HOEGANAES

Ancorsteel® 2000

Ancorsteel 2000 *is a water atomized low-alloy steel powder containing nickel, molybdenum, and manganese which satisfies Metal Powder Industries Federation (MPIF) material specification FL-4200.*

Ancorsteel 2000 is particularly useful for conventional P/M parts requiring greater hardenability than is possible when using admixed or diffusion alloyed powders. It has good compressibility and green strength, enabling parts to be made easily to densities above 6.7 g/cm^3. The use of nickel and molybdenum as the principal alloying elements permits Ancorsteel 2000 to be processed using conventional P/M sintering temperatures and atmospheres.

Ancorsteel 2000, because of its high degree of cleanliness and uniform chemistry, is ideally suited for powder forging (P/F) applications that require the hardenability and mechanical properties associated with cast and wrought steels. Part densities of 7.60 to 7.86 g/cm^3 can be obtained using hot forming pressures of 415–1100 MPa (30–80 tsi).

Typical Analysis and Properties

Composition (weight %) (w/o)

C	Mo	Ni	Mn	O
<0.01	0.61	0.46	0.25	0.13

Apparent Density

2.98 g /cm^3

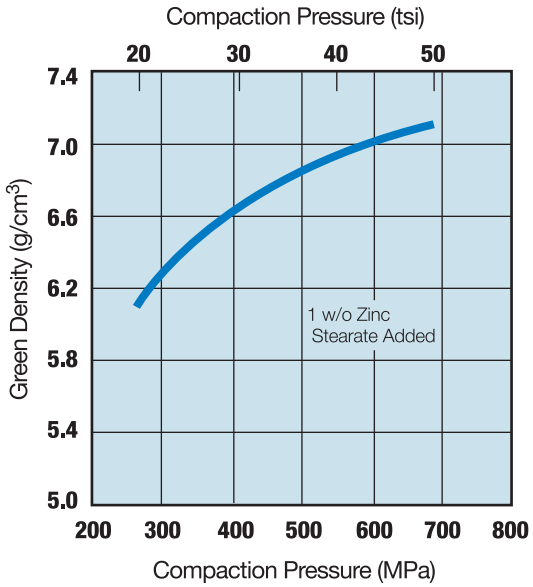
Flow Rate

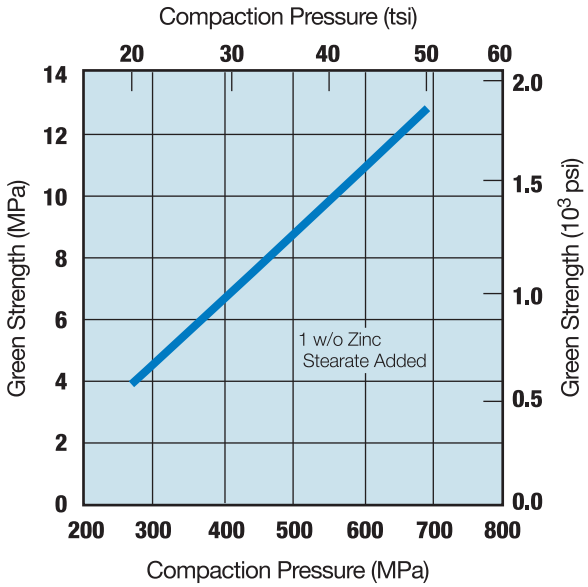
25 s/ 50 g

Sieve Distribution (w/o)

Micrometers	+250	-250 /+150	-150 /+45	-45
U.S. Standard Mesh	+60	-60 /+100	-100 /+325	-325
	Trace	10	65	25

