Synchronous motors with permanent magnets for electric vehicles

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Electromechanics

Content

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1. Introduction of PulnikovEC

PulnikovEC is a team of experts in:

- Design and development of electrical machines
- CFD, FEA and mathematical modelling
- Composite materials and containment technologies
- Programming and automation
- CAD
- Development of technical documentation

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2. SMP 100kW

Front view

Component	Material	Mass, kg
Bearing shield (drive)	Zamak	13,13
Bearing shield (rear)	Zamak	10,71
Housing	Aluminum	15,77
Cover	Steel	3,52
Stator stack	M250-50	19,75
Stator winding	Copper	13,7
Rotor magnets	Barium ferrite	4,93
Rotor stack	M250-50	4,53
Shaft	Steel	4,88
Motor		101,3

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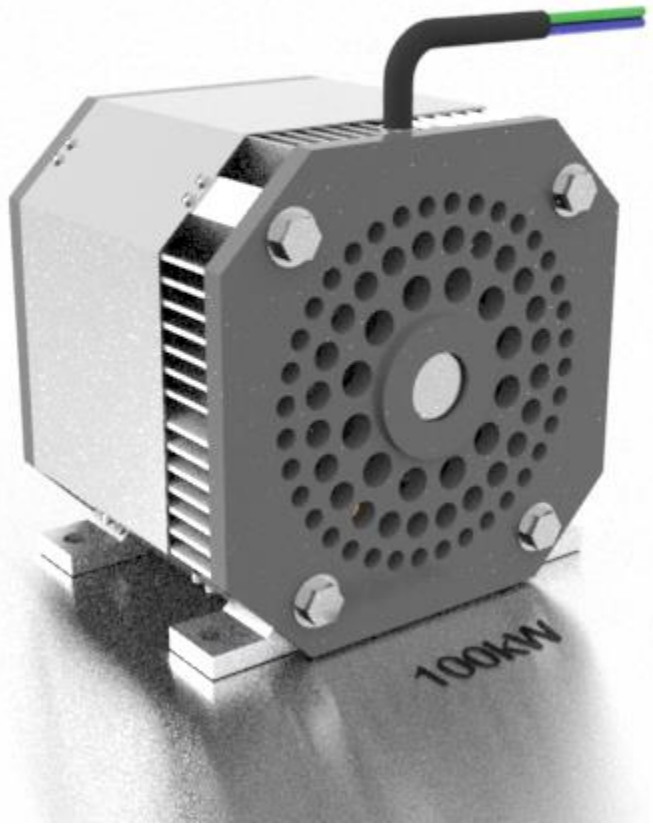
2. SMP 100kW



Back view

Parameter	Variable	Value
Useful power, kW	P2n	100
Winding losses, W	Pw1	2270,6
Core losses, W	Pfe	343,9
Bearing losses, W	Pbear	202,7
Magnet losses, W	Pm	3,9
Air friction losses, W	Pair	47,7
Additional losses (possible variation in series), W		500
Efficiency without fan		0,966
Fan, W	Pfan	360
Efficiency with fan		0,964

