Wet Rotor Cooling

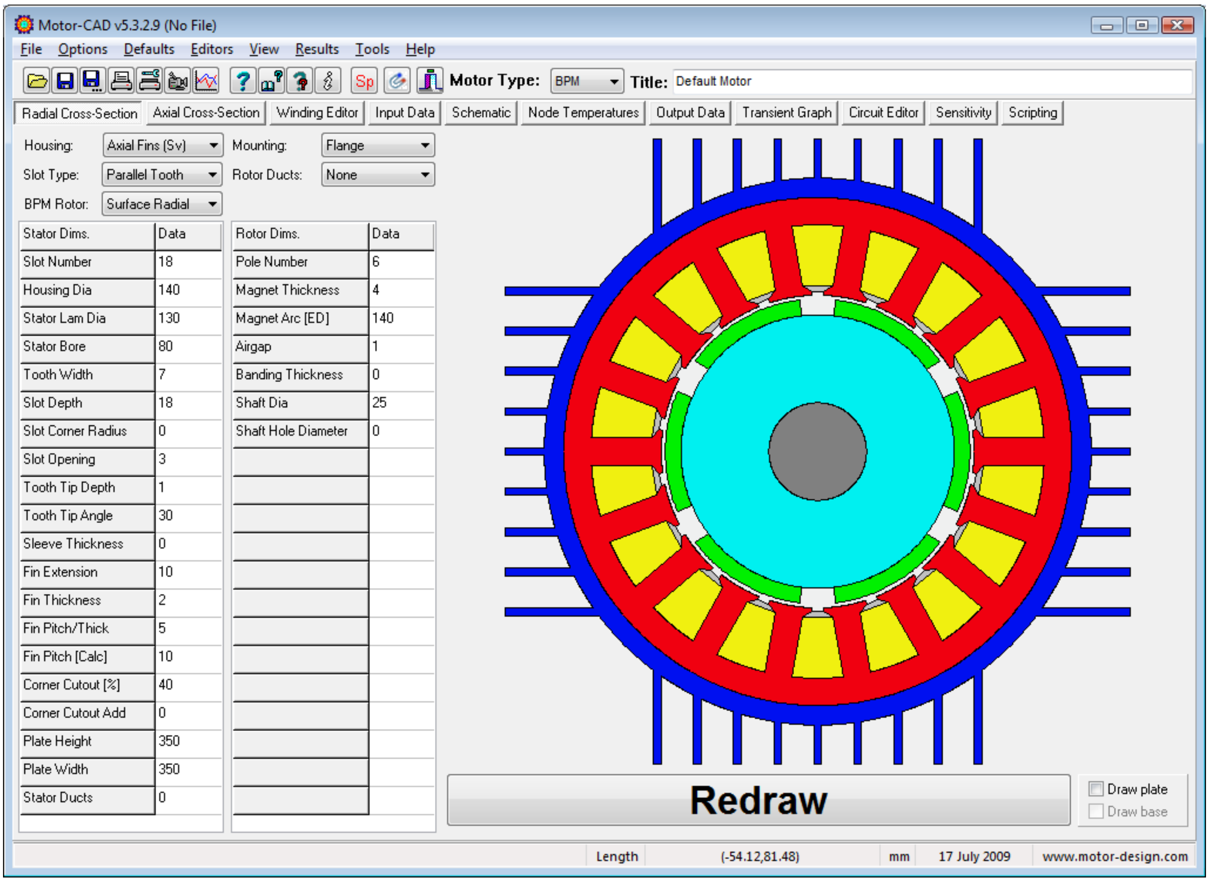
Description

This document gives a brief description of how to set up a Motor-CAD model for a wet rotor machine.

Wet rotor cooling is where a fluid is passed down the airgap of the machine. The fluid also passed over the shaft and end-winding surfaces in the endcap regions of the machine. This form of cooling is often used for integrated pumps where leakage from the pump is used to cool the motor.

