ADJUSTABLE-SPEED PERMANENT MAGNET SYNCHRONOUS MOTOR DESIGN

File: Setup2.res

GENERAL DATA

Rated Output Power (kW):	8.5
Rated Voltage (V):	300
Number of Poles:	20
Frequency (Hz):	100
Frictional Loss (W):	12
Windage Loss (W):	0
Rotor Position:	Inner
Type of Circuit:	Y3
Type of Source:	Sine
Domain:	Time
Operating Temperature (C):	75

STATOR DATA

Number of Stator Slots:	24
Outer Diameter of Stator (mm):	240
Inner Diameter of Stator (mm):	150
Type of Stator Slot:	4
Stator Slot	
hs0 (mm):	0.5
hs1 (mm):	0
hs2 (mm):	31
bs0 (mm):	10.5
bs1 (mm):	11
bs2 (mm):	17.5
rs (mm):	3
Top Tooth Width (mm):	8.75553
Bottom Tooth Width (mm):	10.4038
Skew Width (Number of Slots):	0
Length of Stator Core (mm):	180
Stacking Factor of Stator Core:	0.92
Type of Steel:	m250-35a
Designed Wedge Thickness (mm):	4.64882e-005
Slot Insulation Thickness (mm):	0.3
Layer Insulation Thickness (mm):	0.3
End Length Adjustment (mm):	0
Number of Parallel Branches:	2
Number of Conductors per Slot:	80
Type of Coils:	21
Average Coil Pitch:	1
Number of Wires per Conductor:	1
Wire Diameter (mm):	1.628
Wire Wrap Thickness (mm):	0
Slot Area (mm^2):	495.637
Net Slot Area (mm^2):	454.712
Limited Slot Fill Factor (%):	75
Stator Slot Fill Factor (%):	46.6296
Coil Half-Turn Length (mm):	198.219
Wire Resistivity (ohm.mm^2/m):	0.0217

ROTOR DATA

Minimum Air Gap (mm):	1.5
Inner Diameter (mm):	120
Length of Rotor (mm):	180
Stacking Factor of Iron Core:	0.95
Type of Steel:	steel_1010
Polar Arc Radius (mm):	73.5
Mechanical Pole Embrace:	0.82
Electrical Pole Embrace:	0.784893
Max. Thickness of Magnet (mm):	4.5
Width of Magnet (mm):	18.3548
Type of Magnet:	NdFe45H
Type of Rotor:	1
Magnetic Shaft:	No

PERMANENT MAGNET DATA

Residual Flux Density (Tesla):	1.32
Coercive Force (kA/m):	995
Maximum Energy Density (kJ/m^3):	328.35
Relative Recoil Permeability:	1.05573
Demagnetized Flux Density (Tesla):	0
Recoil Residual Flux Density (Tesla):	1.32
Recoil Coercive Force (kA/m):	995

MATERIAL CONSUMPTION

Armature Wire Density (kg/m^3):	8900
Permanent Magnet Density (kg/m^3):	7400
Armature Core Steel Density (kg/m^3):	7872
Rotor Core Steel Density (kg/m^3):	7872
Armature Copper Weight (kg):	7.05075
Permanent Magnet Weight (kg):	2.20037
Armature Core Steel Weight (kg):	20.4303
Rotor Core Steel Weight (kg):	4.90979
Total Net Weight (kg):	34.5912
Armature Core Steel Consumption (kg):	76.9765
Rotor Core Steel Consumption (kg):	26.7621

STEADY STATE PARAMETERS

Stator Winding Factor:	0.933013
D-Axis Reactive Inductance Lad (H):	0.000991566
Q-Axis Reactive Inductance Laq (H):	0.000991566
D-Axis Inductance L1+Lad (H):	0.00430013
Q-Axis Inductance L1+Laq (H):	0.00430013
Armature Leakage Inductance L1 (H):	0.00330857
Zero-Sequence Inductance L0 (H):	0.00279157
Armature Phase Resistance R1 (H):	0.330618
Armature Phase Resistance at 20C (ohm):	0.27196

NO-LOAD MAGNETIC DATA

Stator-Teeth Flux Density (Tesla):	1.61183
Stator-Yoke Flux Density (Tesla):	0.687196
Rotor-Yoke Flux Density (Tesla):	0.850355
Air-Gap Flux Density (Tesla):	0.773386
Magnet Flux Density (Tesla):	0.827659
Stator-Teeth By-Pass Factor:	0.00548454
Stator-Yoke By-Pass Factor:	1.05982e-005
Rotor-Yoke By-Pass Factor:	5.53394e-005
Stator-Teeth Ampere Turns (A.T):	132.083
Stator-Yoke Ampere Turns (A.T):	0.88214
Rotor-Yoke Ampere Turns (A.T):	5.16357
Air-Gap Ampere Turns (A.T):	1531.59
Magnet Ampere Turns (A.T):	-1670.04
Leakage-Flux Factor:	1
Correction Factor for Magnetic Circuit Length of Stator Yoke:	0.738369
Correction Factor for Magnetic Circuit Length of Rotor Yoke:	0.723754
No-Load Line Current (A):	3.25843
No-Load Input Power (W):	132.148
Cogging Torque (N.m):	0.928347

FULL-LOAD DATA

Maximum Line Induced Voltage (V):	404.664
Root-Mean-Square Line Current (A):	17.3318
Root-Mean-Square Phase Current (A):	17.3318
Armature Thermal Load (A^2/mm^3):	146.99
Specific Electric Loading (A/mm):	35.308
Armature Current Density (A/mm^2):	4.16307
Frictional and Windage Loss (W):	12
Iron-Core Loss (W):	108.968
Armature Copper Loss (W):	297.943
Total Loss (W):	418.911
Output Power (W):	8503.05
Input Power (W):	8921.96
Efficiency (%):	95.3047
Synchronous Speed (rpm):	600
Rated Torque (N.m):	135.33
Torque Angle (degree):	15.68
Maximum Output Power (W):	27079.6

WINDING ARRANGEMENT

The 3-phase, 2-layer winding can be arranged in 6 slots as below:

ABYZCA

Angle per slot (elec. degrees):	150
Phase-A axis (elec. degrees):	90
First slot center (elec. degrees):	0

TRANSIENT FEA INPUT DATA

For Armature Winding:	
Number of Turns:	320
Parallel Branches:	2
Terminal Resistance (ohm):	0.330618
End Leakage Inductance (H):	5.19871e-006
2D Equivalent Value:	
Equivalent Model Depth (mm):	180
Equivalent Stator Stacking Factor:	0.92
Equivalent Rotor Stacking Factor:	0.95
Equivalent Br (Tesla):	1.32
Equivalent Hc (kA/m):	995
Estimated Rotor Inertial Moment (kg m^2):	0.064363