Materials Services | Materials Germany

Plastic-bonded NdFeB magnets

Product information

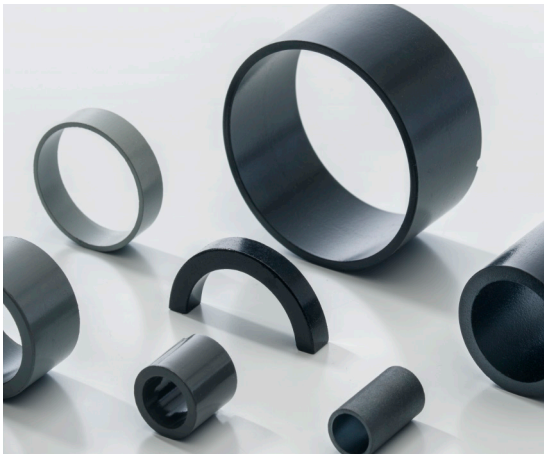
thyssenkrupp

Plastic-bonded magnets are particle composites with permanent-magnet powder embedded in a plastic binder. Hard ferrite (HF), various SmCo and NdFeB powders and, to a very little extent, AlNiCo alloys are used as magnetic powder. For embedding the magnetic particles thermoplastic binders as, for instance, polyamide (PA) or polyphenylene sulfide (PPS) and duroplasts like epoxy resins are used.

Depending on the material composition and production process isotropic and anisotropic magnets with differing magnetic and mechanical specifications are available. Since not only the type of magnet or plastic material but also the filling and alignment degree determine the composite's properties widely varying magnetic parameters and an outstanding variety in types and shapes arise.

The rigid plastic-bonded magnets have two production processes. Injection molding is the most frequently used. Compression molding is used especially for plastic-bonded rare-earth magnets.

Content



Magnet shapes

One of the essential advantages of plastic-bonded magnets is their shaping variety as a result of injection molding. The thermoplastic grades manufactured by injection molding offer easy possibilities of direct embedding into other structural parts, e.g. shafts, hubs, bushings or housing parts. Hence, ready-to-install components can be produced in a single process. The tolerances maintained through injection molding allow the magnets to be squeezed into bores or hubs in a single cycle. Moreover, complex shapes and geometries, thin-walled ring magnets, flat disk and ring magnets, pot-shaped magnets, sections, reinforcement fins, sectional bores and much more are feasible.

Apart from cylinders, blocks and ring shapes, any pressed geometry is feasible.

Such variety is reflected in our product range.

