AlNiCo magnets

Product information

AlNiCo magnets are iron based permanent magnets which are composed primarily of aluminium (Al), nickel (Ni) and cobalt (Co). They also include iron (Fe), copper (Cu) and sometimes titanium (Ti). During the production process, isotropic and anisotropic magnets can be manufactured with different magnetic properties. They have substantial magnetic stability against temperature influences (up to 500 °C) and a high remanence level.

AlNiCo magnets can be magnetized and demagnetized easily. That can be evaluated as an advantage as well as a drawback.

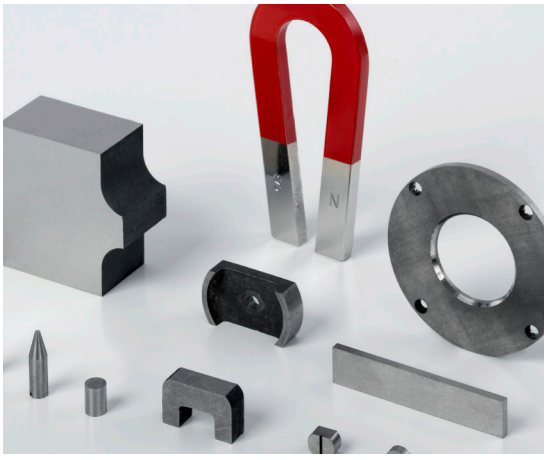
Content

Magnet shapes

In principle all shapes can be produced by powder metallurgy processes or by casting: rod, bar magnets, blocks, horse shoe magnets, ring magnets and other shapes.

AlNiCo magnets are hard and brittle; machining is generally only possible by grinding.

Grooves, drill holes, indents, etc. can be pressed into the magnets as long as they are parallel to the direction of pressing.



Delivery program

Our range comprises a wide selection of various AlNiCo 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		Operating temperature	Temperature coefficient	
		B_r		H_{cJ}		$(BH)_{max}$		T_{max}	$TK(B_r)$	$TK(H_{cJ})$
cast		mT	kG	kA/m	kOe	kJ/m³	MGOe	°C	%/K	%/K
AlNiCo 10/4	i	610	6.1	40	0.50	10.0	1.30	450	-0.030	-0.02
AlNiCo 13/5	i	700	7.0	48	0.60	12.8	1.60	450	-0.030	-0.02
AlNiCo 18/10	i	610	6.1	102	1.30	18.0	2.30	450	-0.030	-0.02
AlNiCo 29/6	a	1000	10.0	60	0.75	29.0	3.65	525	-0.020	0.03
AlNiCo 38/5	a	1220	12.2	50	0.60	38.0	4.75	525	-0.020	0.01
AlNiCo 38/12	a	800	8.0	125	1.57	38.0	4.75	550	-0.020	0.01
AlNiCo 44/5	a	1250	12.5	51	0.65	44.0	5.50	525	-0.020	0.01
AlNiCo 52/6	a	1300	13.0	56	0.70	52.0	6.50	525	-0.020	0.02
AlNiCo 72/11	a	1050	10.5	112	1.40	72.0	9.00	525	-0.020	0.03

a = anisotropic; i = isotropic
The relative permeability (μ_p) is between 2.5–5.

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

Magnetic properties

Raw material		Remanent magnetization		Coercivity		Energy product		Operating temperature	Temperature coefficient	
		B_r		H_{cJ}		$(BH)_{max}$		T_{max}	$TK(B_r)$	$TK(H_{cJ})$
sintered		mT	kG	kA/m	kOe	kJ/m³	MGOe	°C	%/K	%/K
AlNiCo 8/4	i	500	5.0	40	0.50	8	1.10	450	-0.022	-0.03
AlNiCo 12/5	i	640	6.4	50	0.63	12	1.50	450	-0.014	-0.03
AlNiCo 18/8	i	650	6.5	82	1.03	18	2.25	450	-0.020	-0.03
AlNiCo 28/6	a	1000	10.0	58	0.72	28	3.50	525	-0.020	-0.03
AlNiCo 35/5	a	1120	11.2	48	0.61	35	4.39	550	-0.020	-0.03
AlNiCo 36/12	a	800	8.0	123	1.54	36	4.52	525	-0.020	-0.03
AlNiCo 33/14	a	700	7.0	140	1.75	33	4.10	525	-0.020	-0.03

a = anisotropic; i = isotropic
The relative permeability (μ_p) is between 2.5–5.

