Electric Motor Cooling System Design

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ICEM
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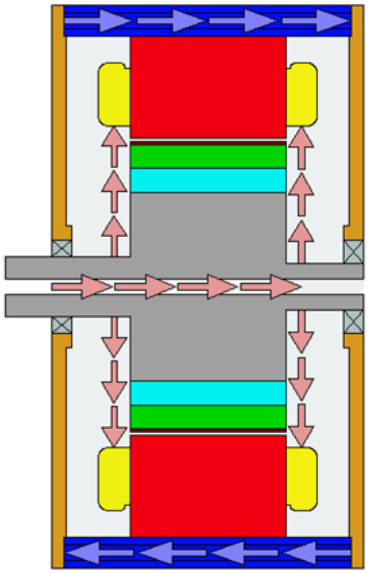
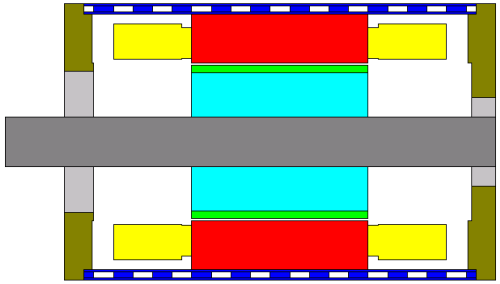
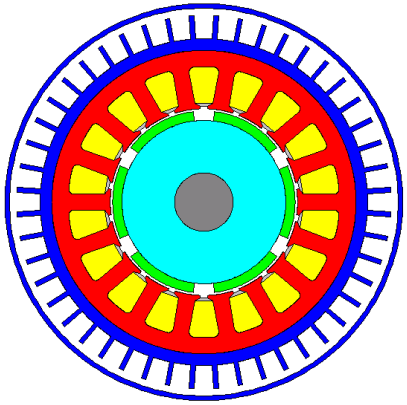
Cooling Types Investigated

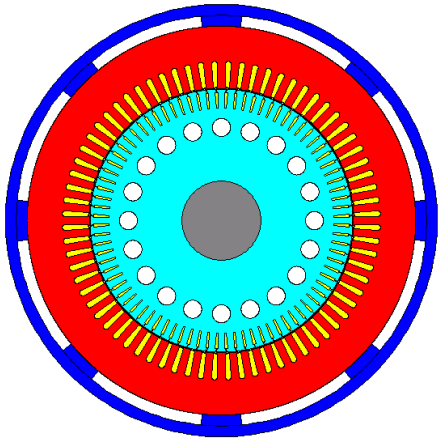
There are an extensive range of cooling types available:

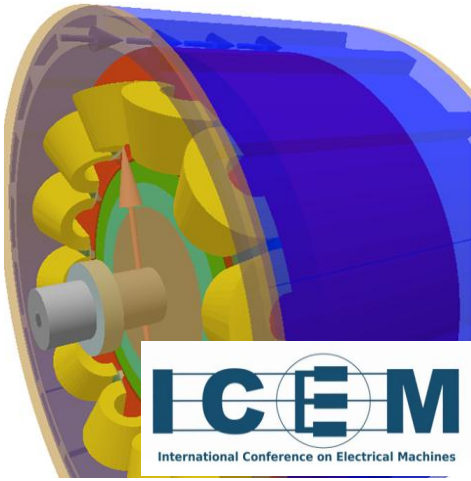
- TENV: Totally enclosed non-ventilated
  - natural convection from housing
- TEFC: Totally enclosed fan cooled
  - forced convection from housing
- Through Ventilation
- TE with Internal Circulating Air
  - Internal air circulating path
  - water jacket as heat exchanger
- Open end-shield cooling
- Water Jackets
  - axial or circumferential
- Submersible cooling
- Wet Rotor & Wet Stator cooling
- Oil Filled
  - Part filled with oil
- Oil Spray Cooling
  - Nozzles on stator and/or rotor
- Direct conductor cooling





