Neodymium-Iron-Boron Magnets

NEOREC series

Issue date: May 2011

- All specifications are subject to change without notice.
- Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

NEOREC(NEODYMIUM-IRON-BORON) MAGNETS

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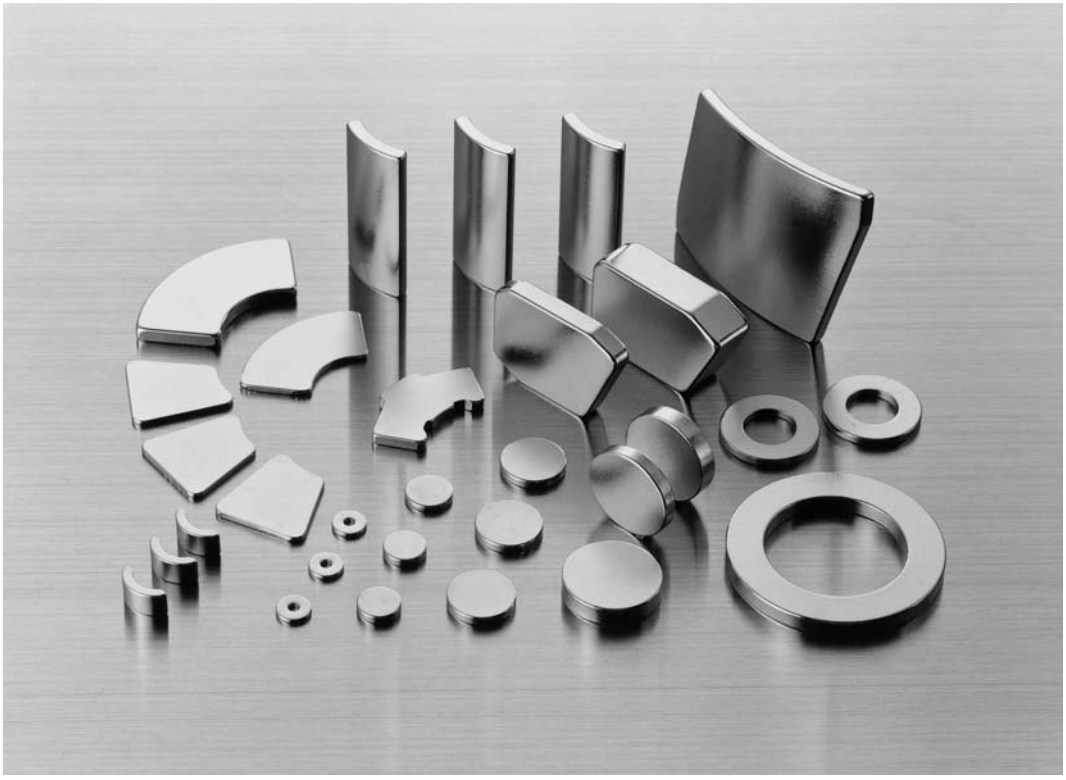
INTRODUCTION

In recent years, small, high-performance rare-earth magnets have been in increasing demand for use in electronics equipment.
In 1977, TDK commercialized a 2-17 type REC magnet, solving the problem of high cost, the main drawback with conventional samarium-cobalt magnets. It not only achieved better cost-performance, its superior performance was appraised as being the highest in the world.

The NEOREC magnet is a new product, surpassing the REC magnet. The main raw materials are neodymium, a rare-earth element, iron and boron. Its magnetic characteristics at the mass production level reach 49MGOe in maximum energy product(BH), achieving 50 to 80% high performance with 10% reduction in specific gravity compared with samarium-cobalt magnets.
Ideal for meeting miniaturization and weight reduction needs for VCMs and other equipment. TDK offers a selection of custom magnets in any shapes and sizes to meet customers' requirements.

TDK also provides a range of technical services, including design of NEOREC magnet-applied products. For further information, please contact TDK or your nearest representatives.

• Development of this product was made under license granted for the use of proprietary techniques developed by Hitachi Metals, Ltd.



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FEATURES/APPLICATIONS

FEATURES

- Magnetic characteristics at the mass production level reach 49MGOe in maximum energy product(BH) max, achieving 50 to 80% higher performance than rare-earth cobalt magnet.
- The specific gravity is 7.4g/cm^3 more than 10% lower than that of rare-earth cobalt magnet. Ideal for meeting miniaturization and weight reduction needs.
- Higher mechanical strength such as bending and tensile strength than rare-earth cobalt magnets, making handling easier than before.
- Since the main raw materials are neodymium and iron, both abundant resources, stable supply is assured.

APPLICATIONS

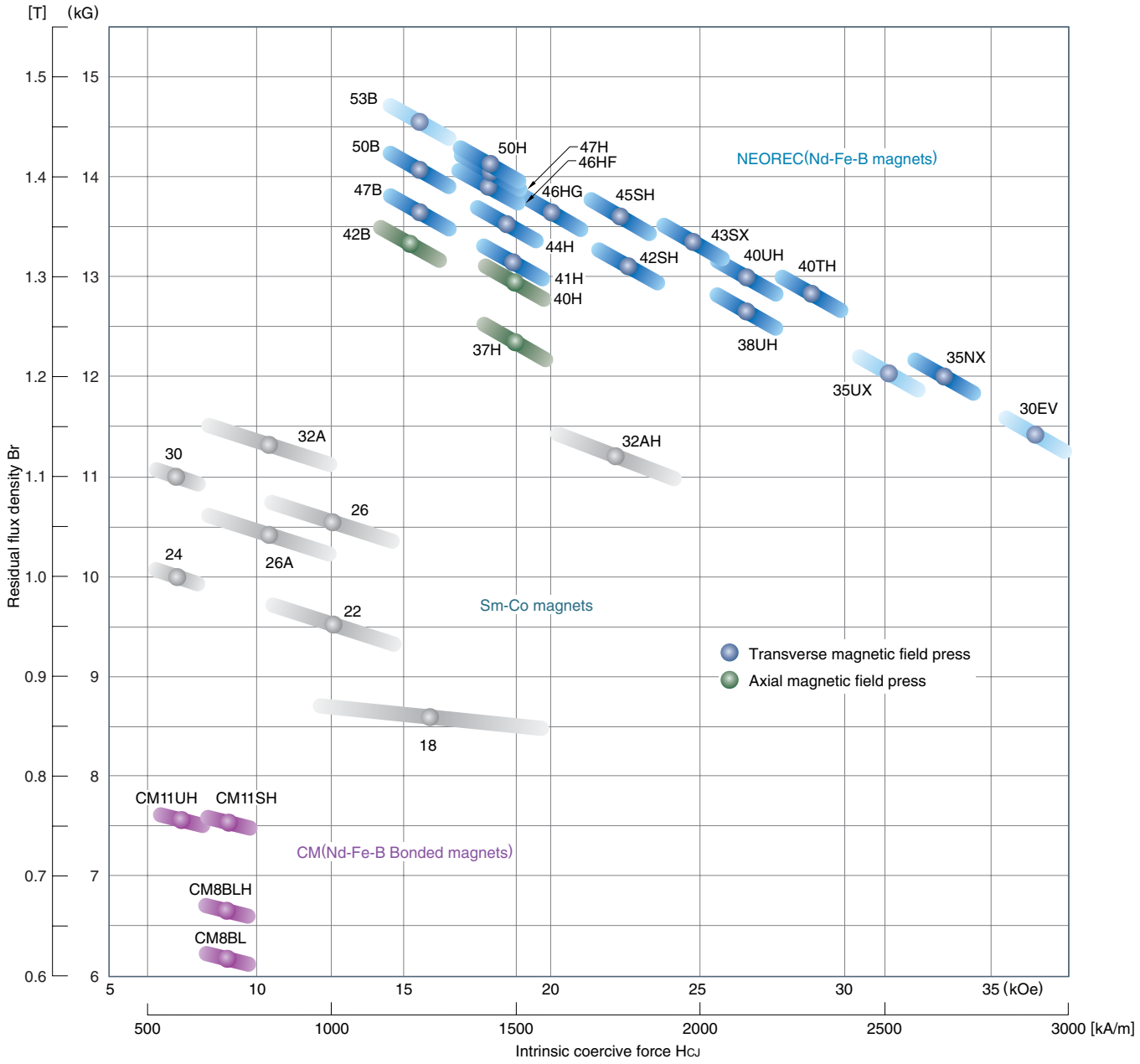
Actuators for magnetic and optical disks, core-less motors, servomotors, stepping motors, MRI's printers, sensors, magnetrons, klystrons, magnetic bearings, magnetic couplings, etc.

DIFFRENCES BETWEEN NdFe-MAGNET AND SmCo-MAGNET

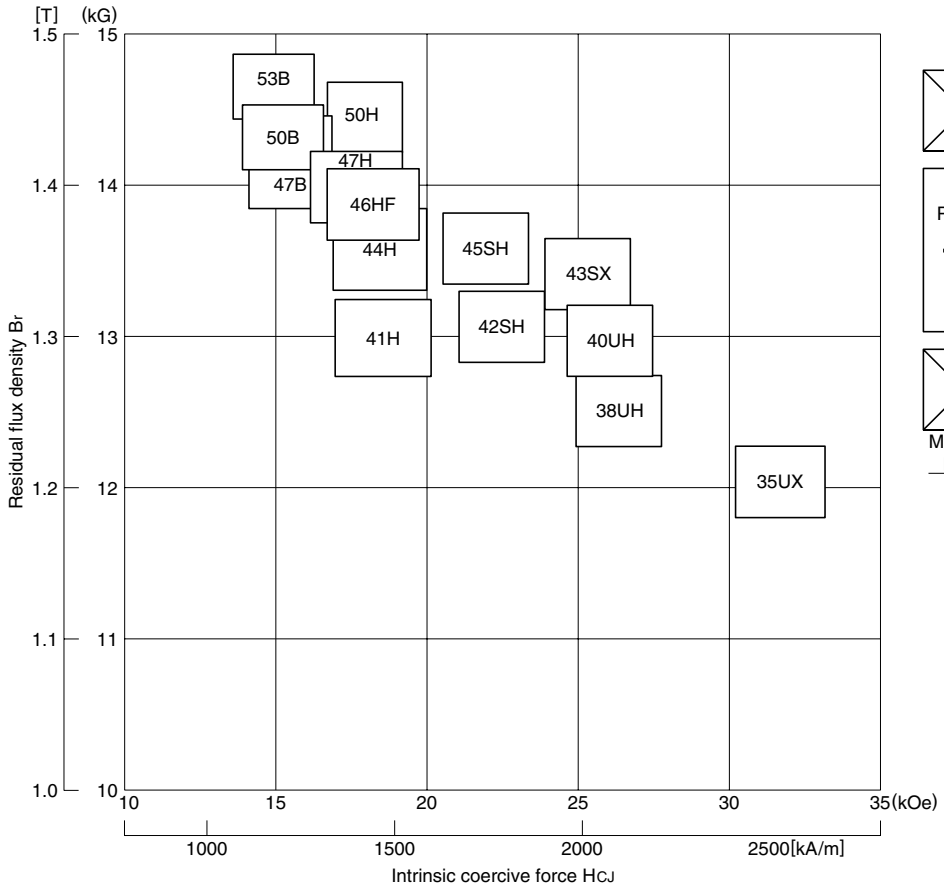
Item		NdFe-magnet	SmCo-magnet
Composition		Nd, Fe, B, and other additives	Sm, Co, Fe, Cu, and other additives
Manufacturing method		Sintering	Sintering
Magnetic characteristics			
Maximum energy product (BH)max		28 to 49MGOe	16 to 32MGOe
Residual flux density Br		10.3 to 13.0kG	8.2 to 11.6kG
Intrinsic coercive force H_{CJ}		11.0 to 25.0kOe	6.2 to 20.0kOe
Recoil permeability		1.05	1.05
Reversible temperature coefficient of Br		–0.11 to –0.13%/°C	–0.03 to –0.04%/°C
Temperature coefficient of H_{CJ}		–0.55 to –0.65%/°C	–0.15 to –0.30%/°C
Physical characteristics			
Curie temperature		320°C	800°C
Density		7.3 to 7.5g/cm^3	8.2 to 8.4g/cm^3
Thermal expansion coefficient	C//*(0 to 100°C)	5.2× 10^{-6}/°C	8× 10^{-6}/°C
	C⊥*(0 to 100°C)	–0.8× 10^{-6}/°C	11× 10^{-6}/°C
Mechanical characteristics			
Deflection strength		25kg/mm^2	15kg/mm^2
Compressive strength		110kg/mm^2	82kg/mm^2
Tensile strength		7.5kg/mm^2	3.6kg/mm^2
Vickers hardness		550 to 650	500 to 550
Electric resistance		130× 10^{-6}Ω cm	86× 10^{-6}Ω cm
Required magnetizing field		25kOe min.	15kOe min.($SmCo_5$ system) 25kOe min.(Sm_2Co_{27} system)
Resistance to cracking		Solid, hard to break	Brittle easily
Resistance to rust		Relatively easy to rust	Relatively resistant to rust

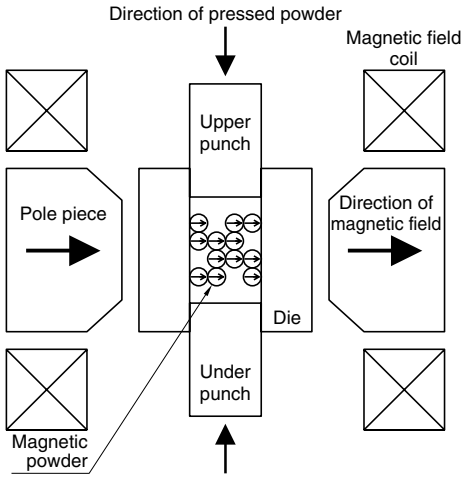
* C// is the value measured in the easy magnetization direction.
C⊥ is the value measured in the vertical direction to the easy magnetization direction.