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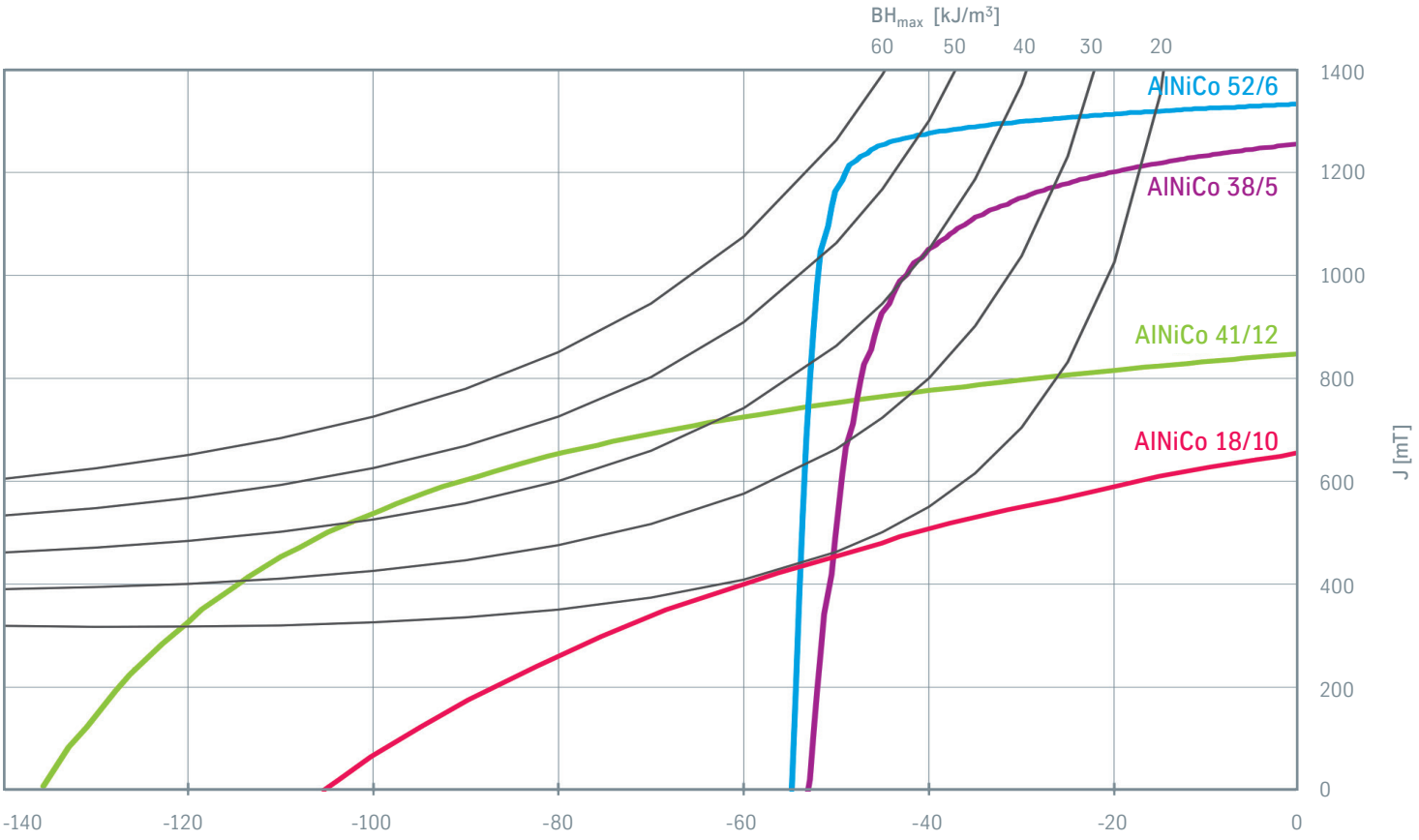
Demagnetizing curves



Demagnetizing curves of selected AlNiCo material qualities

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 magnetizing direction	Coefficient of linear thermal expansion normal to mag. direction
	ρ g/cm³	E kN/mm²	F_B N/mm²	F_P N/mm²	H_v	ρ Ω mm²/m	C J/kg K	λ W/m K	Δ dl_0 10^{-6}/K	Δ dl_0 10^{-6}/K
AlNiCo	7.1–7.3	100–200	250–600	300–400	~ 550	0.45–0.65	~ 400	10–100	13–14	13–14

Curie temperature
Tc = 820–870°C

Chemical resistance

Permanent AlNiCo magnets have an high level of corrosion resistance and are also resistant to oil, organic solvents, petrol and alcohol; they have a limited resistance to acetic acid, organic acids with a concentration level of < 10 %; they are not resistant to inorganic acids, salt water, citric acid, tartaric acid, strong alkaline solutions.

Chemical resistance

Minor effect Good	Moderate effect Fair	Sever effect Not recommended
Organic solvents	Acetic acid	Inorganic acids
Engine oil	Hydrogen peroxide	Tartaric acid
Petrol	Uric acid < 10 %	Citric acid
Alcohol		Salt water
		Aqueous solutions of salts

Production

AlNiCo magnets can be manufactured by casting and sintering.

The casting method is where the prematerials are molten and cast into sand or close tolerance dies.

The sintering process is where the prematerial powders are blended, dispensed into a closed die and then pressed to individual shapes. The components are consequently sintered in an inert gas atmosphere or a vacuum at approximately 1300 °C. This process ensures the required alloying and the density of the magnet. Depending on the press density and sintering temperature, sinter shrinkage of up to approximately 10 % can occur. The magnets are then subjected to certain heat treatment processes in order to further align and stabilize their elemental structure.

Temperature behavior

AlNiCo magnets are among all types of magnet materials those which are most independent in respect of temperature.

AlNiCo magnets are characterized by the lowest temperature coefficient of -0.02 % per Kelvin thus enabling a constant magnetic field even in case of considerable changes of temperature (operating temperature between -270 °C up to +550 °C are possible without generating metallurgical modification).

Losses caused by natural and artificial stabilization process can be remedied by remagnetization.

Toxicity

Due to their production process AlNiCo magnets are chemically inert and can be disposed in an environment – friendly way. Therefore no special measures according to waste disposal law need to be observed. For certain applications, i.e. direct contact with food, a plastic coating is advisable due to the cobalt content.

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