CARPENTER ELECTRIFICATION®

DATASHEET

HIPERCO® 50 HS

Type analysis

Single figures are nominal except where noted.

Iron	Balance	**Cobalt**	48.75 %	**Vanadium**	1.90 %
Niobium	0.30 %	**Carbon**	0.01 %		

Forms manufactured

Strip	**Plate**

Additional details available on page 5, Other Information.

Description

Hiperco 50 HS is an iron-cobalt-vanadium soft magnetic alloy that exhibits high magnetic saturation (24 kilogauss) and a unique combination of high yield strength and moderate core loss. The alloy contains a niobium addition for grain refinement during mill processing and final heat treating to produce higher yield strength than conventional Hiperco 50.

Hiperco 50 HS strip should be considered a candidate for use in the manufacture of rotor laminations for aircraft power generation applications and for high-speed motors. These laminations are stamped from cold rolled strip and must be final annealed in a protective atmosphere or vacuum environment at a temperature that will provide an optimum combination of magnetic and mechanical properties to withstand the high stresses encountered in service.

Key Properties:

- High magnetic saturation
- High yield strength
- Moderate core loss

Markets:

- Aerospace
- Automotive
- Consumer
- Industrial

Applications:

- Rotor laminations for aircraft power generation
- High-speed motors

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Physical properties

PROPERTY	At or From	English Units	Metric Units
SPECIFIC GRAVITY	—	8.12	8.12
DENSITY	—	0.2930 lb/in^3	8.11 g/cm^3
MEAN COEFFICIENT OF THERMAL EXPANSION	77 to 392°F (25 to 200°C)	5.30 x 10^{-6} length/length/°F	9.50 x 10^{-6} length/length/°C
	77 to 752°F (25 to 400°C)	5.60 x 10^{-6} length/length/°F	10.10 x 10^{-6} length/length/°C
	77 to 1112°F (25 to 600°C)	5.80 x 10^{-6} length/length/°F	10.40 x 10^{-6} length/length/°C
	77 to 1472°F (25 to 800°C)	6.30 x 10^{-6} length/length/°F	11.30 x 10^{-6} length/length/°C
THERMAL CONDUCTIVITY	—	206.8 Btu-in/hr/ft^2/°F	29.83 W/m/°C
ELASTIC MODULUS	—	30 x 10^3 ksi	206.8 GPa
ELECTRICAL RESISTIVITY	70°F (21°C)	253.0 ohm-cir-mil/ft	42.1 ohm·m
CURIE TEMPERATURE[1]	—	1720°F	938°C

[1] Curie temperature is phase transition from magnetic to non-magnetic phase

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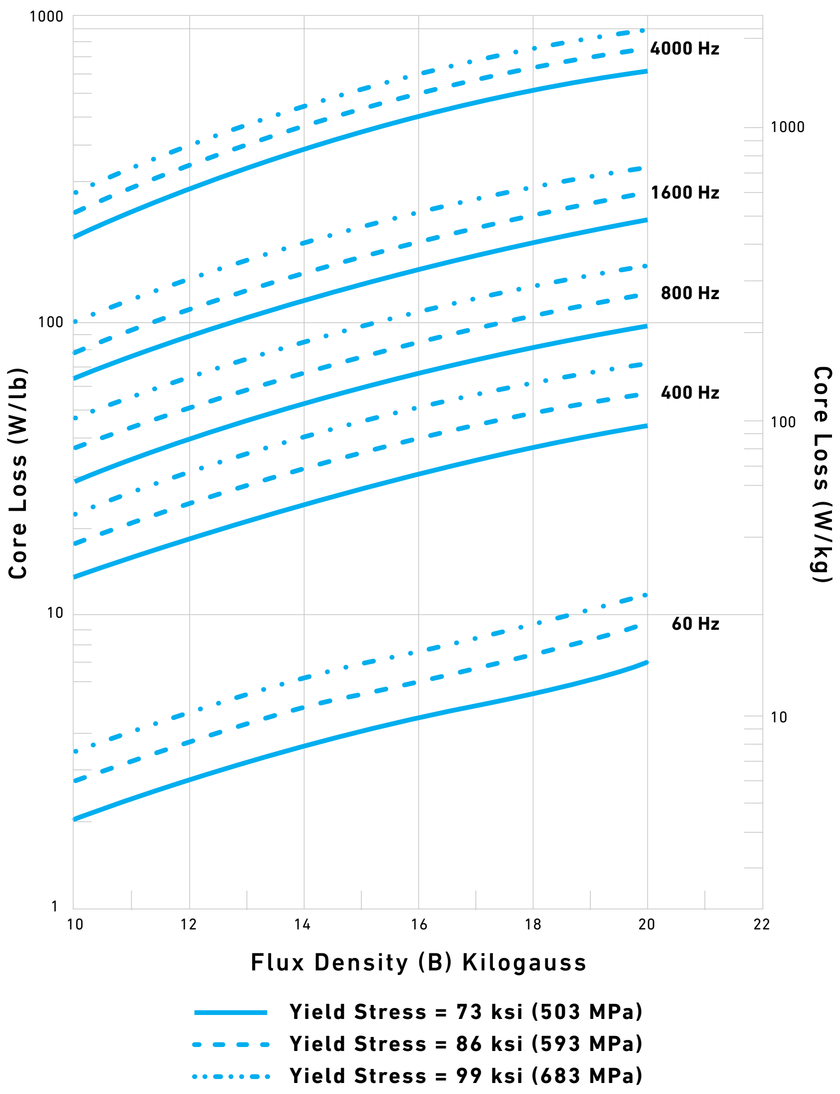
Magnetic properties