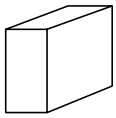
Br/HcJ CHARACTERISTICS DISTRIBUTION



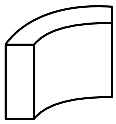
TRANSVERSE MAGNETIC FIELD PRESS



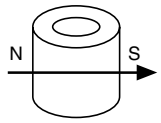




• Block magnet(type) for pick up

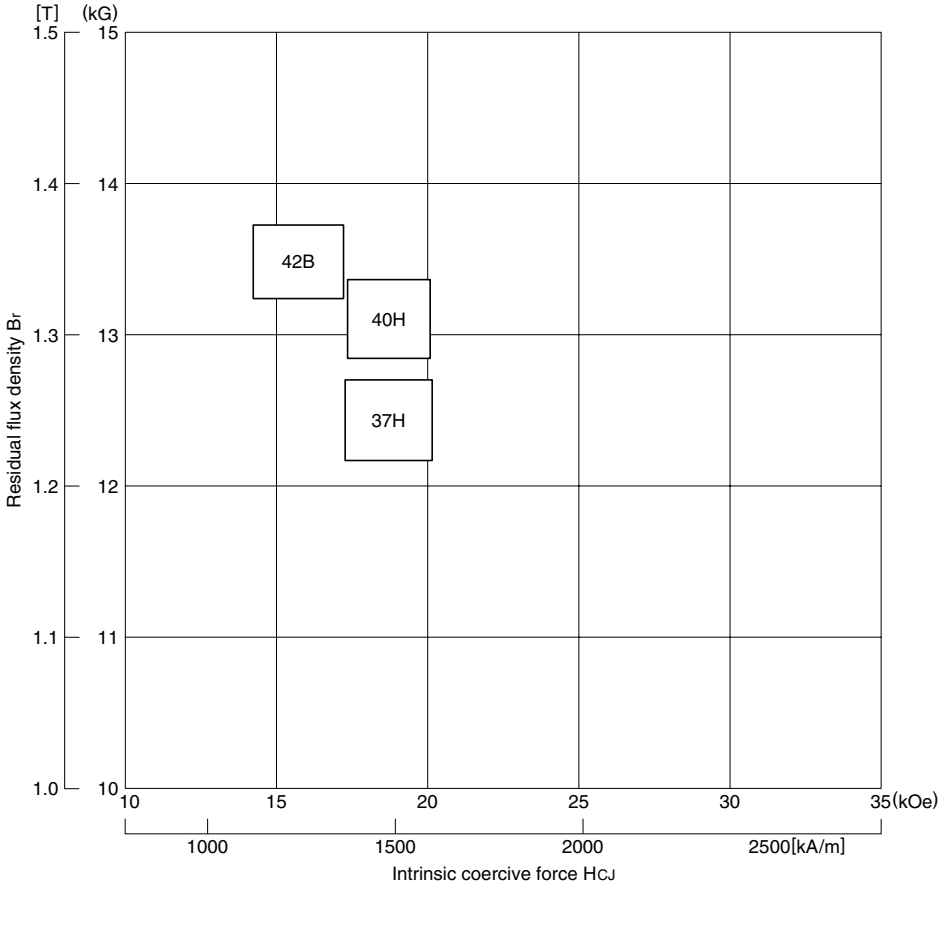


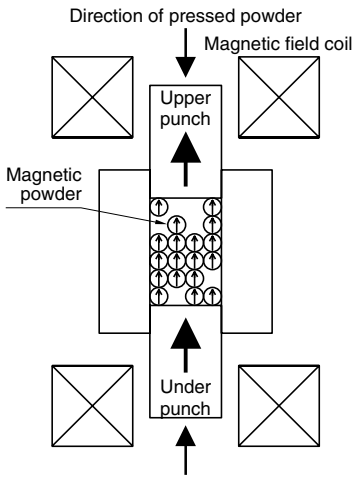
• For FA's motor



• For automotive actuator
• For pager

AXIAL MAGNETIC FIELD PRESS

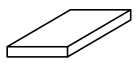




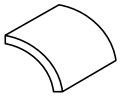
• VCM

• For ABS's sensor

• For CD's and MD's clamper
• For camcorder's motor



• For optical pickup

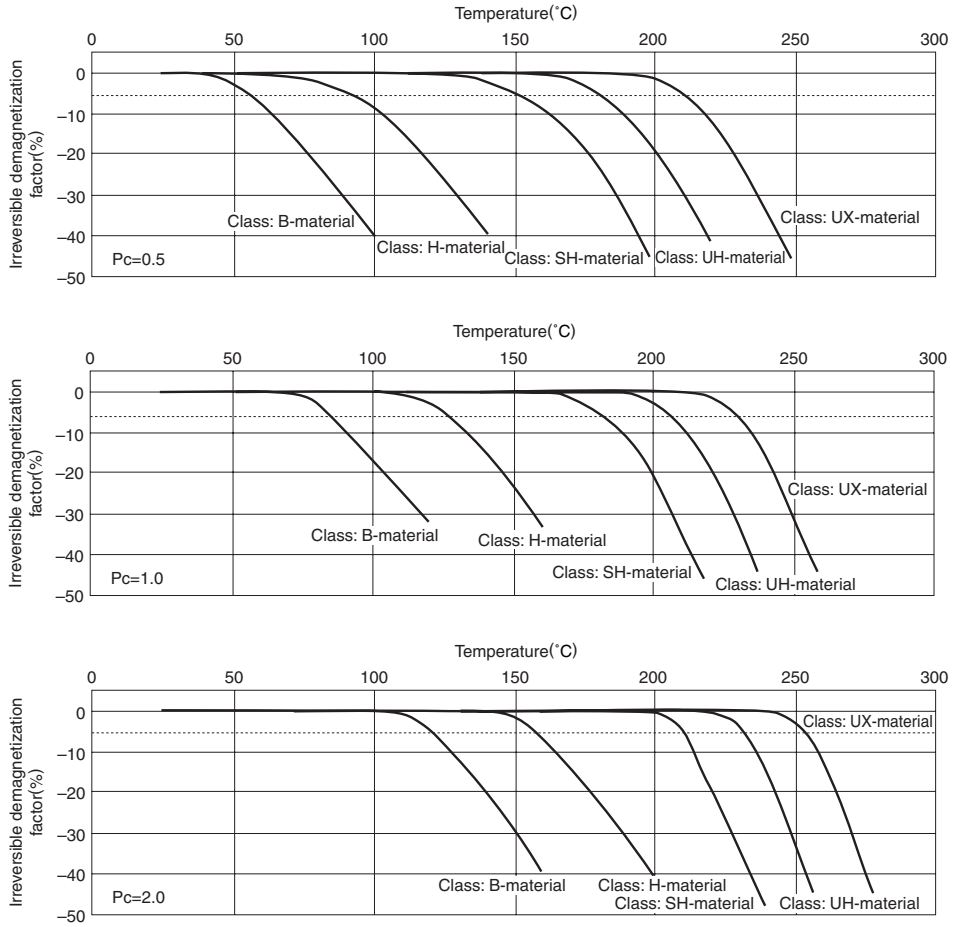


• For FA's motor
• For automotive actuator

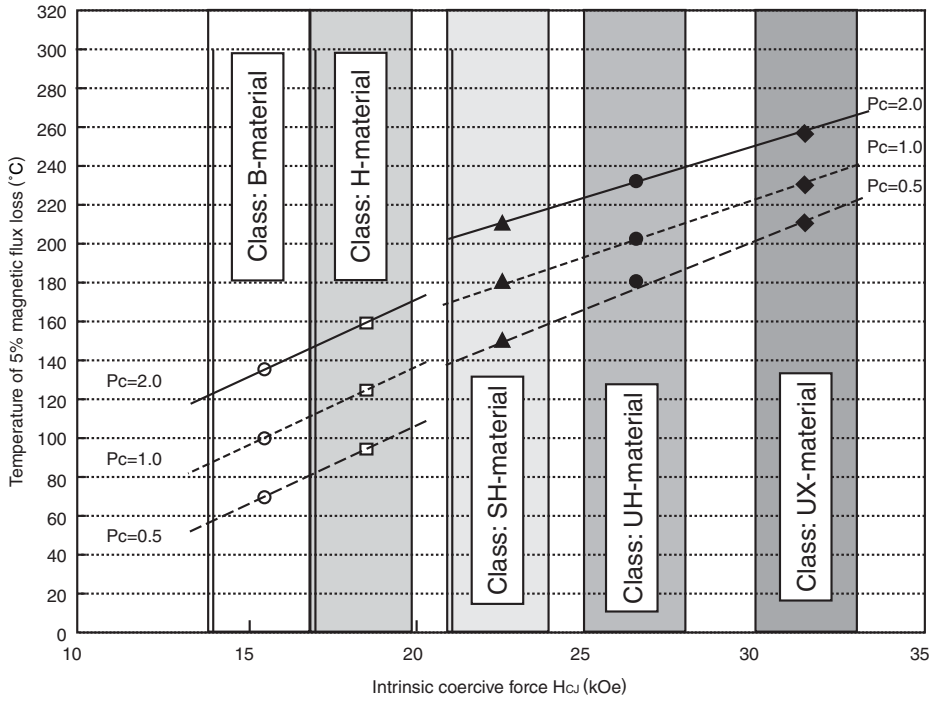
IRREVERSIBLE DEMAGNETIZATION CHARACTERISTICS

The irreversible demagnetization characteristics of NEOREC magnets are dependent on their coercive forces and are not due to their residual flux densities. There is no difference between the irreversible demagnetization characteristics of transversely and longitudinally magnetized products.

TEMPERATURE DEPENDENCE OF IRREVERSIBLE DEMAGNETIZATION FACTOR

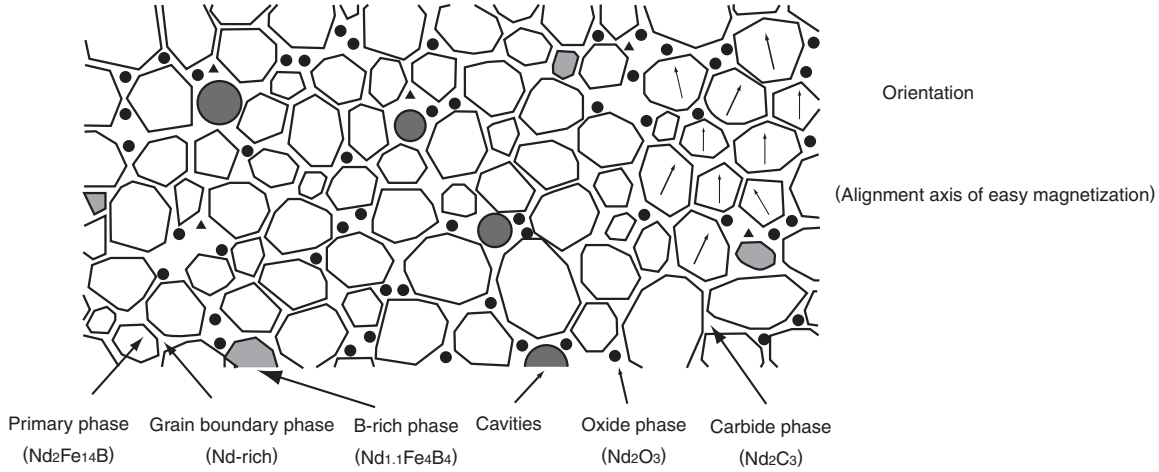


TEMPERATURE OF 5% MAGNETIC FLUX LOSS vs. COERCIVE FORCE

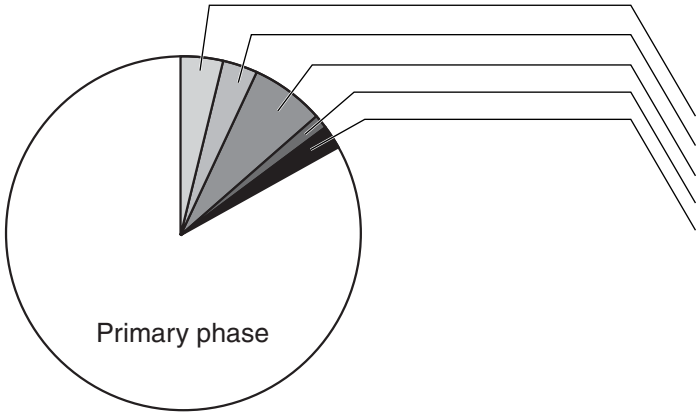


MAGNET STRUCTURES/MAGNETIC CHARACTERISTICS/RUST PREVENTION TREATMENTS

CROSS SECTION OF A MAGNET (MODEL ILLUSTRATION)



PHASE PROPORTIONS AND MAGNETIC CHARACTERISTICS

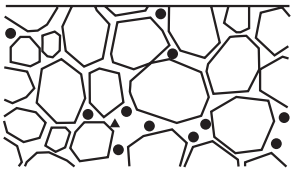


NEOREC Series

(%)	38's	41's	45's	50's
Primary phase	84	88	92	94
Grain boundary phase	4	4	2	2
B-rich phase	3	2	1	0.5
Oxide phase	7	4	3	2.5
Carbide phase	1	1	1	0.5
Cavities	1	1	1	0.5
Orientation (%)	93	93	94	95
Br (kG)	12.7	13.2	13.6	14.2

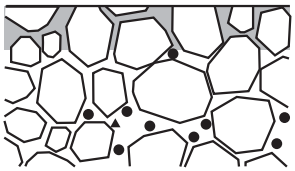
CORROSION RESISTANCE OF MAGNET MATERIALS (MODEL ILLUSTRATION)

Before corrosion



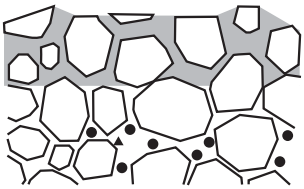
Primary phase crystal grains($Nd_2Fe_{14}B$)
Grain boundary phase(Nd-rich)

Corrosion (early stage)



1) Corrosion on the surface of the primary phase
   → $Fe_2O_3 \bullet H_2O$
2) Corrosion in the grain boundary phase (Nd-rich)
   → (Nd_2O_3, $Nd(OH)_3$)

Corrosion (late stage)



Drop-off of primary phase crystal grains
↓
Corrosion on the surface of the primary phase
Corrosion in the grain boundary phase

RUST PREVENTION TREATMENTS

Surface treatment technique		Ni plating		
		Electrolytic plating	Electrolytic plating with good throwing power	Improvements to corrosion resistance and adhesion
Film structure	Element	Ni	Ni	Ni/Sn
	Spontaneous potential (mV: standard electrode)	–250 to –300	–220 to –170	–100 to –150
	Internal stress (Mpa)	–150 to –100	–50 to 0	–50 to 0
	Vickers hardness (Hv)	400 to 600	200 to 300	200 to 300
	Organic brightener	Used	Not used	Not used
Film thickness	Range (µm)	10 to 20	10 to 20	10 to 20/1 to 3
	Uniformity	Acceptable	Good	Good
Adhesion	Room temperature	Good	Excellent	Excellent
	200°C	Acceptable	Good	Good
	Adhesiveness	Acceptable	Good	Excellent
Reliability	Temperature resistance test (60°C, 90%RH)	>2500 (hr)	>2500 (hr)	>2500 (hr)
	Humidity resistance test (85°C, 85%RH)	>500 (hr)	>500 (hr)	>500 (hr)
	Salt spray test (35°C, 5% NaCl)	<24 (hr)	<24 (hr)	>24 (hr)
	SO_2 gas test (40°C, 75%RH)	<96 (hr)	<96 (hr)	>96 (hr)
Examples of applications		HDD Motors for hard disk drives, audio visual equipment and office automation equipment (electrical household appliances)	Optical pickups, sensors and motors (electrical household appliances, factory automation and automobiles)	Actuators, sensors and motors (factory automation and automobiles)
Maximum operating temperature (°C)		120	220	220

• Please consult us for the different types of surface treatments.