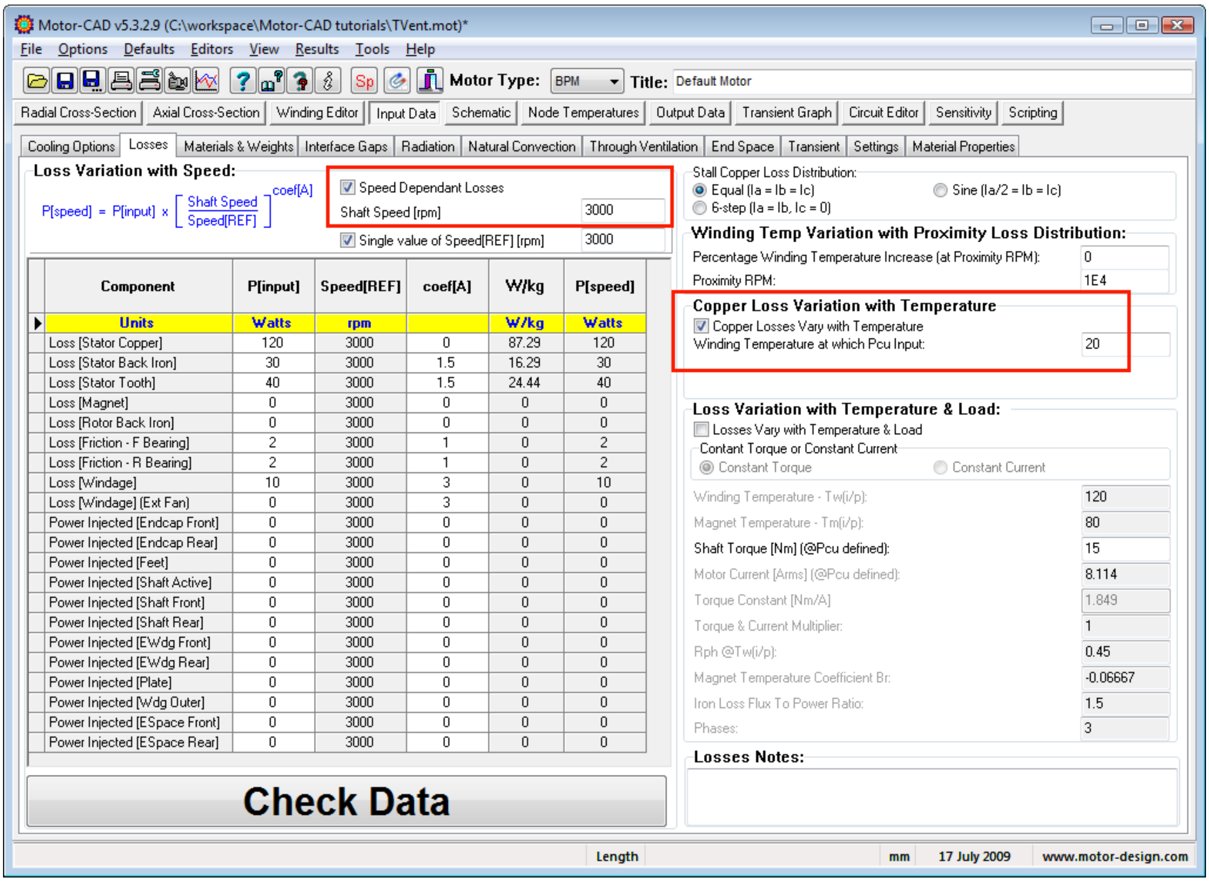
Machine Geometry

For this example the standard machine will be used as shown below.



Setting the machine losses

The losses of the machine are defined in the losses page as shown below. The default losses are used in this example. There are different loss models allowing for the losses to vary with speed, temperature and load.



Setting the machine cooling

The machine cooling is setup as shown below.