The Effect of Compaction Pressure on Green Properties



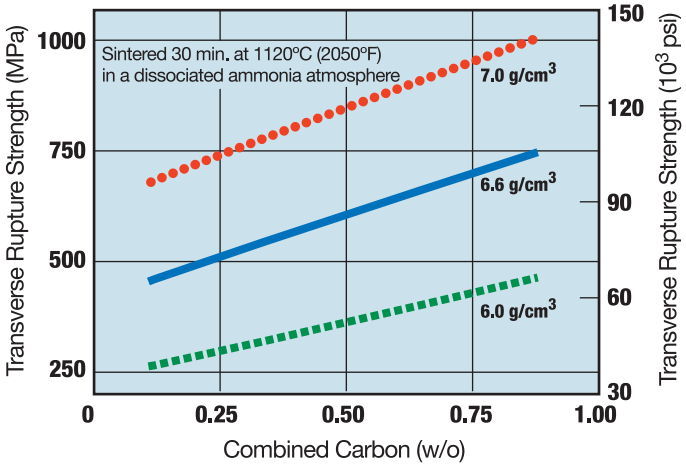


NORTH AMERICA Cinnaminson, NJ: +1-856-829-2220, **shelton.clisby@hoeganaes.com**
EUROPE Buzau, Romania: +40 238 403004, **Cristina.Diaconu@hoeganaes.com**
ASIA Jiangsu, China: +86 138 1842 8736, **Chao.Kuang@hoeganaes.com**

