Total Core Loss –  $P_c$  vs. B

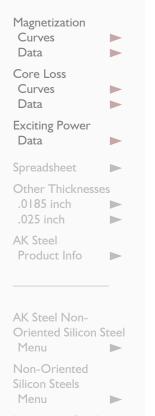
5000

Magnetic Flux Density in Gausses - B

## Non-Oriented Silicon Steels

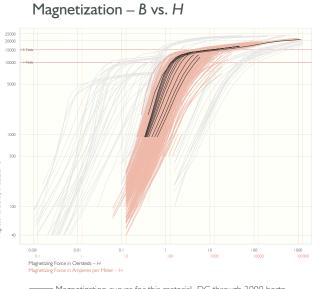
AK Steel Di-Max M-19 Fully Processed .014 inch (.36 mm, 29 gauge)

### Summary Graphs



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## Summary Graphs



Magnetization curves for this material, DC through 2000 hertz All non-oriented silicon steels All other materials Total core loss curves for this material, 50 through 2000 hertz All non-oriented silicon steels All other materials

Summary magnetization and total core loss curves for as-sheared .014 inch (.36 mm, 29 gauge) Di-Max M-19 fully processed cold-rolled non-oriented silicon steel showing their relation to these properties for other materials found in *Lamination Steels Third Edition*. See the following pages for detailed graphs and data values.

Producer: AK Steel, Middletown, Ohio, USA, www.aksteel.com.

Primary standard: ASTM A677 36F155.

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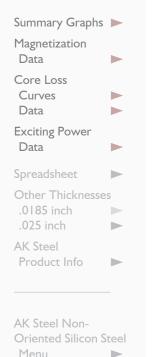
Sprague, Steve, editor. 2007. Lamination Steels Third Edition, A Compendium of Lamination Steel Alloys Commonly Used in Electric Motors. South Dartmouth, Massachusetts: The Electric Motor Education and Research Foundation. CD-ROM. Non-Oriented Silicon Steels: AK Steel Di-Max M-19, Fully Processed, .014 inch (.36 mm, 29 gauge), MIT OCW Excerpts.

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The Electric Motor Education and Research Foundation, Post Office Box P182, South Dartmouth, Massachusetts 02748 USA tel: 508.979.5935 fax: 508.979.5845 email: info@smma.org www.smma.org

## AK Steel Di-Max M-19 Fully Processed .014 inch (.36 mm, 29 gauge)

### Magnetization Curves



### Menu Non-Oriented Silicon Steels

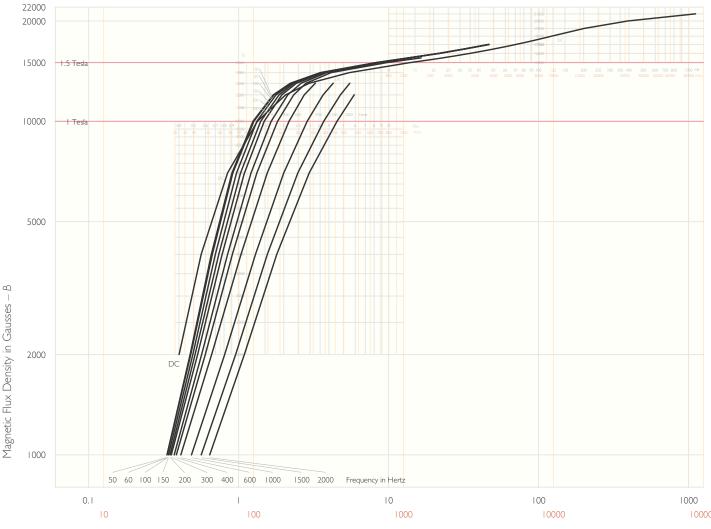
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Lamination Steels

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Magnetizing Force in Oersteds -HMagnetizing Force in Amperes per Meter -H

Magnetization -B vs. H – by Frequency

Typical DC and derived AC magnetizing force of as-sheared .014 inch (.36 mm, 29 gauge) Di-Max M-19 fully processed cold-rolled non-oriented silicon steel. See magnetization data page for data values. DC curve developed from published and AC curves from previously unpublished data for Di-Max M-19 provided by AK Steel, 2000. AC magnetization data derived from exciting power data; see exciting power data page for source data and magnetization data page for conversion information. Chart prepared by EMERF, 2004. Information on this page is not guaranteed or endorsed by The Electric Motor Education and Research Foundation. Confirm material properties with material producer prior to use. © 2007 The Electric Motor Education and Research Foundation. MIT OCW excerpts prepared October 2008.



