IkerMAQ Inset PMSM magnetic and thermal study

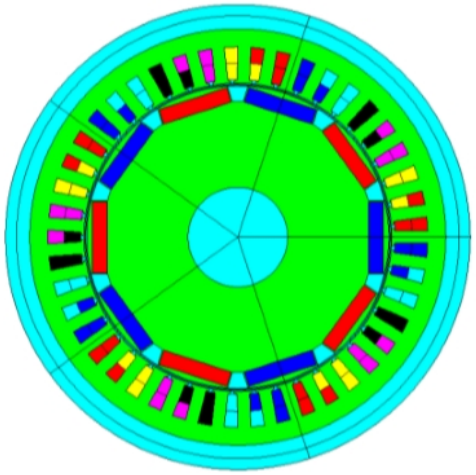
2D Application Note Summary

Introduction

The application note shows a magneto-thermal approach to model and to simulate a surface inset permanent magnet synchronous motor (model IkerMAQ). It covers electromagnetic and thermal analysis, and both analysis results have been compared and verified with measurements.

Keywords

Application-function	Domain	Quantities
• Transient Magnetic • Transient Thermal	• Brushless motor	• Iron losses (LS) • Joule losses • Magnetic quantities • Electric quantities • Circuit quantities • Thermal quantities

Studied device	
The studied device, represented in the following figure, is a surface inset permanent magnet synchronous motor (PMSM) used on traction application with 75 kW power rating. It is a three-phase machine with 45 stator slots and 10 rotor poles made from M800_65A steel.	 

Example 1: Transient magnetic analysis

The objective is to calculate electromagnetic torque and other electrical parameters (phase voltages, phase currents, power, losses, etc.) for different rotor positions under transient analysis. In this case, the transient magnetic application is used and coupled with an external three-phase circuit while varying rotor position. The following curve plots can fully determine the characteristic of the motor and all the results correspond to measurement.

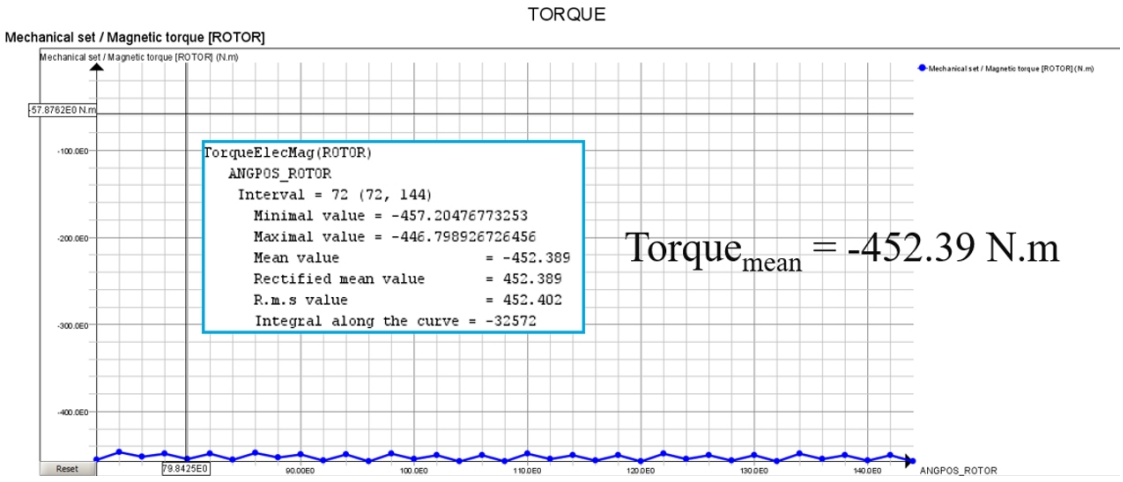


Figure 1: Electromagnetic torque curve (vs rotor position)

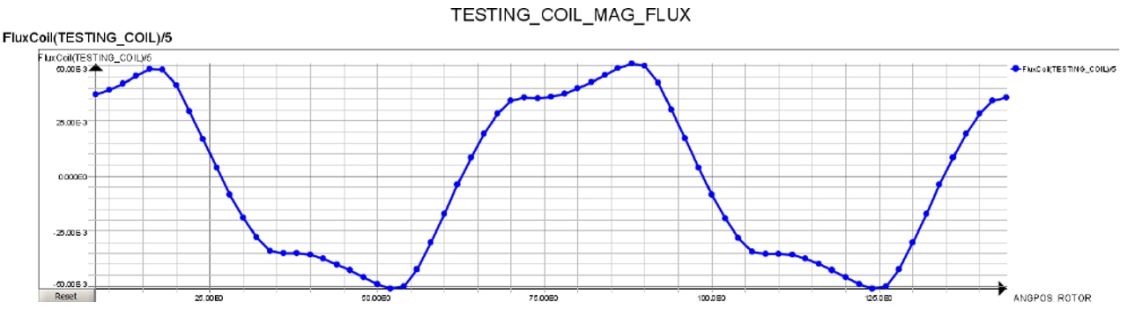


Figure 2: Magnetic flux flowing in the testing coil (vs rotor position)

