Materials Services | Materials Germany

Plastic-bonded hard ferrite 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

engineering.tomorrow.together.

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.

Such variety is reflected in our product range.

Delivery program

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

Mechanical properties

The more favorable mechanical behavior of plastic-bonded hard ferrite magnets when compared to sintered hard ferrite magnets is immediately evident. Due to the plastic-bonded, such magnets feature a certain elasticity or viscosity. Hence, the brittleness characteristic of hard ferrite 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 exanimated in the specific application. In respect to hard ferrite magnets the chemical resistance is mainly given by the used polymer, as the HF powder is chemically stable itself.

Production

In the injection molding process a compound is mixed from the magnet powders and plastics. Then hard ferrite powder is embedded into thermoplastics and granulated. The granulated material is processed on injection molding machines into magnet moldings. In these 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. This is followed by the finishing and surface cleaning stages. Depending on customer demands, the parts are magnetized and the surface marked or coated.

In the compression molding process for rigid plastic-bonded hard ferrite magnets, particles with permanent magnetic properties from barium or strontium ferrite are embedded into a duroplastic. The volume of the hard ferrite powder is a decisive factor in the magnetism achieved. Due to this “thinning effect”, plastic-bonded hard ferrite magnets cannot reach the magnetic values of the input (solid) material. Plastic-bonded magnets will have weaker magnetic properties at the same volume than sintered isotropic magnets. Higher magnetic values can be achieved with anisotropic plastic-bonded hard ferrite magnets, however not reaching the level of sintered anisotropic hard ferrite magnets. The ferrite/plastic mixing ratio will also influence the magnet’s elasticity and hardness.