CORRELATION IN HUMIDITY RESISTANCE TESTS

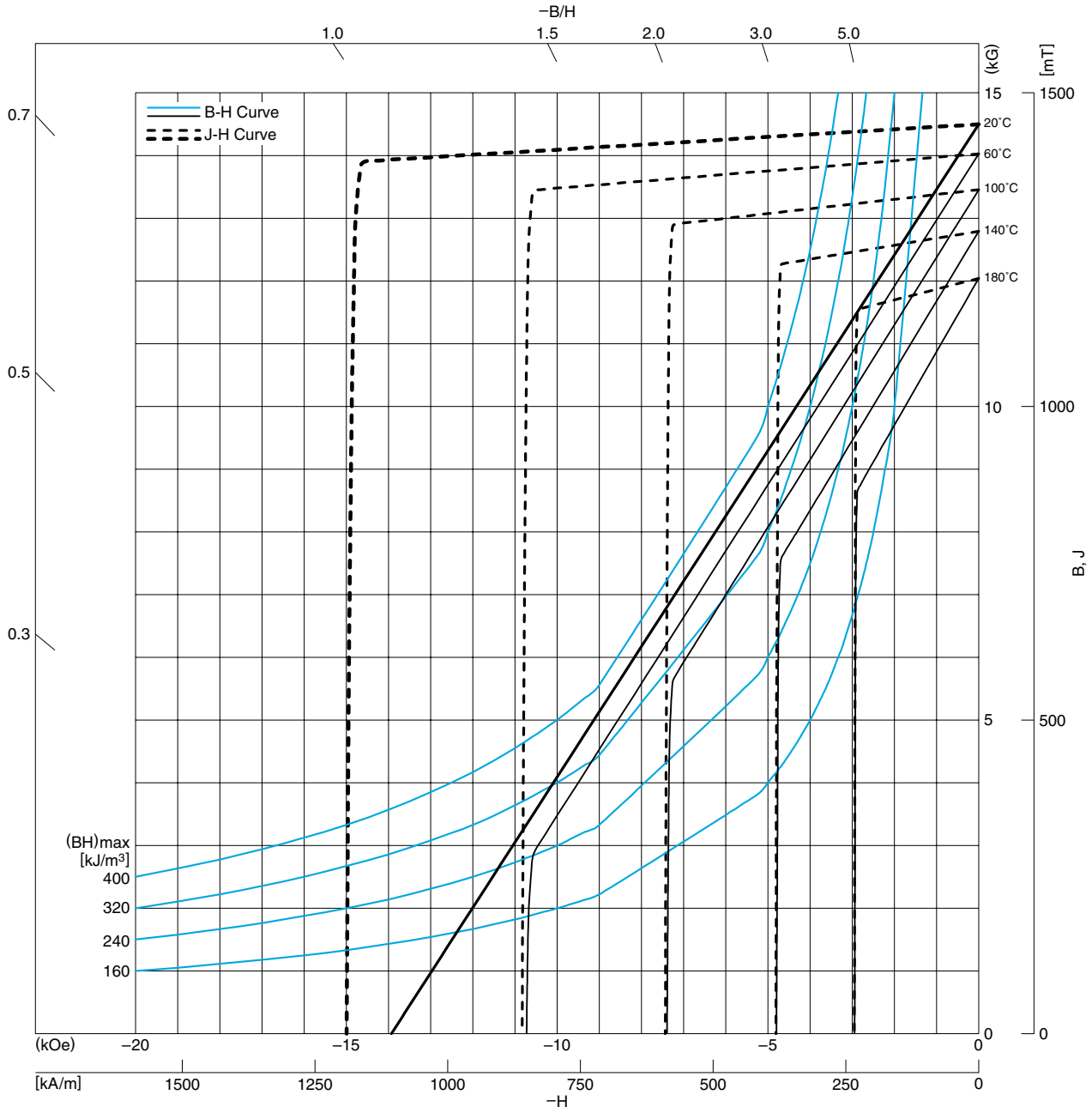
Test items	Conditions		Times				
Pressure cooker test	120°C 2atm, 100%RH		25 (hours)	50	75	100	125
Humidity resistance test	85°C, 85%RH		250 (hours)	500	750	1000	1250
	60°C, 90%RH		1500 (hours)	3000	4500	6000	7500
Cycle test	MIL202F-106E		50 (cycles)	100	150	200	250
Operating environment (estimated)	23.8°C 78%RH Bangkok	Rust (blisters)	4.5 (years)	9.0	13.5	18.0	22.5
		Breaking	18 (years)	36	54	72	90
	16.2°C 67%RH Osaka	Rust (blisters)	22.5 (years)	45	67.5	90	113
		Breaking	90 (years)	180	270	360	450

(↑ 20hr: Pre-shipment inspection)

DEMAGNETIZATION CURVES/MAGNETIC CHARACTERISTICS

NEOREC53B

DEMAGNETIZATION CURVE

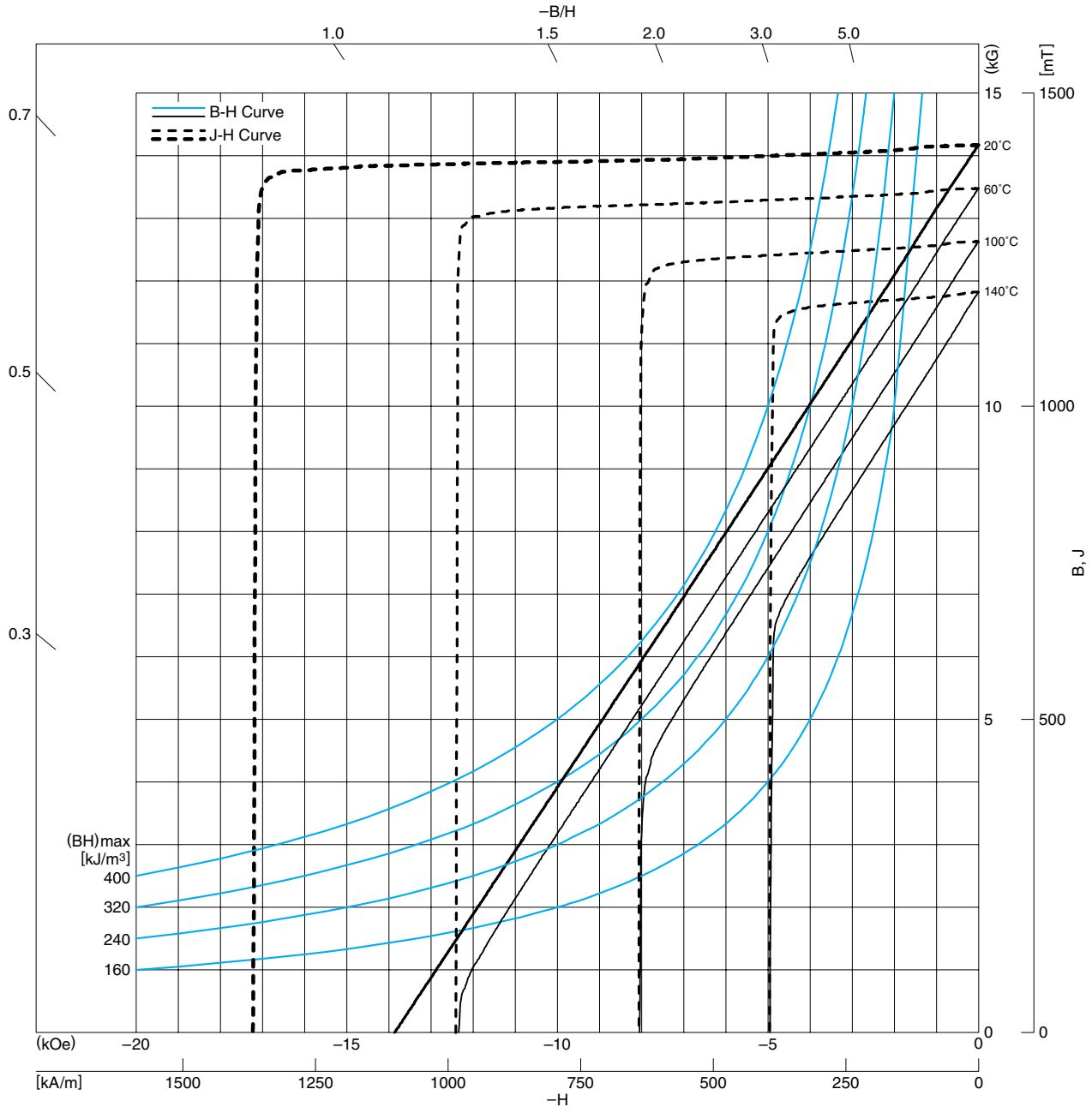


MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1450±20
Br	(kG)	14.5±0.2
Coercive force	[kA/m]	1120±48
H_{CB}	(kOe)	14.1±0.6
Intrinsic coercive force	[kA/m]	≧1114
H_{CJ}	(kOe)	≧14
Maximum energy product	[kJ/m³]	406±16
(BH)max	(MGOe)	51±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC50H
DEMAGNETIZATION CURVE



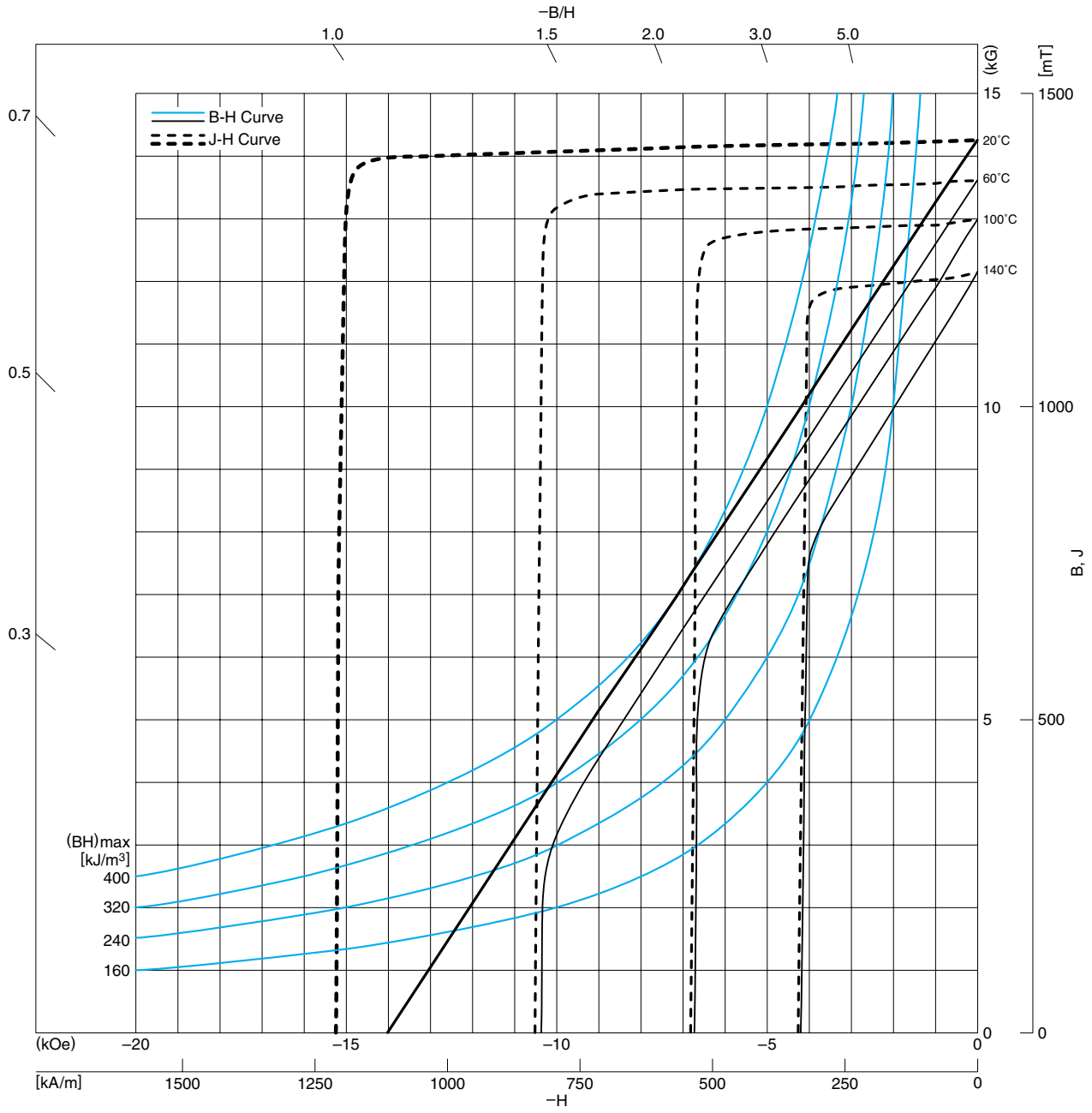
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1420±20
Br	(kG)	14.2±0.2
Coercive force	[kA/m]	1097±48
H_{CB}	(kOe)	13.8±0.6
Intrinsic coercive force	[kA/m]	≧1353
H_{CJ}	(kOe)	≧17.0
Maximum energy product	[kJ/m^3]	390±16
(BH)max	(MGOe)	49.0±2.0