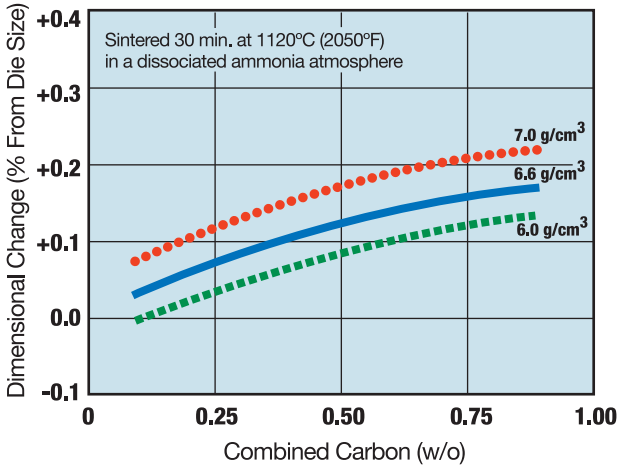
Ancorsteel® 2000

The Effect of the Combined Carbon on Sintered Properties

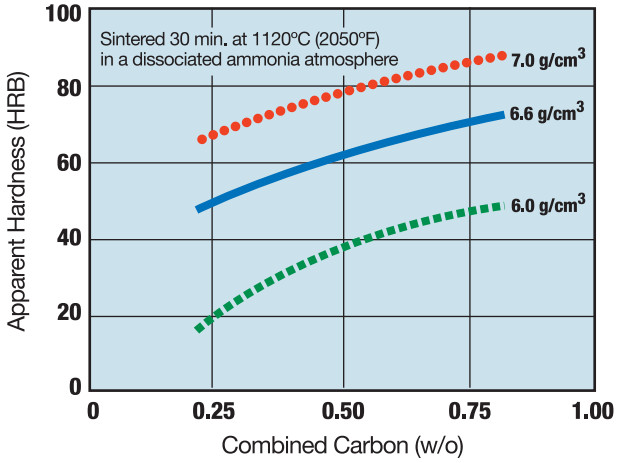
Transverse Rupture Strength



Dimensional Change

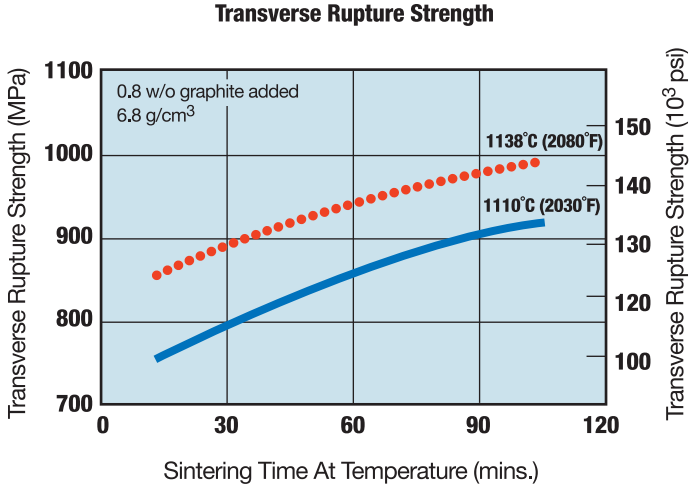


Apparent Hardness

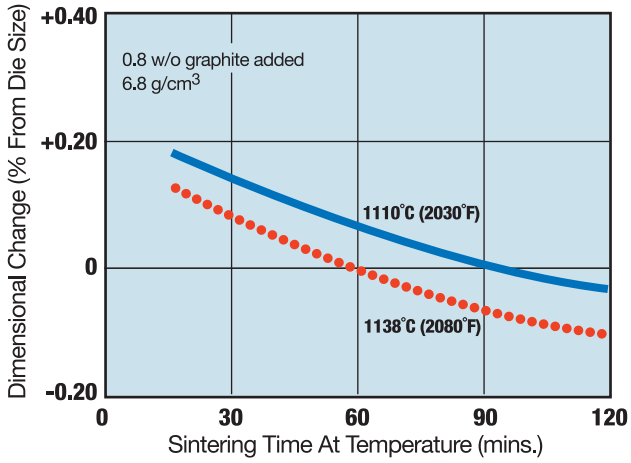


The Effect of the Sintering Temperature and Time on Properties

Transverse Rupture Strength



Dimensional Change

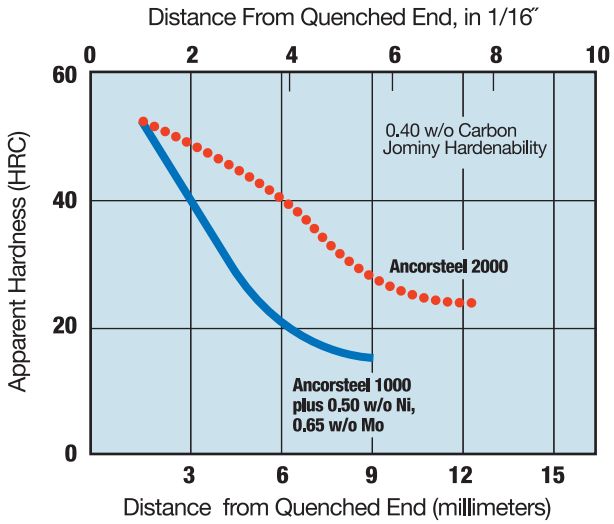


Test specimens were sintered in an endothermic gas atmosphere.

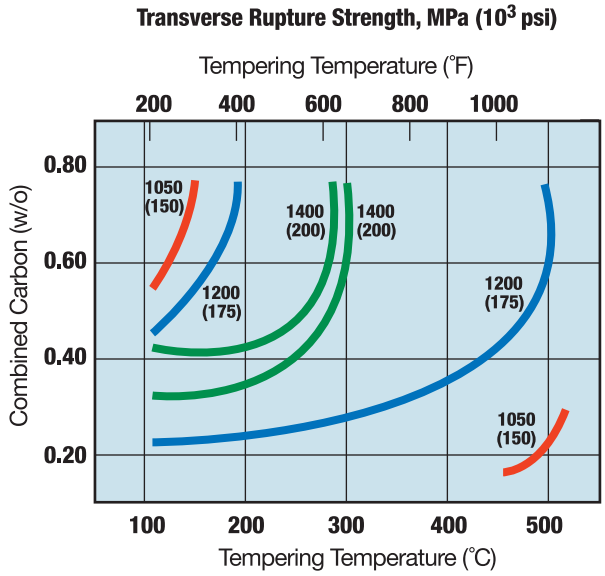
NORTH AMERICA Cinnaminson, NJ: +1-856-829-2220, **shelton.clisby@hoeganaes.com**
EUROPE Buzau, Romania: +40 238 403004, **Cristina.Diaconu@hoeganaes.com**
ASIA Jiangsu, China: +86 138 1842 8736, **Chao.Kuang@hoeganaes.com**

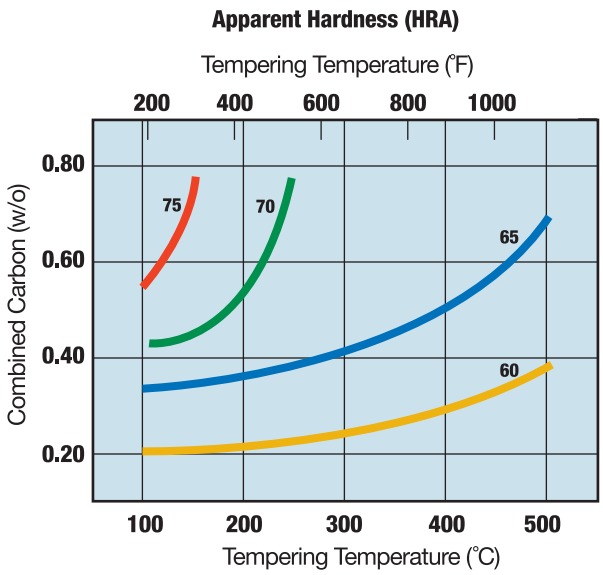
Ancorsteel® 2000

Comparison of the Hardenability of Premixed and Prealloyed Powders with Equivalent Compositions



The Effect of Heat Treatment





Test specimens were at a density of 7.0 g/cm^3. The specimens were austenitized in an endothermic atmosphere at 790°C to 870°C (1450°F to 1600°F), oil quenched and tempered.