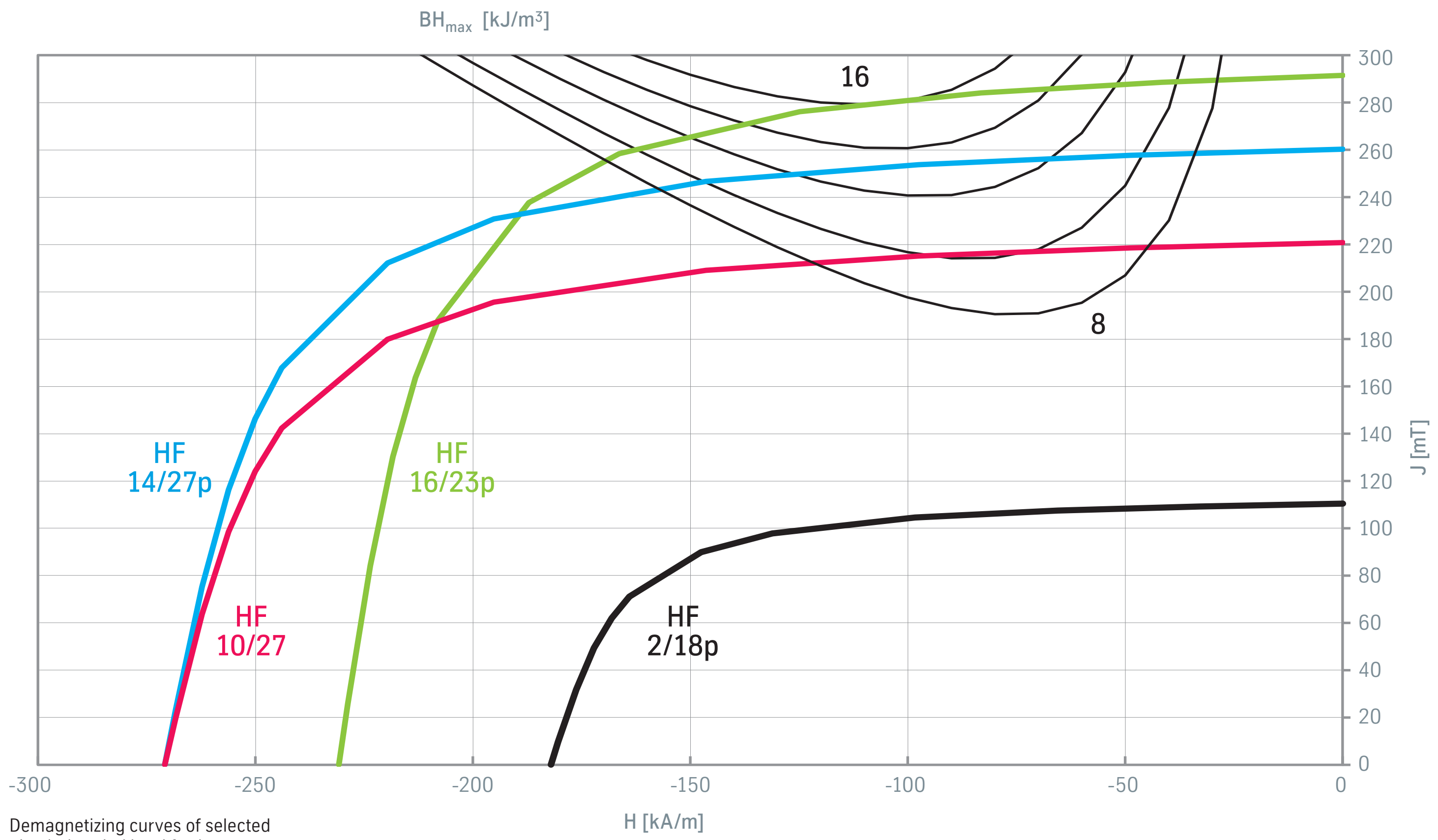
Magnetic properties

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
Hard ferrite 2/18p	i	I	min	110	1100	185	2.3	75	0.9	2.0	0.3	-0.19	0.3	2.8
Hard ferrite 3/20p	i	I	min	130	1300	200	2.5	85	1.1	2.8	0.4	-0.19	0.3	3.5
Hard ferrite 5/22p	i	I	min	170	1700	220	2.8	120	1.5	5.0	0.6	-0.19	0.3	3.5
Hard ferrite 10/27p	a	I	min	240	2400	270	3.4	210	2.6	10.7	1.3	-0.19	0.3	3.2
Hard ferrite 11/23p	a	I	min	240	2400	230	2.9	170	2.1	11.1	1.4	-0.19	0.3	3.3
Hard ferrite 12/22p	a	I	min	250	2500	220	2.8	170	2.1	13.3	1.7	-0.19	0.3	3.4
Hard ferrite 13/23p	a	I	min	260	2600	230	2.9	185	2.3	13.0	1.6	-0.19	0.3	3.4
Hard ferrite 14/27p	a	I	min	260	2600	270	3.4	190	2.4	14.0	1.8	-0.19	0.3	3.8
Hard ferrite 15/21p	a	I	min	280	2800	210	2.6	180	2.3	15.0	1.9	-0.19	0.3	3.8
Hard ferrite 16/23p	a	I	min	290	2900	230	2.9	200	2.5	16.5	2.1	-0.19	0.3	3.8

a = anisotropic; i = isotropic; I = Injection 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.

Demagnetization curves



Demagnetizing curves of selected plastic-bonded hard ferrite magnets

Temperature behavior

The magnetic properties' temperature factor basically equals that of the compact hard ferrite. The temperature coefficient of remanent magnetization TK (B_r) and temperature coefficient of coercivity TK (H_{cJ}) are TK (B_r) = -0.2 %/K and TK (H_{cJ}) = 0.2–0.5 %/K respectively.

The temperature behavior of the plastic-bonded ferrite materials can cause magnets and magnet systems with a very low operating point to suffer a permanent (irreversible) magnetization loss when exposed to low temperatures.

The maximum permitted application temperature primarily depends on the plastic binder used as well as the dimension ratio. For plastic-bonded hard ferrite magnets, this is approx. 130 °C. For higher permanent-use temperatures up to 200 °C, highly temperature-resistant materials are available, with polyphenylene sulfides (PPS) acting as substrate.

Contact
thyssenkrupp Magnettechnik
Branch of thyssenkrupp Schulte GmbH
Am Hellweg 7, 44805 Bochum, Germany
T: +49 234 622014-00
www.thyssenkrupp-magnettechnik.com
magnet@thyssenkrupp-materials.com