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# Magnetization -B vs. H

AK Steel				DC and Derived AC Magnetizing Force in Oersteds and Amperes per Meter at Various Frequencies – $H$ oe Am												
Di-Max M-19				DC	50 Hz	60 Hz	100 Hz	150 Hz	200 Hz	300 Hz	400 Hz	600 Hz	1000 Hz	1500 Hz	2000 Hz	
Fully Processed .014 inch			0 1000		0.333 26.5	0.334 26.6	0.341 27.1	0.349 27.8	0.356 <mark>28.3</mark>	0.372 29.6	0.385 30.6	0.412 32.8	0.485 38.6	0.564 <mark>44.9</mark>	0.642 51.1	
(.36 mm, 29 gauge)	ge)	Gausses	2000	0.401 31.9	0.475 37.8	0.480 38.2	0.495 39.4	0.513 40.8	0.533 <mark>42.4</mark>	0.567 <mark>45.</mark> 1	0.599 47.7	0.661 52.6	0.808 64.3	0.955 <mark>76.0</mark>	1.09 86.9	
		Gau	4000	0.564 44.9	0.659 <mark>52.4</mark>	0.669 53.2	0.700 55.7	0.739 <mark>58.8</mark>	0.777 <mark>61.8</mark>	0.846 67.3	0.911 72.5	1.04 82.8	1.30 103	1.56 <mark>124</mark>	1.80 143	
Magnetization Data		! 	10000	0.845 67.3	0.904 71.9	0.916 72.9	0.968 77.0	1.03 <mark>82.0</mark>	1.09 <mark>87.1</mark>	1.21 96.4	1.33 <mark>105</mark>	1.55 124	2.00 159	2.48 198	2.95 <mark>235</mark>	
			10000	1.34 106	1.25 <mark>99.3</mark>	1.26 101	I.32 105	1.40 112	1.48 118	1.65 131	1.82 145	2.17 173	2.87 228	3.70 <b>294</b>	4.53 361	
Summary Graph	s 🕨		12000	2.06 164	1.71 <mark>136</mark>	1.72 <mark>137</mark>	1.78  4	1.86 <mark> 48</mark>	1.94 155	2.13 169	2.33 185	2.74 <mark>218</mark>	3.66 <mark>291</mark>	4.77 380	5.89 <del>469</del>	
Magnetization Curves		-	13000 13000 14000	2.95 <b>23</b> 5	2.21 1 <mark>76</mark>	2.22 177	2.27 181	2.34 1 <mark>86</mark>	2.42 193	2.61 208	2.82 <mark>224</mark>	3.24 <mark>258</mark>	4.27 <mark>340</mark>	5.50 <mark>438</mark>		
Core Loss		Σ	14000	5.47 <mark>435</mark>	3.51 <b>279</b>	3.51 <mark>279</mark>	3.57 <mark>284</mark>	3.63 289	3.69 <mark>294</mark>	3.86 <mark>307</mark>	4.13 329					
Curves Data			15000	13.9 1109	8.28 <u>659</u>	8.31 662	8.37 <u>666</u>	8.37 <u>666</u>	8.48 675	8.65 <u>68</u> 9	9.74 775					
Exciting Power			15500	22.8 1813	13.6 1084	13.6 1081	13.8 1095	13.7 1092	13.8 1096	4.     <mark>2</mark> 2	16.5 1313					
Data			16000	35.2 <mark>2802</mark>	21.6 1718	21.7 <b>1728</b>	21.8 1735	21.8 1738	21.9 <b>1742</b>							
Spreadsheet			16500	50.9 <mark>4054</mark>	32.4 <mark>2577</mark>	32.5 2587	32.6 <b>2597</b>	32.5 2590	32.6 <b>2594</b>							
Other Thickness	ses		17000	70.3 5592	46.1 3670	46.2 <u>3680</u>	46.4 3692	46.6 3712	46.6 3711							
.0185 inch .025 inch			18000	122 <b>9711</b>												
AK Steel			19000	202 16044												
Product Info			20000	394 31319												
			21000	1112 88491												
									a							

DC and Derived AC Magnetizing Force in Oersteds and Amperes per Meter at Various Frequencies – H

Typical DC and derived AC magnetizing force of as-sheared .014 inch (.36 mm, 29 gauge) Di-Max M-19 fully processed cold-rolled non-oriented silicon steel. DC values in Oersteds from published AK Steel documents. AC values in Oersteds developed from previously unpublished exciting power information provided by AK Steel, 2000. AC values have been derived from RMS Exciting Power using the following formulas:

 $88.19 \times \text{Density}$  (g/cc)  $\times \text{RMS}$  Exciting Power (VA/lb) Magnetizing Force in Oersteds = Magnetic Flux Density (kG)  $\times$  Frequency (Hz) Density of M-19 = 7.65 g/ccValues in Amperes per meter = Oersteds  $\times$  79.58

See exciting power data page for AC exciting power source data. Magnetizing force formula developed by AK Steel; use only for deriving magnetizing force of AK Steel nonoriented silicon steel. Data table preparation, including conversion of data values, by EMERF, 2004.

