KOERDYM™ S

Sintered NdFeB

Koerdym S grades are anisotropic permanent magnets produced using the powder metallurgy process. This process yields magnets densified to better than 99% of their theoretical value by creating an oriented texture of the same $Nd_{12}Fe_4B_1$ phase that produces the magnetic properties of powders. The Koerdym S magnet manufacturing process begins in a foundry. Here, alloying under controlled atmospheric conditions is followed by processes that include casting, directional solidification and melt extraction. The resulting alloys are then reduced to small particle sizes.

The goal of reducing the particle size is to create a particle that has only one preferred direction of orientation. These particles are then charged as powders into mold cavities. While in the mold cavity, pressure and magnetic field are applied to create a shape that will be densified during heating in the sintering process. Secondary processes include some or all of the following: Machining, grinding, electro-discharge machining, and the application of surface treatments, coatings, and platings Koerdym S grades are available with a wide range of intrinsic magnetic properties and temperature capabilities. See Figure 1: Koerdym S Grades The high energy products, 28 - 50 MGOe (220 - 400 kJ/m³) minimize the volume consumption of magnetic material in sensors, disk drive VCM's and latches, communications, motors and home electronics.

The competitive cost structure of Koerdym S grades make possible the development of large motors, separators, magnetic resonance devices, particle accelerator components, and other applications that rely heavily on magnet volume for peak performance. Service temperatures for Koerdym S grades range from the cryogenic (~140K) to the very hot (470K) with operating points of B/H = 0.5 still yielding stable operation. By selecting the proper grade and finishing treatment, long-term resistance to environmental factors is assured. Koerdym S is used under-the-hood in automotive applications, in the chemical process industries, and in aerospace applications as well as in the home and factory. When protected against the external environment, Koerdym S is extremely stable and subject only to the long-term aging (relaxation) that affects all permanent magnets.

KOLEKTOR uses more than one coating or plating to ensure that magnets are protected from the external environment. Table 1 lists some of the coatings and their characteristics available from KOLEKTOR. The most commonly used coatings are electrolytic nickel and epoxy coatings. Nickel plating is impervious to moisture but is sensitive to salt spray. Conversely, epoxy coating has excellent salt spray resistance but is sometimes affected by moisture under some saturated vapor conditions. A consultation with our application engineers is the best opportunity to select the optimum coating.

Koerdym S is the material of choice for a wide range of DC motors, servos, and steppers. Generators from the fraction of a watt to 100 kilowatts regularly use KOLEKTOR Koerdym S material. In addition, large numbers of magnetic couplings that apply torque from 0.001 Nm to 10 kNm are manufactured regularly using Koerdym S grades.

Reversible magnetic effects vary with grade. Temperature coefficients of the intrinsic properties are also temperature dependent. The coefficients of thermal expansion are anisotropic as well as grade and temperature dependent. The coefficients differ in both magnitude and sign. Please refer to the Koerdym S Data table for grade specific coefficients of thermal expansion. Some designs requiring customized grades may need special characterizations of the various physical properties and coefficients.

Magnetization requires applied fields ranging from 2.0 - 4.0 Tesla. The exact value is grade and geometry specific, as well as, time dependent. All KOLEKTOR Koerdym S grades are conductive and eddy current effects can be substantial with either short pulses or large magnets. Some small devices, for example, can be magnetized with pulses of 10's of microseconds. On-the-other-hand, very large devices may require pulses lasting tenths of a second. KOLEKTOR general recommendation is that magnetization exceed 95% of the possible value for the part. If magnetization does not achieve the prescribed 95%, thermal stability may be impaired; or, at least not reach the expected level. Higher levels are frequently required to meet many flux requirements and are readily achieved. With very few exceptions, KOLEKTOR in-house magnetization takes us within 1% of the levels that can be achieved using an 8.0 Tesla field. Multi-pole magnetization is possible at production rates suited for high volume disk drive, office automation, and automotive applications. Most multi-pole magnetization is 95 - 98%.

Koerdym S is an excellent choice for applications requiring precise control of the magnetic moment and its orientation. Most of these applications are for accelerator insertion devices, magnetic resonance devices, or spectrometers. Maximum variations of ±2% in the magnetic moment and ±2° for the orientation are KOLEKTOR standard practice for lots of 1000 pieces or more. Measurement precision of 0.1% for moment and 0.1° for orientation are common practice in our laboratory.

Our applications engineering groups can be contacted through our sales organization. These teams can assist in minimizing costs and procurement efforts while securing the best synthesis of optimum design and manufacturability.

Figure 1: KOERDYM S Grades

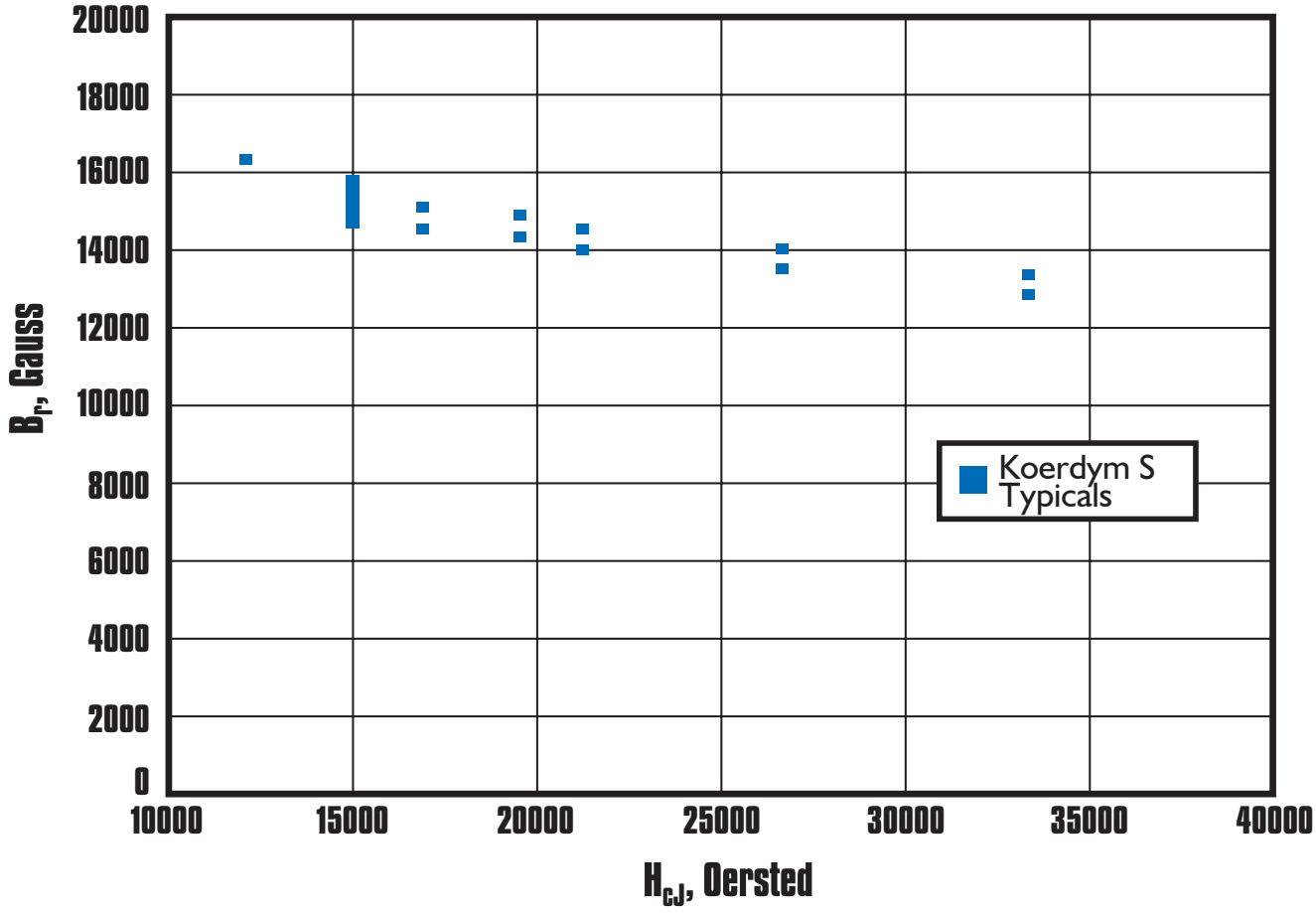


Table 1: Available KOERDYM S Coatings and Characteristics

Type of Coating	Application	Appearance	Thickness Microns	Corrosion Resistance			Comment
				96 HOUR Autoclave	500 HOUR 85C/85%rh	240 HOUR Salt Spray	
NICKEL	ELECTRO-PLATED	HARD DUCTILE SEMI-BRIGHT SILVER	12.5 TO 30 (0.5 to 1.2)	PASS	PASS	48 HOURS	SUITABLE FOR CLEAN-ROOM APPLICATION
EPOXY	SPRAY PAINTED HEAT CURED	MATT BLACK OR PHENOLIC ORANGE PAINT	15 TO 30 (0.6 to 1.2)	PASS	PASS	PASS	GOOD CORROSION RESISTANCE IN MOST ATMOSPHERES SUITABLE FOR LARGER PARTS
ZINC CHROMATED	ELECTRO-PLATED	BRIGHT YELLOW IRREDESCENT	10 TO 25 (0.4 to 1.0)	PASS	PASS	PASS	PARTICULARLY USED IN AUTOMOTIVE APPLICATIONS
PHOSPHATE	DIPPED	DULL BLACK TEMPORARY COATING	25 to 40 mg/Ft2	24 HOURS	24 HOURS	24 HOURS	PASSIVATION LAYER