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC50B

DEMAGNETIZATION CURVE



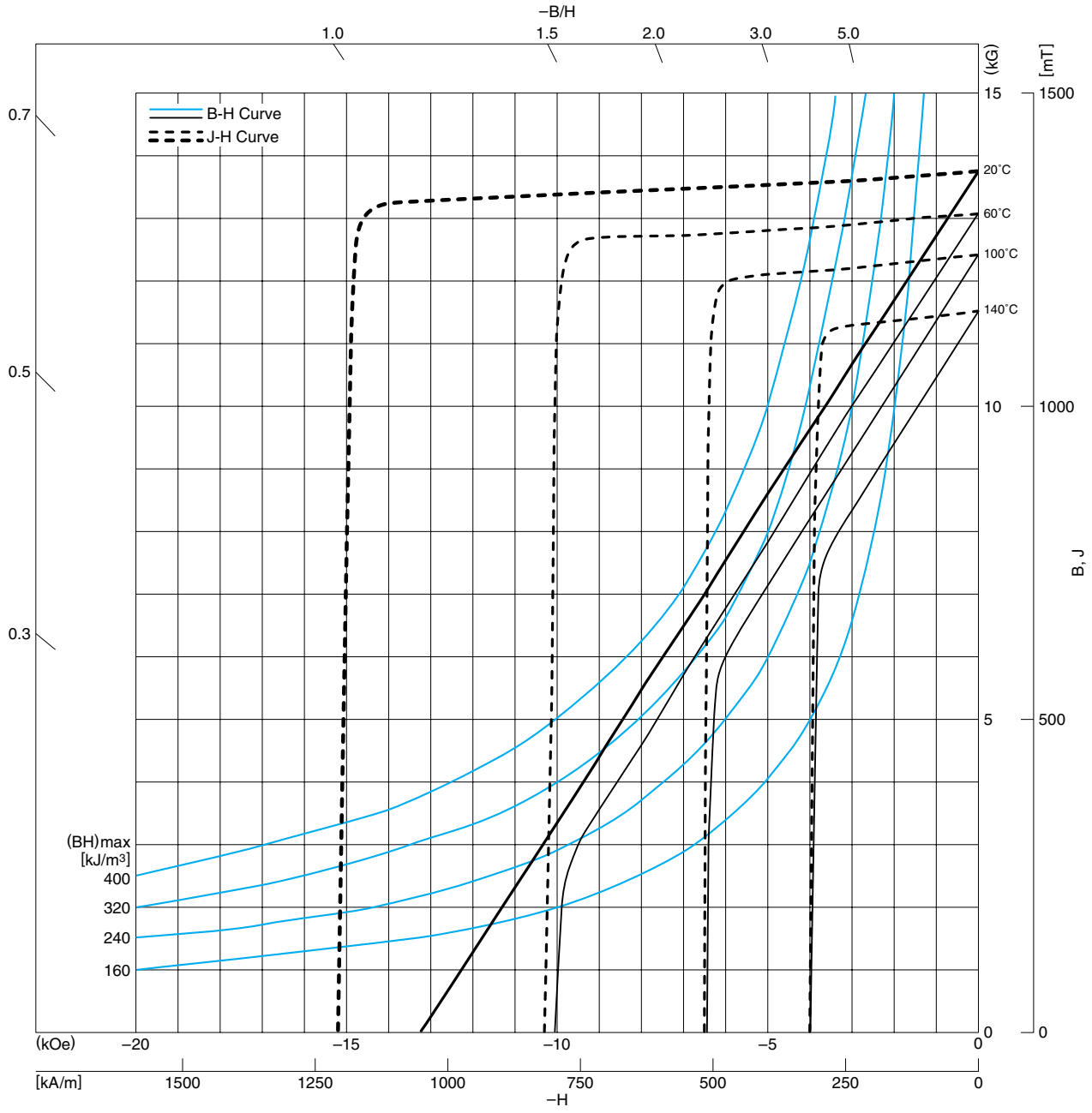
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1420±20
Br	(kG)	14.2±0.2
Coercive force	[kA/m]	1074±48
H_{CB}	(kOe)	13.5±0.6
Intrinsic coercive force	[kA/m]	≧1114
H_{CJ}	(kOe)	≧14.0
Maximum energy product	[kJ/m^3]	390±16
(BH)max	(MGOe)	49.0±2.0

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC47B

DEMAGNETIZATION CURVE



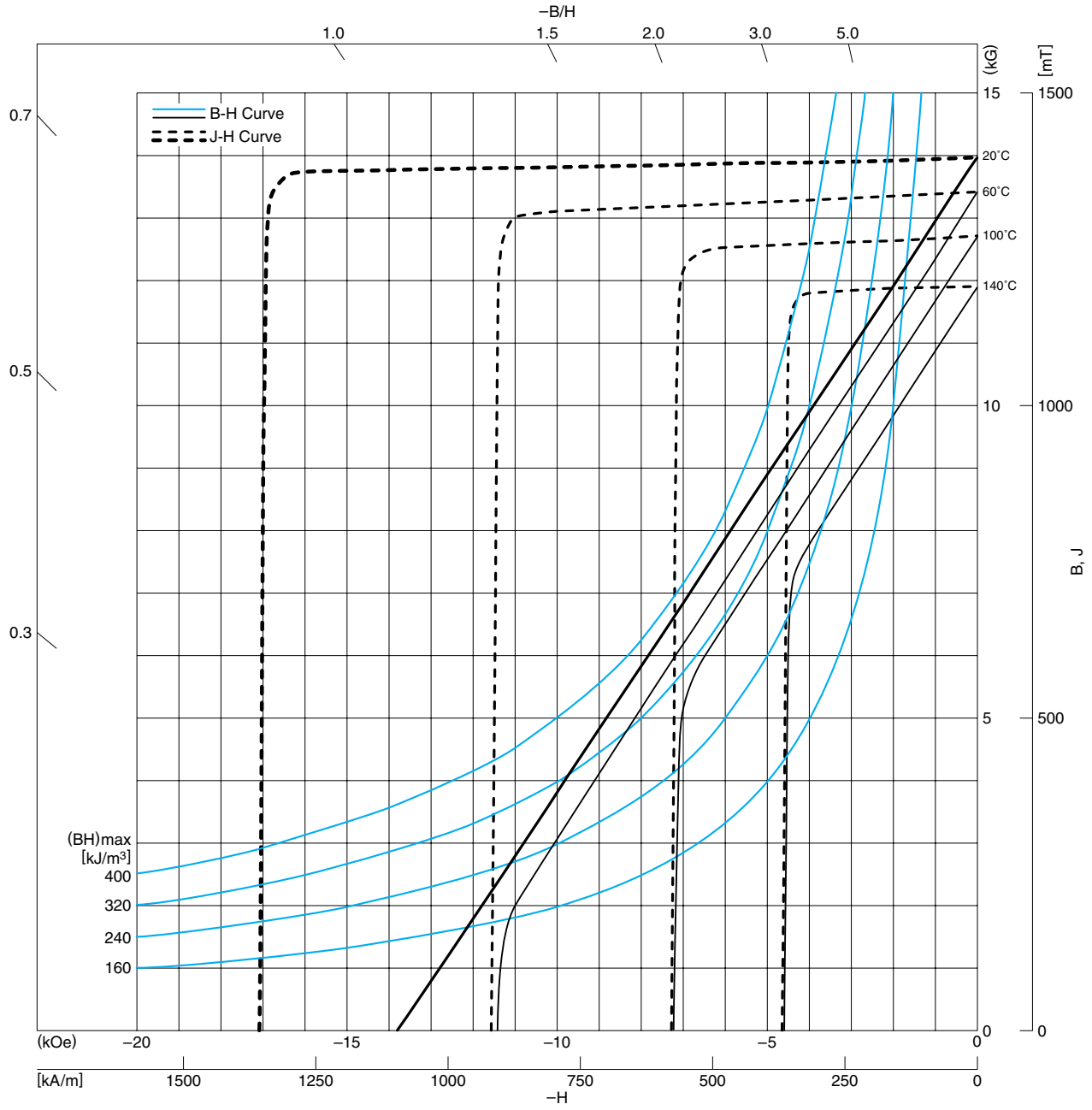
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1390±30
Br	(kG)	13.9±0.3
Coercive force	[kA/m]	1035±56
H_{CB}	(kOe)	13.0±0.7
Intrinsic coercive force	[kA/m]	≧1114
H_{CJ}	(kOe)	≧14.0
Maximum energy product	[kJ/m^3]	366±16
(BH)max	(MGOe)	46±2

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC47H

DEMAGNETIZATION CURVE



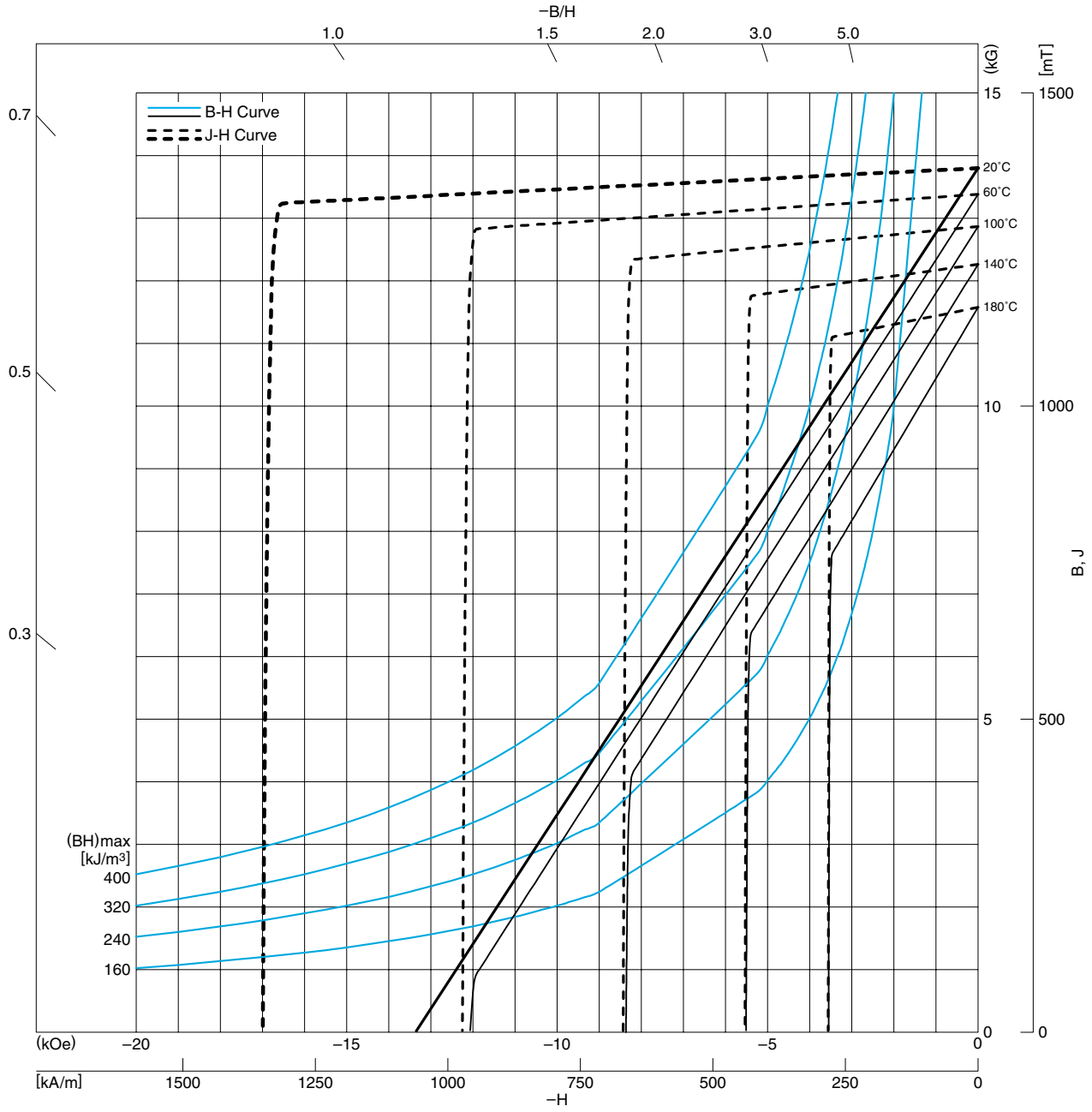
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1390±20
Br	(kG)	13.9±0.2
Coercive force	[kA/m]	1067±48
H_{CB}	(kOe)	13.4±0.6
Intrinsic coercive force	[kA/m]	≧1273
H_{CJ}	(kOe)	≧16.0
Maximum energy product	[kJ/m^3]	374±16
(BH)max	(MGOe)	47.0±2.0

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC46HF

DEMAGNETIZATION CURVE



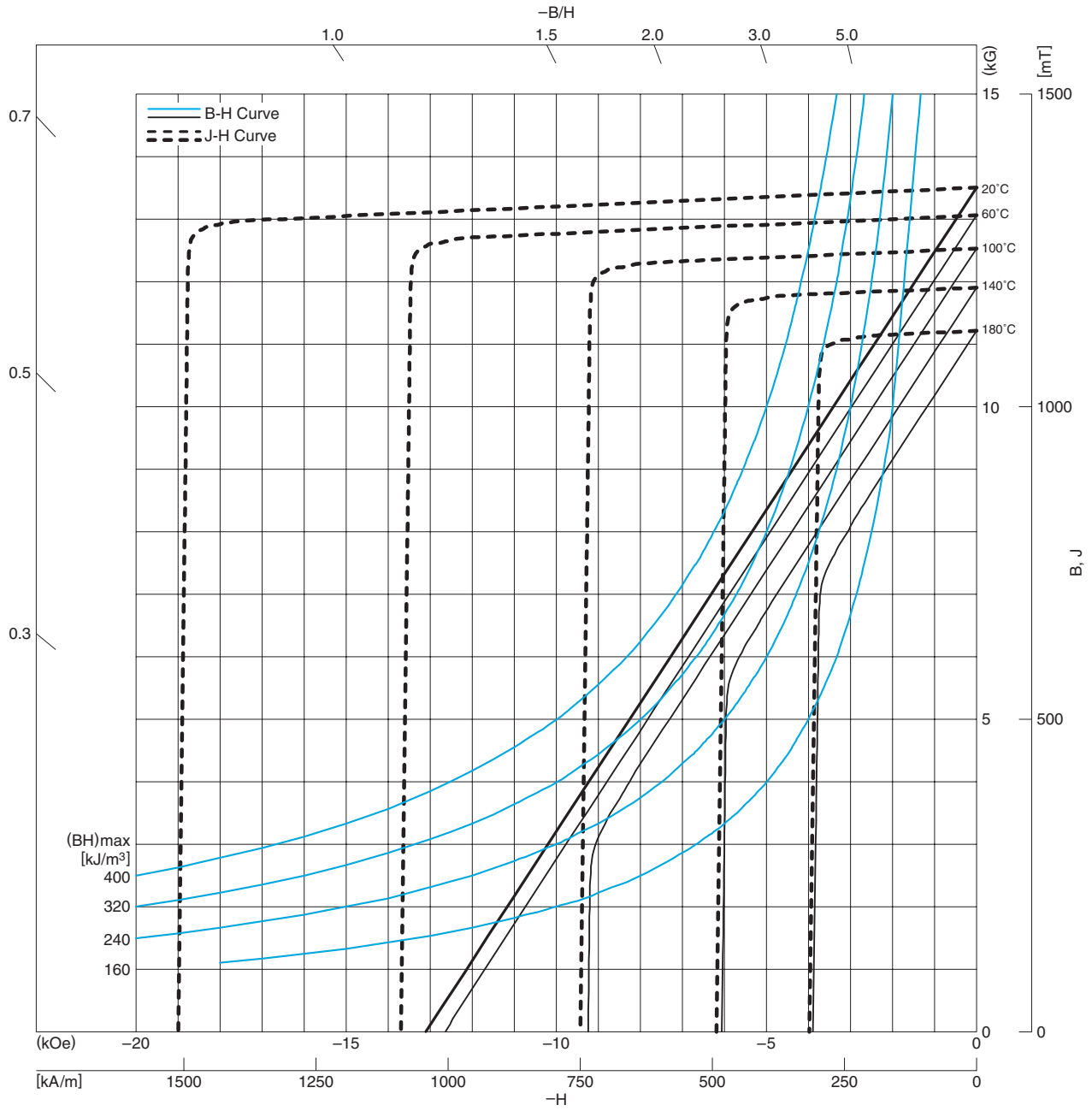
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1380±30
Br	(kG)	13.8±0.3
Coercive force	[kA/m]	1066±56
H_{CB}	(kOe)	13.4±0.7
Intrinsic coercive force	[kA/m]	≧1273
H_{CJ}	(kOe)	≧16
Maximum energy product	[kJ/m^3]	368±16
(BH)max	(MGOe)	46±2