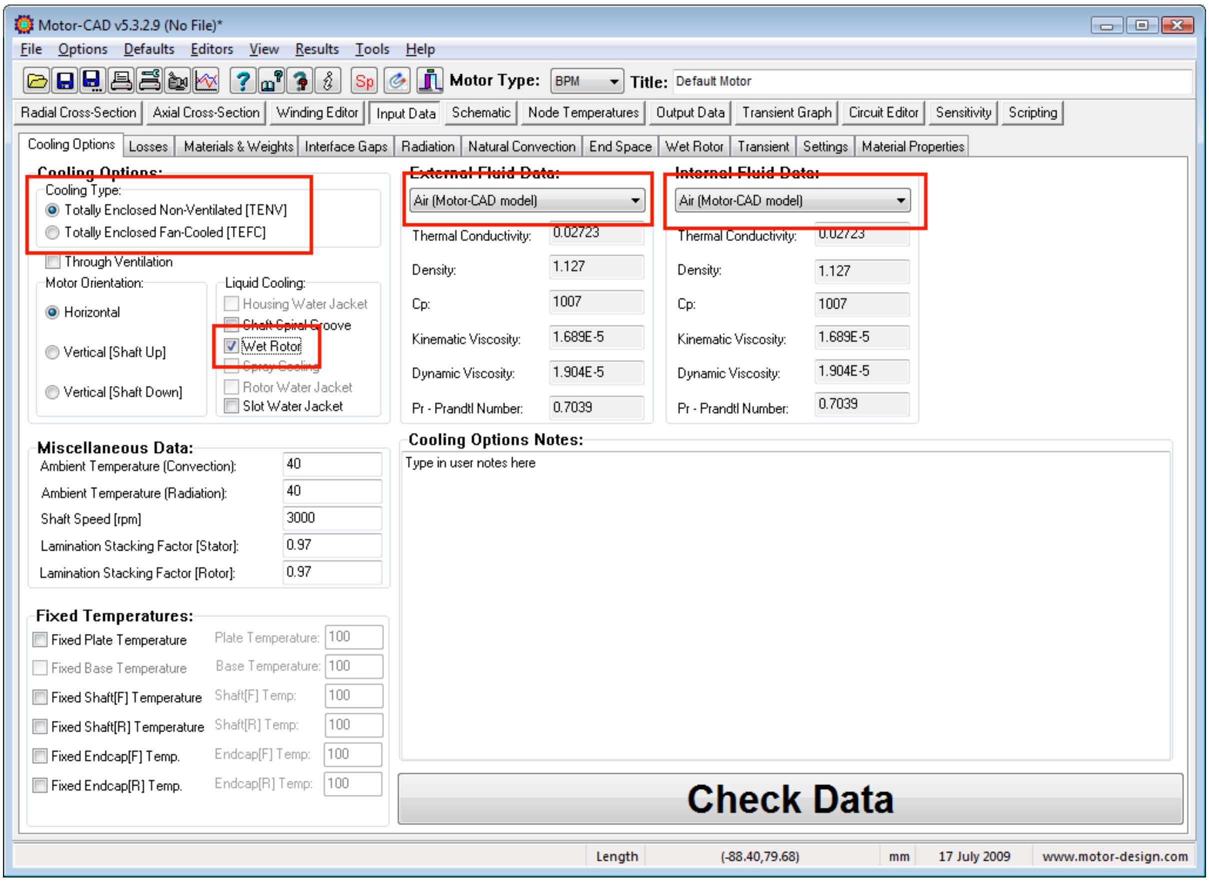
The wet rotor option must be selected.

The cooling type on the exterior of the housing is specified using the Cooling Type option:

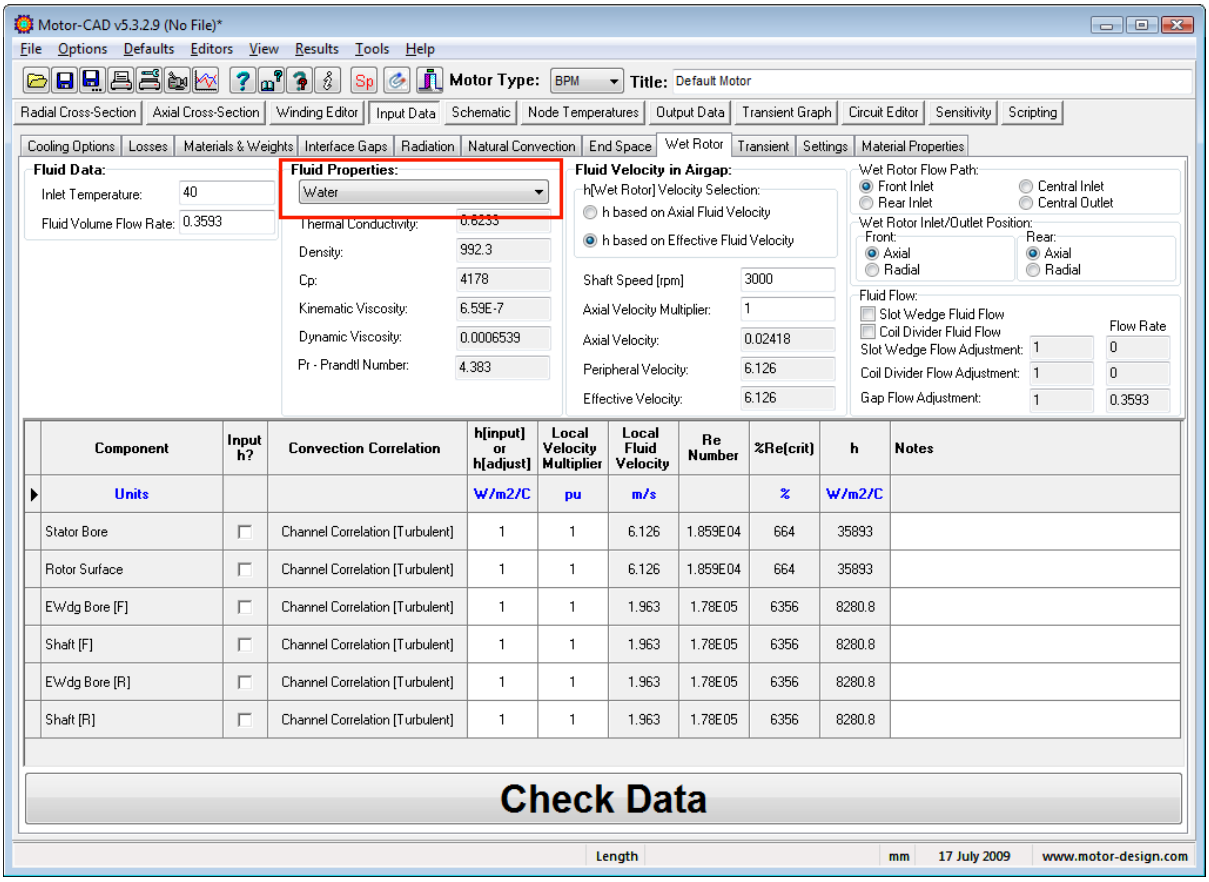
- Totally Enclosed Non-Ventilated = only natural convection and radiation from outside of machine.
- Totally Enclosed Fan-Cooled = air/ fluid is blown over outside of machine.