KOERDYM™ S

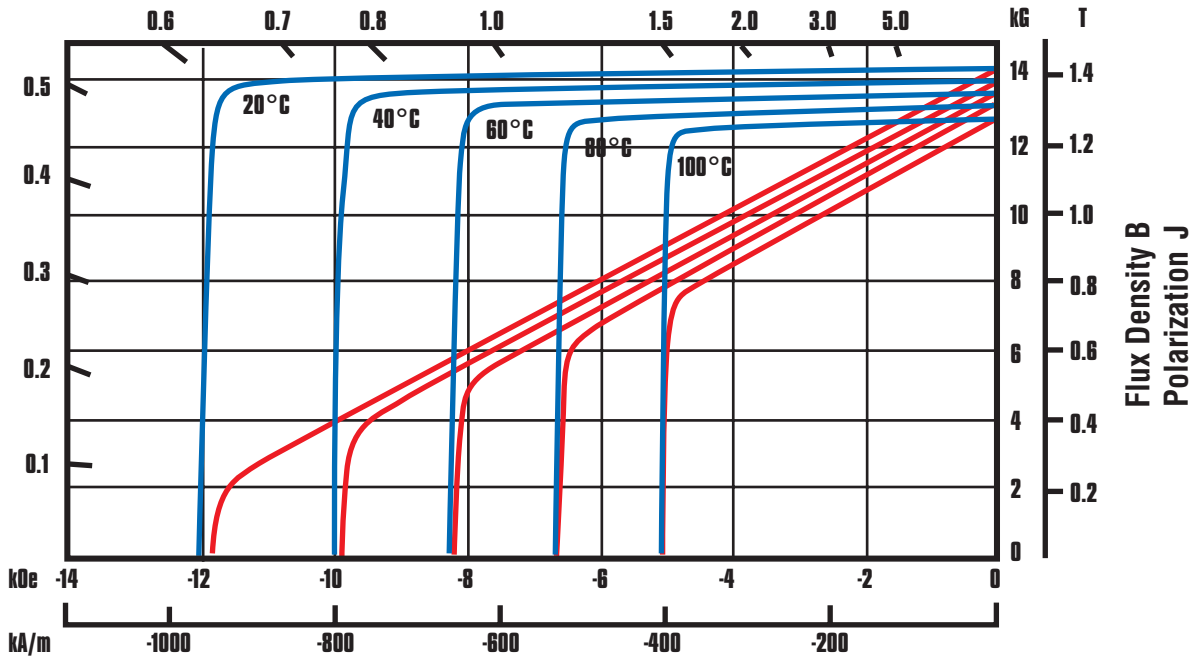
Sintered NdFeB

Product 1)	(BH)max kJ/m³ typ.	(BH)max kJ/m³ min	(BH)max MGOe typ.	(BH)max MGOe min.	Br mT typ.	Br mT min.	Br G typ.	Br G min.	HcB kA/m typ.	HcB kA/m min.	HcB Oe typ.	HcB Oe min.	Intrinsic Coercivity HoJ kA/m typ.	Intrinsic Coercivity HoJ kA/m min.	Intrinsic Coercivity HoJ Oe typ.	Intrinsic Coercivity HoJ Oe min.	Relative Permeability typ.	Required Magnetic Field kA/m min.	Temperature Coefficient of Br, α (23-100 °C) %/K typ.	Temperature Coefficient of HcJ, β (23-100 °C) %/K typ.	Maximum Operating Temperature °C
Koerdym S 50M (374/88) aT	398	374	50	47	1430	1390	14300	13900	915	830	11500	10400	955	875	12000	11000	1.05	2400	–0.12	-0.70	80
Koerdym S 48A (350/112) aT	374	350	47	44	1390	1350	13900	13500	1050	1020	13300	12800	1195	1115	15000	14000	1.05	2400	–0.12	-0.70	80
Koerdym S 46B (334/128) aT	358	334	45	42	1360	1320	13600	13200	1020	985	12800	12400	1350	1275	17000	16000	1.05	2400	–0.12	-0.70	100
Koerdym S 45A (326/112) aT	358	326	45	41	1370	1320	13700	13200	1025	985	12900	12400	1195	1115	15000	14000	1.05	2400	–0.12	-0.70	80
Koerdym S 43A (311/112) aT	343	311	43	39	1340	1280	13400	12800	1025	980	12900	12300	1195	1115	15000	14000	1.05	2400	–0.12	-0.70	90
Koerdym S 42A (302/112) aT	334	302	42	38	1310	1280	13100	12800	985	940	12400	11800	1195	1115	15000	14000	1.05	2400	–0.12	-0.70	80
Koerdym S 40A (287/112) aA	319	287	40	36	1280	1230	12800	12300	960	915	12100	11500	1195	1115	15000	14000	1.05	2400	–0.12	-0.70	110
Koerdym S 41B (303/127) aT	327	303	41	38	1310	1250	13100	12500	1000	955	12600	12000	1350	1275	17000	16000	1.05	2400	–0.12	-0.70	110
Koerdym S 37B (263/127) aA	295	263	37	33	1250	1190	12500	11900	940	890	11800	11200	1350	1275	17000	16000	1.05	2400	–0.12	-0.70	130
Koerdym S 40HC (287/143) aT	319	287	40	36	1290	1230	12900	12300	985	940	12400	11800	1550	1430	19500	18000	1.05	2400	–0.11	-0.70	130
Koerdym S 36HC (255/143) aA	287	255	36	32	1230	1170	12300	11700	920	875	11600	11000	1550	1430	19500	18000	1.05	2400	–0.11	-0.70	150
Koerdym S 38KC (279/159) aT	303	279	38	35	1260	1200	12600	12000	960	915	12100	11500	1710	1590	21500	20000	1.05	2400	–0.11	-0.60	150
Koerdym S 34KC (247/159) aA	271	247	34	31	1200	1140	12000	11400	900	850	11300	10700	1710	1590	21500	20000	1.05	2400	–0.11	-0.60	180
Koerdym S 35UC (247/199) aT	279	247	35	31	1200	1140	12000	11400	915	875	11500	11000	2150	1990	27000	25000	1.05	2400	–0.11	-0.55	180
Koerdym S 31UC (215/199) aA	247	215	31	27	1140	1080	11400	10800	850	810	10700	10200	2150	1990	27000	25000	1.05	2400	–0.11	-0.55	200
Koerdym S 31VC (223/238) aT	247	223	31	28	1130	1070	11300	10700	865	820	10900	10300	2625	2385	33000	30000	1.05	2400	–0.11	-0.55	200
Koerdym S 28VC (199/238) aA	223	199	28	25	1080	1020	10800	10200	810	765	10200	9600	2625	2385	33000	30000	1.05	2400	–0.11	-0.55	200