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC46HG

DEMAGNETIZATION CURVE



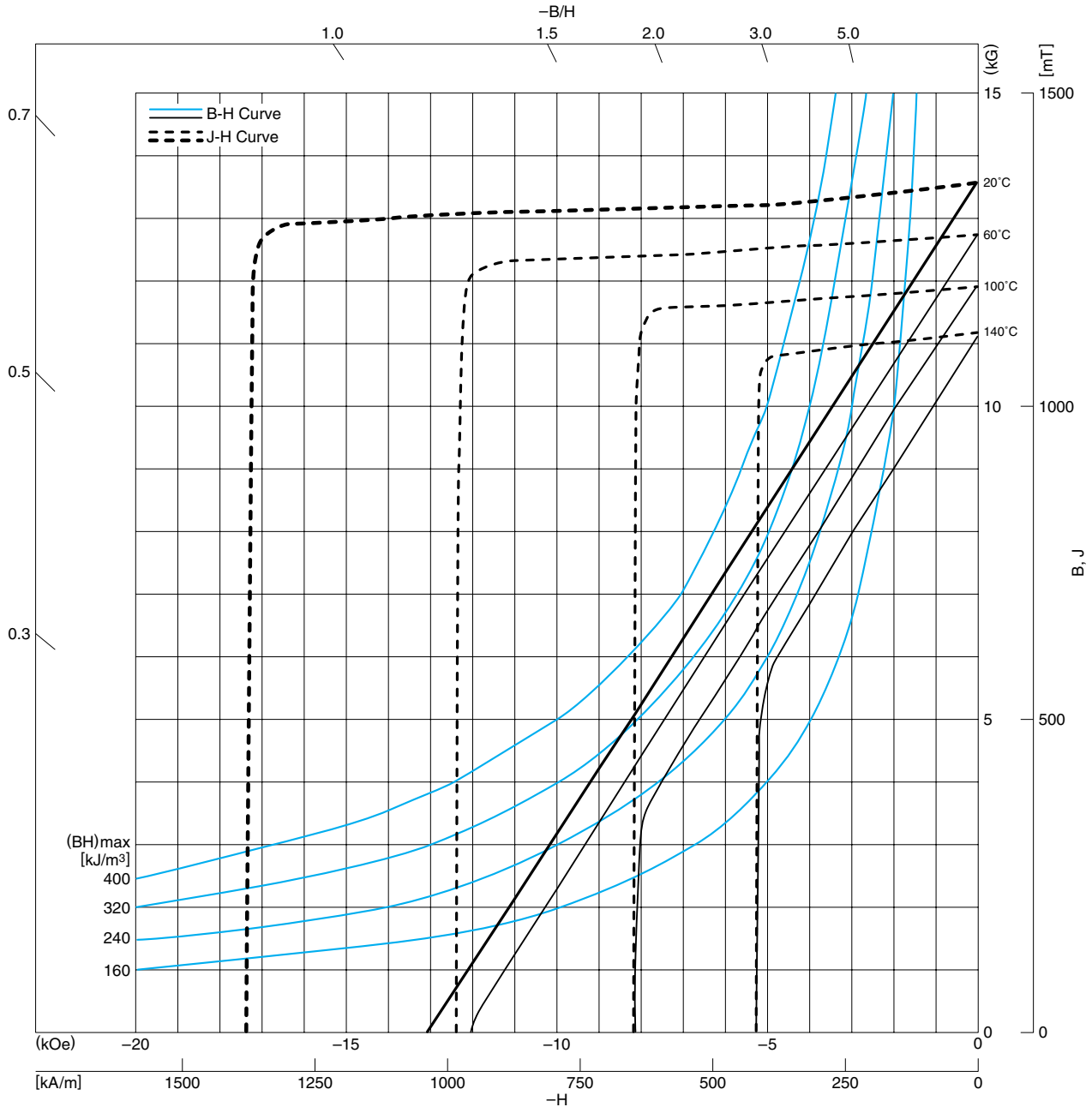
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1350±20
Br	(kG)	13.5±0.2
Coercive force	[kA/m]	1043±48
H_{CB}	(kOe)	13.1±0.6
Intrinsic coercive force	[kA/m]	≧ 1432
H_{CJ}	(kOe)	≧ 18
Maximum energy product	[kJ/m^3]	352±16
(BH)max	(MGOe)	44.2±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC44H

DEMAGNETIZATION CURVE



MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1360±30
Br	(kG)	13.6±0.3
Coercive force	[kA/m]	1003±56
H_{CB}	(kOe)	12.6±0.7
Intrinsic coercive force	[kA/m]	≧1353
H_{CJ}	(kOe)	≧17.0
Maximum energy product	[kJ/m^3]	350±16
(BH)max	(MGOe)	44±2

• [ ]: in the unit of SI
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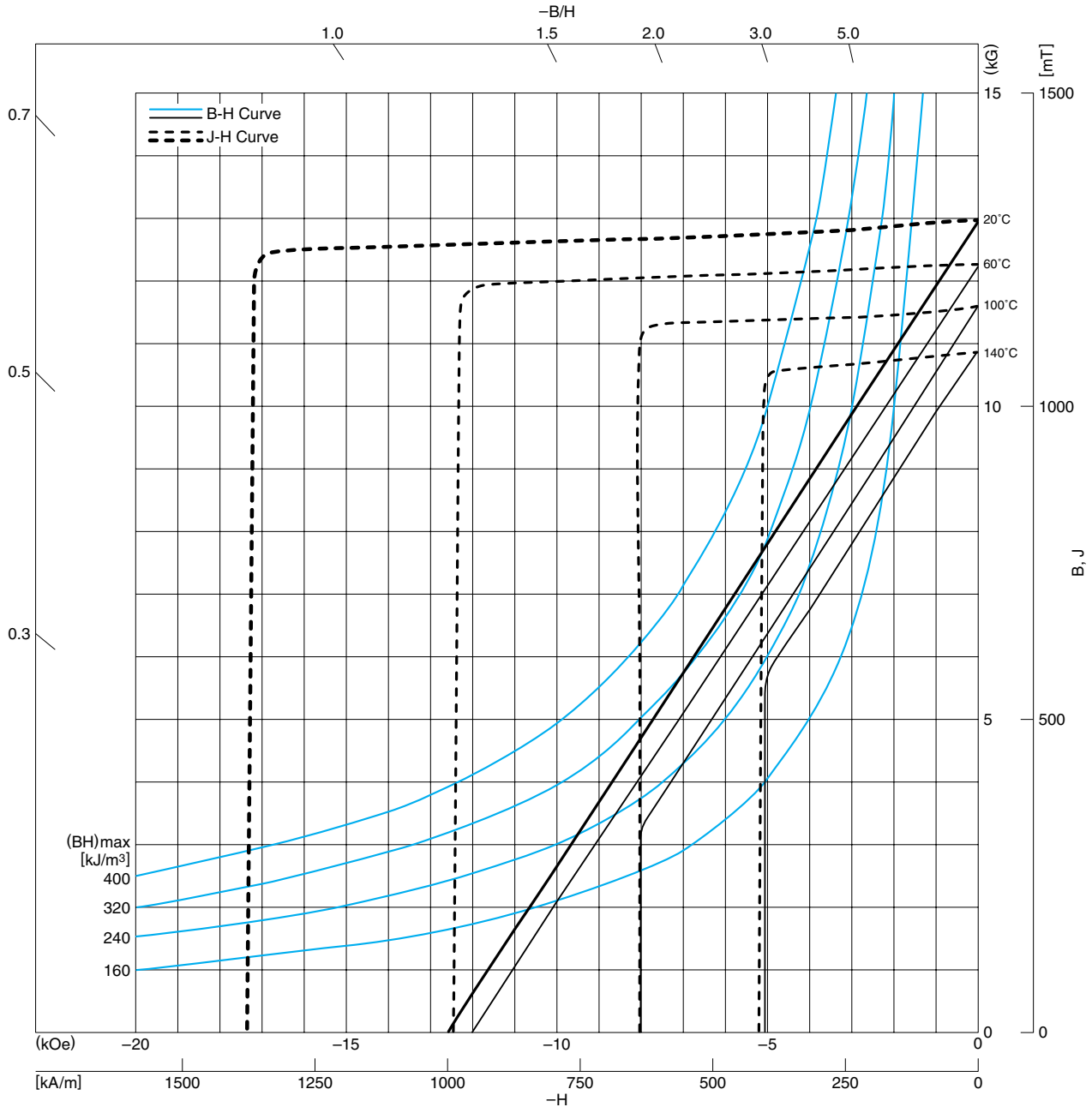
NEOREC41H
DEMAGNETIZATION CURVE



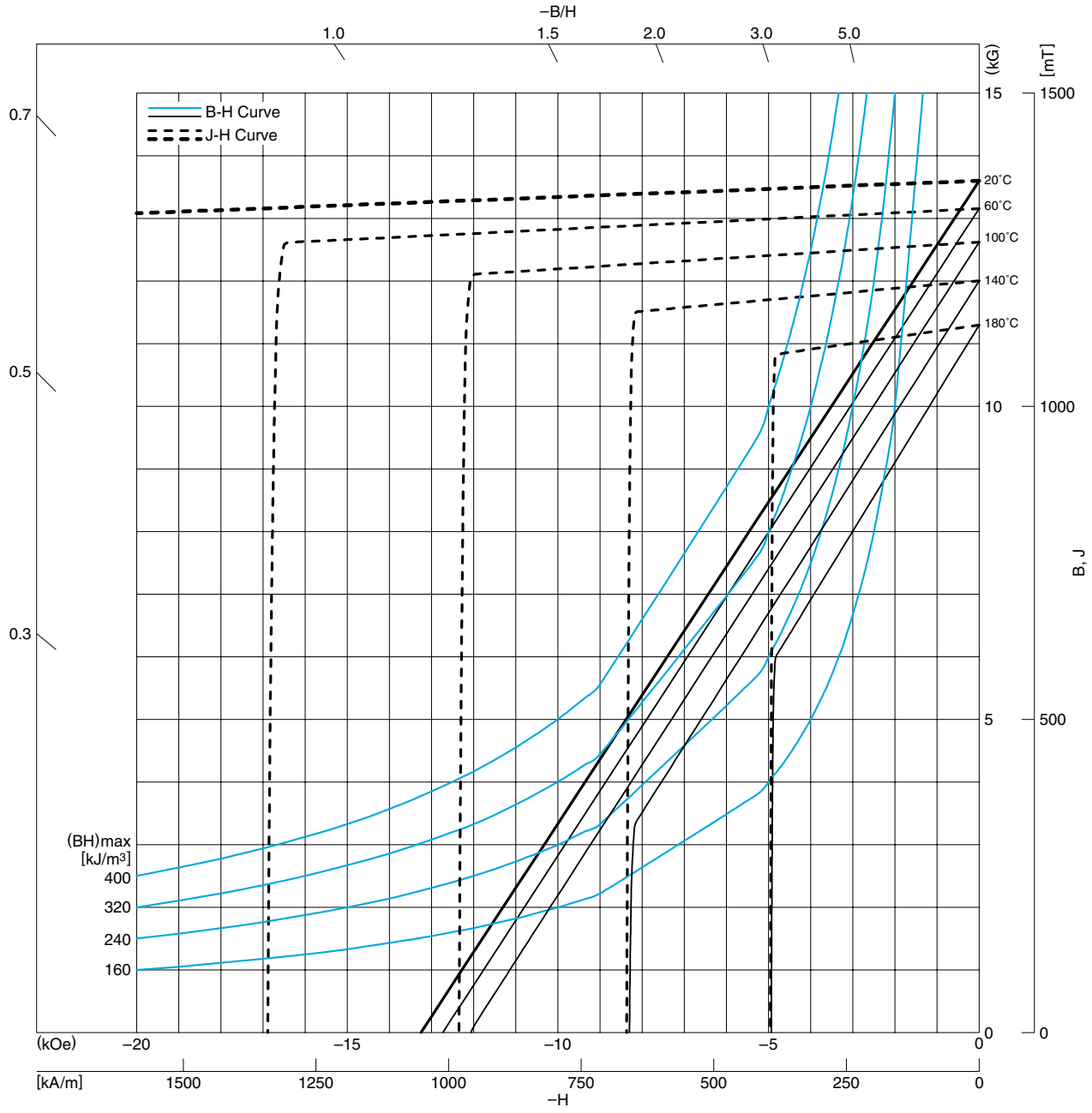
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1300±30
Br	(kG)	13.0±0.3
Coercive force	[kA/m]	971±56
H_{CB}	(kOe)	12.2±0.7
Intrinsic coercive force	[kA/m]	≧1353
H_{CJ}	(kOe)	≧17.0
Maximum energy product	[kJ/m^3]	326±16
(BH)max	(MGOe)	41±2

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC45SH

DEMAGNETIZATION CURVE



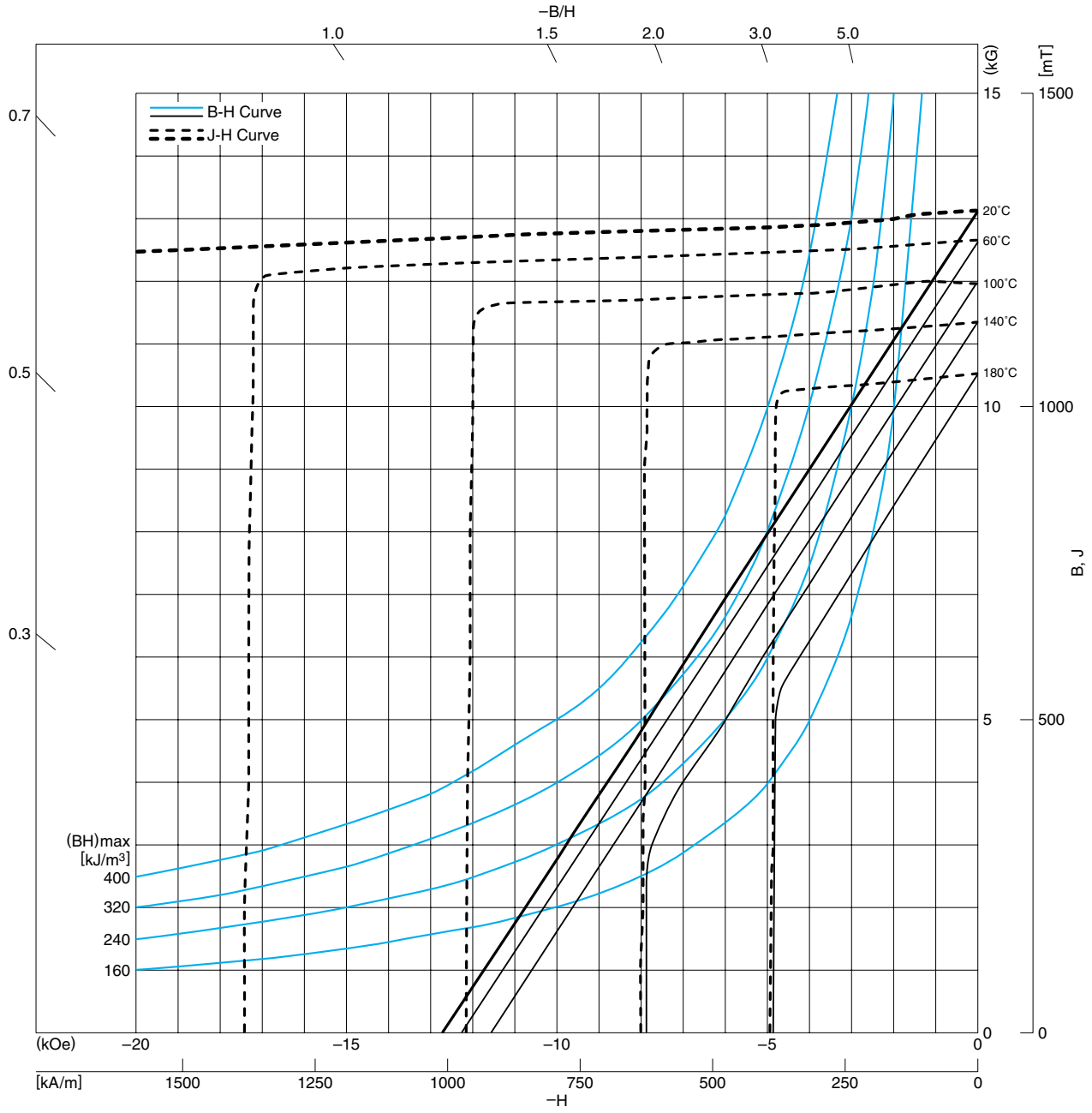
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1360±30
Br	(kG)	13.6±0.3
Coercive force	[kA/m]	1051±56
H_{CB}	(kOe)	13.2±0.7
Intrinsic coercive force	[kA/m]	≧1671
H_{CJ}	(kOe)	≧21
Maximum energy product	[kJ/m^3]	357±16
(BH)max	(MGOe)	45±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC42SH