Delivery program

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

Magnetic properties

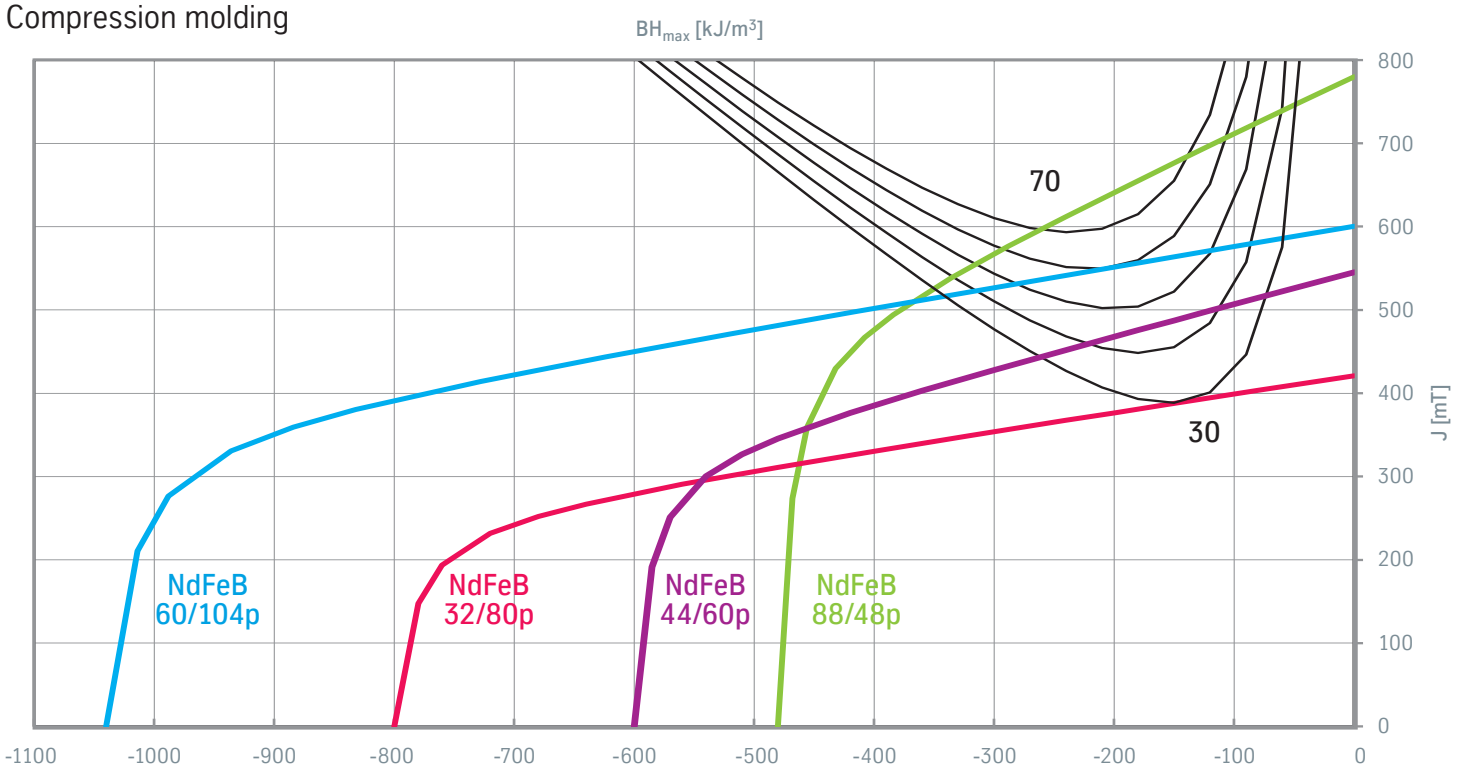
Raw material				Remanent magnetization		Coercivity				Energy product		Temperature coefficient		Density
				B_r		H_{cJ}		H_{cB}		$(BH)_{max}$		$TK(B_r)$	$TK(H_{cJ})$	ρ
				mT	kG	kA/m	kOe	kA/m	kOe	kJ/m³	MGOe	%/K	%/K	g/cm³
NdFeB 40/64p	i	I	min	490	4900	640	8.0	380	4.8	40	5.0	-0.11	-0.6	4.5
NdFeB 43/80p	i	I	min	530	5300	800	10.0	390	4.9	44	5.5	-0.11	-0.6	5.3
NdFeB 44/63p	i	I	min	500	5000	630	7.9	320	4.0	44	5.5	-0.11	-0.6	5.0
NdFeB 44/96p	i	I	min	480	4800	960	12.0	380	4.8	44	5.5	-0.11	-0.6	5.0
NdFeB 51/63p	i	I	min	550	5500	630	7.9	340	4.3	51	6.5	-0.11	-0.6	4.9
NdFeB 87/100p	a	I	min	700	7000	1000	12.5	480	6.0	87	11.0	-0.12	-0.6	5.1
NdFeB 120/100p	a	I	min	840	8400	1000	12.5	550	6.9	120	15.3	-0.12	-0.6	5.5
NdFeB 32/80p	i	C	min	420	4200	800	10.4	290	3.6	32	4.0	-0.11	-0.6	4.4
NdFeB 44/60p	i	C	min	550	5500	600	7.5	285	3.5	44	5.5	-0.11	-0.6	5.5
NdFeB 55/95p	i	C	min	560	5600	950	11.9	380	4.8	56	7.0	-0.12	-0.6	5.9
NdFeB 60/104p	i	C	min	600	6000	1040	13.0	400	5.0	60	7.5	-0.11	-0.6	5.8
NdFeB 76/64p	i	C	min	680	6800	640	8.0	400	5.0	76	9.5	-0.11	-0.6	5.9
NdFeB 88/48p	i	C	min	780	7800	480	6.0	400	5.0	88	11.0	-0.12	-0.6	6.1

a = anisotropic; i = isotropic; I = Injection molding; C = Compression molding
The maximal operation temperature is depending on geometry, magnet material and used plastic binder.

