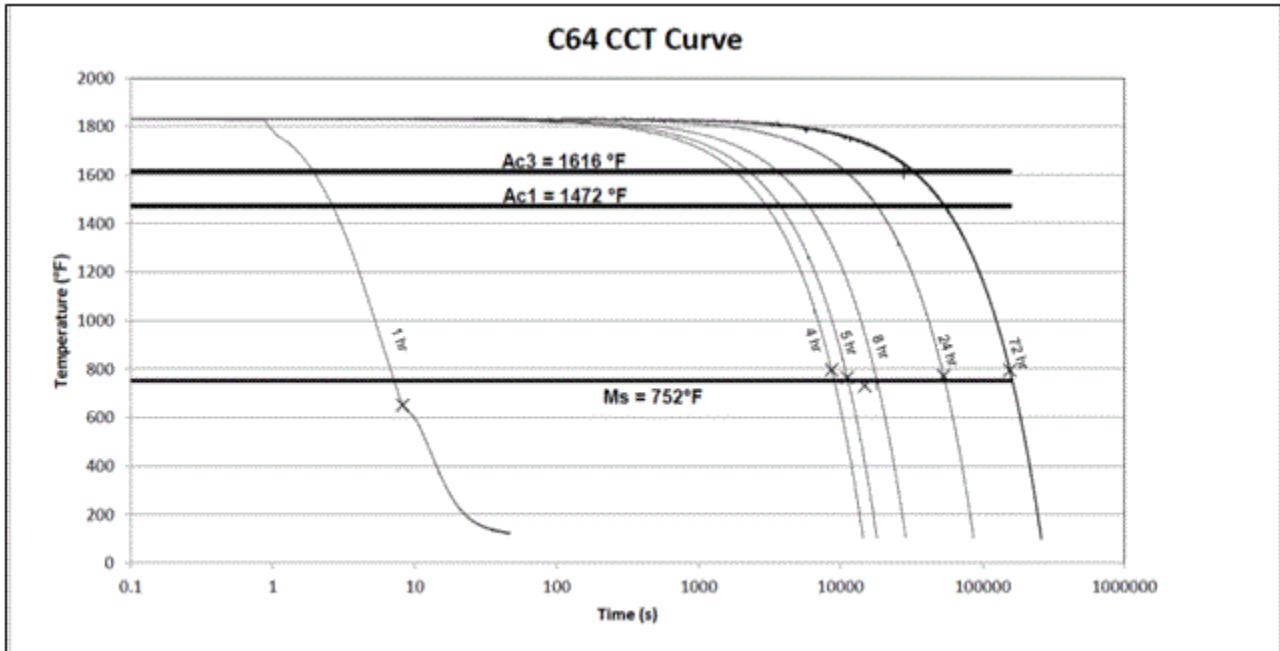
Applications

Typical applications include power transmission shafts, gears and other demanding applications in aerospace, energy, and racing/off-road/mission-critical vehicles and other industries where weight savings, compactness, high temperature resistance and high surface fatigue resistance are valued. The ability of Ferrium C64 to achieve 62-64 HRC while also providing excellent core strength benefits highly-loaded components requiring wear and fatigue resistance. Ferrium C64 is being qualified by leading helicopter OEMs to replace X53 for next generation transmission gears.

Properties

Physical Properties

Density	0.2880 lb/in ³
Mean CTE	
75 to 200°F	5.29 x 10 ⁻⁶ in/in/°F
75 to 400°F	5.18 x 10 ⁻⁶ in/in/°F
75 to 600°F	5.32 x 10 ⁻⁶ in/in/°F
75 to 800°F	5.53 x 10 ⁻⁶ in/in/°F
75 to 1000°F	5.69 x 10 ⁻⁶ in/in/°F
Critical Temperature (AC1)	1472 °F
Critical Temperature (AC3)	1616 °F
Martensite Start	752 °F



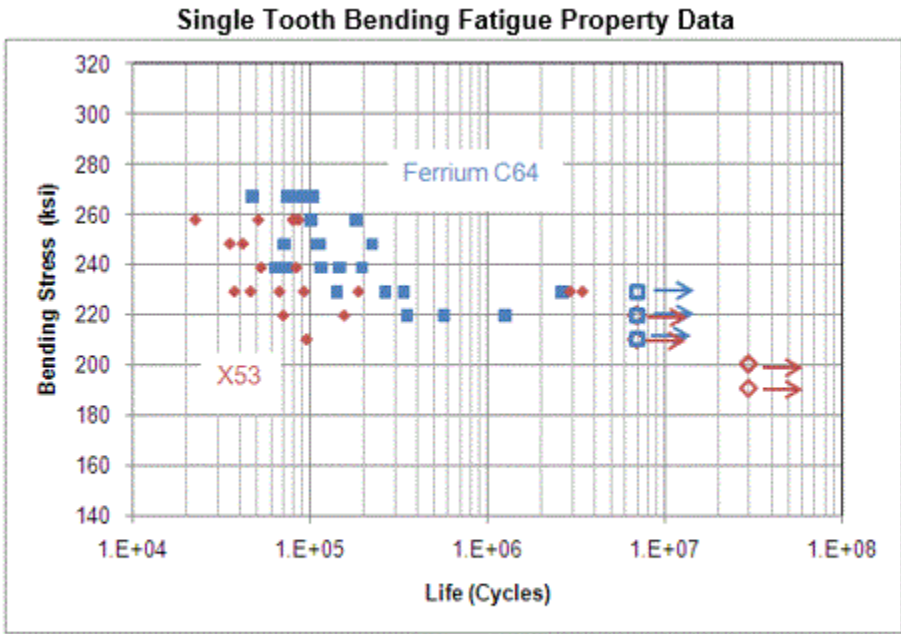
Continuous cooling transformation (CCT) curve of Ferrium C64.
 Ferrium C64 is manufactured and sold under license from QuesTek Innovations LLC.
 Data provided courtesy of QuesTek Innovations LLC.

