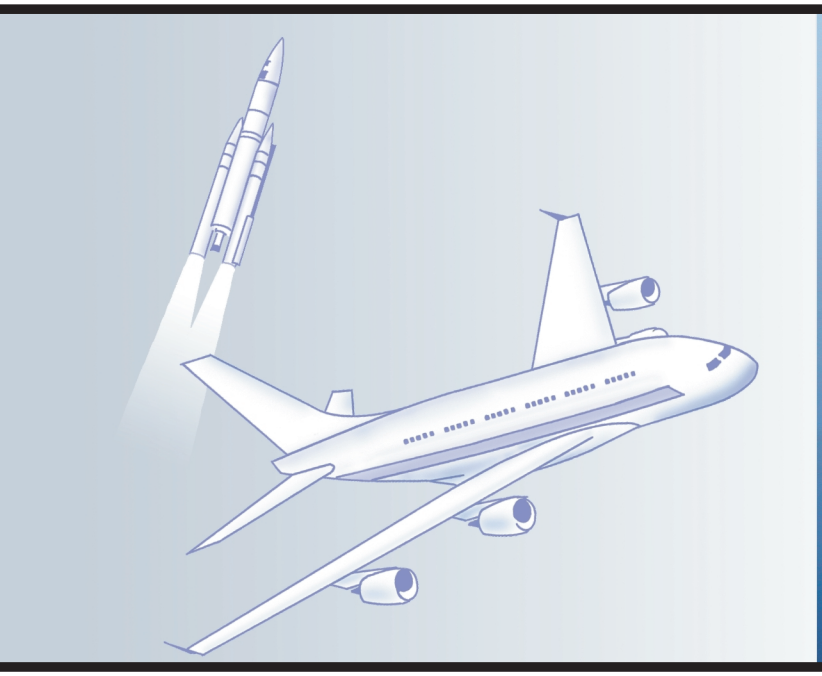
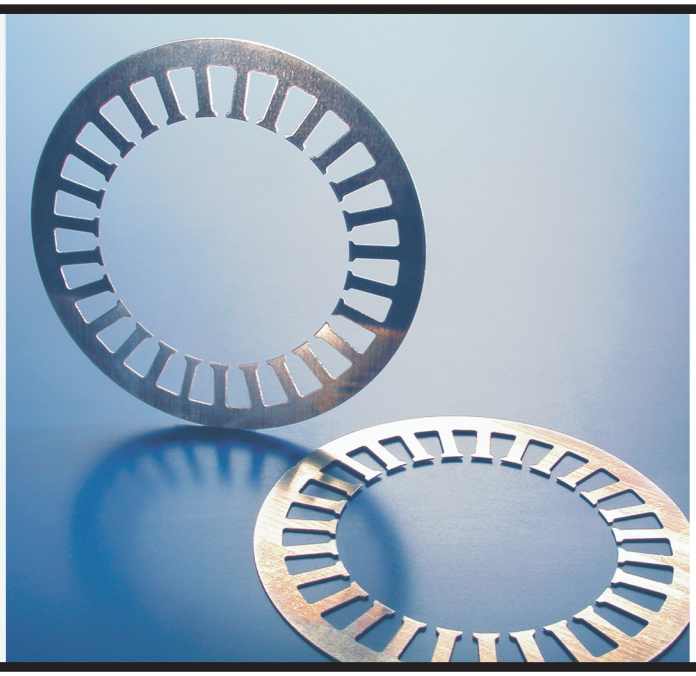
VACUUMSCHMELZE

Soft Magnetic Cobalt-Iron-Alloys

VACOFLUX 48 · VACOFLUX 50
VACODUR 50 · VACOFLUX 17





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VACOFLUX 48 • VACOFLUX 50 VACODUR 50 • VACOFLUX 17