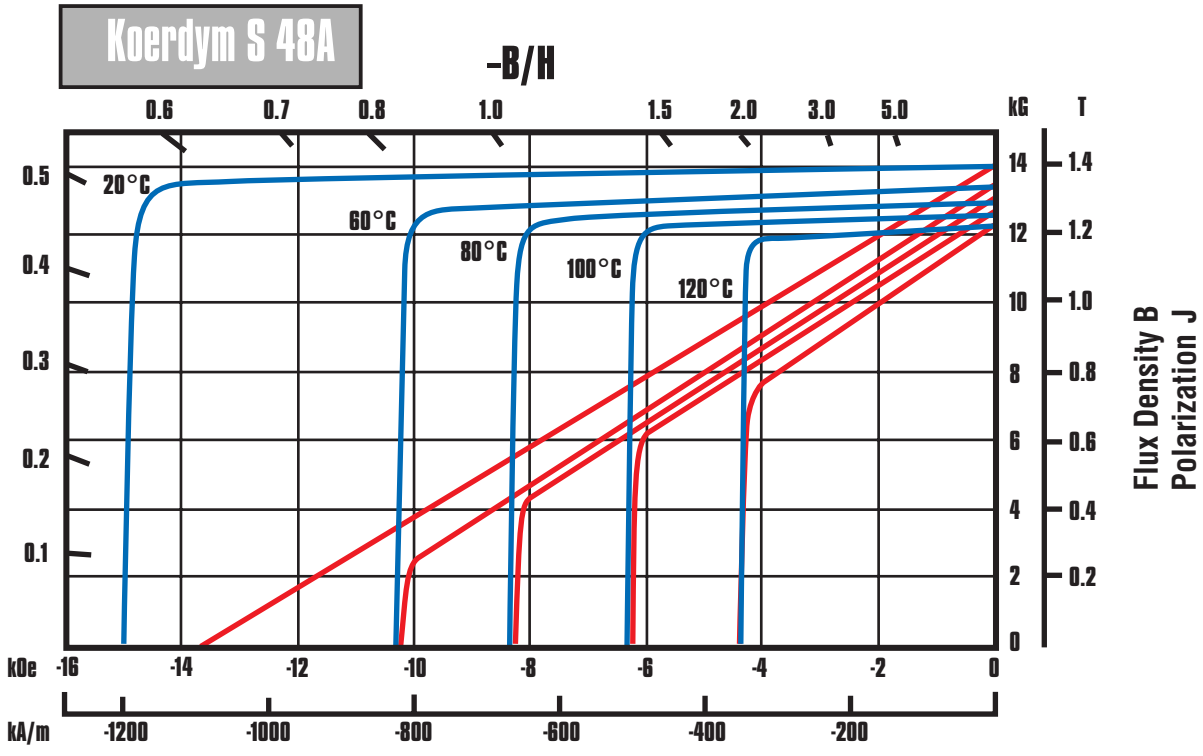
i = Isotropic; a = Anisotropic
A = Axial; T = Transverse

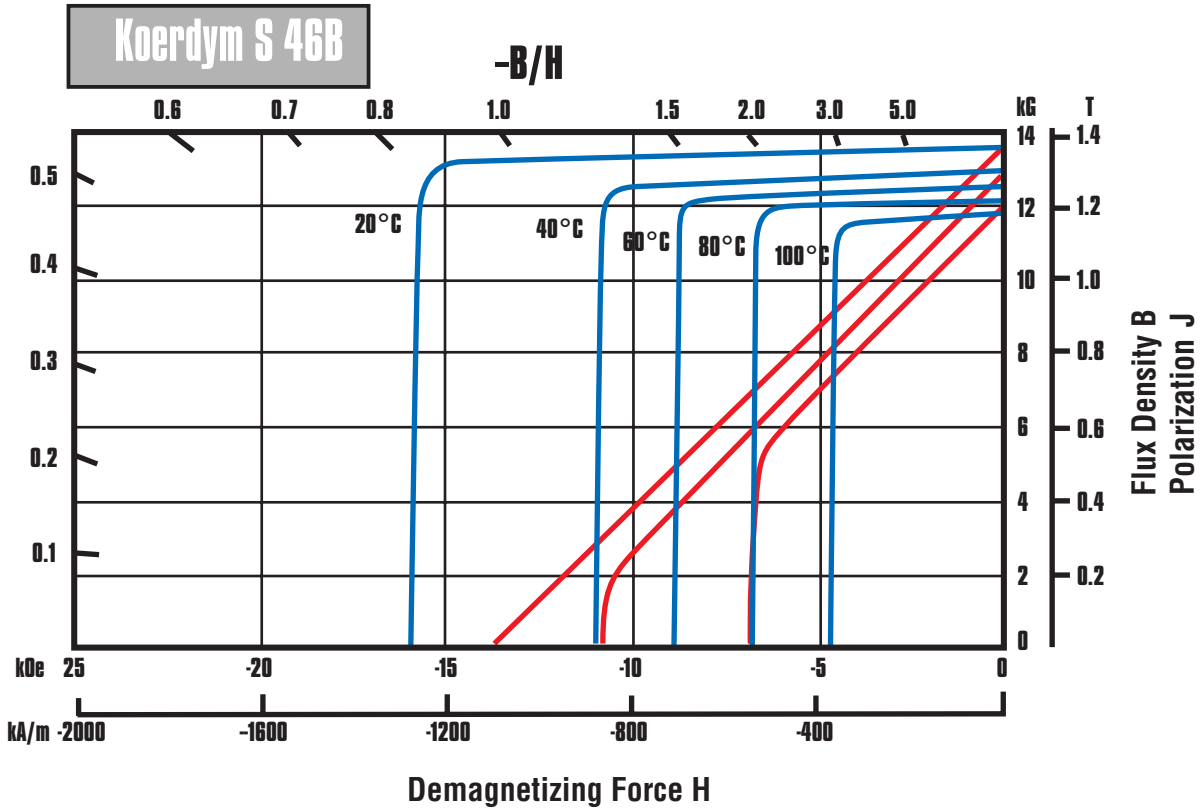
Required Magnetic Field – Values are dependent on size, shape and characteristics of the magnetizing pulse
Maximum Operating Temperature – In the presence of strong demagnetizing fields, or if the magnets operate on a low loadline, the maximum temperature may be lower

Koerdym S 50M

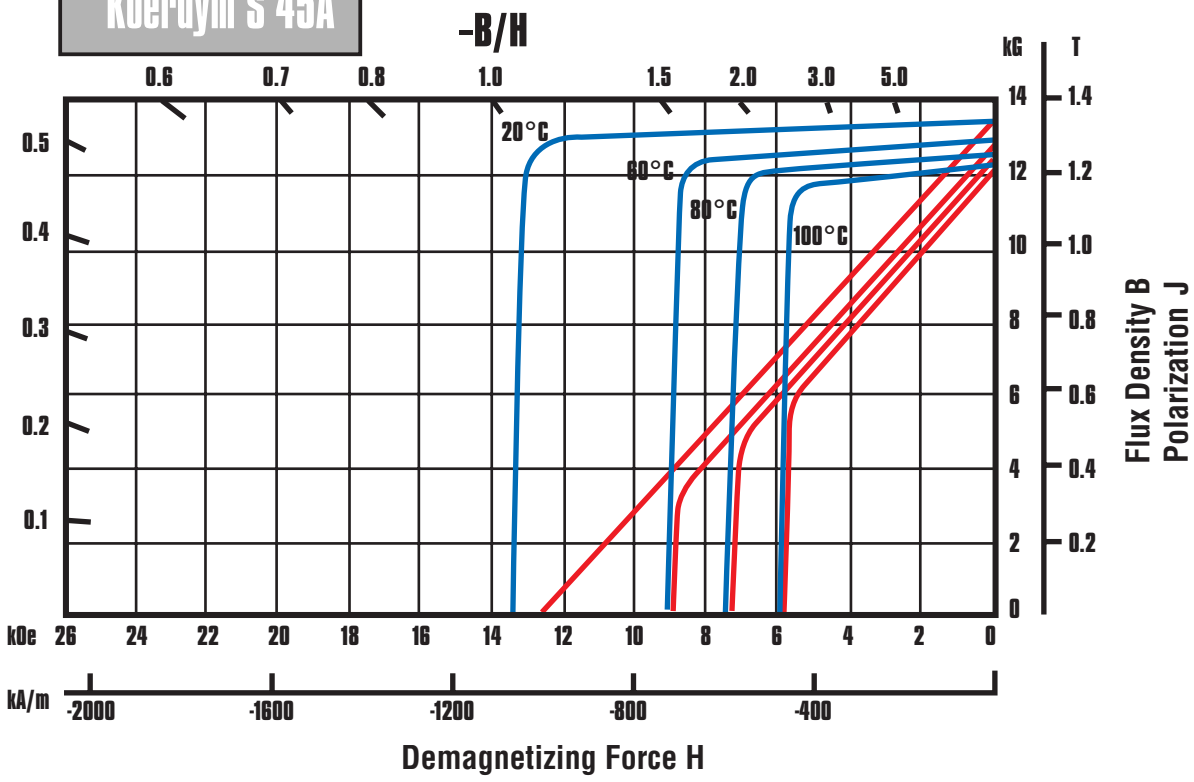


Koerdym S 48A




Koerdym S 46B
-B/H
0.6
0.7
0.8
1.0
1.5
2.0
3.0
5.0
kG
T
14
1.4
12
1.2
10
1.0
8
0.8
6
0.6
4
0.4
2
0.2
0
0.5
0.4
0.3
0.2
0.1
20°C
40°C
60°C
80°C
100°C
kOe 25
-20
-15
-10
-5
0
kA/m -2000
-1600
-1200
-800
-400
Flux Density B
Polarization J
Demagnetizing Force H