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AK Steel Non-

Non-Oriented

Main Menu

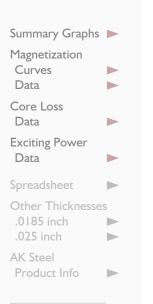
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Menu

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#### Core Loss Curves



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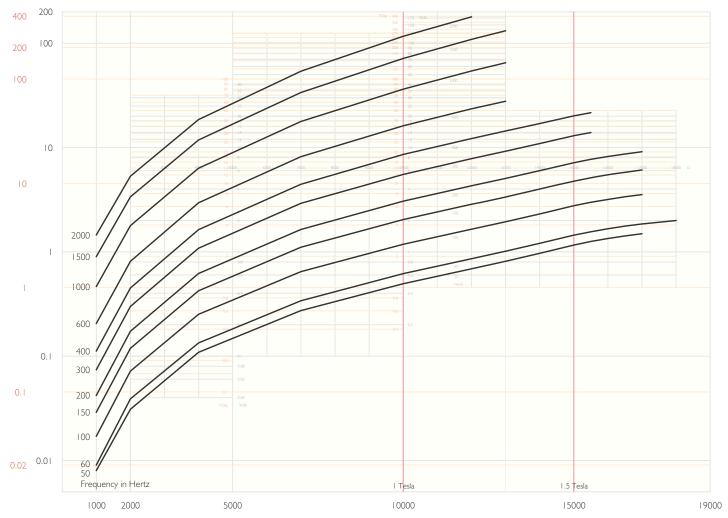
Loss in Watts per Kilogram – Loss in Watts per Pound –  $P_c$ 

Core | Core |

AK Steel Non-Oriented Silicon Steel Menu Non-Oriented Silicon Steels Menu Aministica Steels

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Magnetic Flux Density in Gausses – B

Typical total AC core loss of as-sheared .014 inch (.36 mm, 29 gauge) Di-Max M-19 fully processed cold-rolled non-oriented silicon steel. See core loss data page for data values. Curves developed from previously unpublished information provided by AK Steel, 2000. Chart prepared by EMERF, 2004.

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# Total Core Loss $-P_c$ vs. B

AK Steel				Core Loss W/lb W/kg	in Watts pe	er Pound and	d Watts per	Kilogram at	Various Fre	equencies –	Pc			
Di-Max M-19				50 Hz	60 Hz	100 Hz	150 Hz	200 Hz	300 Hz	400 Hz	600 Hz	1000 Hz	1500 Hz	2000 Hz
Fully Processed .014 inch		В	1000	0.008 0.0176	0.009 0.0198	0.017 0.0375	0.029 0.0639	0.042 0.0926	0.074 0.163	0.112 0.247	0.205 0.452	0.465 1.02	0.9 1.98	1.45 3.20
(.36 mm, 29 gaug	ge)	Gausses -	2000	0.031 0.0683	0.039 0.0860	0.072 0.159	0.119 0.262	0.173 0.381	0.300 <mark>0.66</mark> 1	0.451 0.994	0.812 1.79	1.79 3.94	3.37 7.43	5.32 11.7
Core Loss			4000	0.109 0.240	0.134 0.295	0.252 0.555	0.424 0.934	0.621 1.37	1.09 2.39	1.64 3.60	2.96 6.52	6.34 14.0	11.8 26.1	18.5 40.8
Data		Density in	7000	0.273 0.602	0.340 0.749	0.647 1.43	1.11 2.44	1.64 3.61	2.92 <u>6.44</u>	4.45 9.81	8.18 18.0	17.8 <mark>39</mark> .1	33.7 74.3	54.0 119
			10000	0.494 1.09	0.617 1.36	1.18 2.61	2.04 <b>4</b> .50	3.06 <u>6.74</u>	5.53 12.2	8.59 18.9	16.2 35.7	36.3 <mark>80.0</mark>	71.5 158	117 257
Summary Graph	s 🕨		12000	0.687 1.51	0.858 1.89	1.65 3.63	2.86 6.30	4.29 9.46	7.83 17.3	12.2 26.9	23.5 51.8	54.3 120	109 240	179 395
Magnetization Curves		Magnetic	13000	0.812 1.79	1.01 2.23	1.94 4.28	3.36 7.41	5.06 11.2	9.23 20.3	14.4 31.8	27.8 <mark>61.3</mark>	65.1 1 <mark>43</mark>	132 <b>29</b> 1	
Data		Z	14000	0.969 2.14	1.21 2.66	2.31 5.09	4.00 8.82	6.00 13.2	10.9 24.1	17.0 37.5				
Core Loss Curves			15000	1.16 2.56	1.45 3.19	2.77 6.11	4.76 10.5	7.15 15.8	13.0 28.7	20.1 44.4				
Exciting Power			15500	1.26 <b>2.77</b>	1.56 3.44	2.99 6.59	5.15 11.4	7.71 17.0	13.9 30.7	21.6 47.6				
Data			16000	1.34 2.96	1.67 3.67	3.18 7.01	5.47 12.0	8.19 18.0						
Spreadsheet			16500	1.42 3.13	1.76 3.89	3.38 7.44	5.79 12.8	8.67 19.1						
Other Thickness	ies		17000	1.49 3.29	1.85 <b>4.08</b>	3.54 7.80	6.09 13.4	9.13 20.1						
.0185 inch .025 inch			18000		2.00 4.40									
AK Steel Product Info								nm, 29 gauge) I by AK Steel, 2						