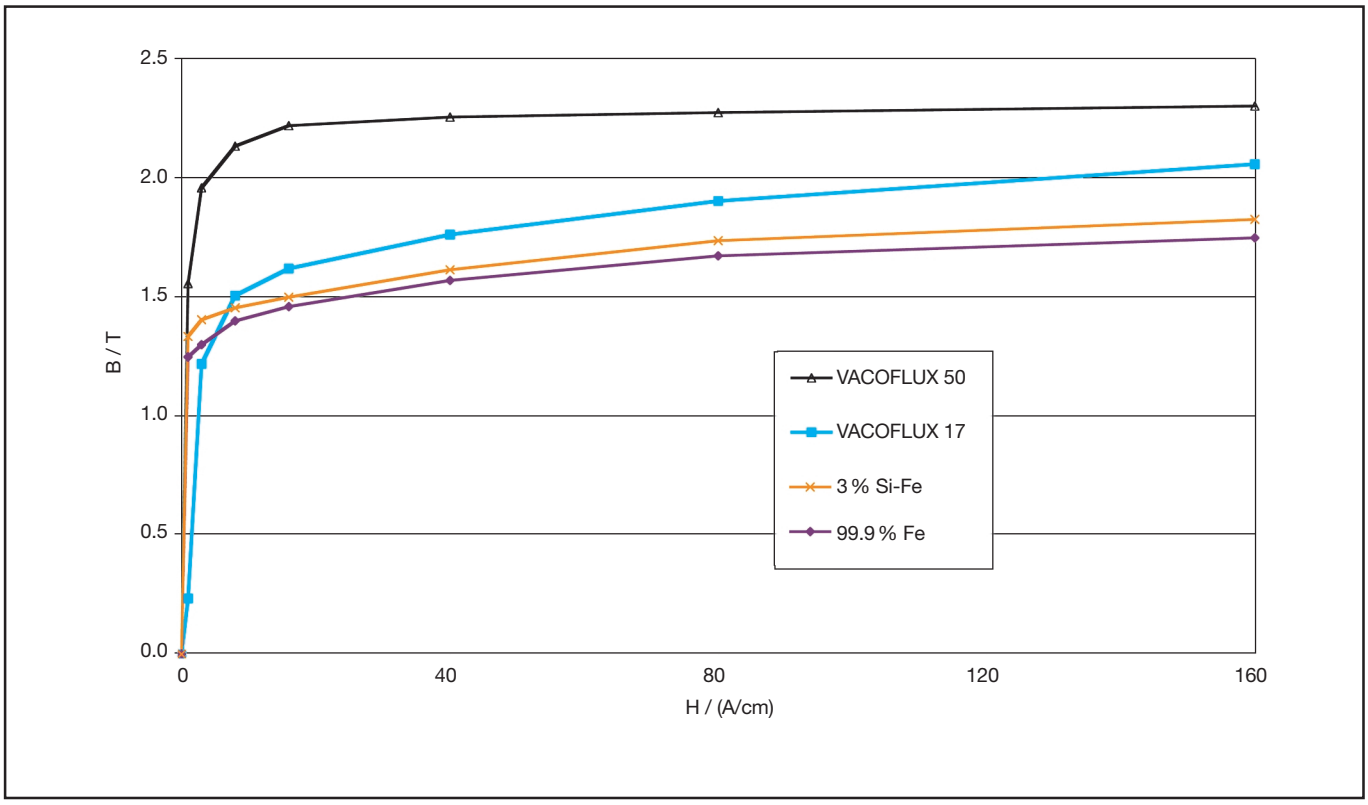

Fig. 1: Typical virgin B(H)-curves of different high saturation soft magnetic alloys for comparison (50 % CoFe ≅ VACOFLUX 50; 17 % CoFe ≅ VACOFLUX 17; 99,98 % Fe ≅ VACOFER S1; 3 % SiFe ≅ TRAFOPERM N3)

1. Introduction

VACUUMSCHMELZE is one of the world leaders in the production of materials with special magnetic and physical properties. The product range covers soft magnetic products as well as permanent magnets and inductive components.

Our strength is the development and production of innovative materials. Especially our know-how in the field of magnetism combined with the awareness for the customer's requirements and visions are considerable benefits VACUUMSCHMELZE can offer. It is our aim to decisively support our partners with products providing a maximum of competitive advantages and making new and downstream solutions feasible.

VACUUMSCHMELZE's product range of soft magnetic materials comprises pure sintered Iron, NiFe, SiFe and CoFe alloys as well as amorphous and nanocrystalline alloys. Our CoFe alloys VACOFLUX® 48 and VACOFLUX 50 show the highest saturation magnetization and do surpass all known soft magnetic materials. Various properties and hysteresis loops can be obtained by using special compositions and selecting the optimum production procedure.

VACODUR® 50 is a further development of VACOFLUX 50 with respect to higher strength and ductility. We are also able to meet the demand for high saturation with the new developed VACOFLUX 17. For processing this alloy additionally offers remarkable features like extrusion moulding and a reduced cobalt content of only 17 % resulting in lower costs.

