MOTOR OPTIMIZATION

USING HIGH PERFORMANCE MAGNETIC MATERIALS AND TECHNOLOGIES

CASE STUDY

- Interior permanent magnet synchronous machine (IPSM)
- Power: 4.5 kW @ 1500 rpm / Torque: 21.5 Nm
- Conventionally magnetized NdFeB magnets
- Stator/rotor stacks made of electrical steel NO20

OPTIMIZATION STEPS

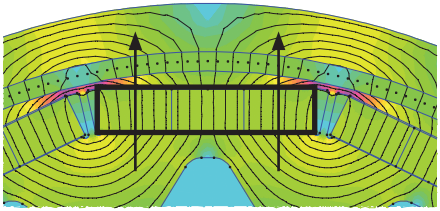
1) cost-neutral VACODYM® 890 using H/C-effect: **6 % torque/power increase**

2a) high saturation VACOFLUX® 48 stator stack: **25 % size/weight reduction**

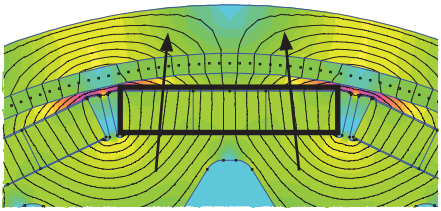
2b) high strength VACODUR® S Plus rotor stack: **33 % speed increase**

STEP 1
PERMANENT NdFeB MAGNETS VACODYM 890

Air gap flux density can be increased by using embedded magnetically profiled and oriented magnets. This may be shown by using magnets with Hot-Side/Cold-Side effect (H/C effect).

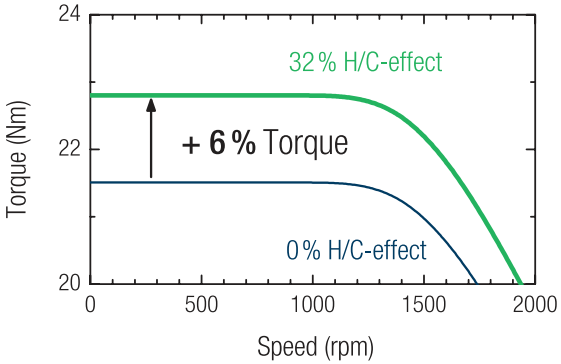


0 % H/C-effect



32 % H/C-effect

Cost-neutral 6 % torque/power increase

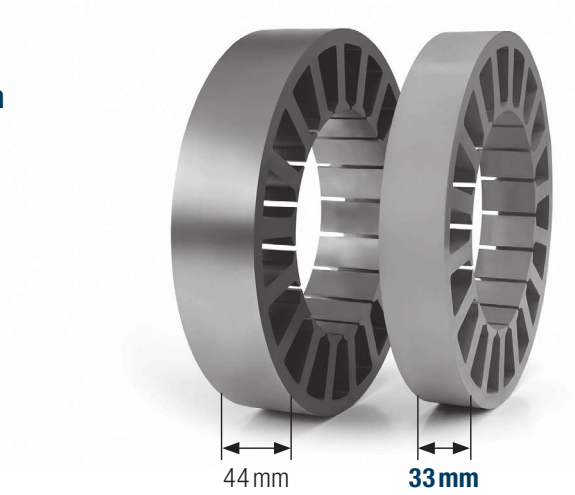


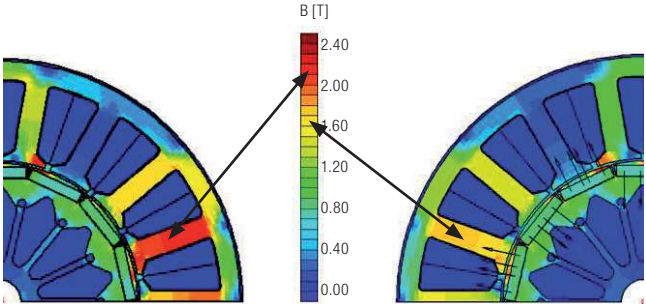
STEP 2
SOFT MAGNETIC CoFe ALLOYS VACOFLUX 48 & VACODUR S PLUS

Stator made of VACOFLUX 48:

25 % size/weight reduction

using a higher saturation material
(no torque/power degradation)



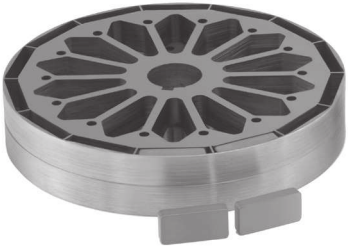


VACOFLUX 48 Electrical steel NO 20

Rotor made of VACODUR S Plus:

33 % speed increase/maximum power

using a higher strength material
(up to 800 MPa yield strength)



SUMMARY
VAC MAGNETIC MATERIALS & TECHNOLOGIES

Embedded permanent magnets (typical values)

VACODYM® 890

32 % H/C magnetization

Remanence $B_{r\,(typ)}$ = 1.07 T

Coercivity H_{cB} = 890 kA/m

Coercivity H_{cJ} = 2360 kA/m

VACCOAT® 20011

⟹ **6 % torque/power increase**

Stator package (typical values)

VACOFLUX® 48

Lamination thickness 0.1 mm

Saturation Polarization J_s = 2.3 T

VACSTACK® technology

package density 98 %

⟹ **25 % size/weight reduction**

Rotor package (typical values)

VACODUR® S Plus

Lamination thickness 0.2 mm

Saturation polarization J_s = 2.25 T

Yield strength $R_{p0.2}$ = 700 MPa

⟹ **33 % speed increase**

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