TYPICAL AC MAGNETIC PROPERTIES

Specimen size — 0.006 in. (0.152 mm) strip. Typical AC core loss values at frequencies of 60, 400, 800, 1600, and 4000 Hz are shown for strip heat treated to the indicated yield strengths. The core loss data were determined on 1.50 in. (38.1 mm) O.D. by 1.25 in (31.8 mm) I.D. ring laminations using ASTM Method A927/A927M and a sinusoidal flux waveform.



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TYPICAL DC MAGNETIC PROPERTIES

Typical DC flux density values as a function of magnetic field strength in oersteds are shown below for strip heat treated to the yield strengths shown. For a given strength level, the flux density is independent of strip thickness.

ASTM METHOD A596/A596M, 1.50 IN (38.1 MM) O.D. x 1.25 IN (31.8 MM) I.D. RING LAMINATIONS

0.2% YIELD STRENGTH		FLUX DENSITY AT INDICATED MAGNETIC FIELD STRENGTH									
		10 Oe 800 A/m		20 Oe 1600 A/m		50 Oe 4000 A/m		100 Oe 8000 A/m		200 Oe 16000 A/m	
ksi	MPa	kG	T	kG	T	kG	T	kG	T	kG	T
73	503	19.3	1.93	20.7	2.07	21.9	2.19	22.3	2.23	23.0	2.30
86	593	19.0	1.90	20.3	2.03	21.8	2.18	22.3	2.23	22.9	2.29
99	683	18.2	1.82	19.9	1.99	21.5	2.15	22.3	2.23	22.9	2.29

Typical mechanical properties

The tensile properties shown are for strips heat treated as indicated and tested at room temperature. All heat treatments were conducted in batch type furnaces (1 hour heat up time) in dry hydrgen followed by cooling rate of 180°F/hr (100°C/hr).

ASTM METHOD E8, 0.006 IN (0.152 MM) STRIP

HEAT TREATMENT			0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 2 IN (50.8 MM)
TEMPERATURE		TIME, HR					
°F	°C		ksi	MPa	ksi	MPa	%
1328	720	1	99	683	185	1280	15
1328	720	2	94	648	177	1220	14
1328	720	4	87	600	156	1080	11
1364	740	1	86	593	168	1160	13
1364	740	2	83	572	167	1150	13
1364	740	4	78	538	158	1090	12
1400	760	1	76	524	149	1030	11
1400	760	2	76	524	166	1140	14
1400	760	4	73	503	145	1000	11
1472	800	4	64	441	142	979	11

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Heat treatment

Annealing	It is important to avoid any contamination of the finished parts during heat treatment. All parts must be cleaned thoroughly to remove any surface contaminants prior to annealing. Batch heat treating in a sealed retort or welded box-type furnace is recommended. Thoroughly degreased and cleaned laminations can usually be stacked without an insulating media separation. To obtain the best degree of lamination flatness, a light weight can be placed on top of the stack. It may be necessary to determine the correct amount of weight to ensure there is no sticking of the laminations within the stack height employed. A dry hydrogen atmosphere or a high vacuum is recommended to minimize oxide contamination of the parts during annealing. When hydrogen is employed, the entry dew point should be dryer than -60°F (-51°C) and the exit dew point dryer than about -40°F (-40°C) when the inside retort temperature is above 900°F (482°C). Anneal parts at 1300/1400°F (704/760°C) for 1 to 4 hours in dry hydrogen or vacuum and cool at 150/350°F (83/194°C) per hour until 600°F (316°C) is reached, after which any cooling rate can be employed. The exact heat treat temperature to be employed will depend upon the particular application and the desired compromise between magnetic and mechanical properties. With increasing temperature, the magnetic properties improve while the yield and tensile strengths decrease. The temperature at no time should exceed 1600°F (871 °C) as an upper limit, as the soft magnetic characteristics start to degrade due to formation of an austenitic phase.

Coatings

Inlac	Inlac coating is applied in a continuous process on coils of strip to create a mix of magnesium-based compounds on both sides of the strip surface. This surface layer acts as an inert barrier between laminations during heat treating and prevents adhesion. Additionally, during AC excitation, it provides improved electrical insulation between laminations reducing eddy current effects on core loss.
Oxide	For certain AC applications, improved magnetic characteristics and/or lower core loss are realized by creating a thin oxide layer on the surface of the annealed laminations. The surface oxide layer can be achieved by heating in an oxygen bearing atmosphere in the range of 600 to 900°F (316 to 482°C) for about 30 to 60 minutes. The exact baking parameters must be determined for the annealing facility employed and the thickness of oxide layer desired.

Other information

Applicable specifications	ASTM A801 Alloy Type 1

For additional information, please contact your nearest sales office:
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