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TM-1197
6023.000

B VS. H CURVES FOR 1008 AND 1020 STEELS

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July 1983

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For the purpose of investigating the saturation regions, we have measured the B vs. H curves for the purchased 1008 and 1020 steels. In order to make a fair representation, the sample was chosen under the following conditions.

- 1) It was taken far away from the flame cutting region.
- 2) A hand saw was used to cut off the sample.
- 3) Finally the sample was machined into a toroidal shape of about 2" OD, 1.75" ID and 1/2" height.

We fabricated two samples of each type of steel in order to check the consistency of the measurements. The results are shown in Figs. 1 to 8.

For comparison, we plotted the curves on USS steel 1010 and 1020 respectively. As shown in Figs. 9 and 10, the measured curves are similar to that of hot rolled types of steel.

For convenience of the interested readers who want to run LINDA, TRIM or POISSON programs, we listed the values of B and H then computed values of B^2 and Gamma as shown in Tables 1 and 2. The samples were measured by Arnold Engineering, Marengo, IL.

We appreciate the technical assistance by J. Robb and L. Tung.

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Table 1
1008 Steel
7/1/83

B (Kg)	H	$B^2 (x 10^8)$	$H \left(\frac{\text{Amp-Turn}}{\text{meter}}, x 10^2 \right)$	$\gamma = \frac{1}{\mu} = \frac{H}{B} (x 10^{-4})$
0	-0.1	0	-.08	-
1.0	0.0	.01	0.00	-
1.5	0.1	.02	.08	.67
2	0.3	.04	.24	1.5
3	0.5	.09	.400	1.67
4	0.8	.16	.64	2.
5	1.0	.25	.80	2.
6	1.4	.36	1.11	2.333
7	1.9	.49	1.51	2.714
8	2.4	.64	1.91	3.00
9	3.4	.81	2.71	3.778
10	4.2	1.00	3.34	4.200
11	5.5	1.21	4.38	5.000
12	7.3	1.44	5.81	6.083
13	9.5	1.69	7.56	7.308
14	13.5	1.96	10.74	9.643
15	24.3	2.25	19.34	16.2
16	45.0	2.56	35.81	28.125
17	74.0	2.89	58.89	49.412
18	127.0	3.24	101.06	70.56
19	205.0	3.61	163.13	107.895

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Table 2

1020 Steel
7/1/83

B (Kg)	H (oersted)	B^2 ($\times 10^8$)	$H \left(\frac{\text{Amp-Turn}}{\text{meter}}, \times 10^2 \right)$	$\gamma = \frac{1}{\mu} = \frac{H}{B} (\times 10^{-7})$
0	0	0	0.00	-
0.5	0.1	.0025	.08	2.
1	0.2	.01	.16	2.
2	0.4	.04	.32	2.
3	0.6	.09	.48	2.
4	0.8	.16	.64	2.
5	1.1	.25	.88	2.2
6	1.5	.36	1.19	2.5
7	2.0	.49	1.59	2.857
8	2.6	.64	2.07	3.25
9	3.6	.81	2.86	4.00
10	4.6	1.00	3.66	4.6
11	6.2	1.21	4.93	5.636
12	8.2	1.44	6.53	6.833
13	11.5	1.69	9.15	8.846
14	17.0	1.96	13.53	12.143
15	28.8	2.25	22.92	19.2
16	47.0	2.56	37.40	29.375
17	86.0	2.89	68.44	50.588
18	138.0	3.24	109.82	76.667
19	215.0	3.61	171.09	113.158

CURVE 6.8137

CURVE 68135

FERNY, L. AB
STEEL RHC #1

B = 8000 gms / 12"

X = 30.04 x 1/2"

Y MAX = 300.80

B MAX = 19.800

B1 = 19.00

H1 = 1.5

D1 = 1.990"

D2 = 1.949"

H2 = 509"

H3 = 411.5 cm

S1 = 14.9536 cm

M1 = 10.00 / 12.015

M2 = 0.140

M3 = 10.1 / 12.0

M4 = 1.800 MS

S100 = 0.14

A = 34.83

MS

B vs. H Figure 2
1008 STEEL, CONTINUOUS CAST
SAMPLE 1
Measured at Arnold Engineering
Marengo, IL

