AMCAN BEARING & BELTING

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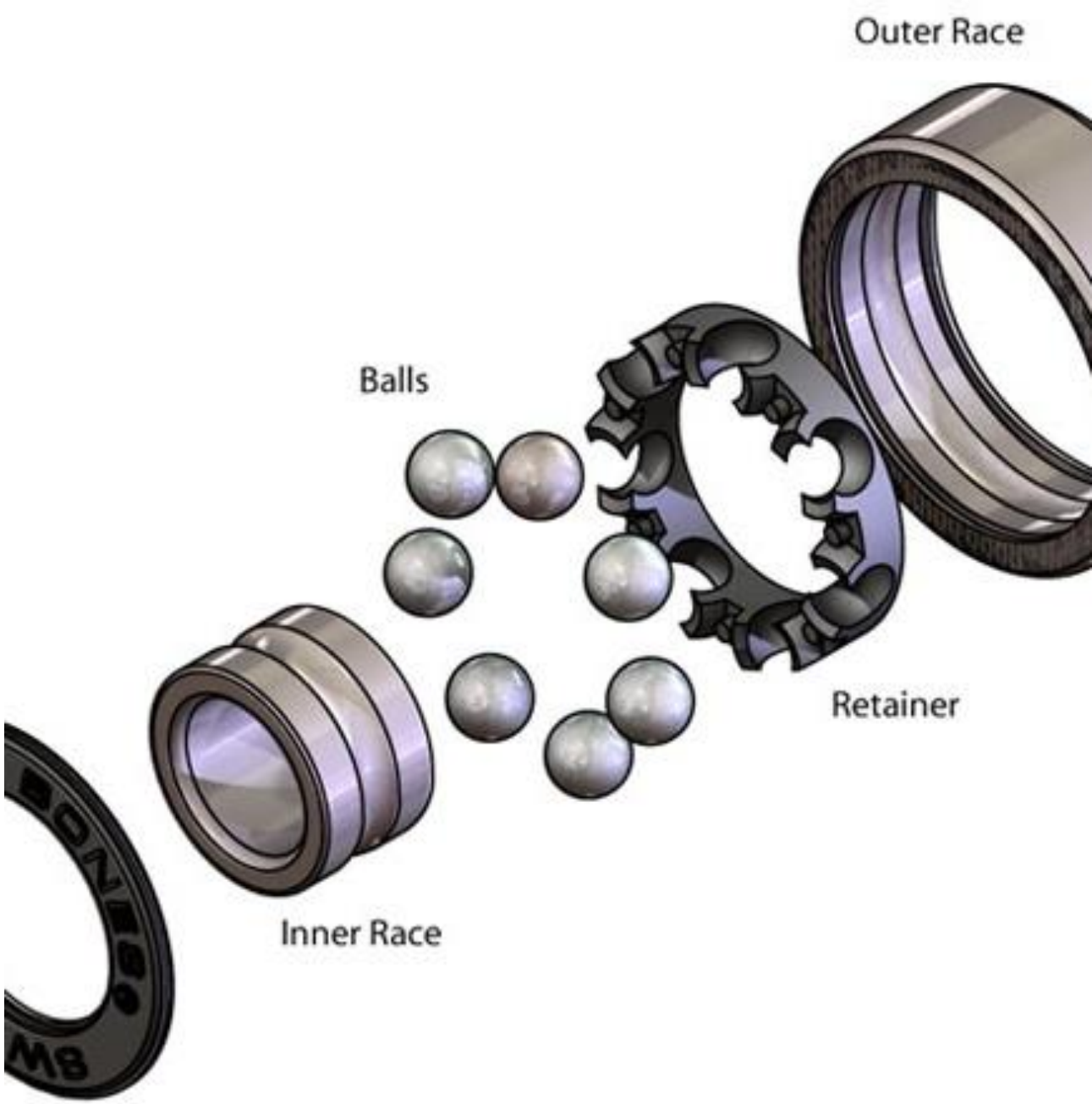
ceramicspeed

Hybrid bearings in Electrical Machines

USA: 866-625-6203 CAN: 877-275-6304
www.amcanbearing.com

Definitions

- Hybrid = combination of materials
- **Ceramic hybrid**
  - **Steel rings**
  - **Ceramic balls**
- Other variants
  - Full Ceramic Bearings
  - Polymer bearings



Why Ceramic Balls?