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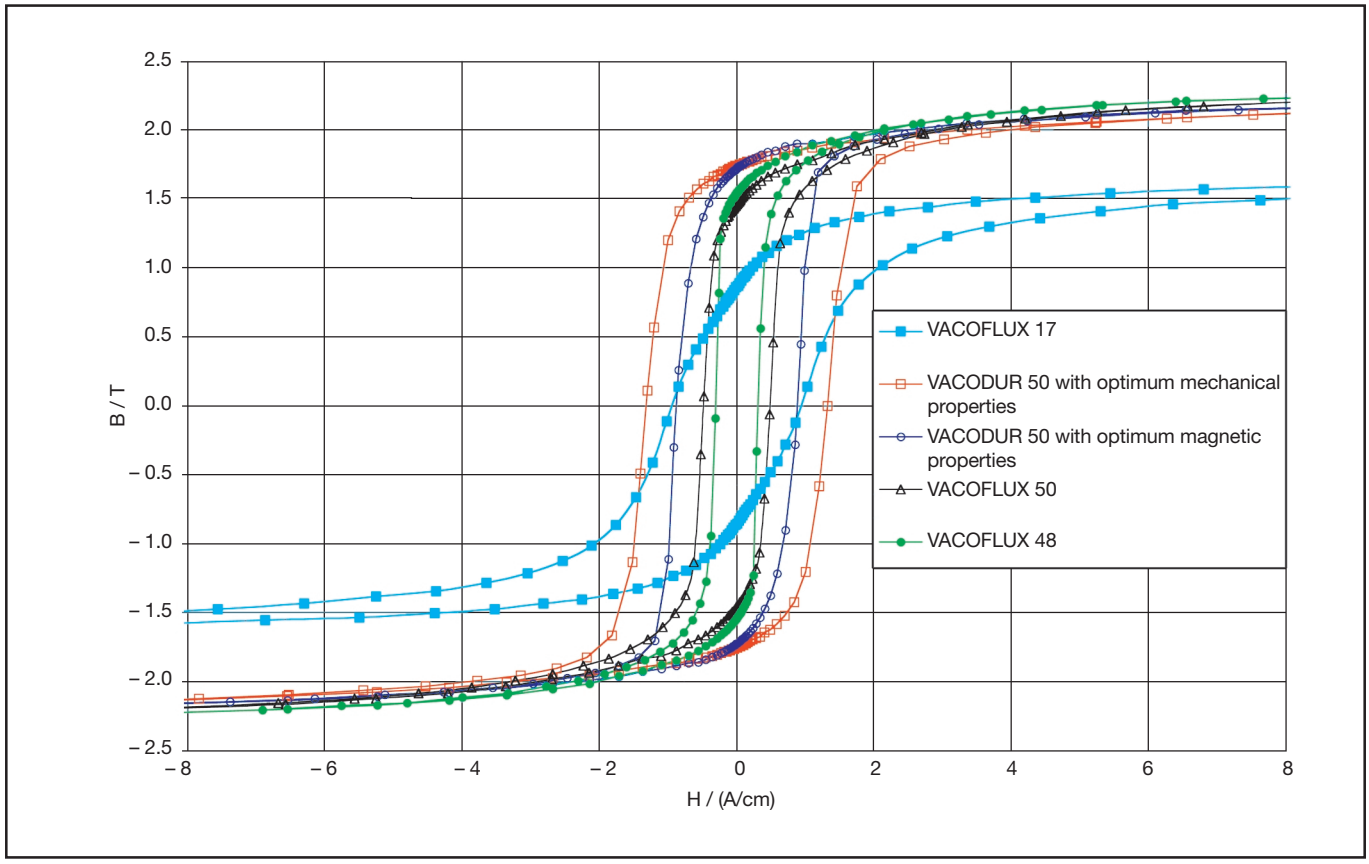

Fig. 2: Static hysteresis loops of our CoFe alloys. These are typical loops for strips with a thickness of 0.35 mm.

2. Application

	Remarks	Applications
VACOFLUX 48 (material according IEC 404-8-6 F11)	Material with a round hysteresis loop and a coercivity of $H_c \leq 0.4$ A/cm and very low losses, especially at flux densities between 1.8 T and 2.2 T.	Special transformers with low losses at very high flux densities, high performance motors.
VACOFLUX 50 (material according IEC 404-8-6 F11)	Material with a round hysteresis loop and a coercivity of $H_c \leq 0{,}8$ A/cm (up to 2 mm thickness).	Very high flux density pole-shoes, electro-magnets with maximum lifting force, magnetic lenses, needle printers, relays, motors and actuators with high torques and forces.
VACODUR 50 (material according IEC 404-8-6 F1)	A further development of VACOFLUX 50 with respect to improved mechanical properties, especially higher strength and ductility.	Alternators and generators with high rotation speed. Applications are comparable to VACOFLUX 50 with special requirements on mechanical properties.
VACOFLUX 17	Alloy with low Co-content and high saturation induction, i.e., very high magnetic force.	Devices and actuators for automotive industry and turned as well as extruded parts.