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

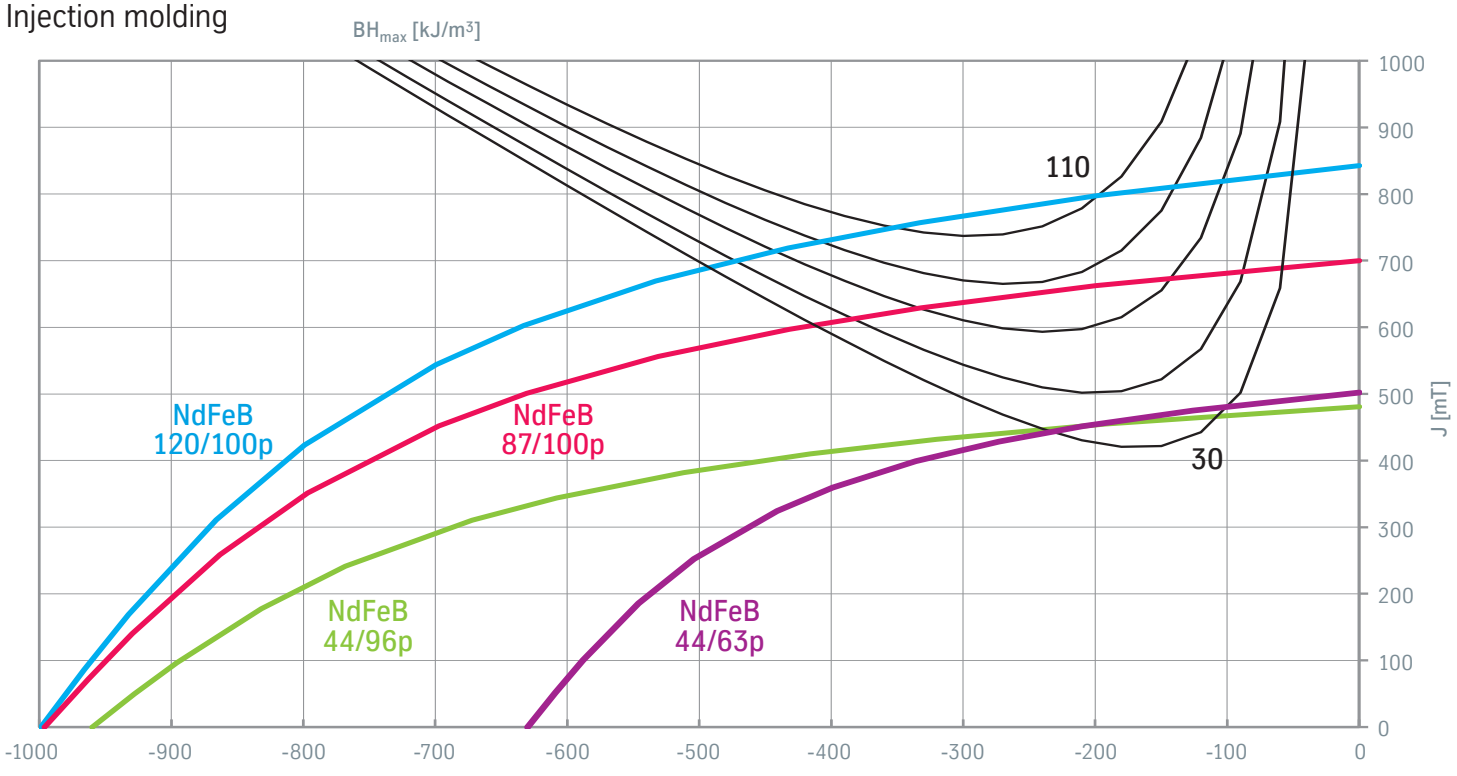
Demagnetizing curves

Compression molding



Demagnetizing curves of selected compression molded plastic-bonded NdFeB magnets

Injection molding



Demagnetizing curves of selected injection molded plastic-bonded NdFeB magnets

Mechanical properties

The more favorable mechanical behavior of plastic-bonded NdFeB magnets when compared to sintered magnets is immediately evident. Due to the plastic bonded, such magnets feature a certain elasticity or viscosity. Hence, the brittleness characteristic of NdFeB magnets is avoided. This offers decisive advantages for further processing the magnets. The given toughness permits a combination with other structural parts by exploiting the tight tolerances in injection molding, as, for instance, pressing-in of axles into rotors from plastic-bonded magnetic materials. But the mechanical properties of plastic-bonded magnets depend to a large degree on the plastic used and the corresponding filling degree. Generally valid statements are therefore hard to make. Hence, application-specific tests have to be carried out in individual cases.

Chemical resistance

For all polymer permanent magnets applies: The chemical resistance to alkalis and acids have to be examined in the specific application.

Production

In the injection molding process a compound is mixed from the magnet powders and plastics. Then the rare-earth powder is embedded into thermoplastics and granulated. The granulate is processed on injection-molding machines into magnet moldings.

In compression molding technology, only of economic relevance for manufacturing plastic-bonded rare-earth magnets, the NdFeB powder is combined with duroplastic resins and then processed in tools and presses. In the compression tools, the compound mixtures are subsequently molded into the most frequently used shapes as blocks, disks, rings, flat sections and segments. After shaping, a thermal hardening phase follows, making the pressed material mechanically stable.

These production processes are followed by finishing and surface cleaning stages. Depending on customer demands, the parts are magnetized and the surface marked or coated.

Plastic-bonded NdFeB magnets are especially used in applications where hard ferrite magnets cannot meet magnetic specifications or where sintered rare-earth magnets are not used for economic or production-related reasons. Further advantages are that plastic-injected magnets based on NdFeB are generally magnetically isotropic and hence can be magnetized in any direction with any number of poles. Additionally the compression-molded grades have a higher energy product which allows smaller component shapes when compared to hard ferrites.

Temperature behavior

The magnetic properties' temperature factor basically equals that of the compact NdFeB. The temperature coefficient of remanent magnetization TK (B_r) and the coercive field strength's temperature coercivity TK (H_{cJ}) are TK (B_r) = -0.12 %/K and TK (H_{cJ}) = -0.4–0.8 %/K respectively.

The maximum permitted application temperature primarily depends on the used plastic binder as well as the dimension ratio. For plastic-bonded NdFeB magnets, this is approx. 100 °C and 150 °C for compression molded and injection molded magnets respectively (PA6, PA12). For temperatures up to 180 °C highly temperature-resistant materials are available, e.g. polyphenylene sulfides (PPS). These descriptions are to be regarded as guidelines and have to be checked on a case-by-case basis.

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