Koerdym S 45A



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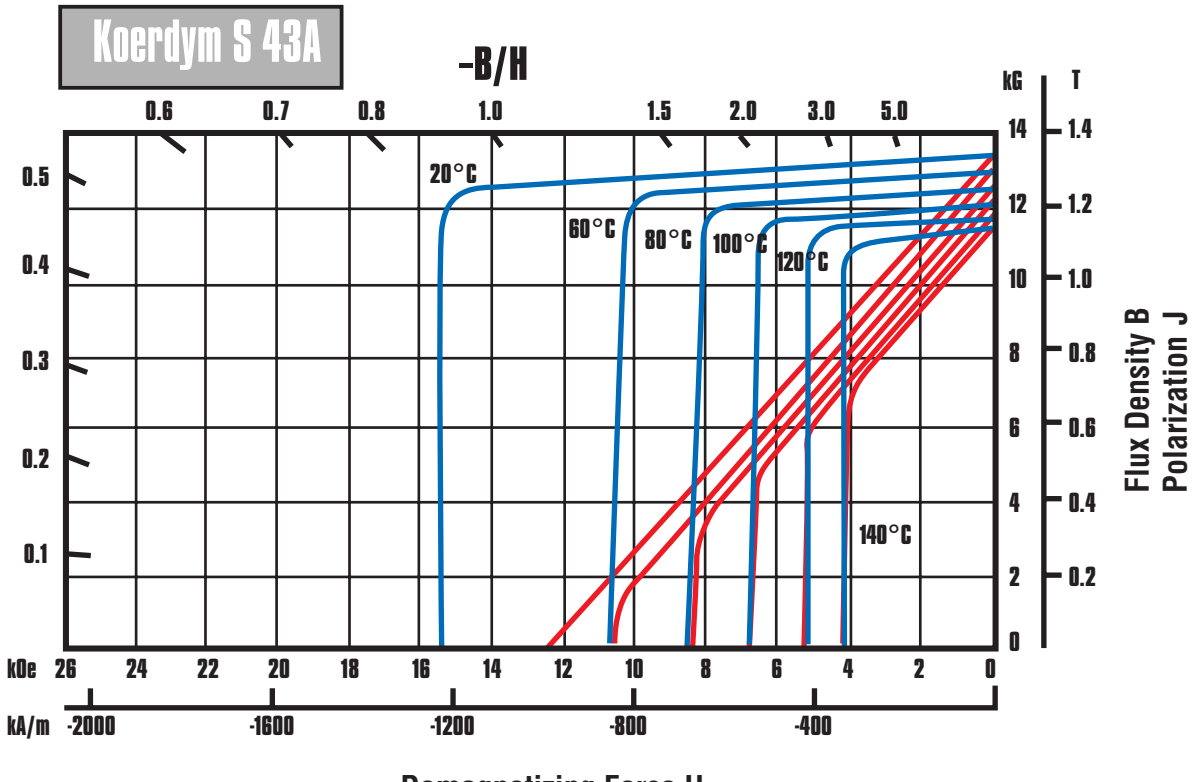

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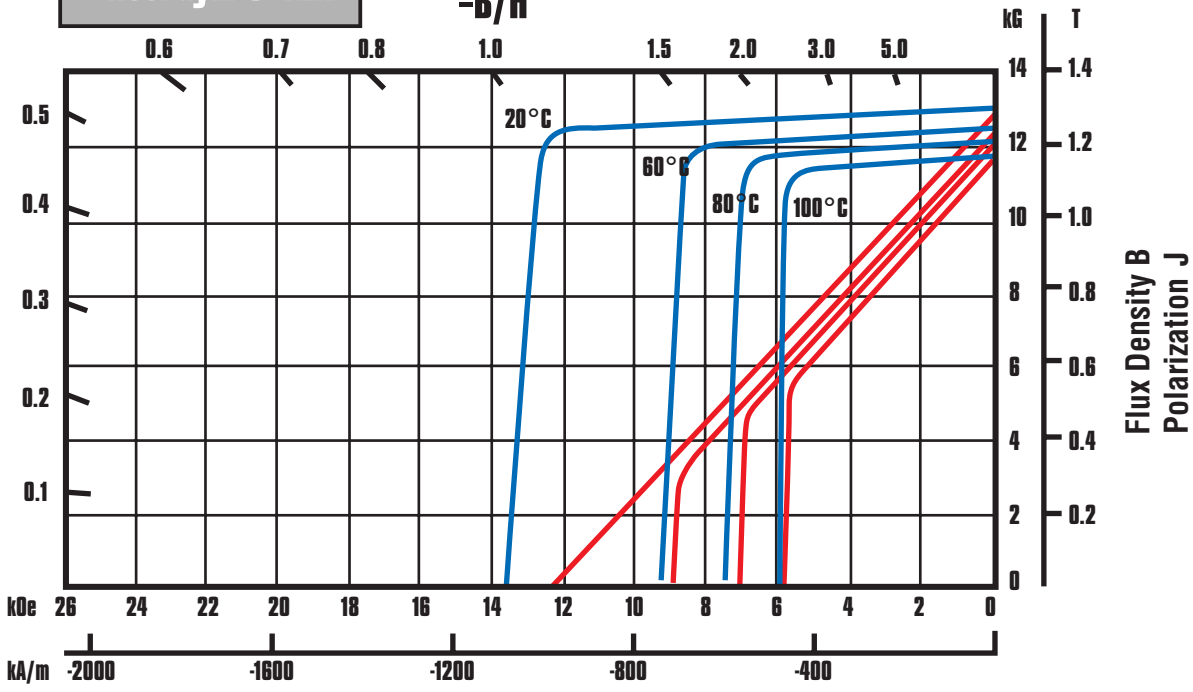

