

# Neodymium-Iron-Boron magnets

Product information



thyssenkrupp



REFeB magnets are made of an alloy of neodymium (Nd), iron (Fe), and boron (B) ( $\text{Nd}_2\text{Fe}_{14}\text{B}$ ). The highest qualities are reached by adding materials like Co, Dy and Tb. They are the strongest commercially available types of permanent magnets.

Magnets made from REFeB alloys enable the realisation of new technological solutions as well as the reduction of magnetic material with the same performance level of the system and not least the possibility of miniaturising the whole system.

In contrast to RECo magnets the raw materials for REFeB magnets are more readily available as the content of neodymium in rare earth ores is substantially higher than that of samarium. Recently admixtures of precious materials as Co, Dy and Tb are used to achieve higher qualities.

## Magnet shapes

Compression-mold pressed block, ring, segment and cylinder magnets can be produced. Small and micro magnets can be cut from larger blocks. Today it is common sense to press bigger blocks which will be subsequently cut down, grinded or eroded to the needed size.

## Delivery program

Our range comprises a wide selection of REFeB materials with differing magnetic properties. They permit material selection tailored to individual application requirements. We look forward to advising you in detail.

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## Magnetic properties

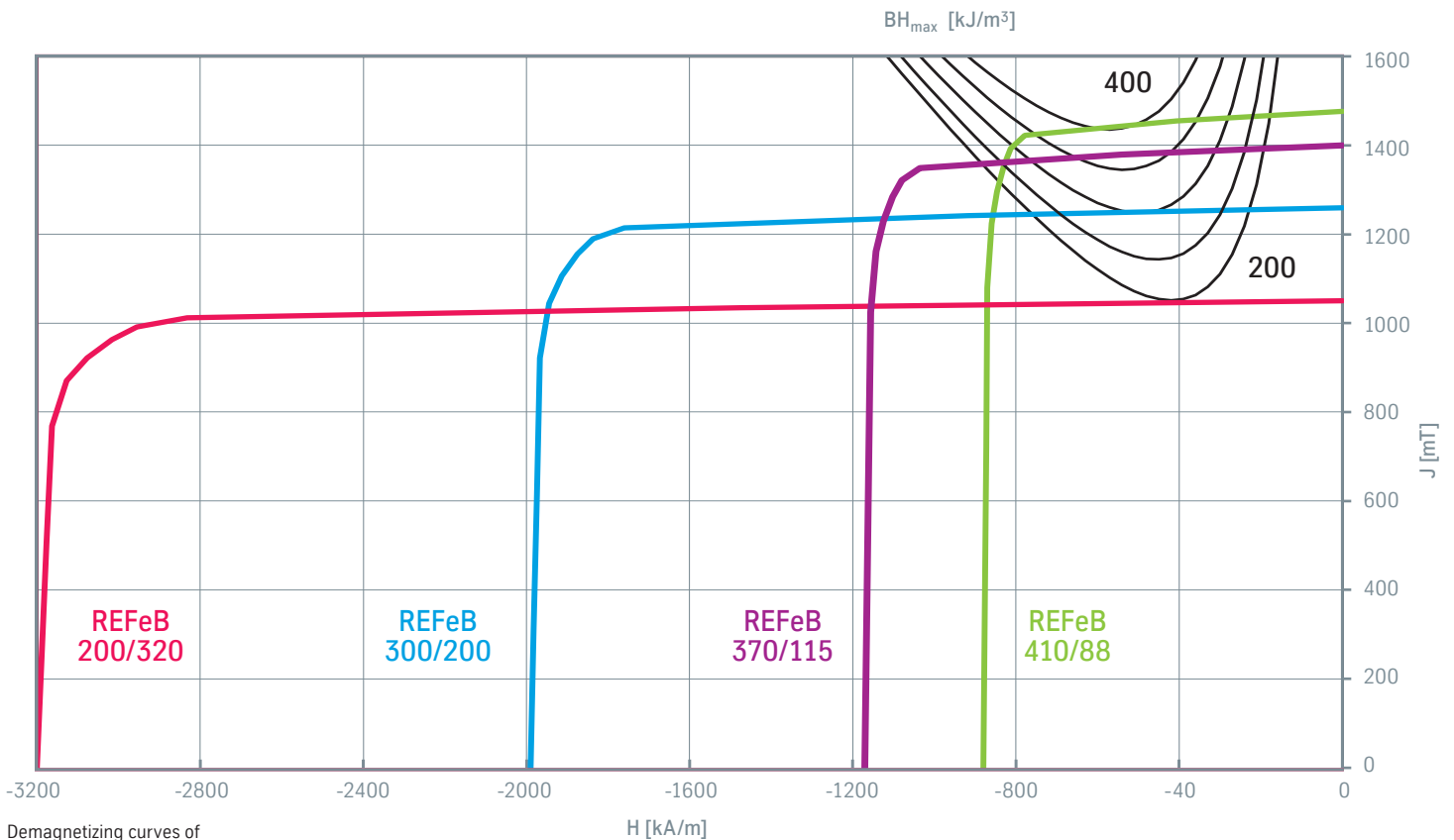
Raw material		Remanent magnetization		Coercivity				Energy product		Operation temperature	Temperature coefficient	
		$B_r$		$H_{cJ}$		$H_{cB}$		$(BH)_{max}$		$T_{max}^*$	$TK(B_r)$	$TK(H_{cJ})$
		mT	kG	kA/m	kOe	kA/m	kOe	$\text{kJ/m}^3$	MGOe	°C	%/K	%/K
REFeB 410/88	min	1470	14.7	880	11	836	10.5	414	52	70	-0.110	-0.75
REFeB 370/110	min	1400	14.0	1100	14	1040	13.1	374	47	80	-0.100	-0.65
REFeB 330/140	min	1300	13.0	1350	17	970	12.2	330	41	120	-0.110	-0.55
REFeB 340/160	min	1330	13.3	1590	20	995	12.5	340	43	150	-0.100	-0.50
REFeB 300/200	min	1260	12.6	1990	25	940	11.8	300	38	180	-0.100	-0.50
REFeB 300/240	min	1260	12.6	2400	30	940	11.8	300	38	200	-0.095	-0.50
REFeB 225/280	min	1140	11.4	2800	35	850	10.7	225	31	225	-0.090	-0.45
REFeB 200/320	min	1050	10.5	3200	40	770	9.7	200	26	250	-0.090	-0.45