- 58 % lighter
- 128 % harder
- 400 % smoother
- 70% less thermal expansion
- Chemically resistant / none corrosive
- Electrically insulating

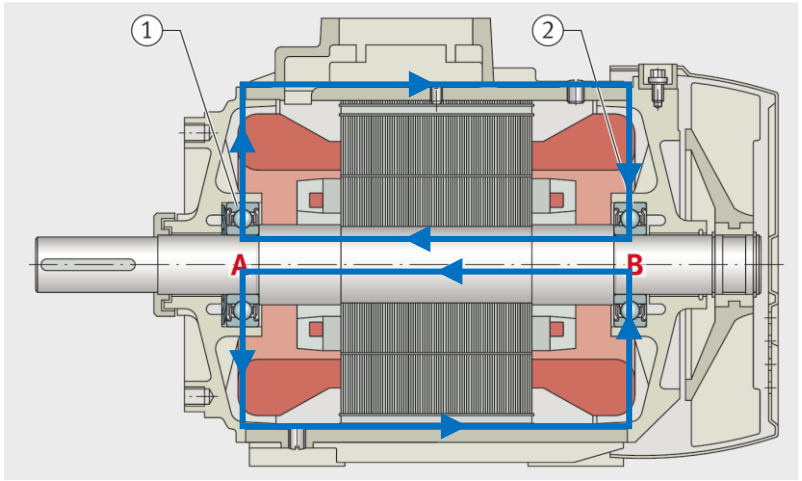
How hybrids improve E-motors

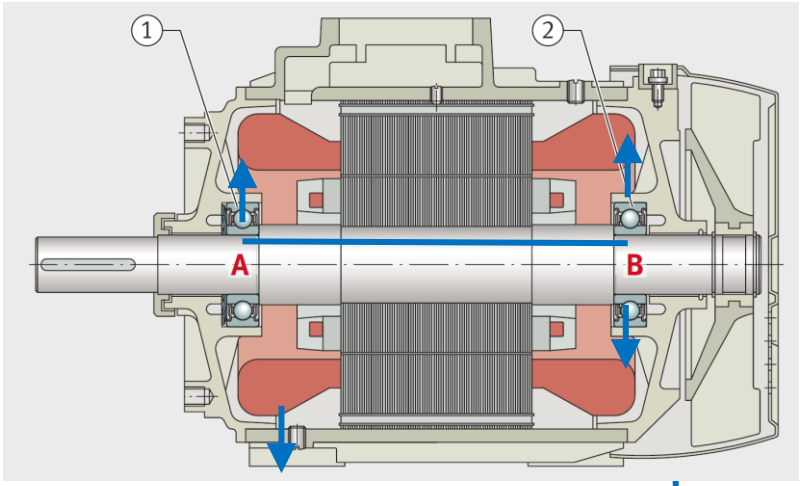
- Prevent Bearing Currents (Guaranteed)
  Longer Service Life
- Reduce friction losses
  Improved efficiency
- Reduce bearing temperature
  Longer grease life -> Longer service life