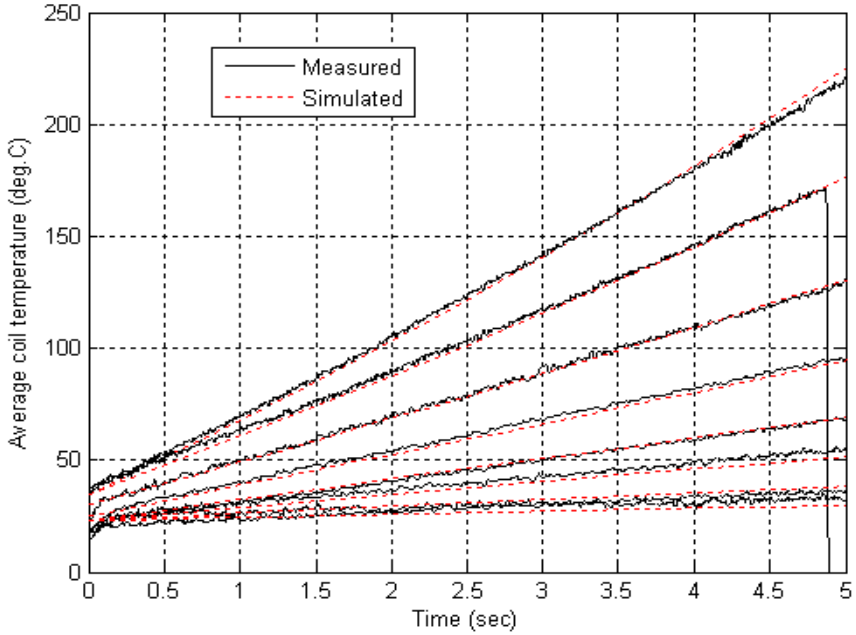




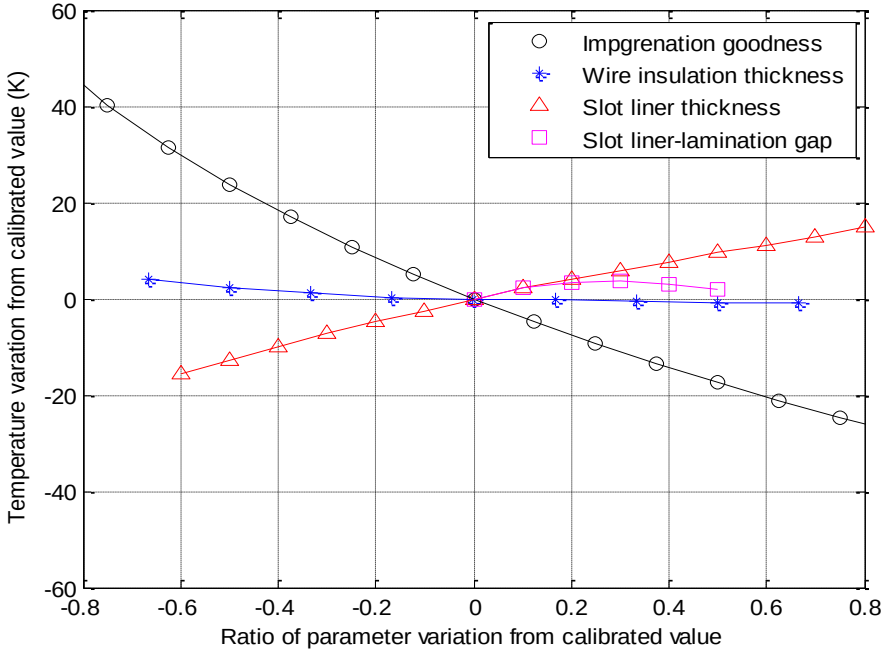


Thermal Modeling of a Short Duty Motor

- Motor designed to have minimum size and weight for a high performance short-duty cycle application.
- Optimization of thermal criteria such slot insulation system is critical for minimized weight and size for this transient load design
- Excellent agreement with test data when prototype built