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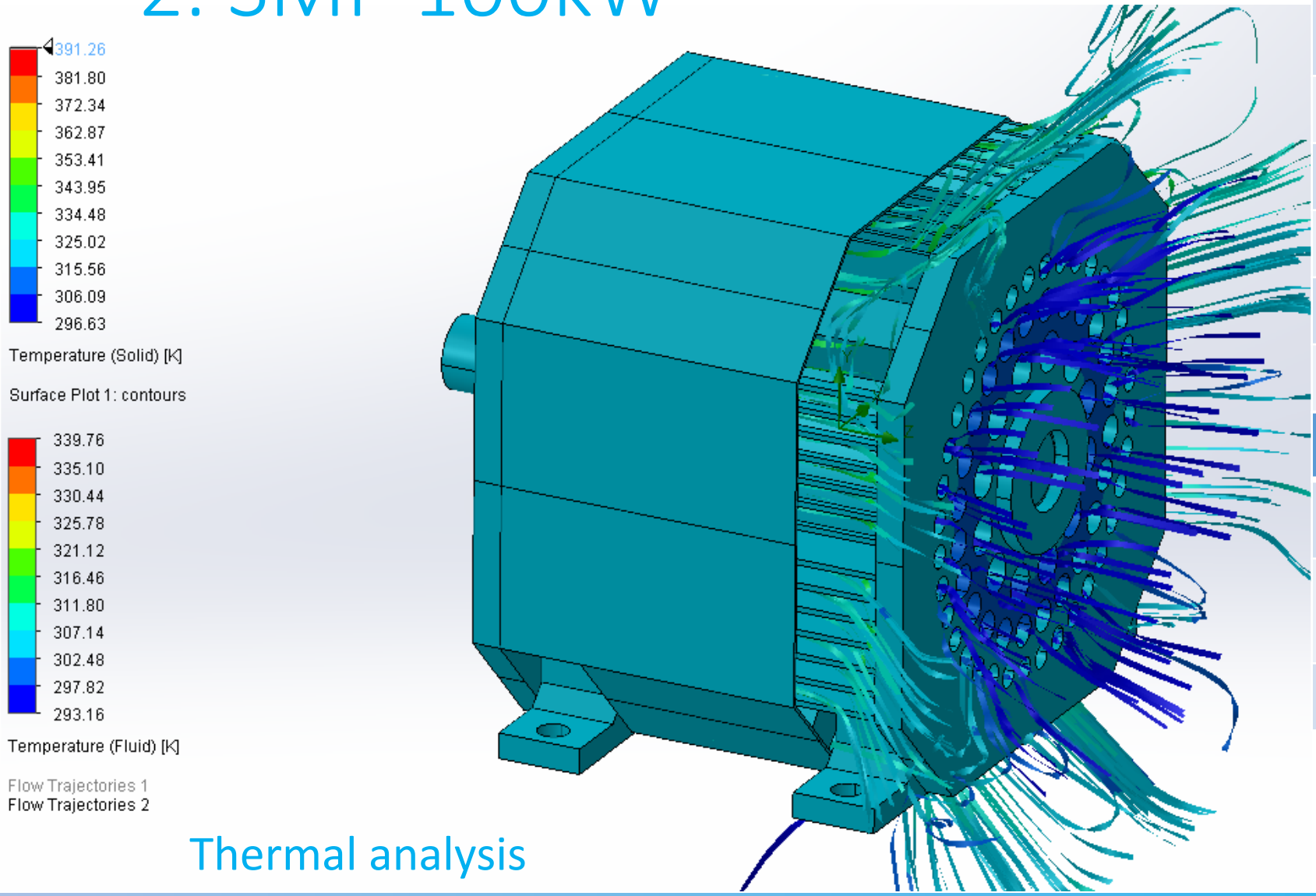

Thermal analysis

Component	Overheating, °C
Winding	74
Stator core	38
Rotor magnet	17
Bearing shield (drive)	26
Housing	29
Bearing shield (rear)	26

Parameter	Value
Inlet air temperature, °C	20
Outlet air temperature, °C	38
Air flow, m^3/sec	0,19