3. Magnetic Properties after Final Annealing*)

	Static Values (strip material, thickness 0.35 mm)		Static Values (solide material)		J_s (T)	Curie-Temperature (°C)	λ_s
	H_c (A/cm)	μ_{max}	H_c (A/cm)	μ_{max}			
VACOFLUX 48	≤ 0.4	15000	–	–	2.35	950	$70 \cdot 10^{-6}$
VACOFLUX 50	≤ 0.8	13000	≤ 2.4	4500	2.35	950	$70 \cdot 10^{-6}$
VACODUR 50 (with optimum magnetic properties)	≤ 1.6	10000	–	–	2.3	950	$70 \cdot 10^{-6}$
VACODUR 50 (with optimum mechanical properties)	≤ 2.0	7000	–	–	2.3	950	$70 \cdot 10^{-6}$
VACOFLUX 17	≤ 2.0	3500	≤ 2.0	2500	2.22	920	$25 \cdot 10^{-6}$

H_c = Coercivity, μ_4 = Permeability at 4 mA/cm, μ_{max} = Maximum Permeability, B_s = Saturation Polarisation, λ_s = Saturation Magnetostriction
*) Typical values for strip material

3.1 Static Values for 0.35 mm Stamped Samples*)

	B at 3 A/cm (T)	B at 8 A/cm (T)	B at 16 A/cm (T)	B at 40 A/cm (T)	B at 80 A/cm (T)	B at 160 A/cm (T)
VACOFLUX 48	2.05	2.15	2.25	2.27	2.3	–
VACOFLUX 50	1.9	2.1	2.2	2.25	2.27	2.3
VACODUR 50 (with optimum magnetic properties)	1.80	2.05	2.15	2.20	2.28	–
VACODUR 50 (with optimum mechanical properties)	1.70	2.00	2.1	2.18	2.25	–
VACOFLUX 17	1.2	1.5	1.6	1.75	1.9	2.05