The External fluid is the fluid on the outside of the machine. The internal fluid is the fluid blown through the machine.

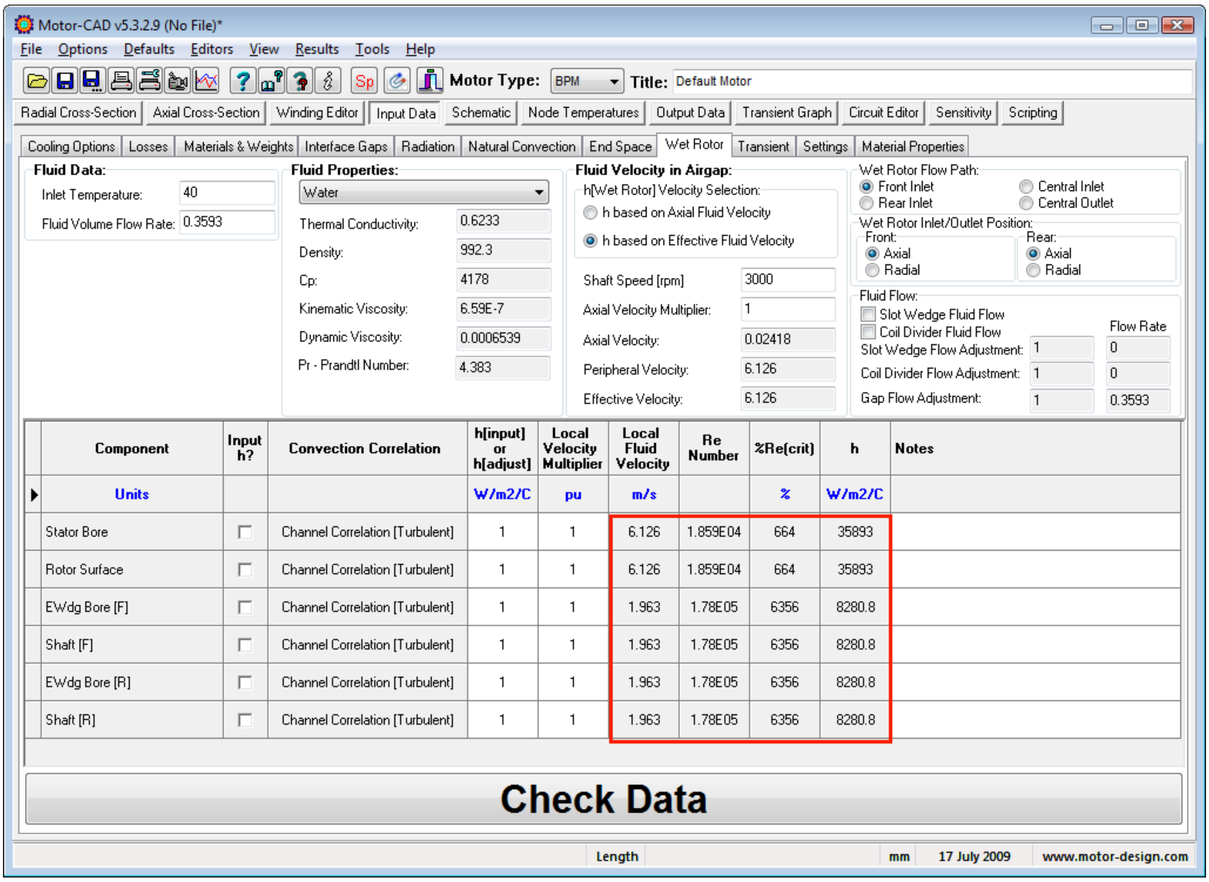
The fluids and their properties can be created and edited in the fluid data base (Input Data->Material Properties->Fluids).