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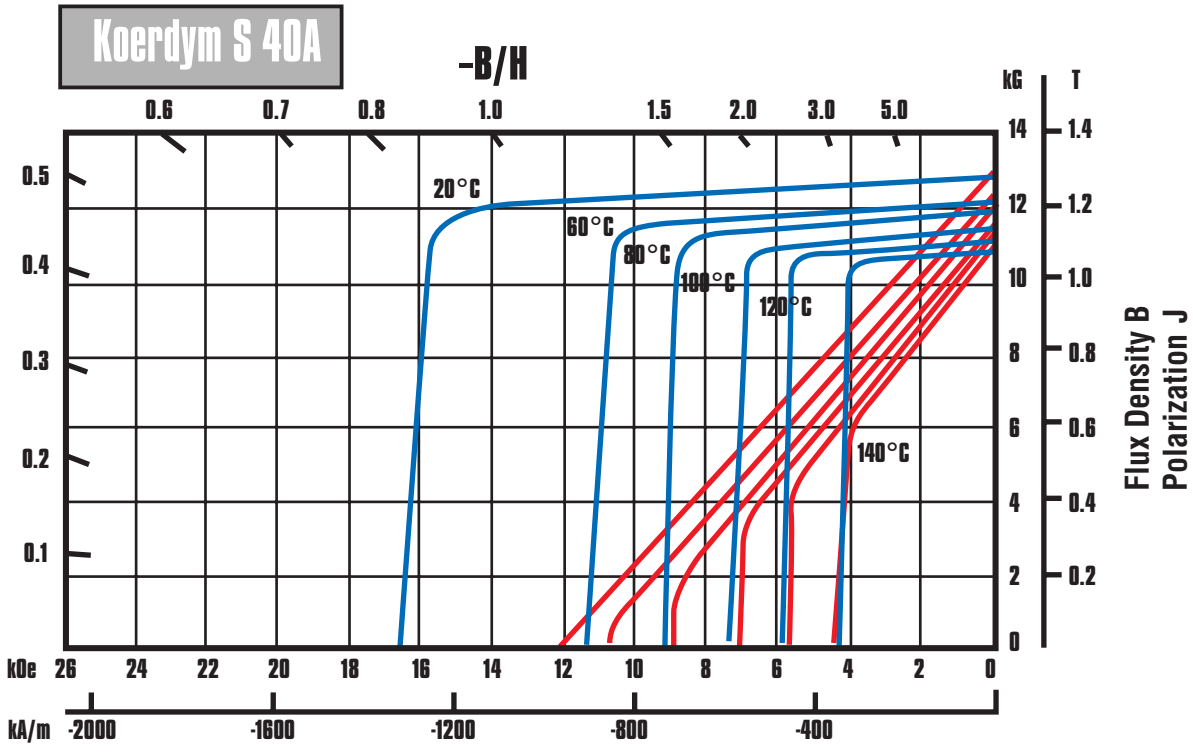
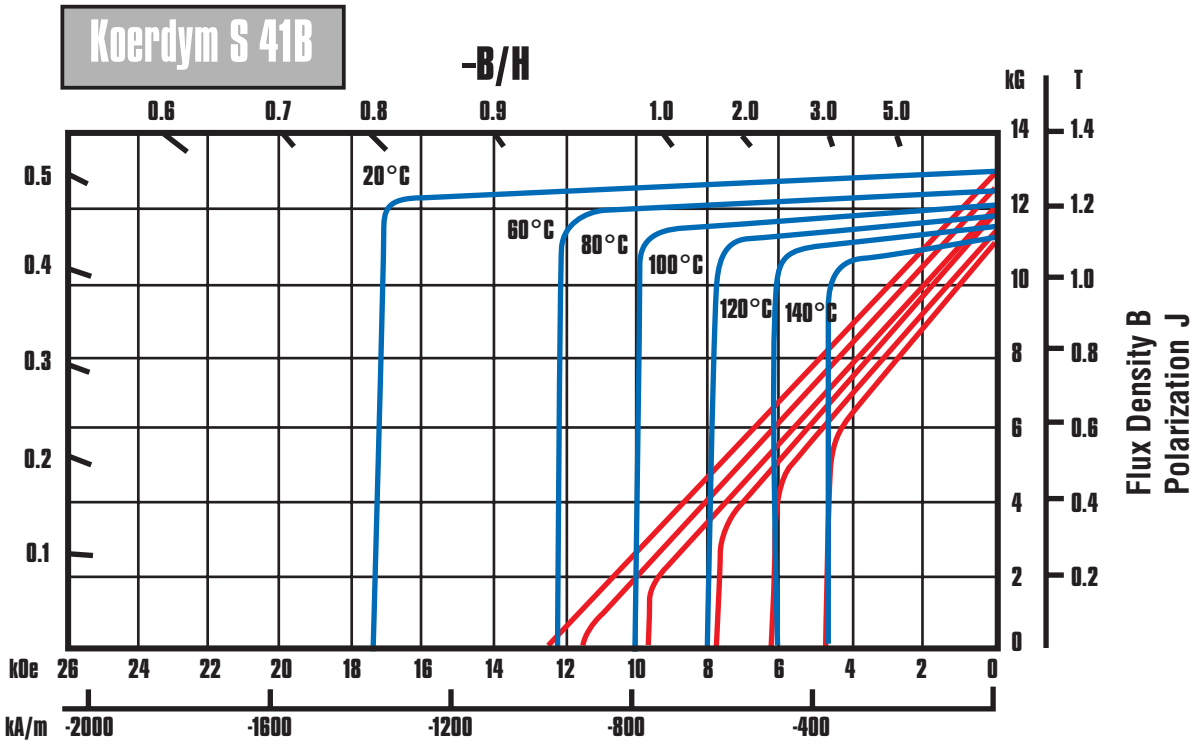
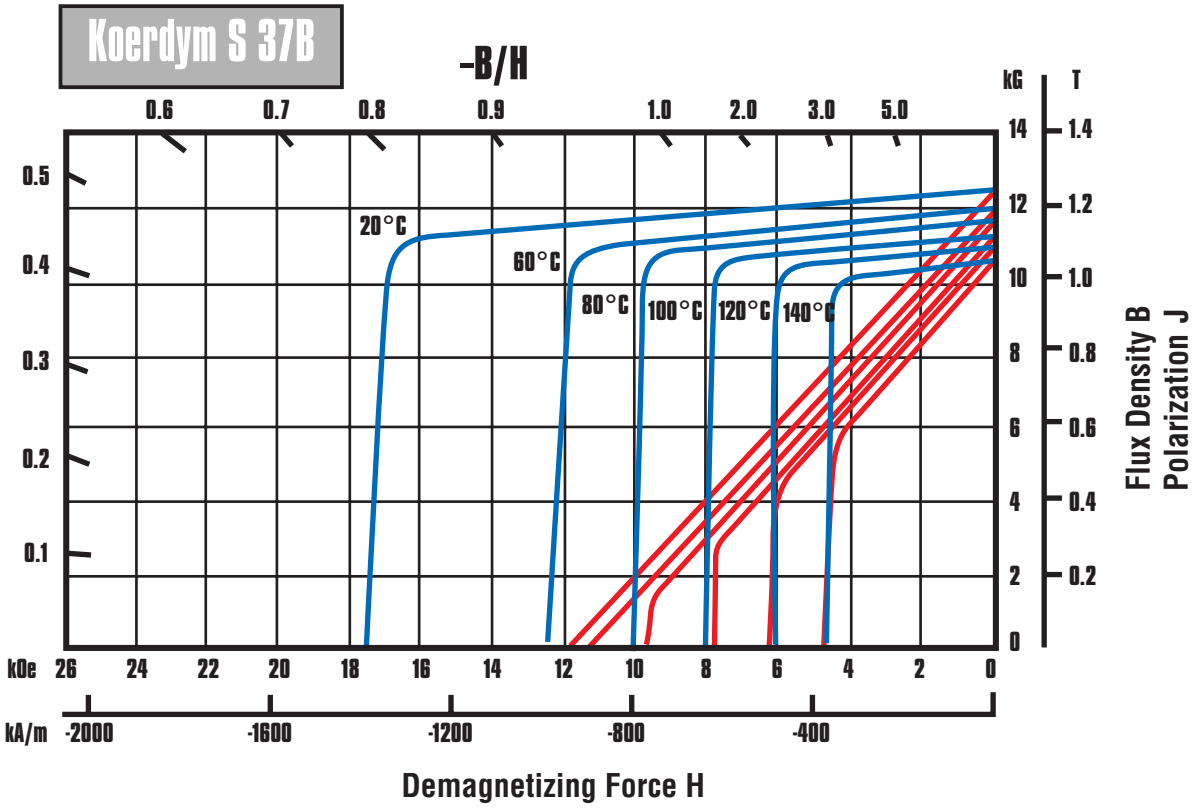
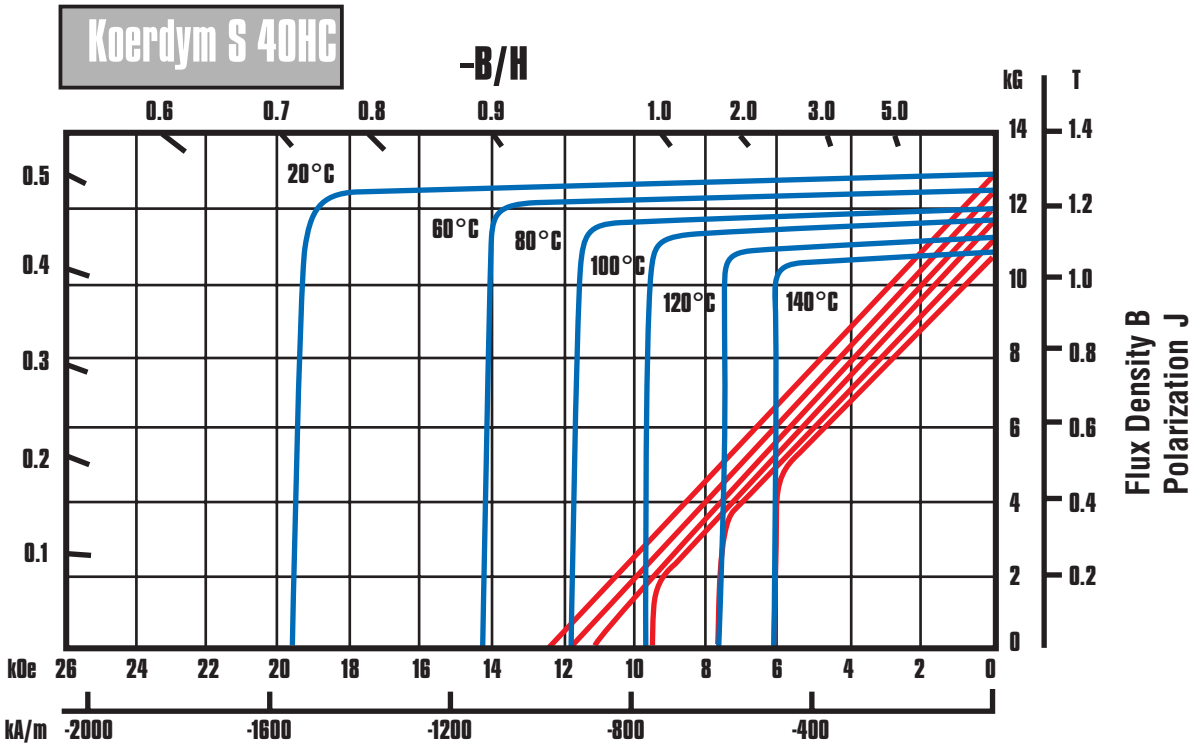