NORTH AMERICA Cinnaminson, NJ: +1-856-829-2220, **shelton.clisby@hoeganaes.com**
EUROPE Buzau, Romania: +40 238 403004, **Cristina.Diaconu@hoeganaes.com**
ASIA Jiangsu, China: +86 138 1842 8736, **Chao.Kuang@hoeganaes.com**

Ancorsteel® 2000

The Effect of Sintering Temperature and Sintered Carbon on the Tensile Properties of Ancorsteel 2000 Compacted to 6.8 g/cm³

Sintering Temperature °C	Sintering Temperature °F	Sintered Carbon w/o	Yield Strength 2% Offset MPa	Yield Strength 2% Offset psi	Ultimate Tensile Strength MPa	Ultimate Tensile Strength psi	Elongation % in 25.4 mm (1 inch)
1120	2050	0.4	250	36,500	290	42,000	<1.0
1260	2300	0.4	285	41,500	365	53,000	1.9
1120	2050	0.6	295	42,500	345	50,000	<1.0
1260	2300	0.6	330	48,000	420	61,000	1.5
1120	2050	0.8	360	52,000	385	56,000	<1.0
1260	2300	0.8	410	59,000	510	74,000	1.2

The Effect of Sintering Temperature and Sintered Carbon on the Tensile Properties of Heat Treated Ancorsteel 2000 Compacted to 6.8 g/cm³

Sintering Temperature °C	Sintering Temperature °F	Sintered Carbon w/o	Ultimate Tensile Strength MPa	Ultimate Tensile Strength psi	Yield Strength 0.2% Offset	Elongation	Apparent Hardness HRC
1120	2050	0.4	620	90,000	There was no yielding or elongation in the heat treated bars.		28
1260	2300	0.4	815	118,000			28
1120	2050	0.6	495	72,000			36
1260	2300	0.6	705	102,000			36
1120	2050	0.8	430	62,000			42
1260	2300	0.8	620	90,000			42

The test bars were austenitized at 845°C (1550°F) and 815°C (1500°F) for the 0.4 w/o and 0.6 w/o sintered carbon respectively. All bars were quenched in a fast cooling oil and stress relieved at 175°C (350°F).

Sinter-Hardening Characteristics of Ancorsteel 2000 Premixed With 2 w/o Copper

Graphite Additions* w/o	Compaction Pressure for 6.8 g/cm³ MPa	Compaction Pressure for 6.8 g/cm³ psi	Temper 60 min.	Dimensional Change %	Apparent Hardness HRB	Transverse Rupture Strength MPa	Transverse Rupture Strength psi	Martensite %
0	490	71,200	—	+0.44	31	480	71,400	0
0.3	490	71,200	—	+0.46	66	790	114,200	0
0.6	495	72,000	—	+0.33	72	885	128,000	0
0.6	495	72,000	260°C (500°F)	+0.33	73	890	128,700	0
1.0	510	73,600	—	+0.05	89	945	136,700	30
1.0	510	73,600	150°C (300°F)	+0.03	89	1040	150,900	30
1.0	510	73,600	200°C (400°F)	+0.03	89	1065	154,500	30
1.0	510	73,600	260°C (500°F)	+0.03	89	1010	146,700	30

*All mixes include 0.75 w/o zinc stearate and were sintered at 1120°C (2050°F) for 30 minutes in a dissociated ammonia atmosphere.