The Wet rotor settings are defined by setting the options shown below. In this case the default model settings are used and the fluid is changed to water.

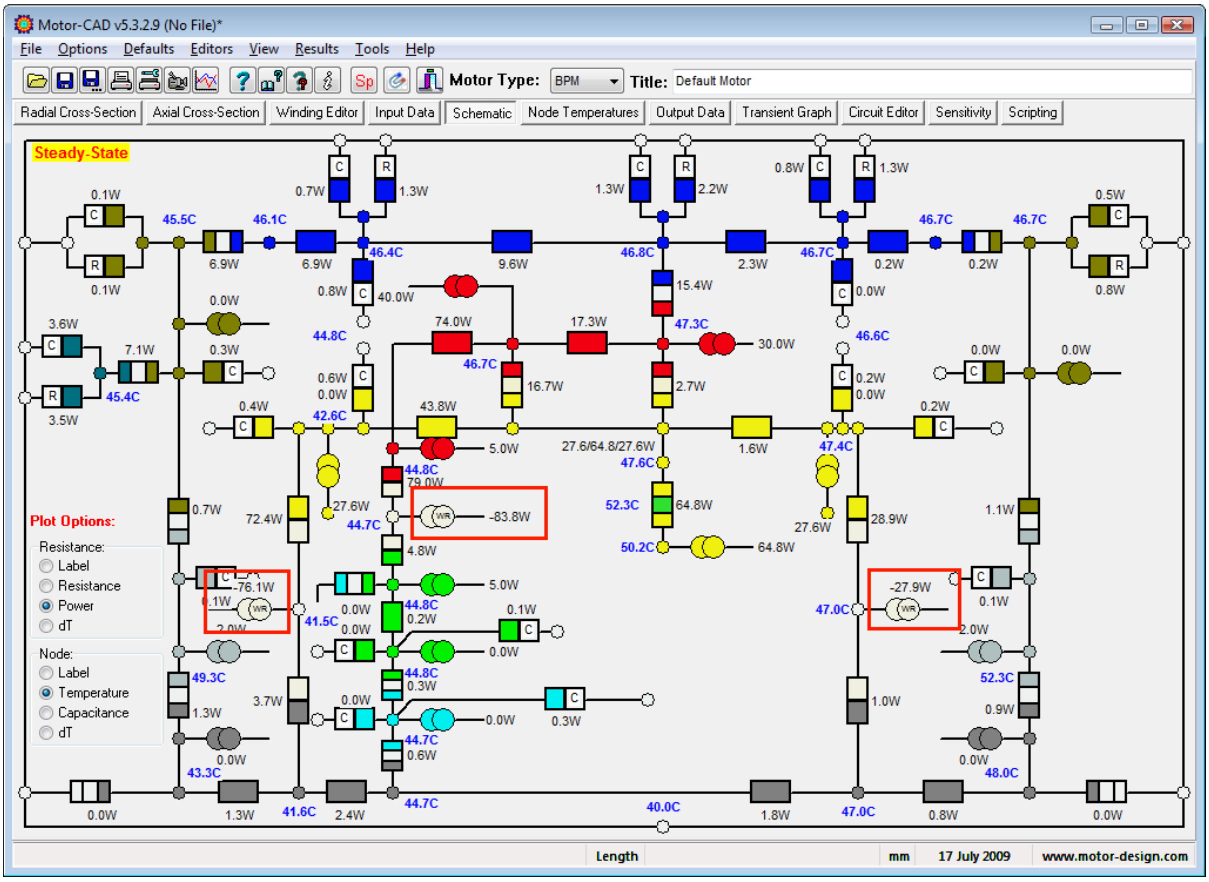


The flow velocities and heat transfer coefficients are calculated by Motor-CAD as shown below.