Typical Mechanical Properties

Average Jominy End Quench Hardenability

	Distance from Quenched End (1/4 inch)							
	1	2	3	4	5	6	7	8
Rockwell C	43	43	43	43	43	43	42.5	42.5

Ferrium C64 is a secondary hardening steel that will increase hardness after tempering. (Typical core hardness after tempering is 47 – 50 HRC)



Single Tooth bending fatigue data of C64 and X53, under identical shot peening parameters and gear geometries. Ferrium C64 is manufactured and sold under license from QuesTek Innovations LLC. Data provided courtesy of QuesTek Innovations LLC

Typical Mechanical Properties									
Core Tensile Properties of Ferrium C64									
Test Temperature		Tensile Strength		Yield Strength		Elongation	R. of A.	Fracture Toughness	
°F	°C	ksi	MPa	ksi	MPa	(% in 1")	(%)	ksi√in	MPa√m
Room Temperature		229	1579	199	1372	18	65	85	94

Heat Treatment

Normalizing

Heat uniformly to 1800°F (982°C) and air cool.

Annealing

Heat uniformly to 1250°F (677°C), hold for 2 to 8 hours and air cool.

Carburizing

Vacuum carburize at 1830°F (1000°C), followed by quenching in gas (1.5 Bar Nitrogen or higher) or oil medium.

Solution Treatment

If it is desired to achieve the core properties of C64 without carburizing, this can be done by performing an austenitizing step at 1830°F +/- 25°F (999°C +/- 14°C) for 1 hour followed by quenching in gas (1.5 Bar Nitrogen or higher) or oil medium.

Quenching

Gas, Oil, or Equivalent.

Cold Treatment

A refrigeration treatment at -100°F (-73°C) or lower for 1 hour is recommended. This should be performed with minimal delay after completion of the quench, and is mandatory within 8 hours of quench.

Straightening

Operations such as shaft straightening (if required) should preferably be done after the sub zero treatment but prior to the temper. C64 achieves full mechanical strength after tempering, and thus trying to straighten parts after tempering will be more difficult.

If excessive distortion exists after the solution treatment, quench and sub-zero treatment, then it is recommended to heat the part to 392°F (200°C) in air for 1 hour, hot-straighten the part (temperature determined by amount of force required to straighten part; temperature should be maintained below 700F (371C) to avoid any tempering or decarburization; a small oxide layer may form at this temperature), and allow the component to air cool. The full temper cycle must then be applied.

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Tempering

Temper at 925°F (496°C) for 6 to 10 hours and air cool. It is preferred that tempering be performed in vacuum but can also be performed in air.

Workability

Hot Working

1800 – 2100°F (982 – 1149°C).

Recommended reduction ratio of 4:1.

Forging

Standard forging of billet and bar stock should be conducted at 1800 – 2050°F (982 – 1121°C). If higher forging temperatures are preferred, hot fire temperatures of 2300-2350°F (1260 – 1288°C) may be used, provided a minimum of 4:1 forging reduction ratio is achieved. Following forging the parts should be air cooled to room temperature, followed by normalization, cold treatment and annealing to improve machinability.

Machinability

Bars and Forgings for machining shall not exceed 352 HRB, or equivalent, as descaled.

Preheating of Dies

None

Plating

Like other carburizing-grade steels, C64 can be copper-plated prior to carburization (in accordance with ASTM 2418 or other standards), in order to protect or shield the surfaces that are not to be carburized. Suitable stop-off paints may also be used.

It is highly recommended that areas adjacent to carburized surfaces (e.g. the tips and side faces of gear teeth, splines, etc.) be masked with copper plating, stop-off paint, or other suitable means in order to prevent excess carburization at the edges/corners of carburized surfaces.

Other Information

Descaling (Cleaning)

Bar Peeling

Metallurgical Requirements

Metallurgical Requirements

Per below material specifications.

Applicable Specifications

Note: While this material meets the following specifications, it may be capable of meeting or being manufactured to meet other general and customer-specific specifications.

- AMS 6509

Forms Manufactured

- Bar-Flats
- Bar-Rounds
- Bar-Rectangles
- Billet

References

SAE AMS 2759/3 for thermal processing

SAE AMS 2759/9 for hydrogen bake out parameters

SAE AMS 2759/11 for stress relieve parameters

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