Increasing bearing life with Hybrids

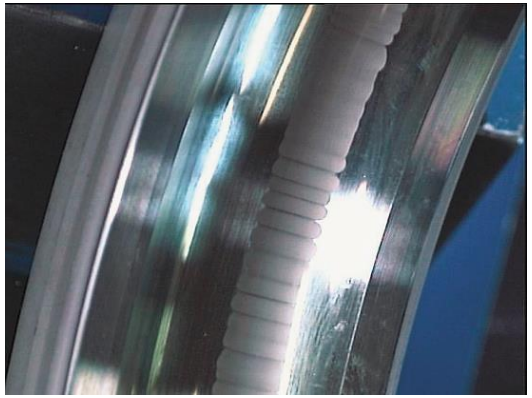
Bearing Currents

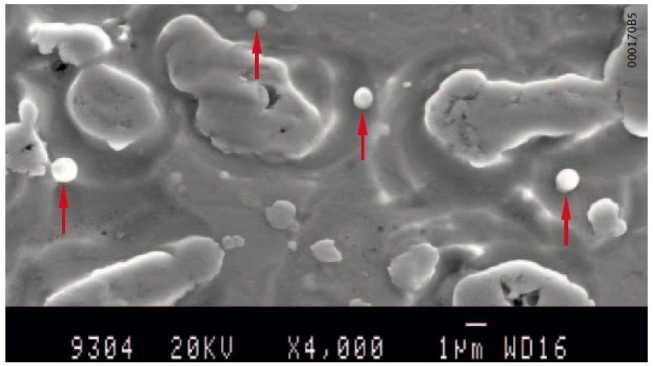
Circulating currents vs. enduced Currents





Bearing Currents / Electrical Erossion





How to protect Bearings

Coated Bearing

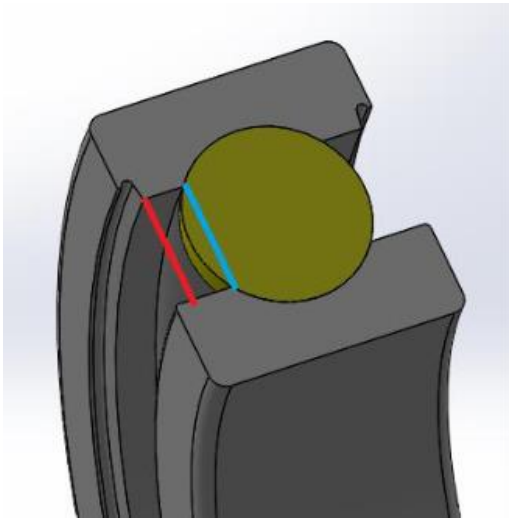
Insulating layer thickness:

0,1 mm

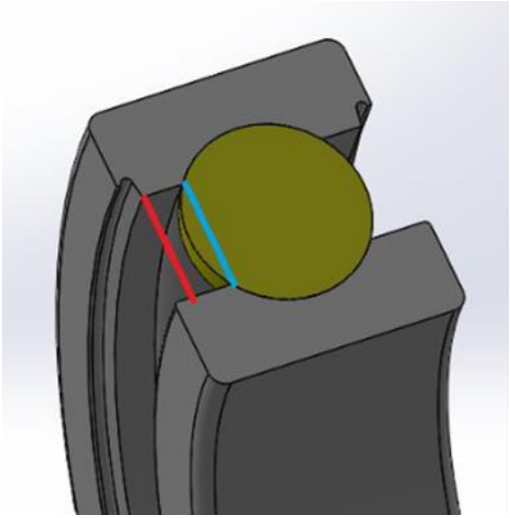
CeramicSpeed Hybrid

Insulating layer thickness:

Full Airgap



Calculated Insulation



Wälzlagerbezeichnung	D_2 [mm]	d_1 [mm]	Ringspalt [mm]	Maximale Spannung	
				Luftspalt	Si3N4 ball
6005	42,2	32	5,1	5 kV	77 kV
6206	54,1	40,4	6,85	7 kV	103 kV
6316	147	108	19,5	19 kV	293 kV
6324	215	165	25	24 kV	360 kV
6330	263	206	28,5	28 kV	420 kV

Bearing Currents / Electrical Erossion

Increasing bearing life with Hybrids

Friction & Temperature

Theoretical Bearing Losses

- Combined Losses

$$P_{tab} = \tau_{fric} \cdot \omega$$

- Frictional moment

$$\tau_{fric} = \tau_{rr} + \tau_{sl} + \tau_{seal} + \tau_{drag}$$

- Rolling resistance

$$\tau_{rr} = R_1 \cdot d_m^{1,96} \cdot \left(F_r + \frac{R_2}{\sin(\alpha_F)} \cdot F_a \right)^{0,54} \cdot (\nu \cdot n)^{0,6}$$

$$\alpha_F = 24{,}6 \cdot (F_a / C_0)^{0,44}$$

- Sliding Friction
  - Deformation and spin

$$\tau_{sl} = S_1 \cdot d_m^{-0,145} \cdot \left(F_r^5 + \frac{S_2 \cdot d_m^{1,5}}{\sin(\alpha_F)} \cdot F_a^4 \right)^{1/3} \cdot \mu_{sl}$$