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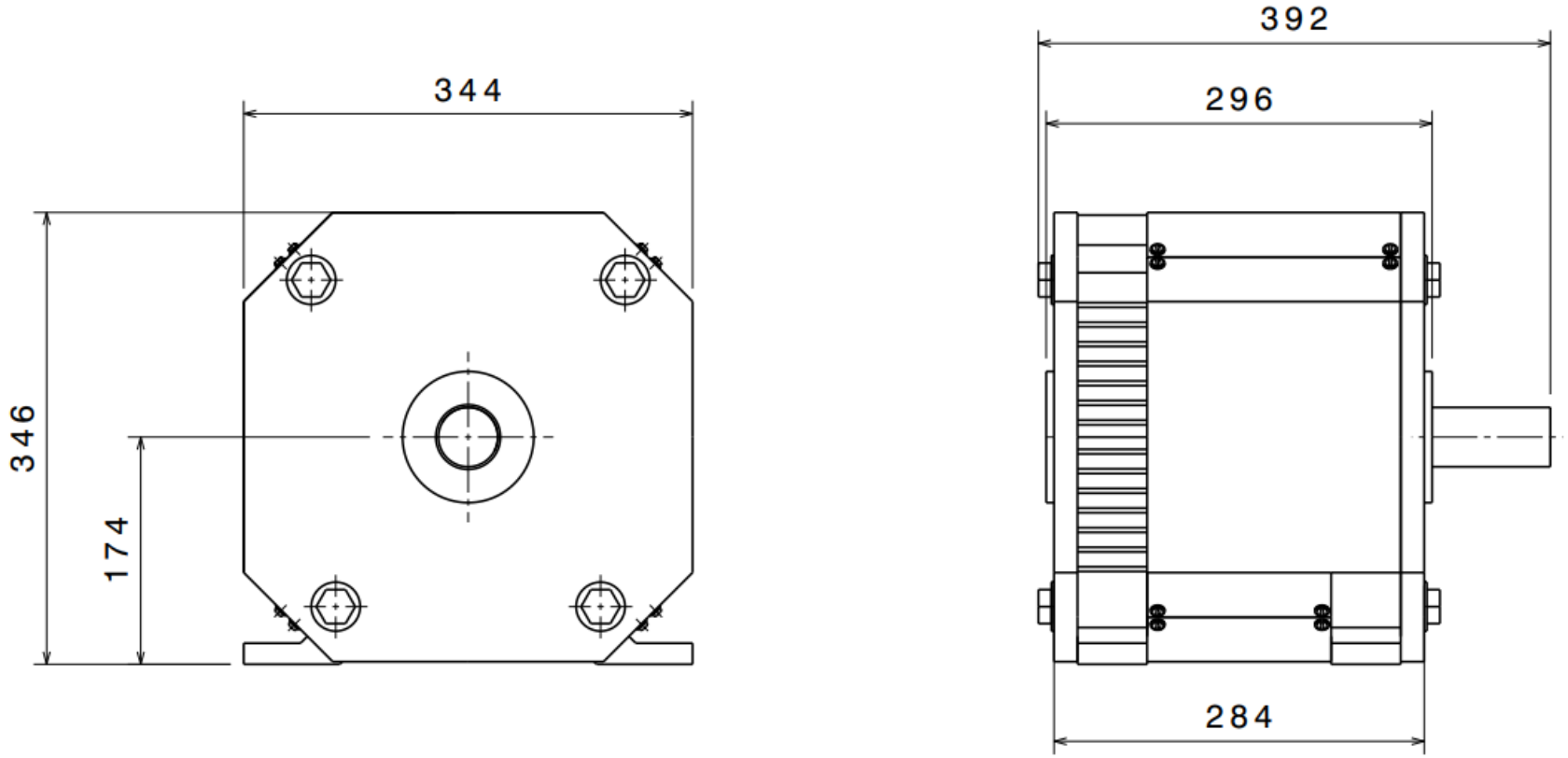

