Thermal Management of PMSM Using LPTN Model

Name: Muhammad Towhidi
Supervisor: Dr. Narayan Kar
Program: Electrical Engineering
Level of studies: MASc

Project Description

High torque and power density in PMSM results in high temperature causing

- Decreased motor life
- Unsatisfactory motor performance
- Motor demagnetization
- Winding insulation breakdown

Motor temperature must be monitored and maintained within safe limit

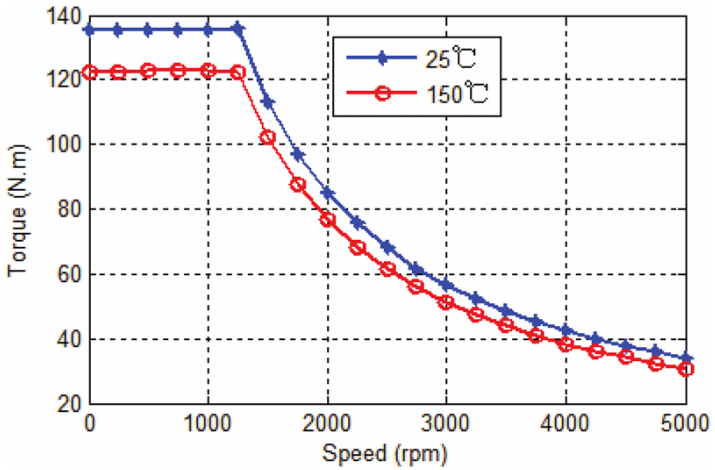

Fig 1. Torque-speed characteristic [1] .

[1] Z. Zhang *et al.*, "Research on Effect of Temperature on Performance and Temperature Compensation of Interior Permanent Magnet Motor", June 2016.

Objective(s)

- To propose an LPTN model to dynamically predict motor temperature
- To regulate the coolant flow rate as required

Tasks/Plan

- Motor loss data – input
- To determine the thermal resistances and capacitances.
- To determine the liquid flow parameters in the cooling channel.
- Simulation for temperature results
- Varying the coolant flow rate as required

Expected Outcome & Deliverables

- Thermal model having all the thermal resistances and liquid flow parameters.
- Motor temperature results with different flow rates of the coolant.
- One journal paper is expected.