- Seal resistance

$$\tau_{seal} = K_{S1} \cdot d_s^{\beta} + K_{S2}$$

- Oil drag

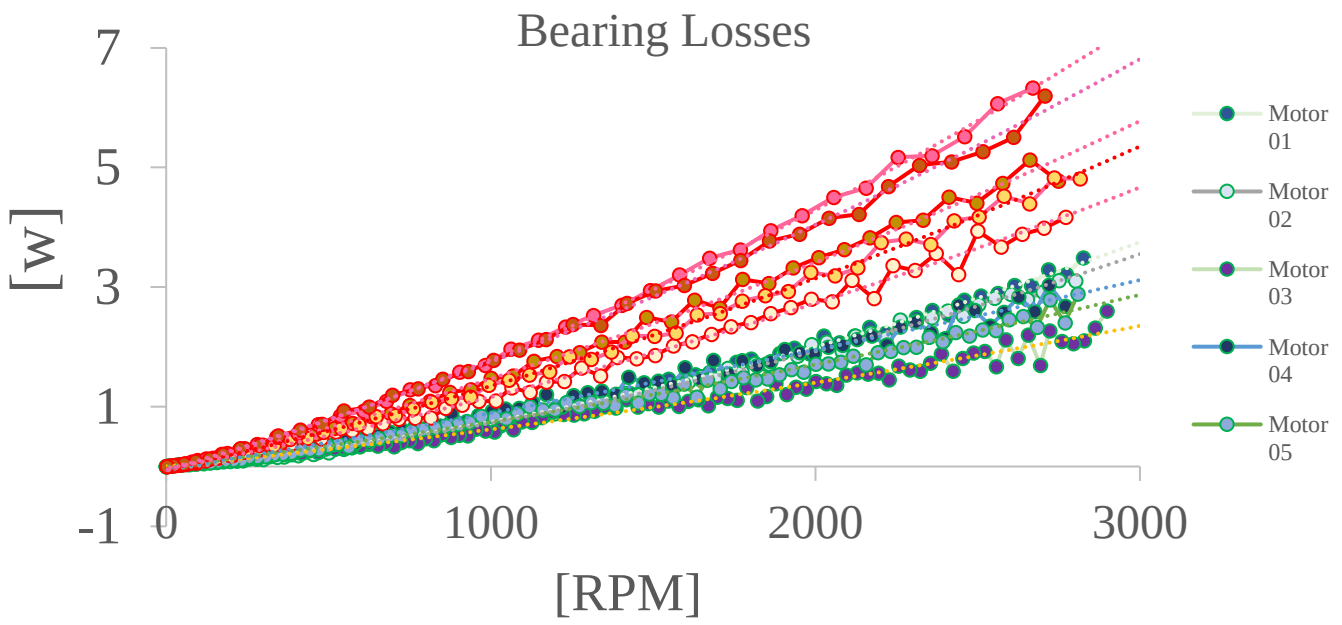
$$\tau_{drag} = V_m \cdot K_{ball} \cdot d_m^5 \cdot n^2$$