Dimensions

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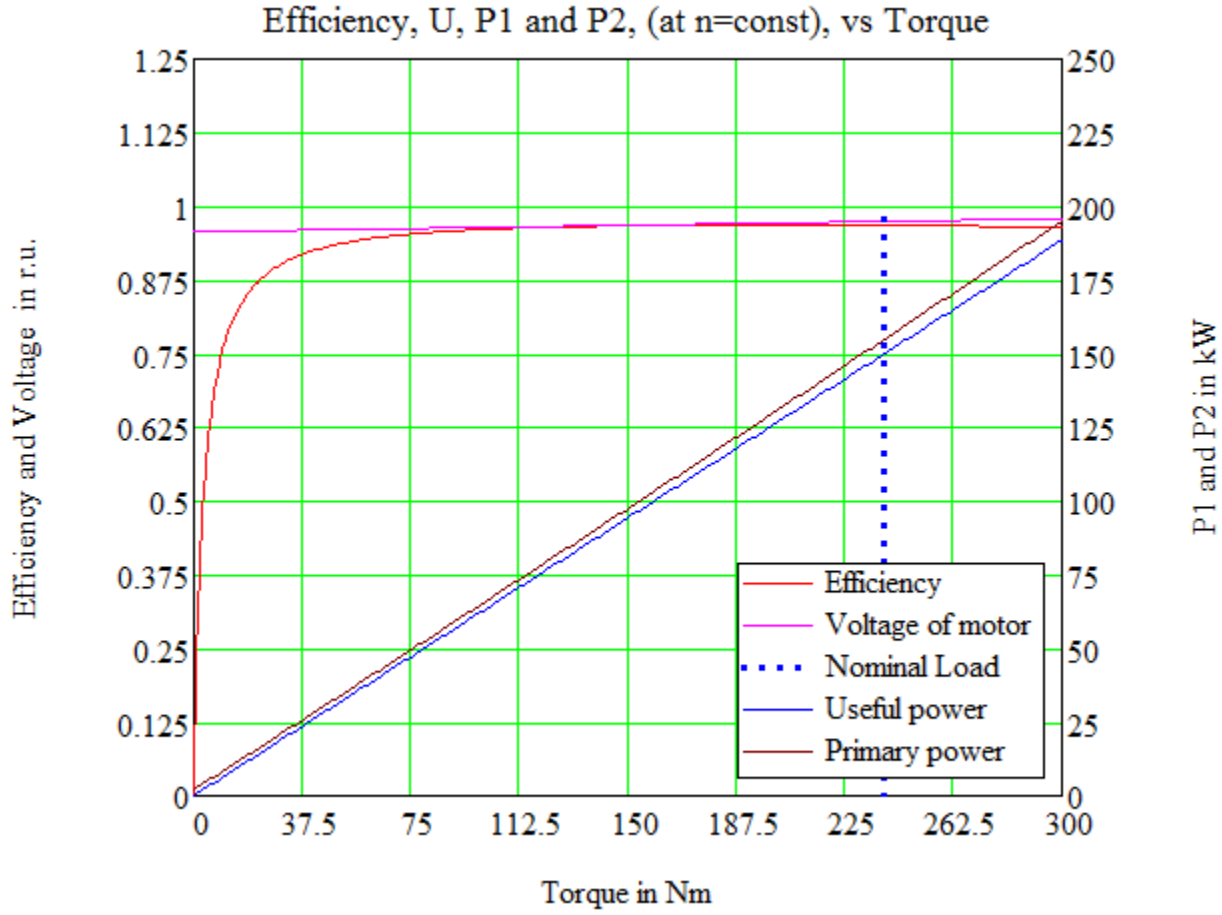