LPTN Model for PMSM

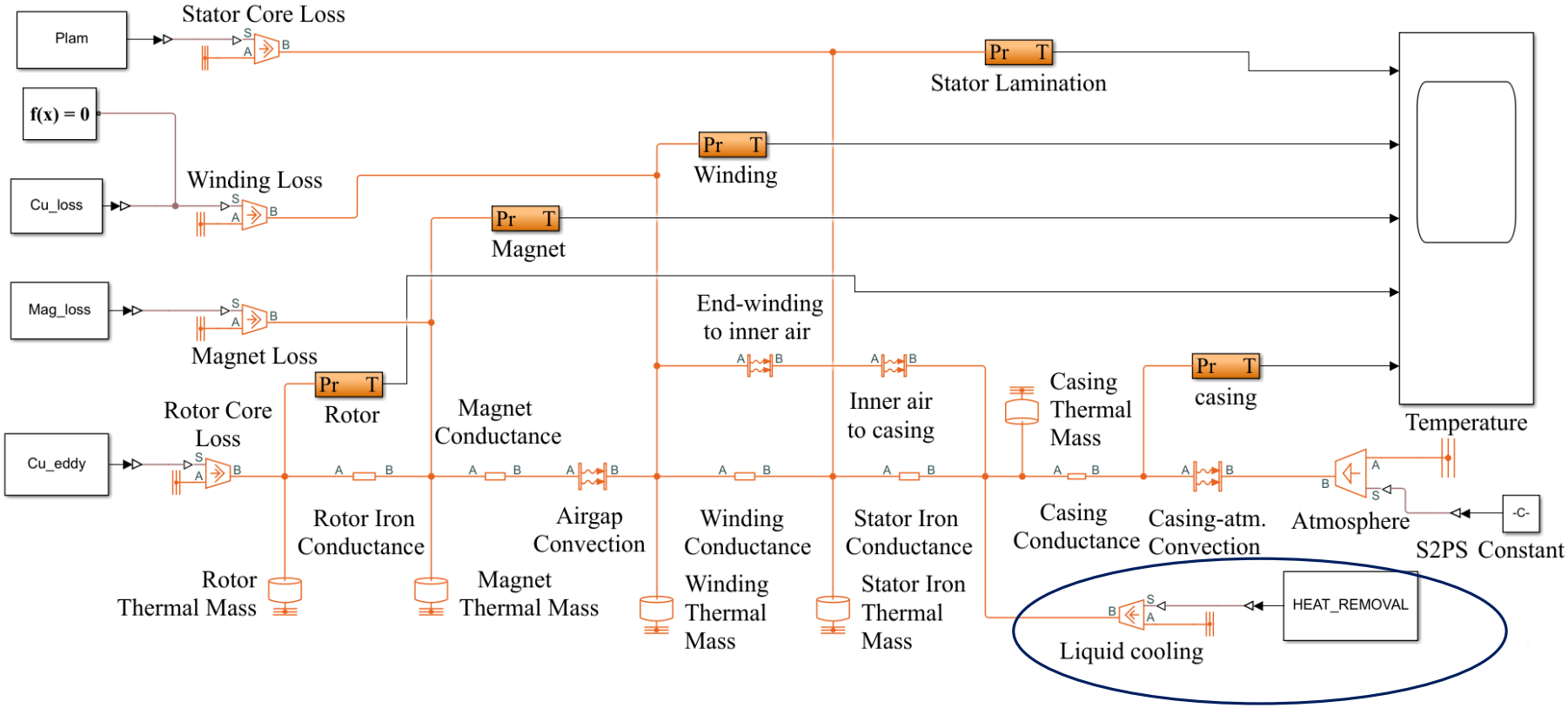

Fig 2. LPTN Model in MATLAB Simulink

Progress Report

- Thermal resistances and capacitances
- Pressure loss and minor loss parameters for fluid flow
- Simulation results were obtained for stator winding temperature.
- After implementing flow rate regulation in the LPTN model, will work on the cooling channel design optimization.

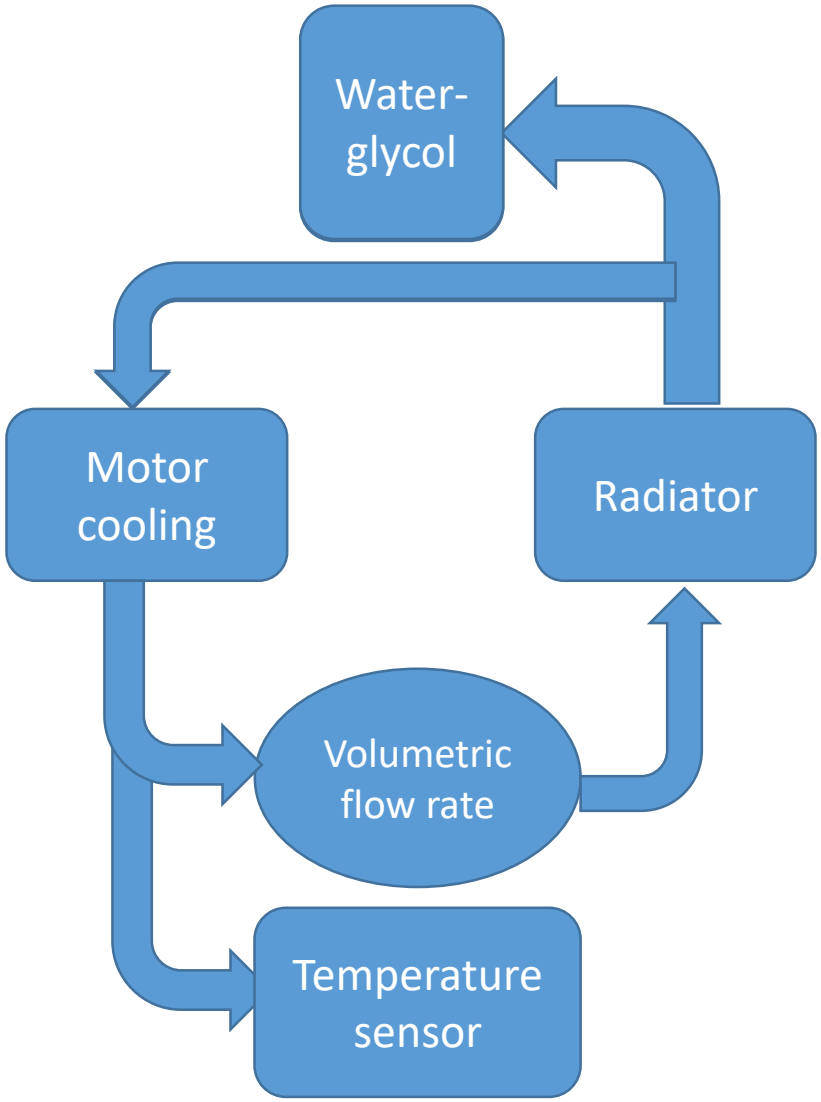

Fig 3. Modification of LPTN Model with cooling blocks.