Elgetti Test Rig

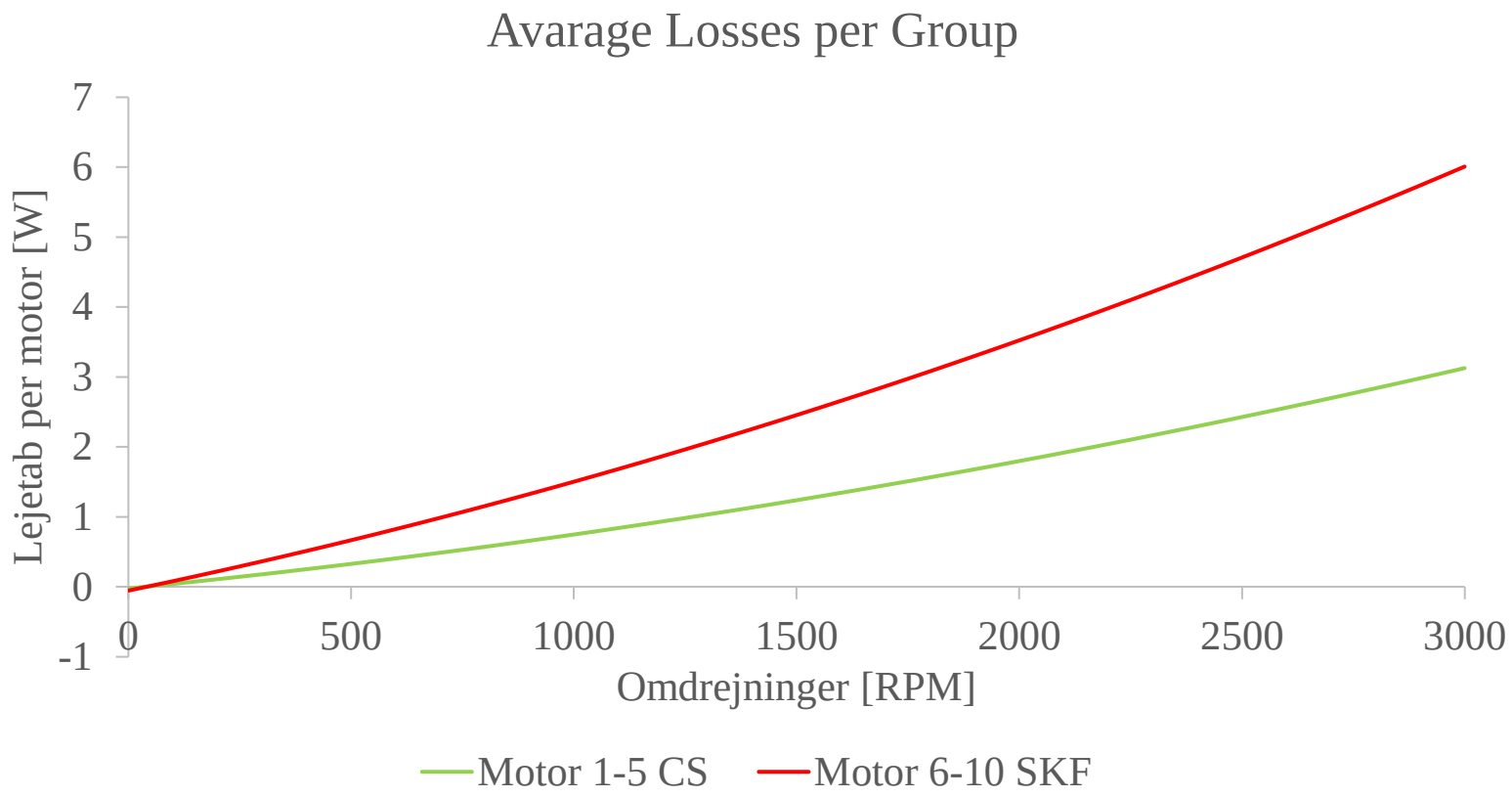
High Load: 8kN on each bearing
4 x 6208 bearings

Losses Std.	324 W
Losses CSB	220 W
Difference start up	50%
Diff. steady state	32%

Coast Down test – Statistical Batch Size



Results Normalized



Results, absolute Values

Motor ID	Losses @ 3000 RPM [Watt]	
1	3,7	
2	3,5	
3	2,4	
4	3,1	Avarage CS
5	3,0	3,1W
6	4,7	
7	5,9	
8	5,4	
9	7,5	Avarage SKF
10	6,9	6,1W