Performance characteristics

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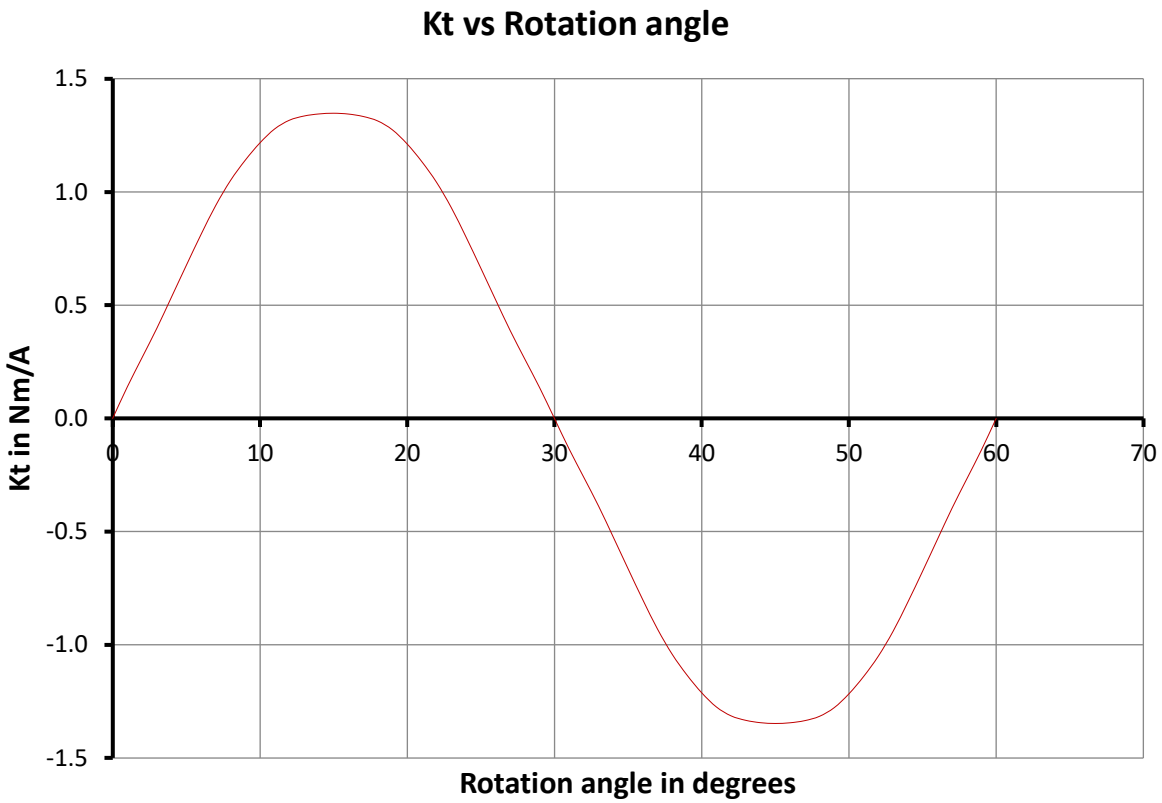

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3. Series of synchronous motors with permanent magnets for electric vehicles

Useful power, kW	Torque, N*m	Axis height, mm	Outer diameter of the stator, mm	Length of stator stack, mm	Kt at operating temperature, N*m/A	Active phase-phase resistance Rphph, Ohm	Phase inductance Lph, mH	Phase voltage Ua, V	Phase current Ia, A	Efficiency, %
50	79.6	132	225	100	0.579	0.168	1.993	283.4	69.5	95.5
75	119.4	160	274	100	0.585	0.042	0.834	207.6	144.2	96.5
100	159.2	160	274	130	0.602	0.032	0.884	224.2	187.0	96.6
130	206.9	180	313	160	0.552	0.014	0.574	221.2	234.0	97.5
150	238.7	180	313	180	0.533	0.011	0.475	214.1	279.8	97.5

Data provided for 6000 rpm

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3. Series of synchronous motors with permanent magnets for electric vehicles

Useful power, kW	Mass of active materials, kg	Cost of active materials, €
50	26.2	89.28
75	39.5	148.95
100	49.3	177.68
130	81.0	298.04
150	91.7	335.11

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4. Advantages of the series compared to motors available on the market

1. Use of ferrite magnets instead of rare-earth magnets (NdFeB or SmCo)
   a) availability of of ferrite magnets
   b) low price for ferrite magnets (10€/kg instead of 80-100€/kg) and for the whole motor
2. High efficiency
3. Air cooling for motors of the series
   a) Built-in fan on the rotor shaft;
   b) External fan with power of about 300W;
4. Low motor cost
5. Max rotor speed 6000rpm instead of 12000rpm
   a) low operating frequency for the drive, low losses in transistors, higher drive efficiency;
   b) higher reliability of the bearings;
   c) a possibility of using conventional transmissions, because the speed range of our motors corresponds to the combustion engines

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