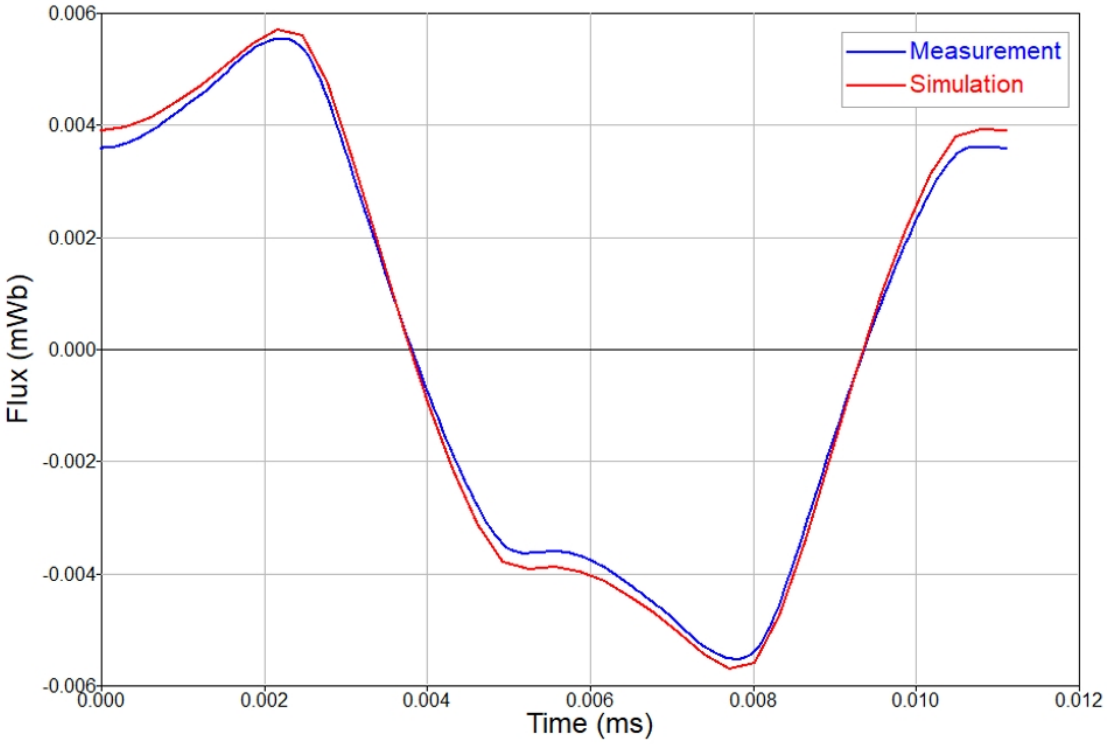


Figure 3: Comparison of magnetic flux in test coil

Example 2: Steady-state thermal analysis

Once the PMSM is electromagnetically computed, the second step is to analyze its thermal characteristics. In Flux, the most common way is to export the copper loss information from the transient magnetic analysis and compute the thermal application based on it. The following temperature distribution figure provides a primary analysis of the thermal characteristic inside the motor. Furthermore, all the results are compared to the measurement.

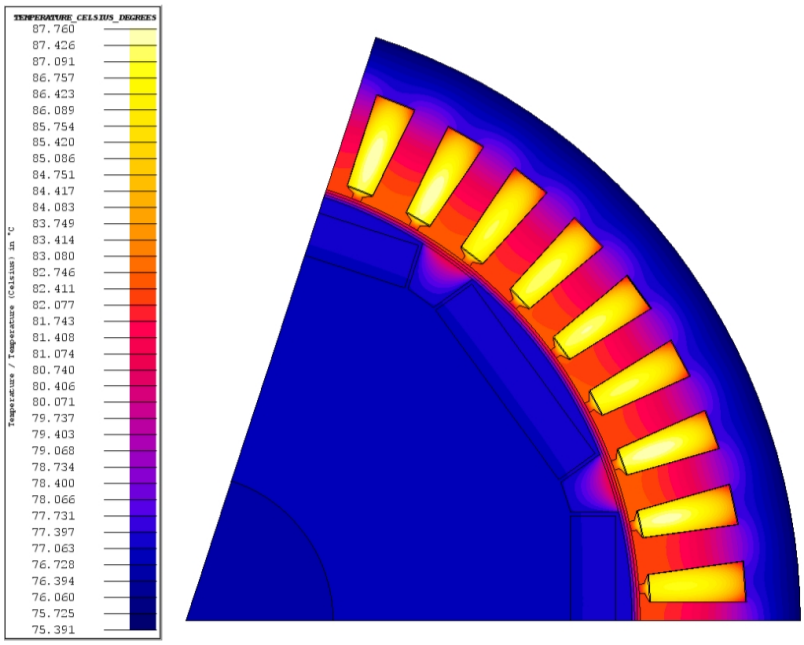


Figure 4: Temperature distribution inside the motor

Temperature result comparision table			
	Simulated / ºC	**Measured / ºC**	**Difference**
Slot (mean)	83.05	85.60	3.07%
Slot (max)	86.13	86.30	0.20%
Stator (mean)	79.15	79.50	0.44%
Magnet (mean)	75.13	76.00	1.16%