Koerdym S 41B
-B/H
0.6
0.7
0.8
0.9
1.0
2.0
3.0
5.0
kG
T
0.5
0.4
0.3
0.2
0.1
14
12
10
8
6
4
2
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
20°C
60°C
80°C
100°C
120°C
140°C
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H


Koerdym S 37B
-B/H
0.6
0.7
0.8
0.9
1.0
2.0
3.0
5.0
kG
T
0.5
0.4
0.3
0.2
0.1
14
12
10
8
6
4
2
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
20°C
60°C
80°C
100°C
120°C
140°C
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H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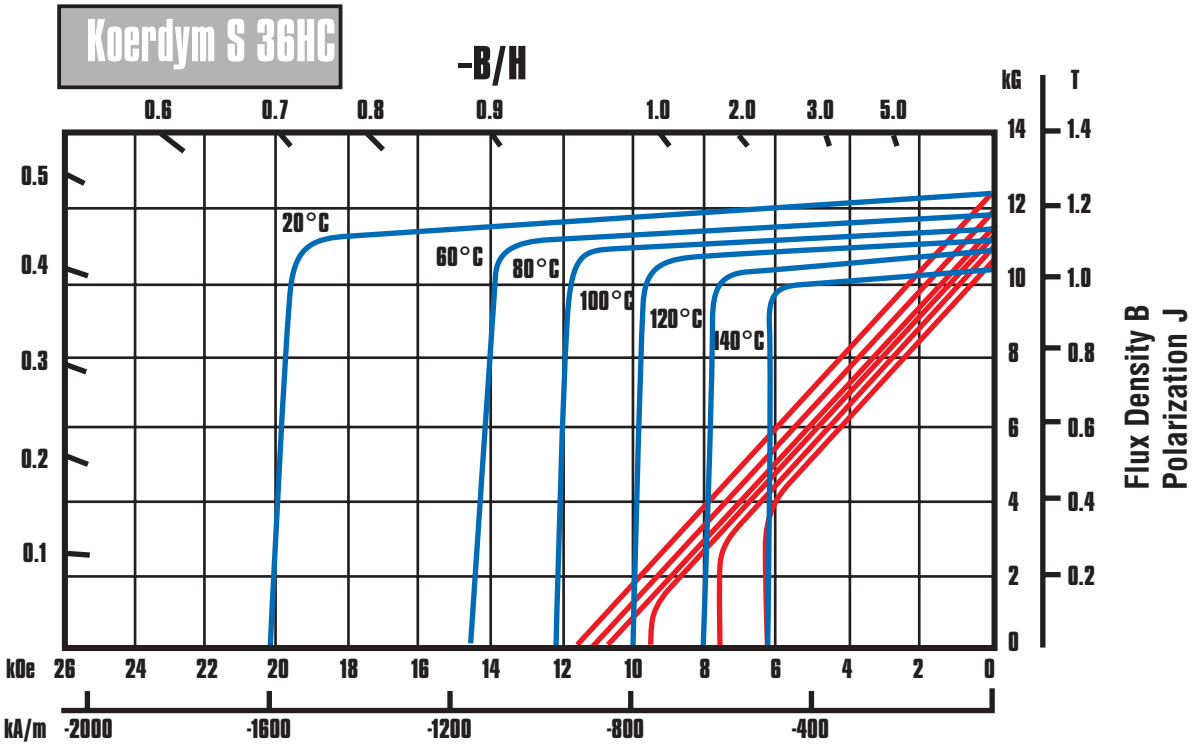
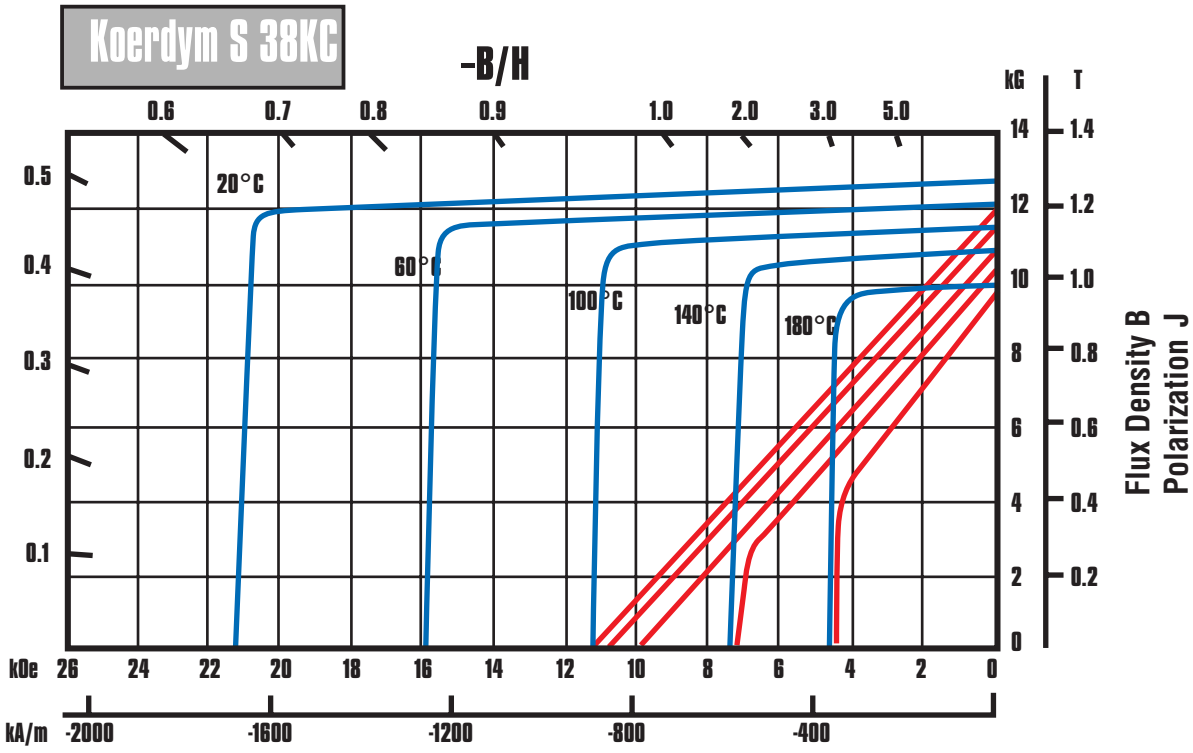
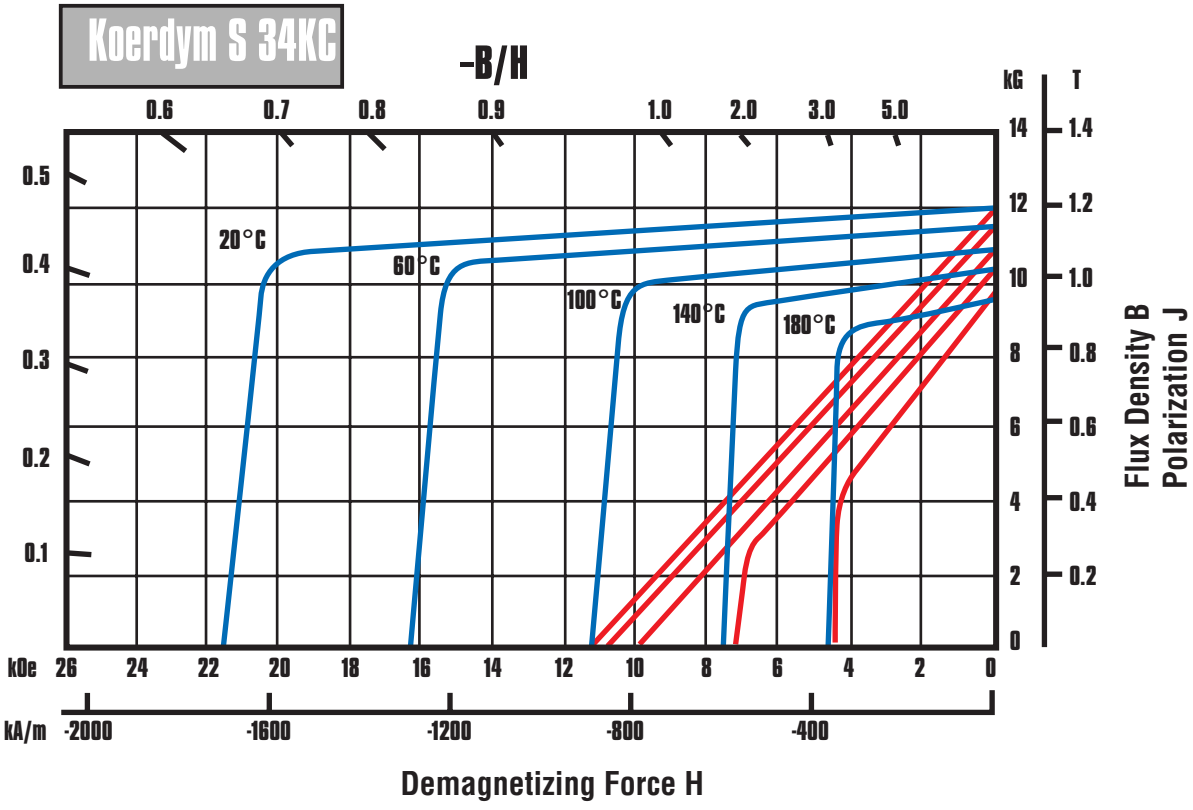
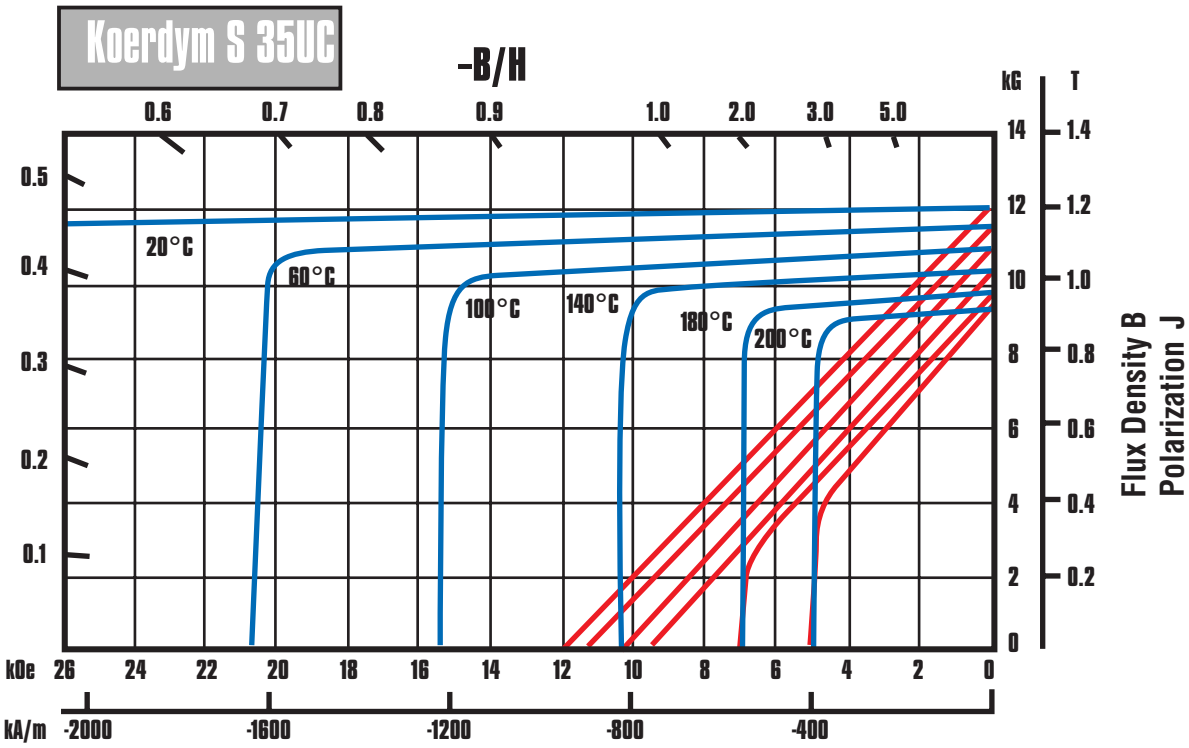
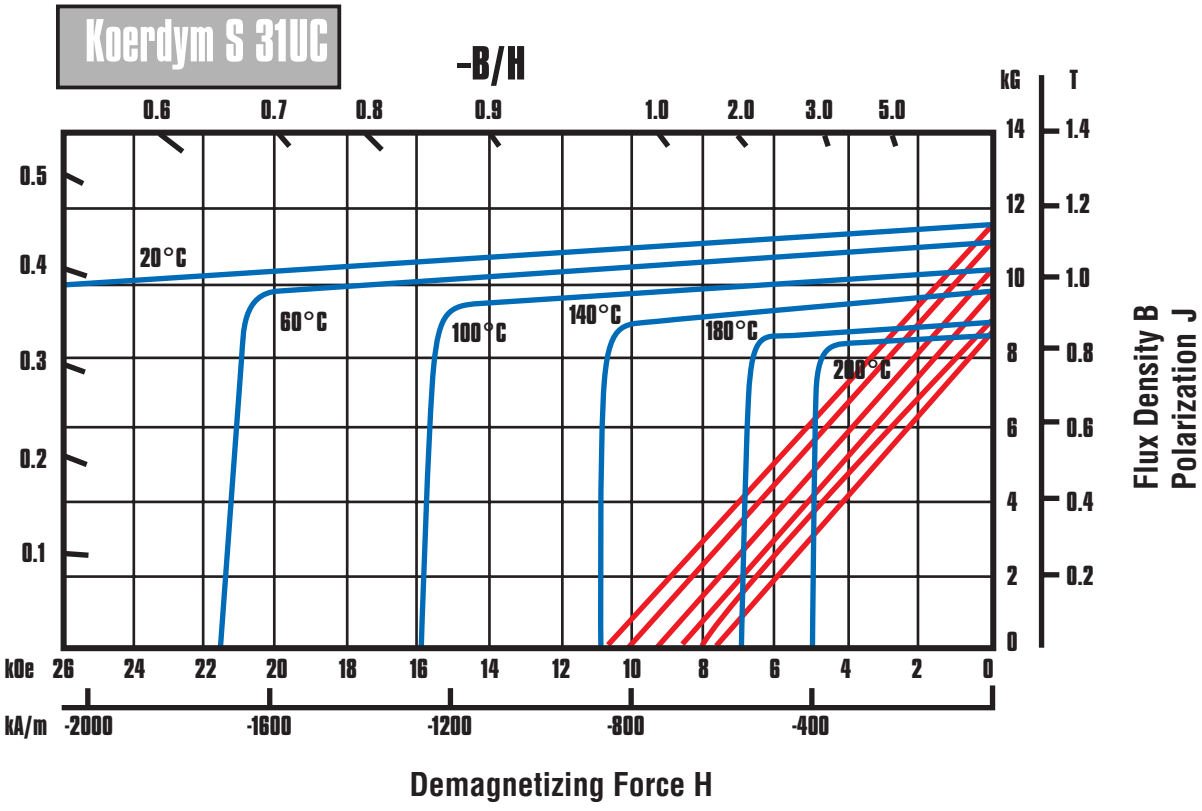
-B/H
0.6
0.7
0.8
0.9
1.0
2.0
3.0
5.0
kG
T
0.5
0.4
0.3
0.2
0.1
20°C
60°C
80°C
100°C
120°C
140°C
14
12
10
8
6
4
2
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H