B = Induction
*) Typical values

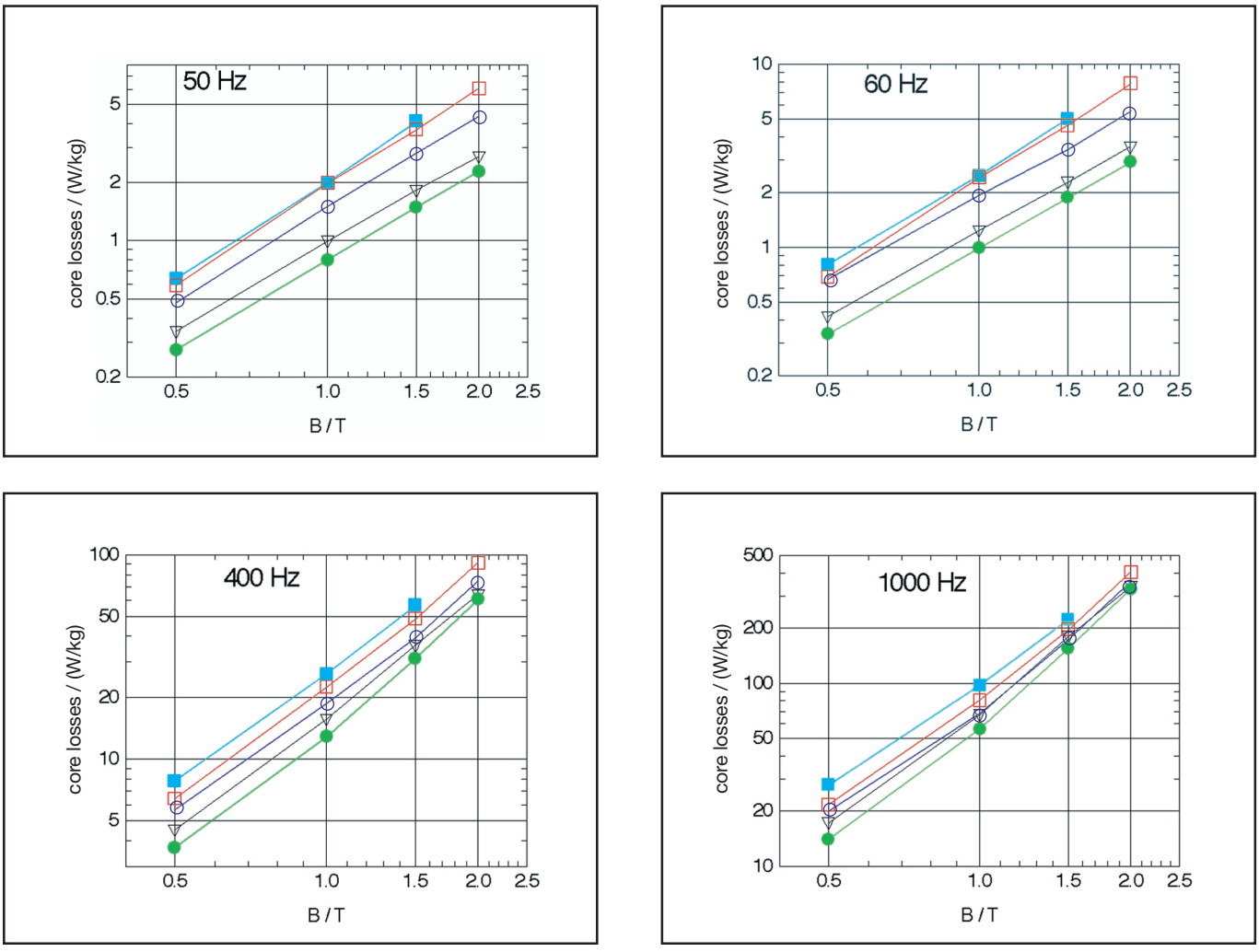

Fig. 3: Typical core losses of strips with a thickness of 0,35 mm at different frequencies.
(■ = VACOFLUX 17, □ = VACODUR 50 with optimum mechanical properties, ○ = VACODUR 50 with optimum magnetic properties, ▽ = VACOFLUX 50, ● = VACOFLUX 48)

4. Physical Properties*)

	Electrical Resistivity (after final annealing) (Ω mm^2/m)	Coefficient of Thermal Expansion (20 . . . 200°C) (10^{-6}/K)	Density (g/cm^3)
VACOFLUX 48	0.44	9.5	8.12
VACOFLUX 50	0.44	9.5	8.12
VACODUR 50 (wit optimum magnetic properties)	0.43	10.2	8.12
VACODUR 50 (with optimum mechanical properties)	0.42	10.2	8.12
VACOFLUX 17	0.39	10.8	7.94

*) Typical values

5. Final Annealing

	Temperature (°C)	Time of Annealing (h)	Atmosphere	Rate of Cooling (K/h)	Cooling until*) (°C)
VACOFLUX 48	880	10	dry hydrogen	~100	200
VACOFLUX 50	820	4-10	dry hydrogen	~100	200
VACODUR 50 (with optimum magnetic properties)	820	2-5	dry hydrogen	~100	200
VACODUR 50 (with optimum mechanical properties)	750	2-5	dry hydrogen	~100	200
VACOFLUX 17	850	10	dry hydrogen	~100	200

*) At lower temperature any cooling rate in any atmosphere is possible

6. Mechanical Properties after Final Annealing*)

	$Rp_{0,2}$ (N/mm^2)	R_m (N/mm^2)	Young's-Modulus (kN/mm^2)	Elongation until Fracture	Hardness HV
VACOFLUX 48	200	220	200	2 %	180
VACOFLUX 50[1])	250	350	210	3 %	190
VACODUR 50 (with optimum magnetic properties)	390	620	250	6 %	210
VACODUR 50 (with optimum mechanical properties)	450	720	250	6 %	230
VACOFLUX 17[1])	250	450	200	32 %	140