Watts per kilogram values developed using this formula: Watts per Kilogram = Watts per Pound  $\times$  2.204 .

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AK Steel Non-

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Lamination Steels Main Menu

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AK Steel

Product Info

AK Steel Non-

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## **Exciting Power**

AK Steel			Exciting Power in Volt-amps per Pound and Volt-amps per Kilogram at Various Frequencies										
Di-Max M-19			50 Hz	60 Hz	100 Hz	150 Hz	200 Hz	300 Hz	400 Hz	600 Hz	1000 Hz	1500 Hz	2000 Hz
Fully Processed .014 inch		<u>م</u> 1000	0.025 0.055	0.030 0.066	0.051 0.112	0.078 0.172	0.106 0.234	0.165 0.364	0.228 0.503	0.366	0.719 1.58	1.25 2.76	1.90 4.20
(.36 mm, 29 gau	uge)	2000 gansses 4000	0.07 0.154	0.085 0.187	0.147 0.324	0.228 0.503	0.316 0.696	0.504  .	0.710 1.56	1.18 2.59	2.40 5.28	4.25 9.36	6.48 14.3
			0.195 0.430	0.238 0.525	0.415 0.915	0.657 1.45	0.921 2.03	1.51 3.32	2.16 4.76	3.70 8.15	7.70 17.0	13.9 30.5	21.4 47.1
Exciting Power Data		Density in 0000 0000	0.469 1.03	0.57 1.26	1.00 2.21	1.60 3.53	2.27 5.00	3.77 <mark>8.3</mark> 1	5.50 12.1	9.67 21.3	20.8 45.7	38.7 <mark>85.2</mark>	61.3 135
			0.925 2.04	1.12 2.48	1.96 4.32	3.12 6.88	4.39 <mark>9.68</mark>	7.33 16.2	10.8 23.8	19.3 <mark>42.5</mark>	42.5 <mark>93</mark> .7	82.2 81	134 296
Summary Graph	hs 🕨	Х 12000	1.52 3.34	1.83 4.04	3.16 6.96	4.96 10.9	6.91 15.2	11.4 25.0	16.6 36.5	29.2 64.4	65.1 143	127 280	210 462
Magnetization Curves		00051 Xagnetic	2.13 4.69	2.57 5.66	4.38 9.65	6.77 14.9	9.34 20.6	15.1 33.2	21.7 47.8	37.5 82.7	82.3 8	159 350	
Data		Σ 14000	3.64 8.02	4.37 9.63	7.41 16.3	11.3 24.9	15.3 33.8	24.0 52.9	34.3 75.6				
Core Loss Curves		15000	9.20 20.3	11.1 24.4	18.6 41.0	27.9 61.5	37.7 <mark>83.</mark> 1	57.7 127	86.6 191				
Data		15500	15.6 34.5	18.7 41.3	31.6 69.6	47.3 104	63.3 140	97.2 214	152 334				
Spreadsheet		16000	25.6 <mark>56.4</mark>	30.9 <mark>68.</mark> 1	51.7 114	77.7  7	104 229						
Other Thicknesses		16500	39.6 <mark>87.3</mark>	47.7 105	79.8 176	119 263	159 351						
.0185 inch .025 inch		17000	58.1 128	69.9 154	117 258	176 389	235 518						

Typical RMS Exciting Power of as-sheared .014 inch (.36 mm, 29 gauge) Di-Max M-19 fully processed cold-rolled non-oriented silicon steel. Volt-amps per pound values from previously unpublished information provided by AK Steel, 2000. Data table preparation, including conversion of data values, by EMERF, 2004.

Volt-amps per kilogram developed using this formula: Volt-amps per kilogram = Volt-amps per pound  $\times$  2.204 .

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