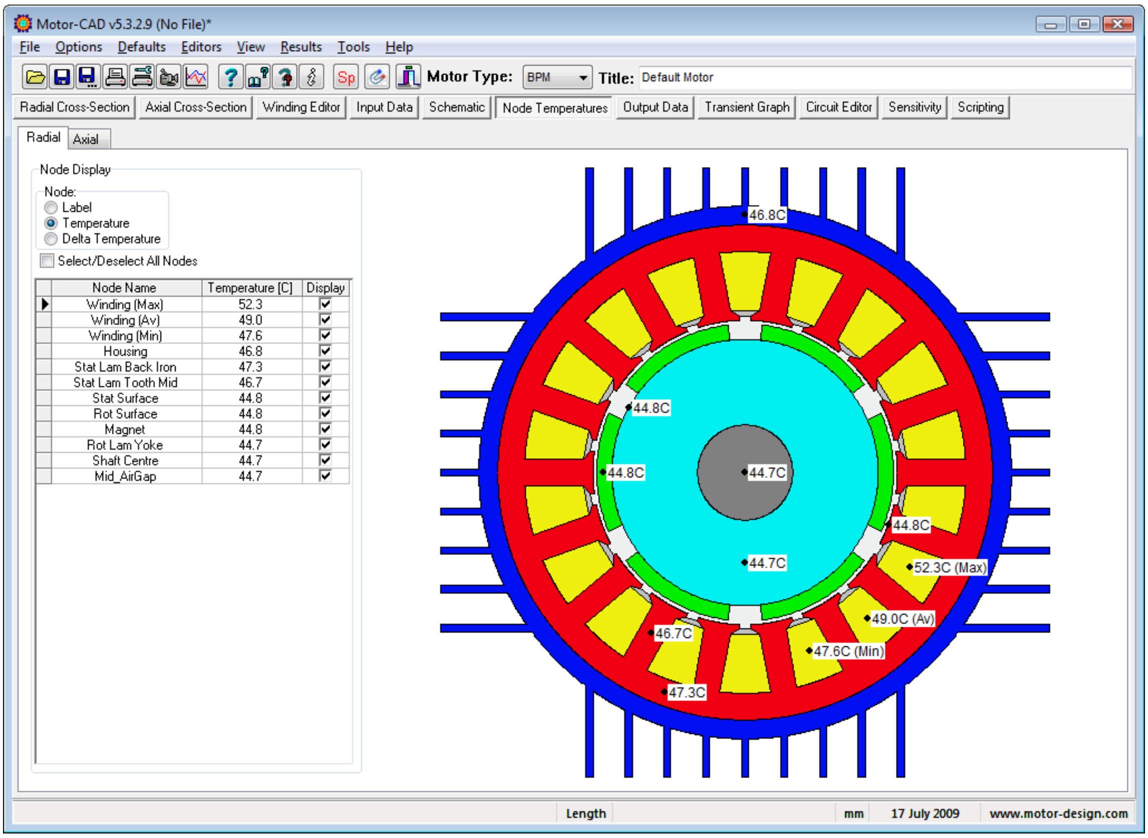


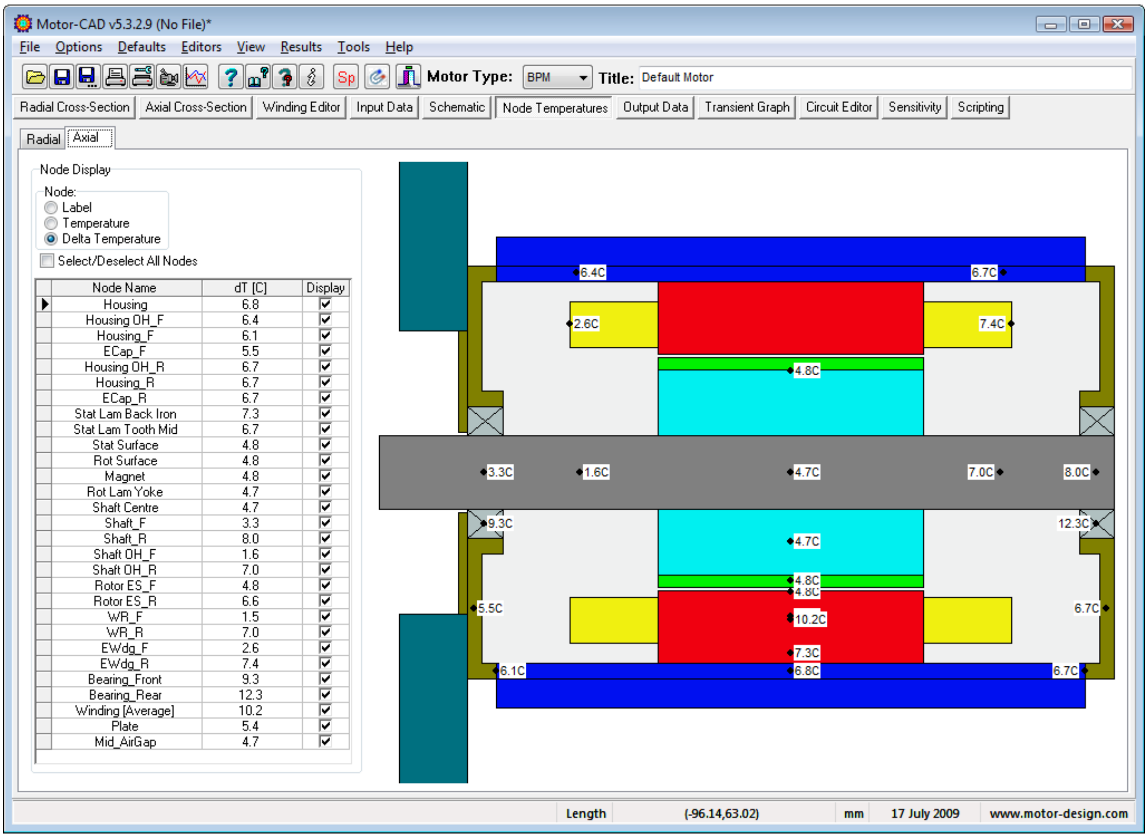
Viewing the results

The power removed from the machine by the wet rotor fluid from airgap, end windings and