DEMAGNETIZATION CURVE



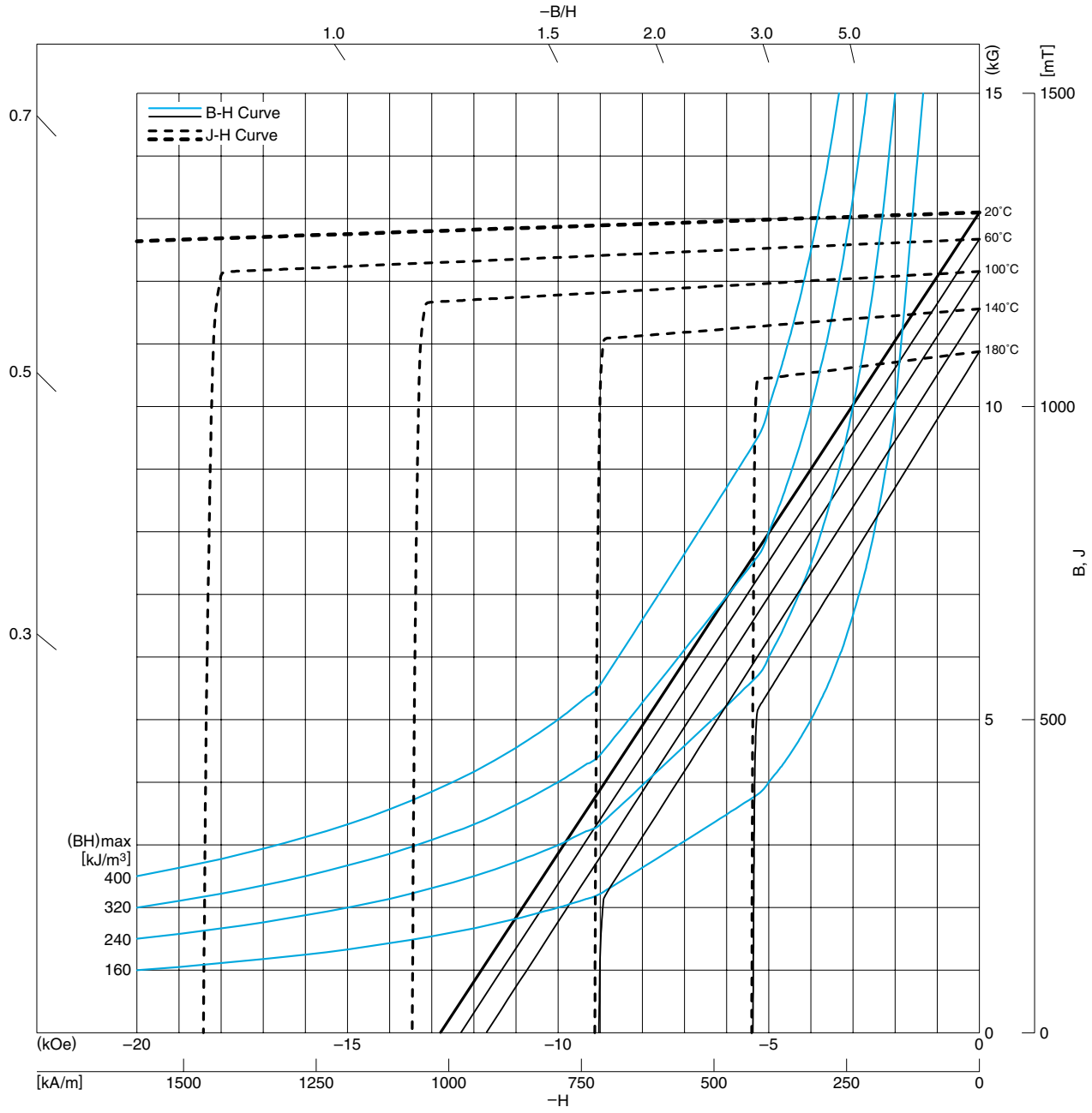
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1300±30
Br	(kG)	13.0±0.3
Coercive force	[kA/m]	979±56
H_{CB}	(kOe)	12.3±0.7
Intrinsic coercive force	[kA/m]	≧1671
H_{CJ}	(kOe)	≧21.0
Maximum energy product	[kJ/m3]	326±16
(BH)max	(MGOe)	41±2

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC43SX

DEMAGNETIZATION CURVE



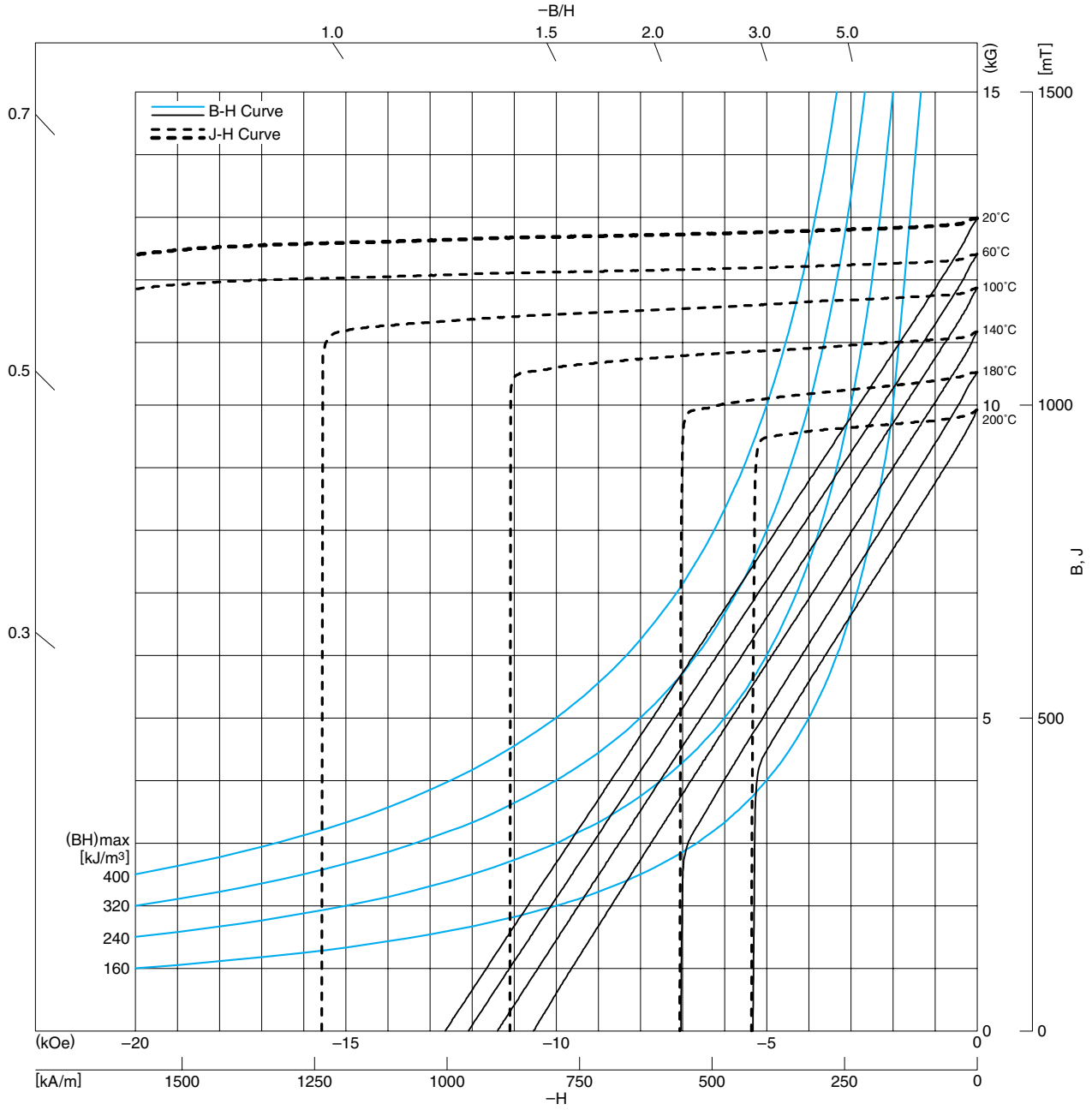
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1310±30
Br	(kG)	13.1±0.3
Coercive force	[kA/m]	1012±56
H_{CB}	(kOe)	12.7±0.7
Intrinsic coercive force	[kA/m]	≧1830
H_{CJ}	(kOe)	≧23
Maximum energy product	[kJ/m^3]	331±16
(BH)max	(MGOe)	42±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC40UH

DEMAGNETIZATION CURVE



MAGNETIC CHARACTERISTICS

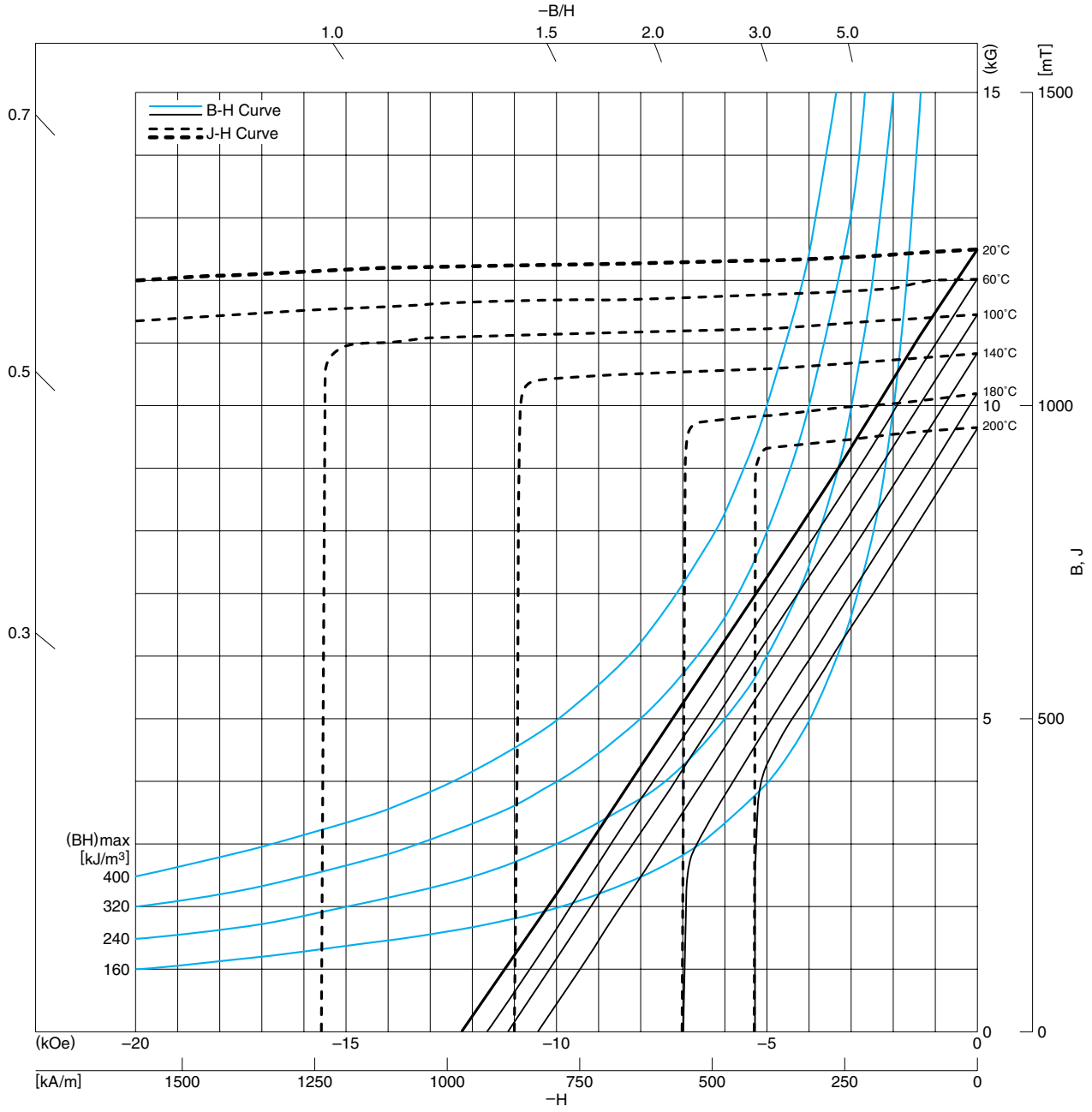
Residual flux density	[mT]	1290±30
Br	(kG)	12.9±0.3
Coercive force	[kA/m]	995±56
H_{CB}	(kOe)	12.5±0.7
Intrinsic coercive force	[kA/m]	≧1990
H_{CJ}	(kOe)	≧25
Maximum energy product	[kJ/m^3]	310±16
(BH)max	(MGOe)	39±2

- [ ]: in the unit of SI
  ( ): in the unit of CGS

• All specifications are subject to change without notice.