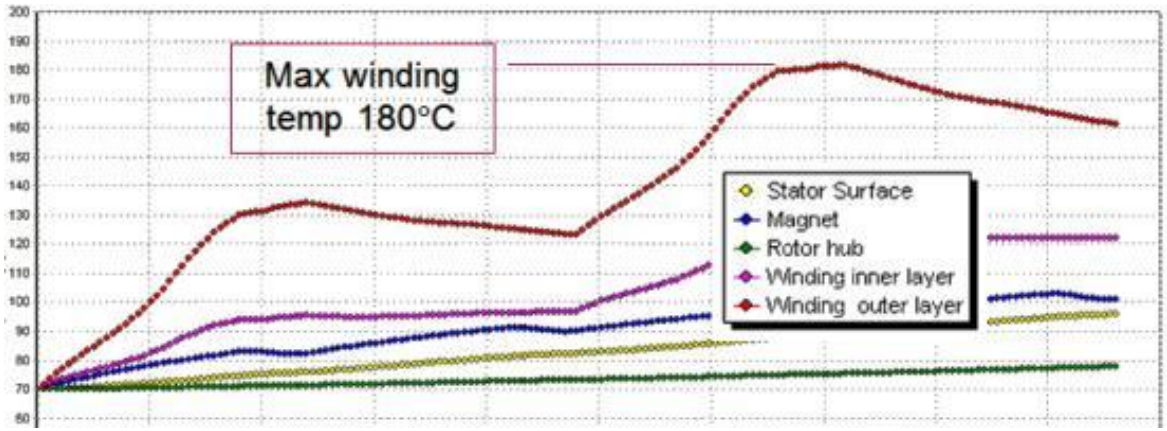
Winding temperature rise with DC currents (0.2 to 1.1 p.u.) - Test & Model

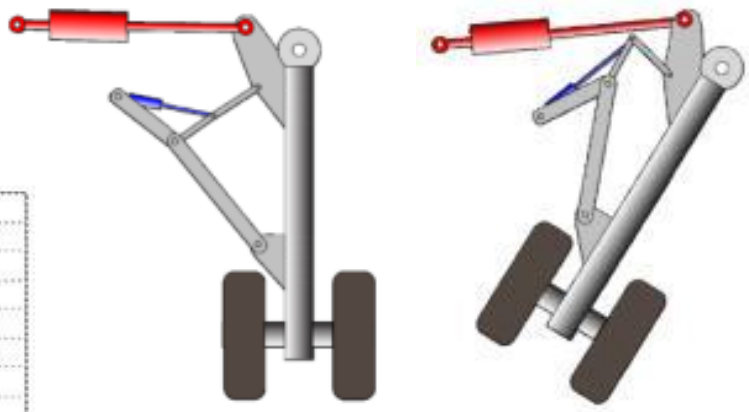


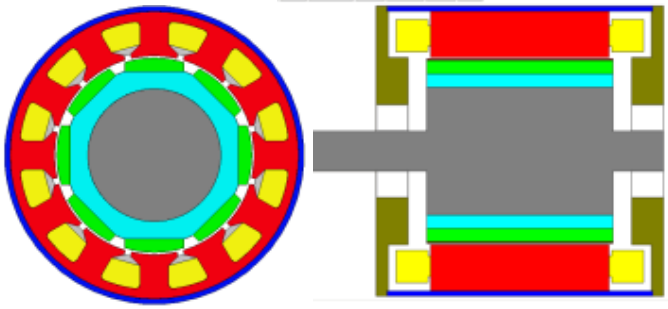
Sensitivity analysis to determine optimum slot insulation system

Motor Size and Weight Reduction

- Example of an aerospace motor size and weight reduction due to thermal optimisation:
  - Weight reduction 31%
  - Volume reduction 39%







Parameter	Unit	Before optimisation	After optimisation
Stator diameter	mm	110	105
Stator length	mm	100	67
Effective volume	cm^3	950	580
Active mass	kg	5.45	3.75

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Example published at UK Magnetics Society Meeting 2008