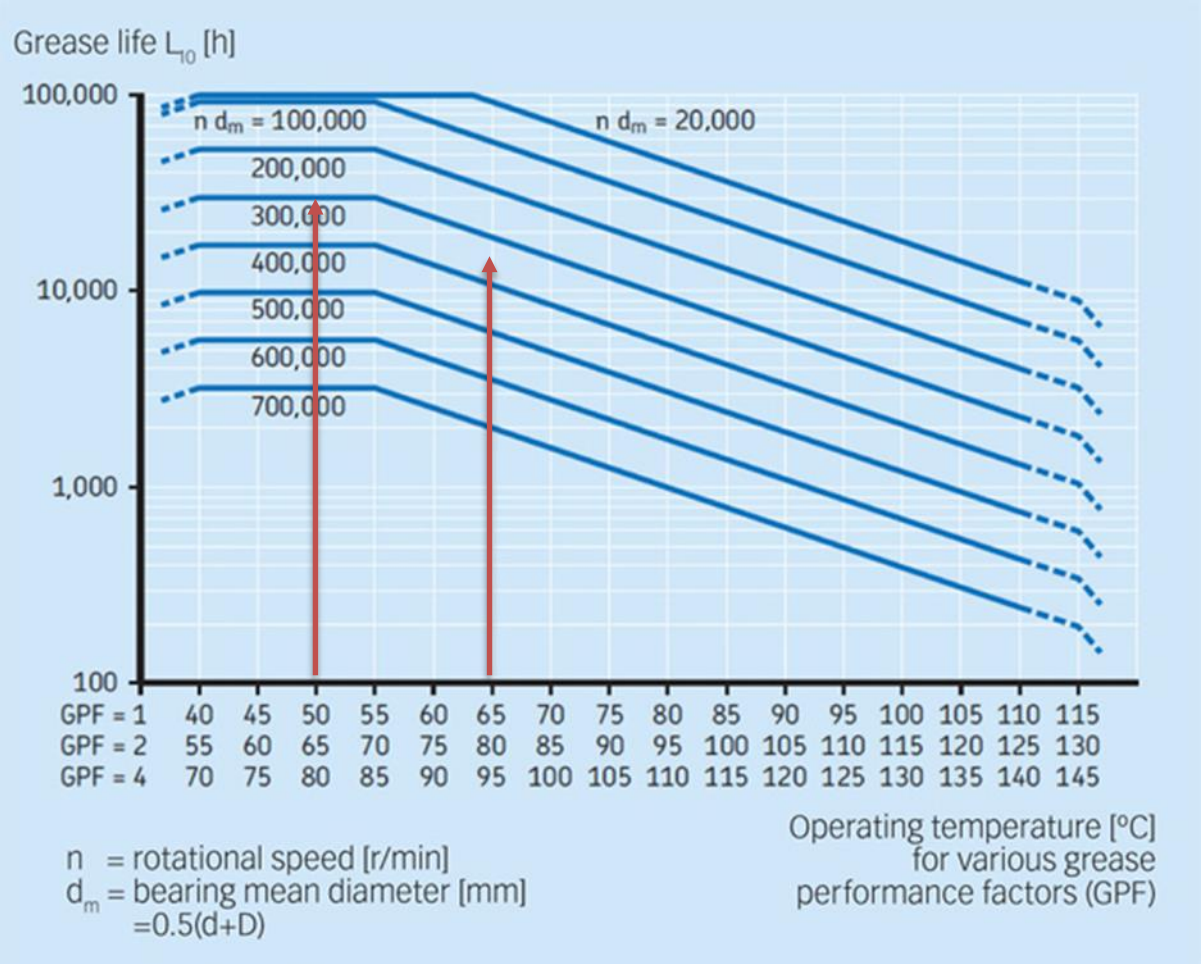
Reduction of 48%

Friction = Heat

Hybrids run cooler!

Increased Grease life

- Sealed bearings will seize with the lubricant failing
- Lubricants /grease age with mechanical impact and temperature
- Grease life will increase with reduced temperature (factor 2 by 15K)
- Lower temperature equals longer grease life equals longer bearing life



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