NORTH AMERICA Cinnaminson, NJ: +1-856-829-2220, **shelton.clisby@hoeganaes.com**
EUROPE Buzau, Romania: +40 238 403004, **Cristina.Diaconu@hoeganaes.com**
ASIA Jiangsu, China: +86 138 1842 8736, **Chao.Kuang@hoeganaes.com**

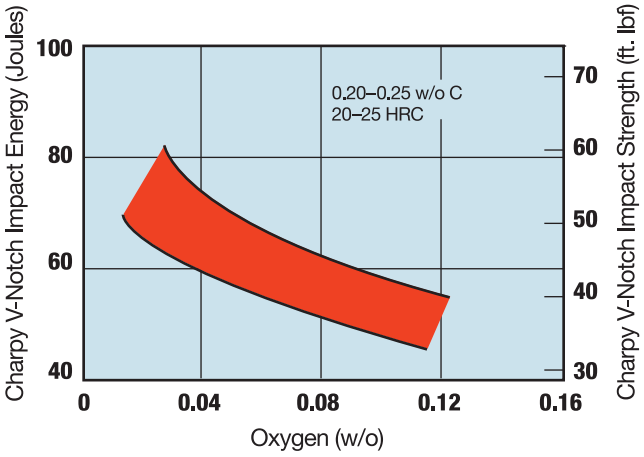
Ancorsteel® 2000

Powder Forging

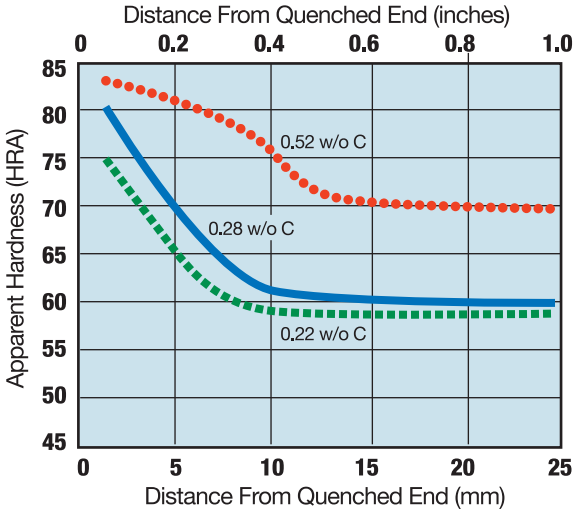
Power forging (P/F) is a natural extension of the conventional press and sinter (P/M) process, which has long been recognized as an effective technology for producing a great variety of parts to net or near-net shape. In essence, a porous preform is densified by means of hot forming in a single operation. Forging is carried out in heated, totally enclosed dies, and virtually no flash is generated.

Powder forging, therefore, is a deformation processing technology aimed at increasing the density of P/M parts and thus their performance characteristics.

The Effect of Oxygen Content on the Impact Energy of the Finished P/F Part



The Effect of P/F Carbon Content on Hardenability



Tensile and Impact Properties for Heat Treated Ancorsteel 2000 with Various Forged Carbon Levels

Forged Carbon	Tempering Temp		Yield Strength 0.2% Offset		Ultimate Tensile Strength		Tensile Elongation	Reduction of Area	R.T. Charpy V-Notch Impact Energy		Core Hardness
w/o	°C	°F	MPa	psi	MPa	psi	% in 25.4 mm (1 in)	%	Joules	ft. lbf	HRA
0.28	175	350	900	130,000	1050	152,700	11	43	22	16	67
0.37	315	600	1385	200,700	1450	210,300	10	33	10	7	73
0.56	315	600	1560	226,100	1685	244,400	10	29	10	7	73
0.70	345	650	1560	226,500	1805	261,900	5	12	7	5	76
0.86	425	800	1310	189,800	1430	207,400	10	30	7	5	73
0.26	620	1150	700	101,800	830	120,700	23	58	34	25	63
0.38	650	1200	785	113,800	860	124,700	21	57	54	40	64
0.55	660	1225	840	119,100	920	133,100	18	50	42	31	66
0.73	675	1250	860	124,400	970	140,400	15	43	20	15	66
0.87	675	1250	850	122,800	995	144,200	16	34	12	9	66

IMPORTANT NOTICE: *The data shown are based on laboratory processing standard test specimens. Results may vary from those obtained in production processing.*

NORTH AMERICA Cinnaminson, NJ: +1-856-829-2220, **shelton.clisby@hoeganaes.com**
EUROPE Buzau, Romania: +40 238 403004, **Cristina.Diaconu@hoeganaes.com**
ASIA Jiangsu, China: +86 138 1842 8736, **Chao.Kuang@hoeganaes.com**