shaft is shown in the steady state schematic.

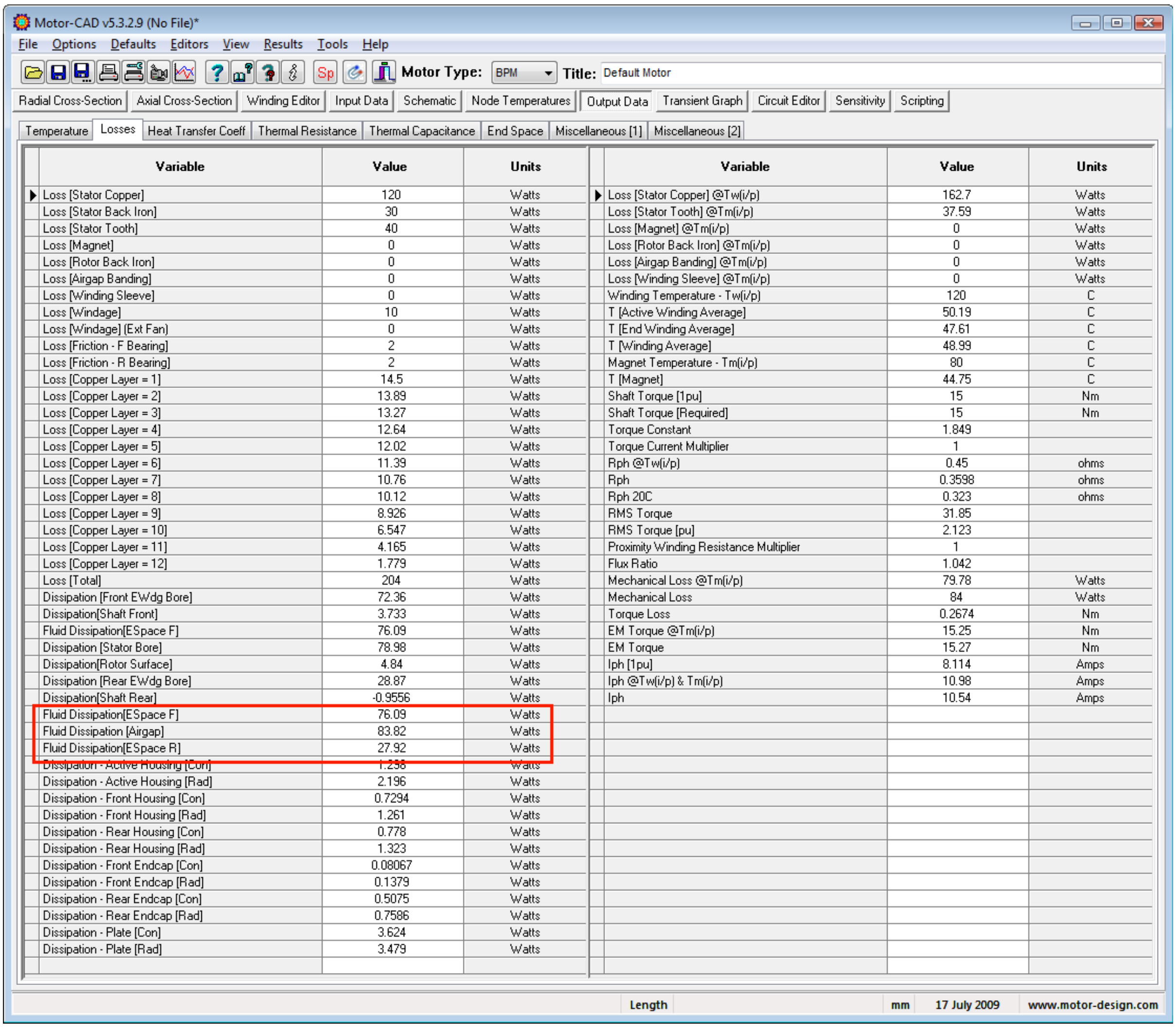


The node temperatures can also be viewed on the radial and axial cross sections as shown below.