NEOREC38UH

DEMAGNETIZATION CURVE

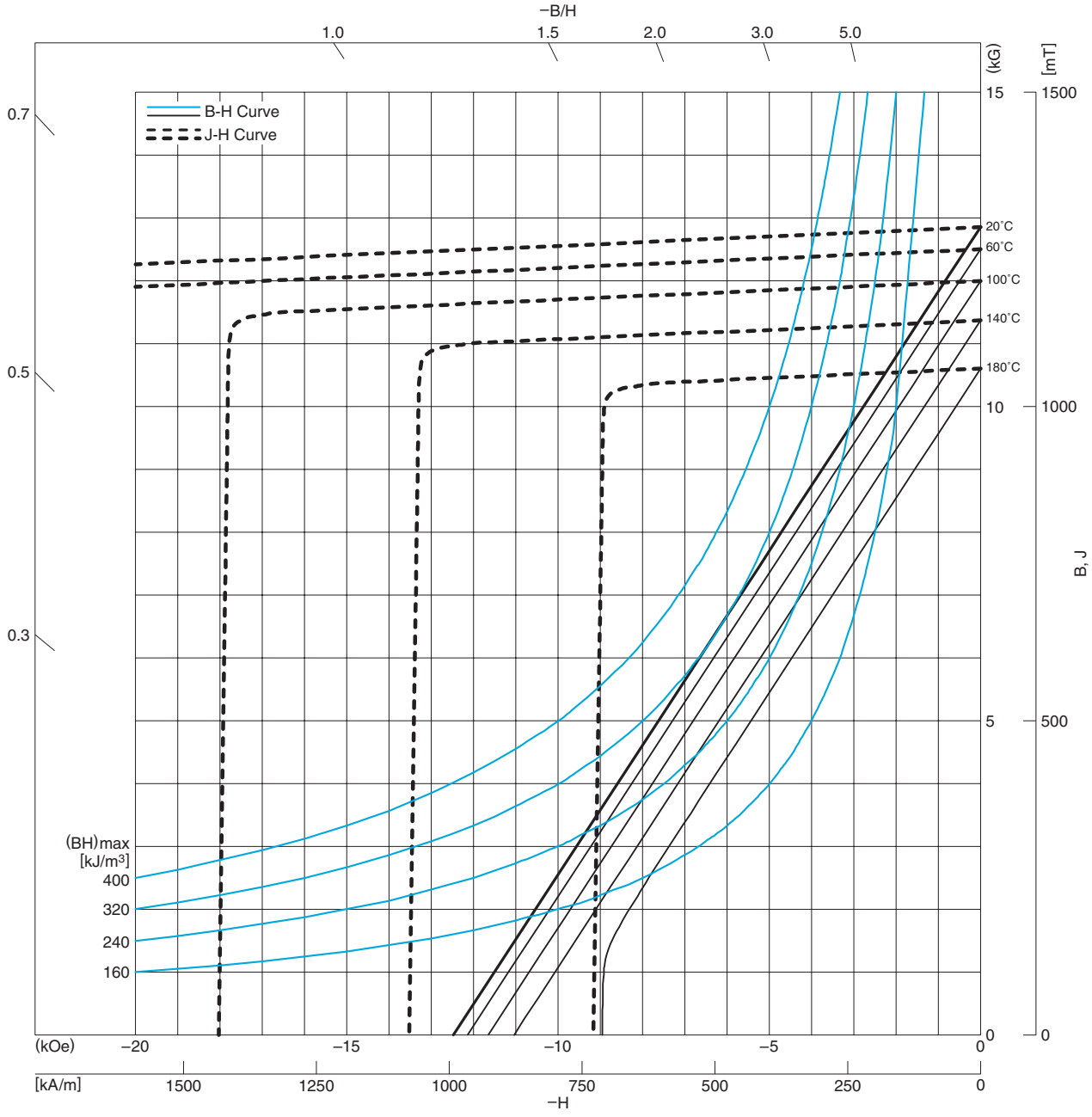


MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1260±30
Br	(kG)	12.6±0.3
Coercive force	[kA/m]	963±56
H_{CB}	(kOe)	12.1±0.7
Intrinsic coercive force	[kA/m]	≧1990
H_{CJ}	(kOe)	≧25
Maximum energy product	[kJ/m^3]	294±16
(BH)max	(MGOe)	37±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC40TH
DEMAGNETIZATION CURVE



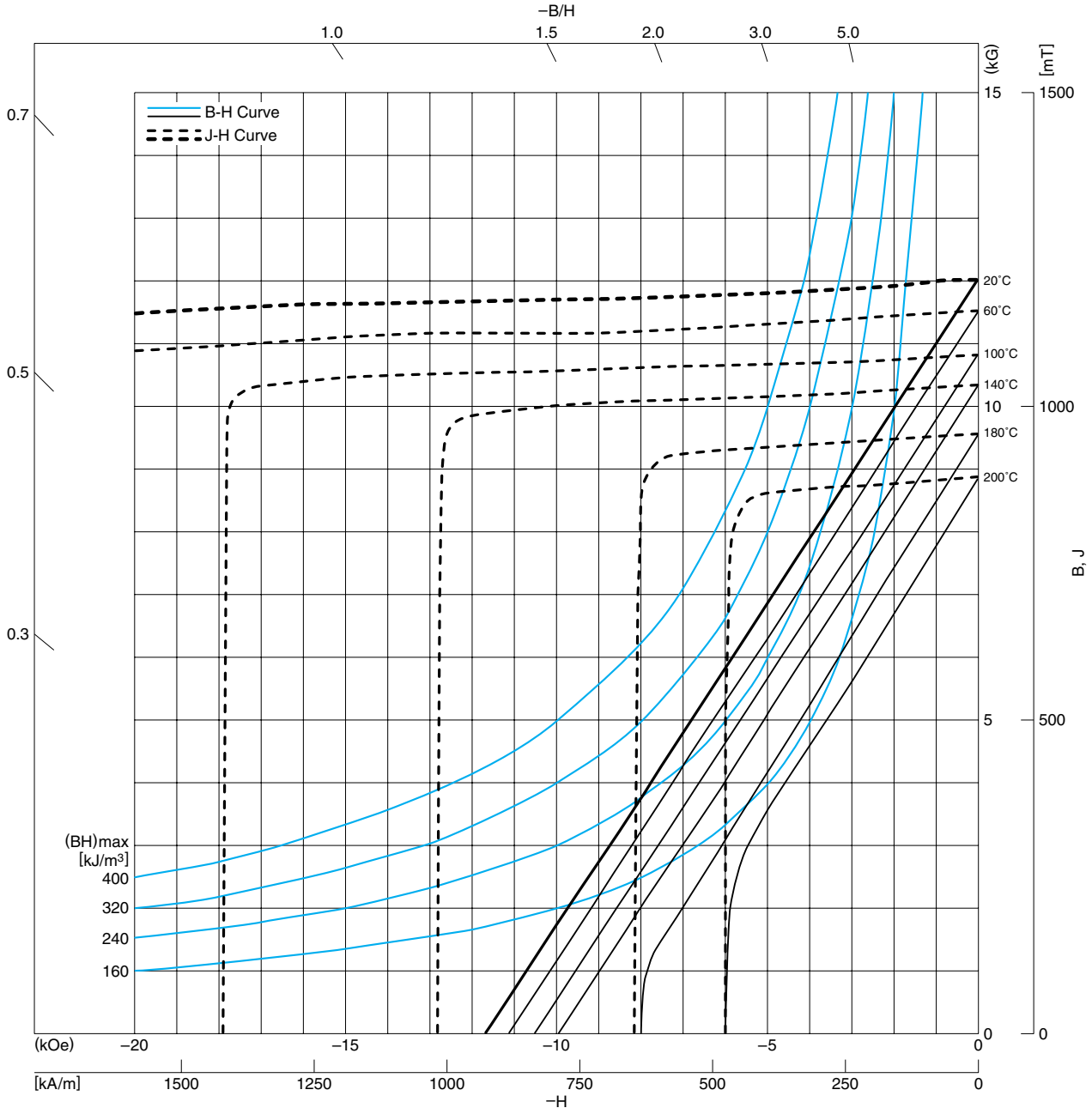
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1285±30
Br	(kG)	12.85±0.3
Coercive force	[kA/m]	993±56
H_{CB}	(kOe)	12.5±0.7
Intrinsic coercive force	[kA/m]	≧ 2109
H_{CJ}	(kOe)	≧ 26.5
Maximum energy product	[kJ/m³]	319±16
(BH)max	(MGOe)	40.1±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC35UX

DEMAGNETIZATION CURVE



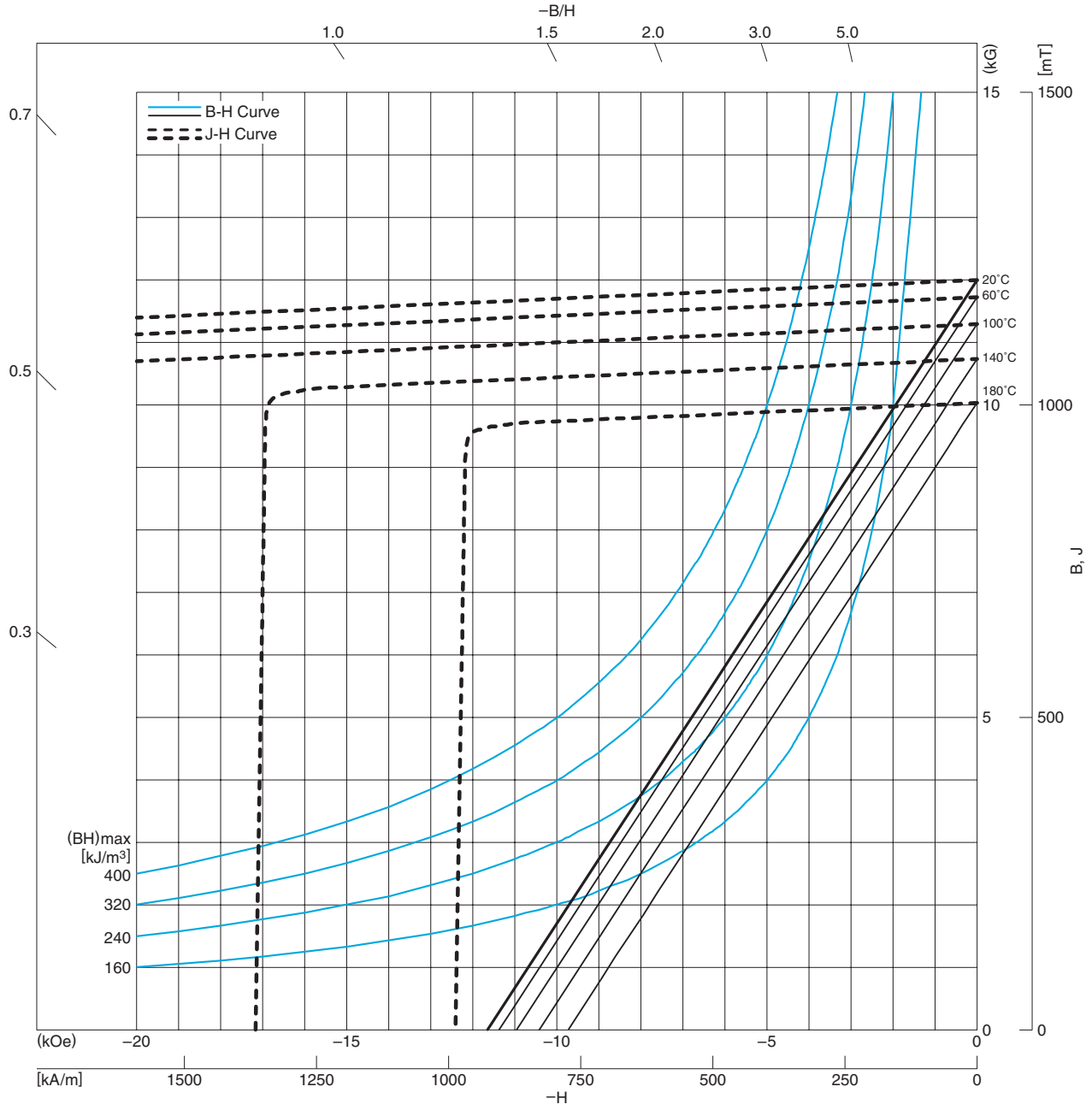
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1200±30
Br	(kG)	12.0±0.3
Coercive force	[kA/m]	923±56
H_{CB}	(kOe)	11.6±0.7
Intrinsic coercive force	[kA/m]	≧2388
H_{CJ}	(kOe)	≧30
Maximum energy product	[kJ/m^3]	271±16
(BH)max	(MGOe)	34±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC35NX

DEMAGNETIZATION CURVE



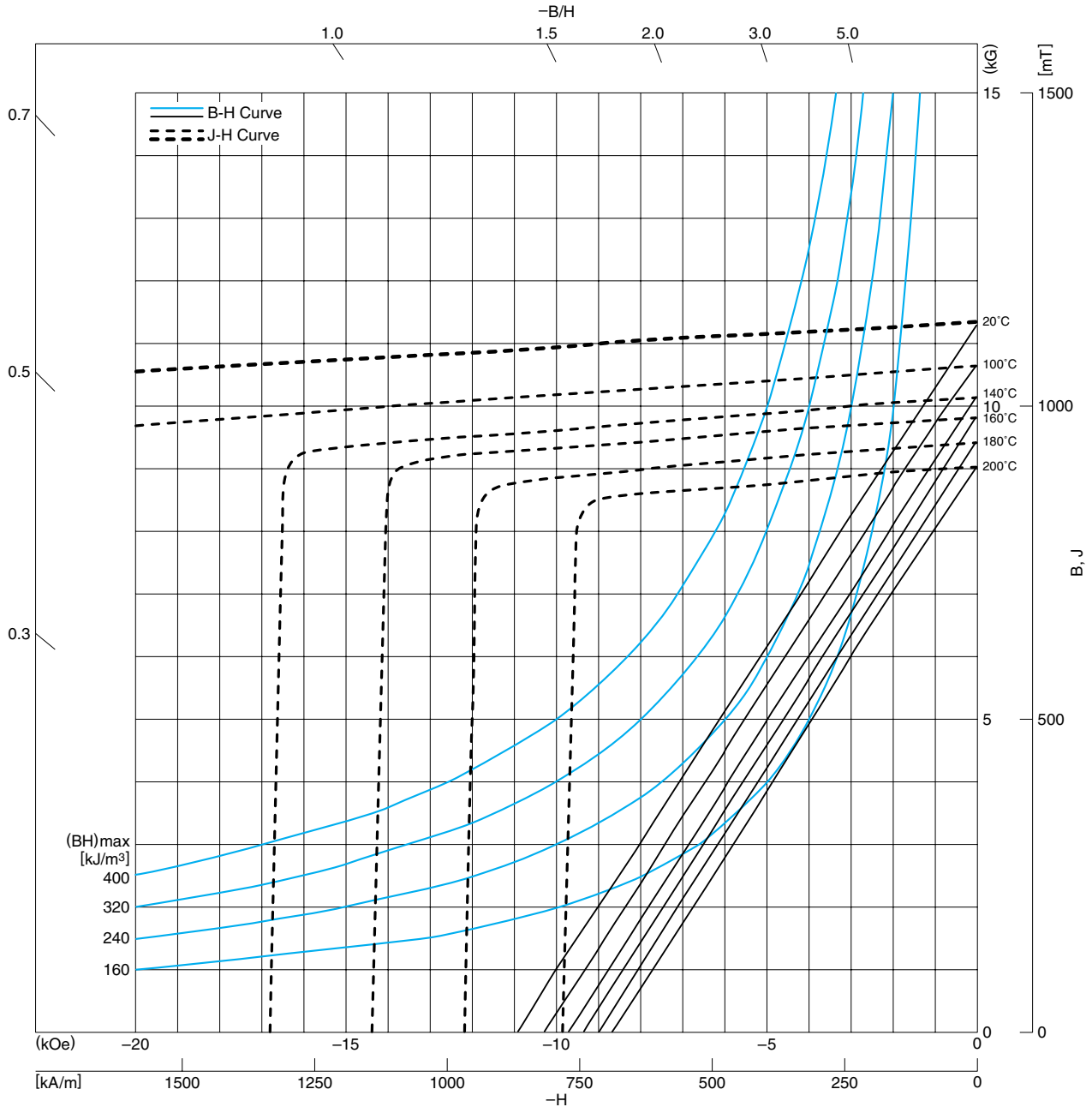
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1200±30
Br	(kG)	12.0±0.3
Coercive force	[kA/m]	920±56
H_{CB}	(kOe)	11.6±0.7
Intrinsic coercive force	[kA/m]	≧ 2626
H_{CJ}	(kOe)	≧ 33
Maximum energy product	[kJ/m^3]	278±16
(BH)max	(MGOe)	35.0±2

