ADJUSTABLE-SPEED PERMANENT MAGNET SYNCHRONOUS MOTOR DESIGN

File: Setup2.res

GENERAL DATA

Rated Output Power (kW): 8

Rated Voltage (V): 298

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): 270

Inner Diameter of Stator (mm): 180

Type of Stator Slot: 3

Stator Slot

hs0 (mm): 2

hs1 (mm): 1

hs2 (mm): 30

bs0 (mm): 10.9

bs1 (mm): 11.3317

bs2 (mm): 19.2308

rs (mm): 1

Top Tooth Width (mm): 13

Bottom Tooth Width (mm): 13

Skew Width (Number of Slots): 0

Length of Stator Core (mm): 135

Stacking Factor of Stator Core: 0.95

Type of Steel: M19-24G

Designed Wedge Thickness (mm): 0.999985

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: 2

Wire Diameter (mm): 1.15

Wire Wrap Thickness (mm): 0

Slot Area (mm^2): 510.156

Net Slot Area (mm^2): 441.77

Limited Slot Fill Factor (%): 75

Stator Slot Fill Factor (%): 47.8983

Coil Half-Turn Length (mm): 156.9

Wire Resistivity (ohm.mm^2/m): 0.0217

ROTOR DATA

Minimum Air Gap (mm): 1.25

Inner Diameter (mm): 120

Length of Rotor (mm): 135

Stacking Factor of Iron Core: 0.95

Type of Steel: M19-24G

Polar Arc Radius (mm): 38.75

Mechanical Pole Embrace: 0.81

Electrical Pole Embrace: 0.731444

Max. Thickness of Magnet (mm): 6.5

Width of Magnet (mm): 21.7571

Type of Magnet: NdFe35

Type of Rotor: 1

Magnetic Shaft:No

PERMANENT MAGNET DATA

Residual Flux Density (Tesla): 1.23

Coercive Force (kA/m): 890

Maximum Energy Density (kJ/m^3): 273.675

Relative Recoil Permeability: 1.09981

Demagnetized Flux Density (Tesla): 0

Recoil Residual Flux Density (Tesla): 1.23

Recoil Coercive Force (kA/m): 890

MATERIAL CONSUMPTION

Armature Wire Density (kg/m^3): 8900

Permanent Magnet Density (kg/m^3): 7400

Armature Core Steel Density (kg/m^3): 7650

Rotor Core Steel Density (kg/m^3): 7650

Armature Copper Weight (kg): 5.56967

Permanent Magnet Weight (kg): 2.6866

Armature Core Steel Weight (kg): 19.1954

Rotor Core Steel Weight (kg): 9.75553

Total Net Weight (kg): 37.2072

Armature Core Steel Consumption (kg): 51.5022

Rotor Core Steel Consumption (kg): 21.6191

STEADY STATE PARAMETERS

Stator Winding Factor: 0.933013

D-Axis Reactive Inductance Lad (H): 0.000763809

Q-Axis Reactive Inductance Laq (H): 0.000763809

D-Axis Inductance L1+Lad (H): 0.00348632

Q-Axis Inductance L1+Laq (H): 0.00348632

Armature Leakage Inductance L1 (H): 0.00272251

Zero-Sequence Inductance L0 (H): 0.00226392

Armature Phase Resistance R1 (H): 0.262233

Armature Phase Resistance at 20C (ohm): 0.215708

NO-LOAD MAGNETIC DATA

Stator-Teeth Flux Density (Tesla): 1.44354

Stator-Yoke Flux Density (Tesla): 0.844773

Rotor-Yoke Flux Density (Tesla): 0.430296

Air-Gap Flux Density (Tesla): 0.863592

Magnet Flux Density (Tesla): 0.925878

Stator-Teeth By-Pass Factor: 0.00180841

Stator-Yoke By-Pass Factor: 9.83411e-006

Rotor-Yoke By-Pass Factor: 7.79884e-006

Stator-Teeth Ampere Turns (A.T): 50.4444

Stator-Yoke Ampere Turns (A.T): 1.67862

Rotor-Yoke Ampere Turns (A.T): 0.428556

Air-Gap Ampere Turns (A.T): 1377.62

Magnet Ampere Turns (A.T): -1430.36

Leakage-Flux Factor: 1

Correction Factor for Magnetic
Circuit Length of Stator Yoke: 0.660192

Correction Factor for Magnetic
Circuit Length of Rotor Yoke: 0.756185

No-Load Line Current (A): 6.73217

No-Load Input Power (W): 140.693

Cogging Torque (N.m): 0.996205

FULL-LOAD DATA

Maximum Line Induced Voltage (V): 386.932

Root-Mean-Square Line Current (A): 17.207

Root-Mean-Square Phase Current (A): 17.207

Armature Thermal Load (A^2/mm^3): 120.98

Specific Electric Loading (A/mm): 29.2116

Armature Current Density (A/mm^2): 4.14152

Frictional and Windage Loss (W): 12

Iron-Core Loss (W): 92.01

Armature Copper Loss (W): 232.927

Total Loss (W): 336.937

Output Power (W): 8000.97

Input Power (W): 8337.9

Efficiency (%): 95.959

Synchronous Speed (rpm): 600

Rated Torque (N.m): 127.339

Torque Angle (degree): 12.1924

Maximum Output Power (W): 32051

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): 0.262233

End Leakage Inductance (H): 1.30732e-005

2D Equivalent Value:

Equivalent Model Depth (mm): 135

Equivalent Stator Stacking Factor: 0.95

Equivalent Rotor Stacking Factor: 0.95

Equivalent Br (Tesla): 1.23

Equivalent Hc (kA/m): 890

Estimated Rotor Inertial Moment (kg m^2): 0.102618