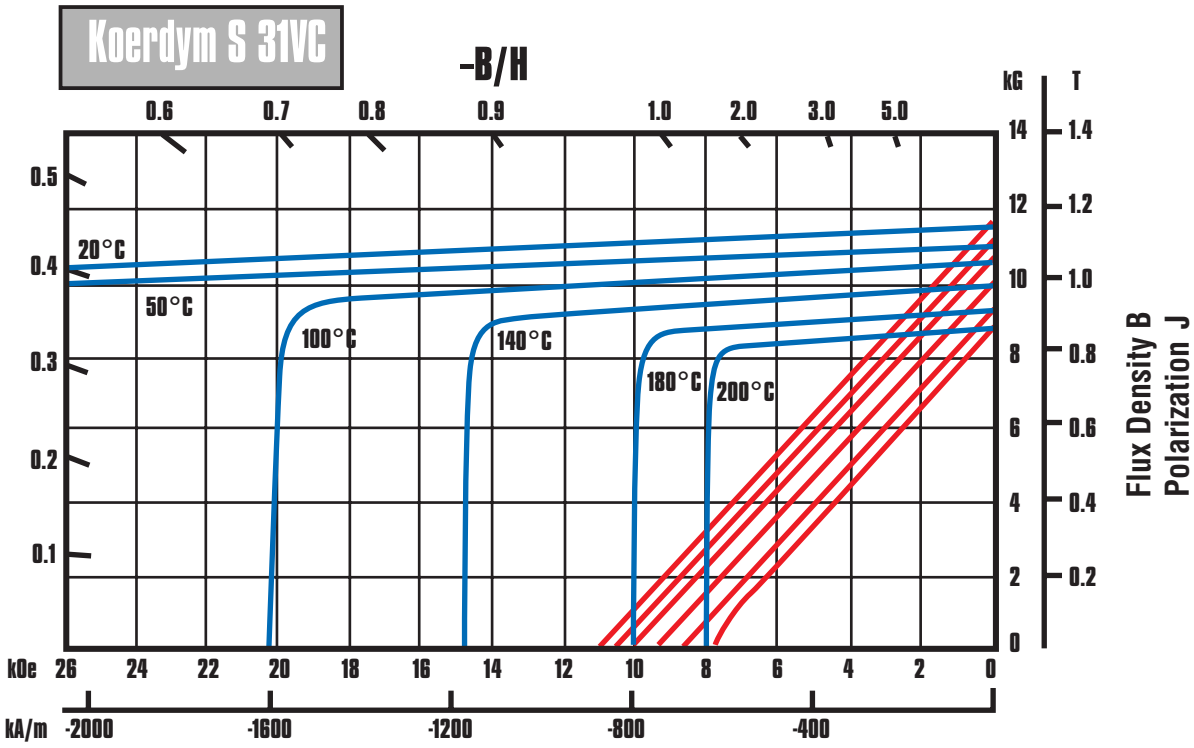

Koerdym S 36HC
-B/H
0.6
0.7
0.8
0.9
1.0
2.0
3.0
5.0
kG
T
0.5
0.4
0.3
0.2
0.1
20°C
60°C
80°C
100°C
120°C
140°C
14
12
10
8
6
4
2
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H


Koerdym S 38KC
-B/H
0.6 0.7 0.8 0.9 1.0 2.0 3.0 5.0
kG
T
0.5
0.4
0.3
0.2
0.1
20°C
60°C
100°C
140°C
180°C
14 12 10 8 6 4 2 0
1.4 1.2 1.0 0.8 0.6 0.4 0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H


Koerdym S 34KC
-B/H
0.6 0.7 0.8 0.9 1.0 2.0 3.0 5.0
kG
T
0.5
0.4
0.3
0.2
0.1
20°C
60°C
100°C
140°C
180°C
14 12 10 8 6 4 2 0
1.4 1.2 1.0 0.8 0.6 0.4 0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H


Koerdym S 35UC
-B/H
kG
T
0.6
0.7
0.8
0.9
1.0
2.0
3.0
5.0
0.5
0.4
0.3
0.2
0.1
20°C
60°C
100°C
140°C
180°C
200°C
14
12
10
8
6
4
2
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H


Koerdym S 31UC
-B/H
kG
T
0.6
0.7
0.8
0.9
1.0
2.0
3.0
5.0
0.5
0.4
0.3
0.2
0.1
20°C
60°C
100°C
140°C
180°C
200°C
14
12
10
8
6
4
2
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H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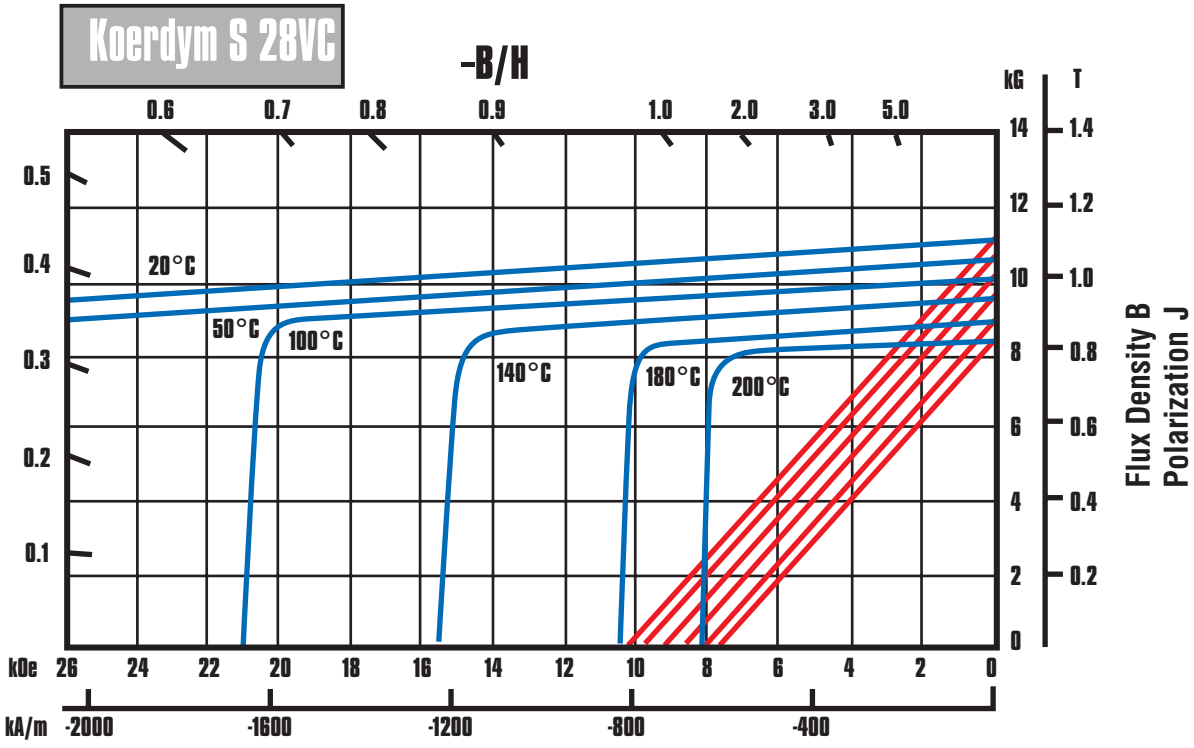
-B/H
0.6 0.7 0.8 0.9 1.0 2.0 3.0 5.0
kG
T
0.5
0.4
0.3
0.2
0.1
20°C
50°C
100°C
140°C
180°C
200°C
14 12 10 8 6 4 2 0
1.4 1.2 1.0 0.8 0.6 0.4 0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H


Koerdym S 28VC
-B/H
0.6 0.7 0.8 0.9 1.0 2.0 3.0 5.0
kG
T
0.5
0.4
0.3
0.2
0.1
20°C
50°C
100°C
140°C
180°C
200°C
14 12 10 8 6 4 2 0
1.4 1.2 1.0 0.8 0.6 0.4 0.2
Flux Density B
Polarization J
kOe 26 24 22 20 18 16 14 12 10 8 6 4 2 0
kA/m -2000 -1600 -1200 -800 -400
Demagnetizing Force H