CURVE 68136

FERMILAB
STEEL RING #2

B = 3000 pins/1/2"

H = 5000/1/2"

X MAX = 50000

Y MAX = 16000

BA = 11900

AC = 2

OD = 11990"

TD = 1.377"

WF = 509"

AL = 1.1165 cm

2nd VHS 30 cm

WV = 12000 10000

X = 18V

Y = 1518000

NA = 710000

SHOOT = 0.14

6-20-73

Figure 3
B vs. H
1008 STEEL, CONTINUOUS CAST
SAMPLE 2
Measured at Arnold Engineering
Marengo, IL

CURVE 68137

FERMI LAB
STEEL RING #2

YMM = 30000

BMM = 14600

BT = 8360

YC = 1.5

BD = 1.998"

UD = 1.249

YF = 5092

AC = 4105.6

SA = 14.93380

NA = 1000 Firms

BS = 3000.044 1/2"

Y = 3000.044 1/2"

X = 1.40

SB = 10.2180

NE = 4.10945

SHAD = 01.4

CS = 6.30453

XS

Figure 4
B vs. H
1008 STEEL, CONTINUOUS CAST
SAMPLE 2
Measured at Arnold Engineering
Natenko, IL

CURVE 68138

Figure 5

B vs. H
1020 STEEL, 2" PLATE
SAMPLE 3
Measured at Arnold Engineering
Marengo, IL

CURVE 68139

FERRY LAB

STEEL RING #3

B = 300 gms/in²

H = 30.45 in

Hmax = 300 lbs

Break = 17,800

BT = 9180

Hc = 3.2

BD = 1.555

VD = 1.750

WT = 1.990

Ac = 3936 cm²

Em = 147,330

Wt = 802.70 lbs

K = 0.12

Rd = 165,520

Wt = 47.40 lbs

Shrinkage

6.2383

255

Figure 6

B vs. H

1020 STEEL, 2" PLATE

SAMPLE 3

Measured at Arnold Engineering

Marengo, IL

CURVE 68/H40

FIGURE 7

B vs. H
1020 STEEL, 2" PLATE
SAMPLE 4
Measured at Arnold Engineering
Marengo, IL

CURVE 68141

FERRI LAB

STEEL ANGLE #4

B = 300.9 mm / 12"

H = 300.9 mm / 12"

MMR = 300.0

BMR = 175.0

BR = 8600

HC = 3.33

OD = 1.999

ID = 1.750

HT = 500

AC = 450.6

$I_x = 119578$

$I_y = 90000.8$

K = 112

RAE = 103.4611

NS = 470.0

SHUNT = 0.014

6.8383

MS

30000

18000

15000

12000

10000

8000

6000

4000

2000

0

-2000

-4000

-6000

-8000

-10000

-12000

-14000

-16000

-18000

-20000

-22000

-24000

-26000

-28000

-30000

-32000

-34000

-36000

-38000

-40000

-42000

-44000

-46000

-48000

-50000

-52000

-54000

-56000

-58000

-60000

-62000

-64000

-66000

-68000

-70000

-72000

-74000

-76000

-78000

-80000

-82000

-84000

-86000

-88000

-90000

-92000

-94000

-96000

-98000

-100000

FIGURE 8

B vs. H
1020 STEEL, 2" PLATE
SAMPLE 4

Measured at Arnold Engineering
Marengo, IL

USS
Hot Rolled Carbon Steel Plates
 Grade 1010—Over .250 Inches
 DC Magnetization

Figure 9

- 1 = As hot rolled
- 2 = Sample annealed at 1300°F
- 3 = Sample annealed at 1400°F
- 4 = Sample annealed at 1500°F
- Sample furnace cooled
- 5 = Measured 1008 steel

1008 measured

Figure 10

- 1 = As hot rolled
- 2 = Sample annealed at 1300°F
- 3 = Sample annealed at 1400°F
- 4 = Sample annealed at 1500°F
- Sample furnace cooled
- 5 = Measured 1020 steel

USS
Hot Rolled Carbon Steel Plates
Grade 1020—Over .250 Inches
DC Magnetization

1020 measured