$Rp_{0,2}$ = Yield strength, R_m = Tensile strength
[1]) strip
*) Typical values

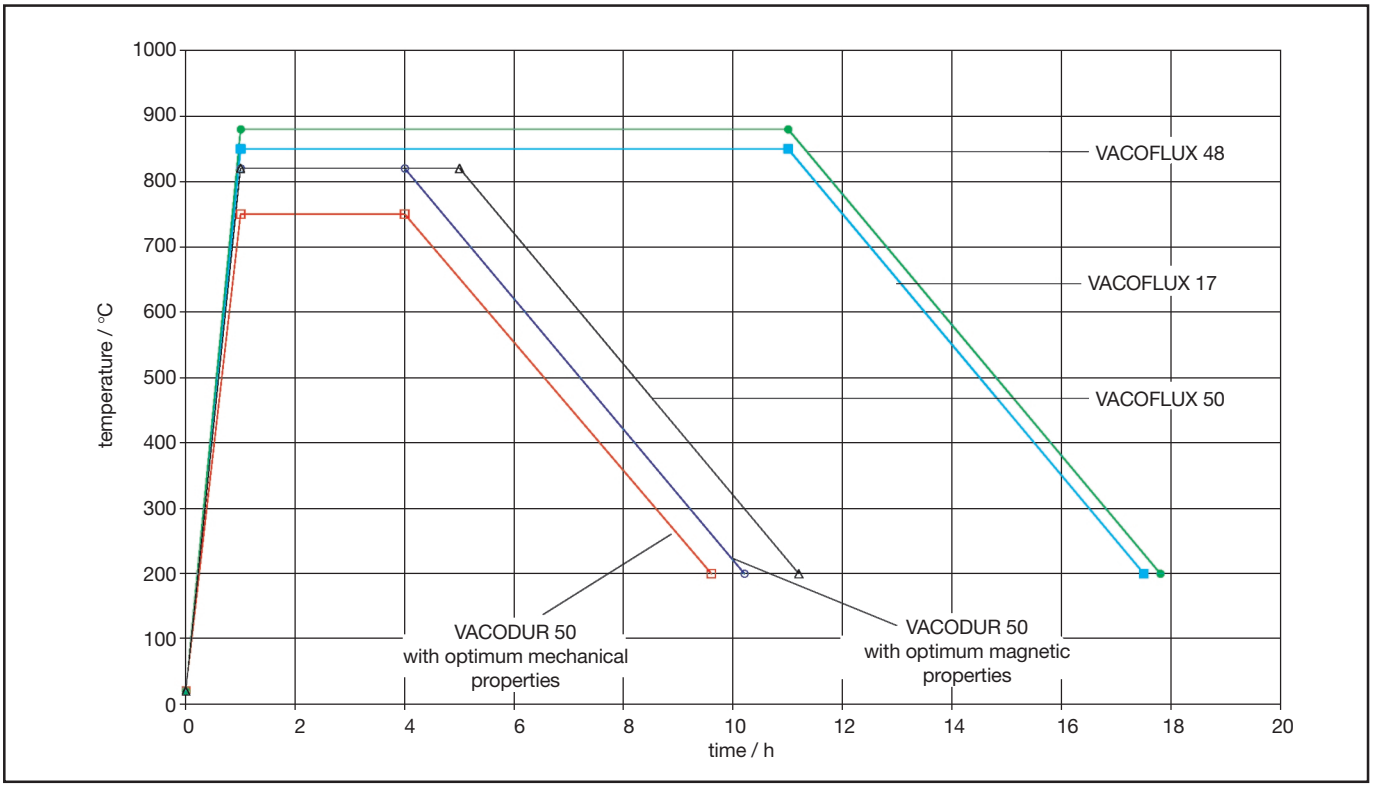

Fig. 4: Temperature profile of the magnetic final annealing.

7. Forms of Supply

	Semifinished Products		Finished Parts			
	Strips	Solid-profile-material, rods, wires	Strip-wound cores	Core laminations, stamped parts	Laminated packages, EK-cores	Solid and shaped parts
VACOFLUX 48	•	–	•	•	•	–
VACOFLUX 50	•	•	•	•	•	•
VACODUR 50	•	–	–	•	•	–
VACOFLUX 17	•	•	–	•	•	•

• available
– not available

Product Survey

Semi-Finished Products and Parts

Metallic Semi-Finished Products
Soft magnetic alloys
Magnetically semi-hard alloys
Ductile permanent magnets
Thermobimetals
Spring alloys
Glass/ceramic-to-metal sealing alloys

Parts
Stamped/bent parts
Laminations
Magnetic shielding

Superconductors

Cores and Components

Magnetic Cores
Tape-wound cores made of crystalline, amorphous and nano-crystalline alloys

Inductive Components
for xDSL, ISDN and switched-mode power supplies, for current detection and for driving power semiconductors

Rare-Earth Permanent Magnets

Magnets on Sm-Co and Nd-Fe-B Base

Polymer Bonded Magnets

Magnet Assemblies

VACUUMSCHMELZE GMBH & CO. KG

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