Progress Report

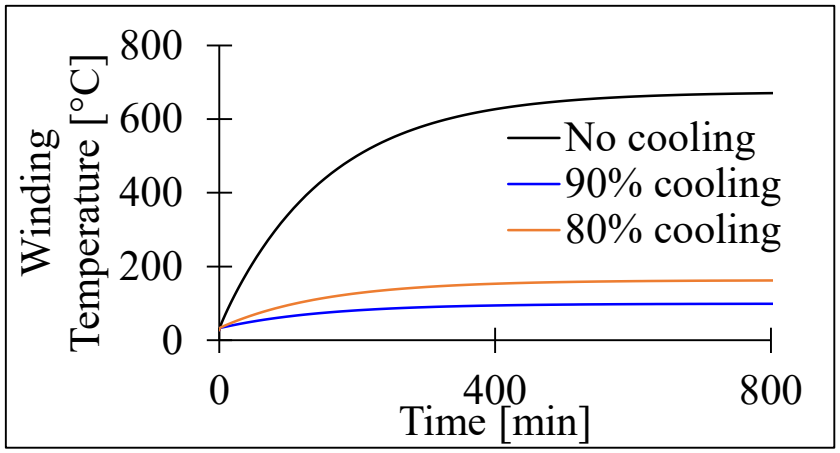

Fig 4. Winding Temperature of PMSM at 500 rpm and 65 Nm.

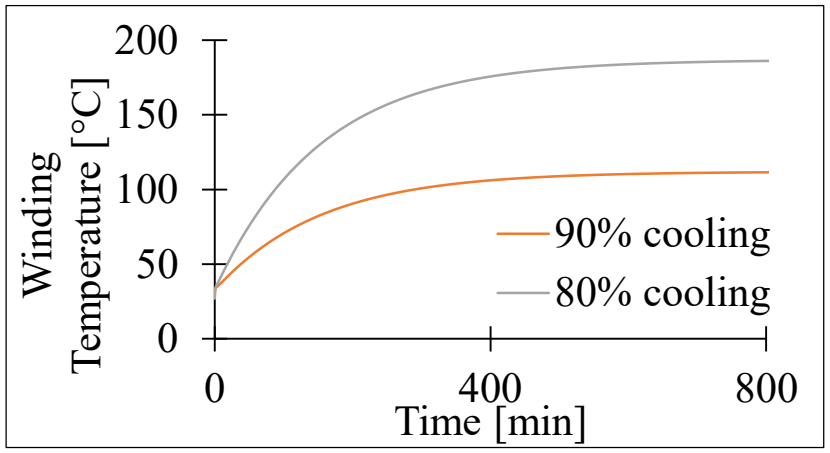

Fig 5. Winding Temperature of PMSM at 2,500 rpm and 71 Nm.

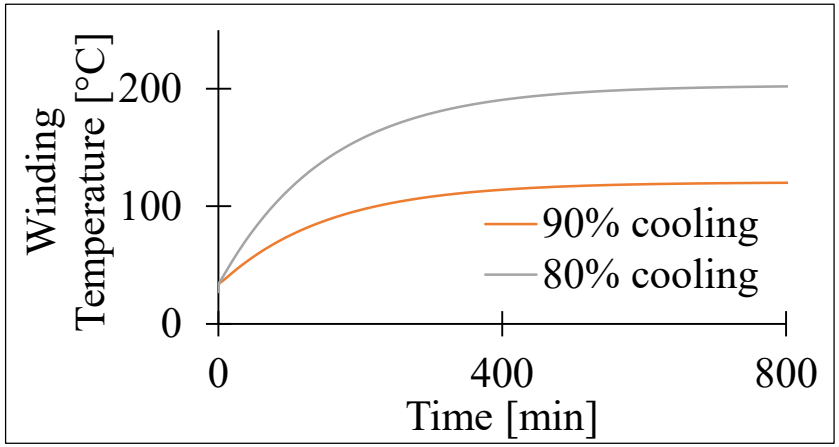

Fig 6. Winding Temperature -Prototype A at 5,000 rpm and 50 Nm.