The wet rotor fluid dissipation values are shown in the output data sheet as shown below.



Variable	Value	Units
Loss [Stator Copper]	120	Watts
Loss [Stator Back Iron]	30	Watts
Loss [Stator Tooth]	40	Watts
Loss [Magnet]	0	Watts
Loss [Rotor Back Iron]	0	Watts
Loss [Airgap Banding]	0	Watts
Loss [Winding Sleeve]	0	Watts
Loss [Windage]	10	Watts
Loss [Windage] (Ext Fan)	0	Watts
Loss [Friction - F Bearing]	2	Watts
Loss [Friction - R Bearing]	2	Watts
Loss [Copper Layer = 1]	14.5	Watts
Loss [Copper Layer = 2]	13.89	Watts
Loss [Copper Layer = 3]	13.27	Watts
Loss [Copper Layer = 4]	12.64	Watts
Loss [Copper Layer = 5]	12.02	Watts
Loss [Copper Layer = 6]	11.39	Watts
Loss [Copper Layer = 7]	10.76	Watts
Loss [Copper Layer = 8]	10.12	Watts
Loss [Copper Layer = 9]	8.926	Watts
Loss [Copper Layer = 10]	6.547	Watts
Loss [Copper Layer = 11]	4.165	Watts
Loss [Copper Layer = 12]	1.779	Watts
Loss [Total]	204	Watts
Dissipation [Front EWdg Bore]	72.36	Watts
Dissipation[Shaft Front]	3.733	Watts
Fluid Dissipation[ESpace F]	76.09	Watts
Dissipation [Stator Bore]	78.98	Watts
Dissipation[Rotor Surface]	4.84	Watts
Dissipation [Rear EWdg Bore]	28.87	Watts
Dissipation[Shaft Rear]	-0.9556	Watts
Fluid Dissipation[ESpace F]	76.09	Watts
Fluid Dissipation [Airgap]	83.82	Watts
Fluid Dissipation[ESpace R]	27.92	Watts
Dissipation - Active Housing [Con]	1.238	Watts
Dissipation - Active Housing [Rad]	2.196	Watts
Dissipation - Front Housing [Con]	0.7294	Watts
Dissipation - Front Housing [Rad]	1.261	Watts
Dissipation - Rear Housing [Con]	0.778	Watts
Dissipation - Rear Housing [Rad]	1.323	Watts
Dissipation - Front Endcap [Con]	0.08067	Watts
Dissipation - Front Endcap [Rad]	0.1379	Watts
Dissipation - Rear Endcap [Con]	0.5075	Watts
Dissipation - Rear Endcap [Rad]	0.7586	Watts
Dissipation - Plate [Con]	3.624	Watts
Dissipation - Plate [Rad]	3.479	Watts

Variable	Value	Units
Loss [Stator Copper] @Tw(i/p)	162.7	Watts
Loss [Stator Tooth] @Tm(i/p)	37.59	Watts
Loss [Magnet] @Tm(i/p)	0	Watts
Loss [Rotor Back Iron] @Tm(i/p)	0	Watts
Loss [Airgap Banding] @Tm(i/p)	0	Watts
Loss [Winding Sleeve] @Tm(i/p)	0	Watts
Winding Temperature - Tw(i/p)	120	C
T [Active Winding Average]	50.19	C
T [End Winding Average]	47.61	C
T [Winding Average]	48.99	C
Magnet Temperature - Tm(i/p)	80	C
T [Magnet]	44.75	C
Shaft Torque [1pu]	15	Nm
Shaft Torque [Required]	15	Nm
Torque Constant	1.849	
Torque Current Multiplier	1	
Rph @Tw(i/p)	0.45	ohms
Rph	0.3598	ohms
Rph 20C	0.323	ohms
RMS Torque	31.85	
RMS Torque [pu]	2.123	
Proximity Winding Resistance Multiplier	1	
Flux Ratio	1.042	
Mechanical Loss @Tm(i/p)	79.78	Watts
Mechanical Loss	84	Watts
Torque Loss	0.2674	Nm
EM Torque @Tm(i/p)	15.25	Nm
EM Torque	15.27	Nm
Iph [1pu]	8.114	Amps
Iph @Tw(i/p) & Tm(i/p)	10.98	Amps
Iph	10.54	Amps

Transient Analysis

Transient analysis can also be performed on this model. Full details of the transient analysis options and method of calculation are given in the transient analysis tutorial.