• [ ]: in the unit of SI
( ): in the unit of CGS

NEOREC30EV

DEMAGNETIZATION CURVE



MAGNETIC CHARACTERISTICS

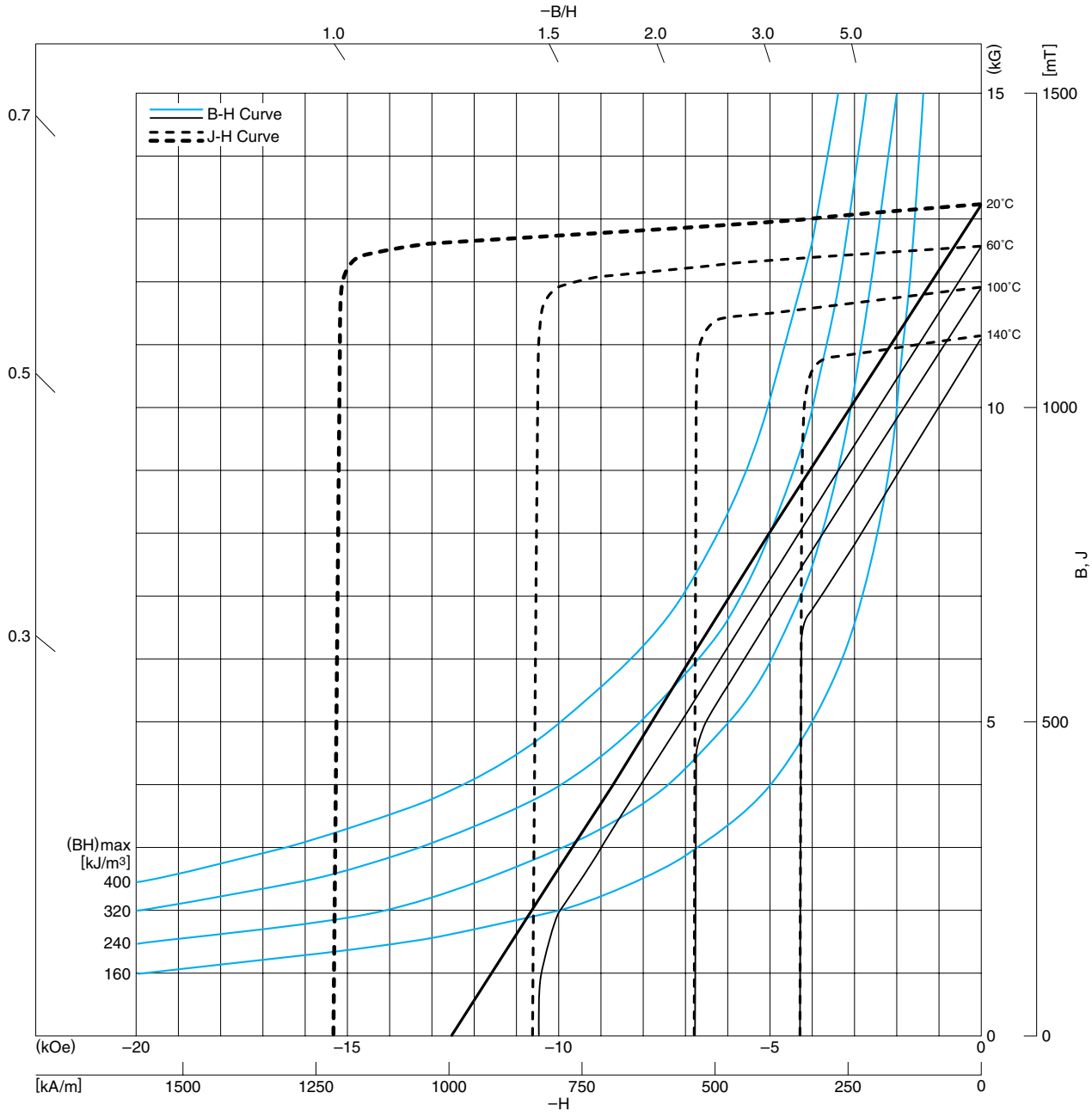
Residual flux density	[mT]	1140±30
Br	(kG)	11.4±0.3
Coercive force	[kA/m]	867±56
H_{CB}	(kOe)	10.9±0.7
Intrinsic coercive force	[kA/m]	≧756*
H_{CJ}	(kOe)	≧9.5*
Maximum energy product	[kJ/m3]	231±16
(BH)max	(MGOe)	29±2

* at 200 °C

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC42B

DEMAGNETIZATION CURVE



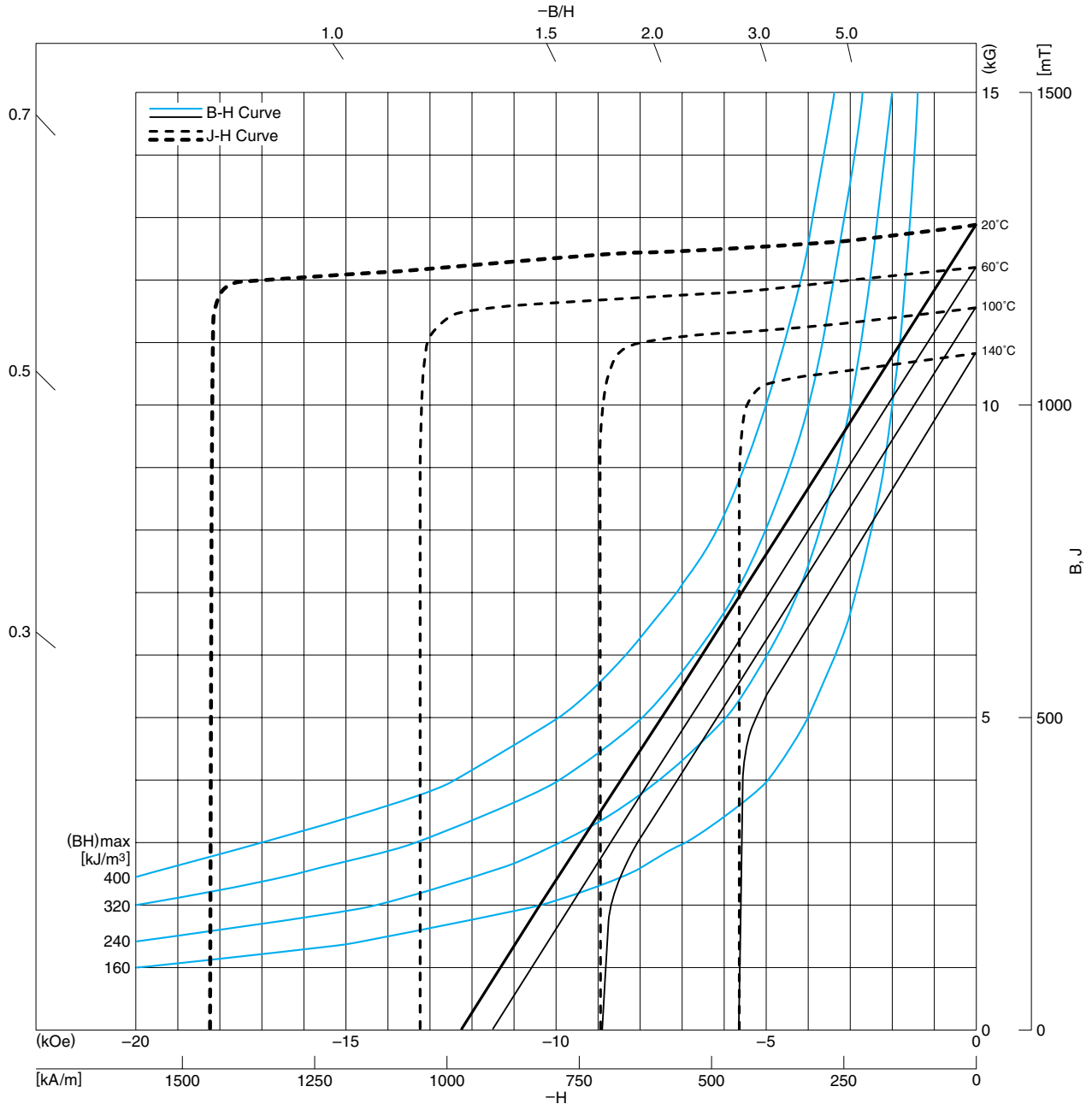
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1330±30
Br	(kG)	13.3±0.3
Coercive force	[kA/m]	987±56
H_{CB}	(kOe)	12.4±0.7
Intrinsic coercive force	[kA/m]	≧1114
H_{CJ}	(kOe)	≧14.0
Maximum energy product	[kJ/m^3]	334±16
(BH)max	(MGOe)	42±2

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC40H

DEMAGNETIZATION CURVE



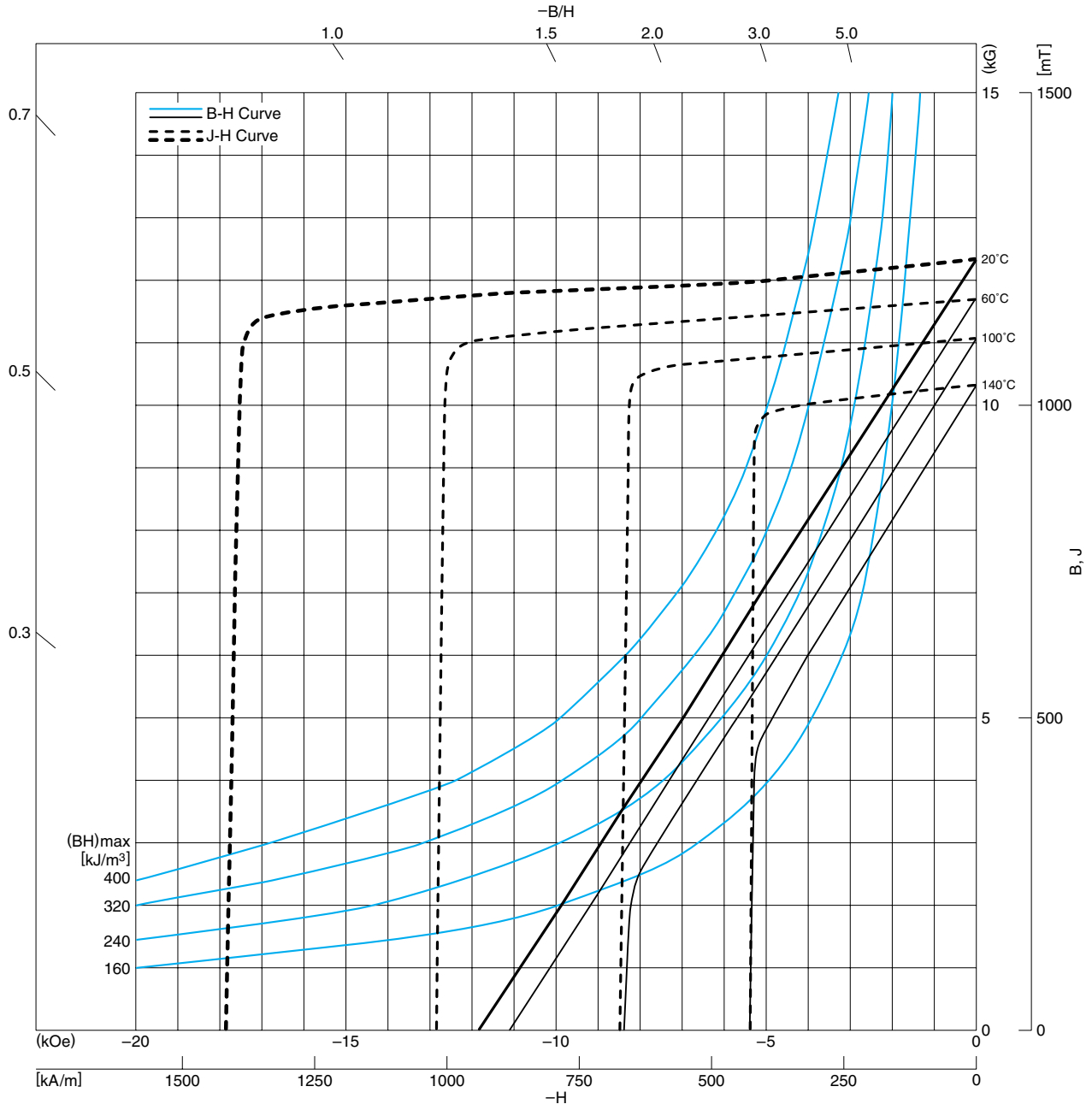
MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1300±30
Br	(kG)	13.0±0.3
Coercive force	[kA/m]	971±56
H_{CB}	(kOe)	12.2±0.7
Intrinsic coercive force	[kA/m]	≧1353
H_{CJ}	(kOe)	≧17.0
Maximum energy product	[kJ/m^3]	318±16
(BH)max	(MGOe)	40±2

- [ ]: in the unit of SI
  ( ): in the unit of CGS

NEOREC37H

DEMAGNETIZATION CURVE



MAGNETIC CHARACTERISTICS

Residual flux density	[mT]	1240±30
Br	(kG)	12.4±0.3
Coercive force	[kA/m]	923±56
H_{CB}	(kOe)	11.6±0.7
Intrinsic coercive force	[kA/m]	≧1353
H_{CJ}	(kOe)	≧17.0
Maximum energy product	[kJ/m^3]	294±16
(BH)max	(MGOe)	37±2

• [ ]: in the unit of SI
( ): in the unit of CGS