The relative permeability ( $\mu_p$ ) is between 1.04–1.12.

\* The actual maximum application temperature depends on the magnet's shear. This can only be precisely determined through a field-numeric calculation.

Selected material qualities (according EN 60404-8-1:2015). Further qualities on request.

## Demagnetizing curves



## Physical properties

Raw material	Density	Young's modulus	Flexural strength	Compressive strength	Vickers hardness	Electrical resistivity	Heat capacity	Thermal conductivity	Coefficient of linear thermal expansion	
									in mag. direction	normal to mag. direction
	$\rho$ g/cm <sup>3</sup>	E kN/mm <sup>2</sup>	F <sub>B</sub> N/mm <sup>2</sup>	F <sub>P</sub> N/mm <sup>2</sup>	H <sub>v</sub>	$\rho$ Ω mm <sup>2</sup> /m	C J/kg K	$\lambda$ W/m K	$\Delta dl_0$ 10 <sup>-6</sup> /K	$\Delta dl_0$ 10 <sup>-6</sup> /K
REFeB	~7.5	140	250	750	570	1.5	440	9	5	-1

Curie temperature  
T<sub>c</sub> = 310-370°C

## Chemical resistance

REFeB magnets are not resistant to inorganic acids and alkaline solutions. Due to their high level of susceptibility to corrosion (surface rust corrosion) suitable surface protection should be applied for certain applications. This comes in the form of metallic coatings based on tin (Sn), zinc (Zn) and nickel (Ni). Varnish or plastic coatings can also be used.

Recent progress in the further development of this material has successfully diminished the corrosion problem.

## Production

Like RECo magnets, Neodymium-Iron-Boron magnets are produced by the process of powder metallurgical sintering. The alloys can be produced by different processes: by melting and blending of certain raw materials or by reduction/diffusion of rare earth oxides and metals followed by grinding.

The nanocrystalline powder with a grain size of approximately 3–5 μm is dispensed into the blanking die of a mold. Then pressing under the influence of a magnetic field produces an anisotropic magnet. This aligns the anisotropic powder particles

parallel to the direction of the magnetic field. The pressing process condenses the material and fixes the alignment. After that, in order to archive even higher quantities, an isostatic pressing process takes place. By this the density and homogeneity are increased. The magnets are then sintered at temperatures between 1030–1100°C in an inert gas atmosphere or a vacuum. Sintering results in shrinkage of between 15–20%. The density values measure between 7.4–7.6 g/cm<sup>3</sup>. The components are subsequently heat treated at temperatures of 600–900°C. If specific tolerances are required the components can be ground after heat treatment.

## Temperature behavior

The strong temperature dependence of REFeB magnets is mirrored by changing magnetic values affected by temperature. Due to the negative temperature coefficients of rare earth metals the relocation of the operating point should be considered. The values of the above mentioned table (Magnetic properties) have been measured at room temperature of 20°C.

## General note

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