Motor Management of Permanent Magnet Synchronous Machines

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Due to rising demand for mobility together with contradictions as climate change and scarce resources a rising variety of solutions for electric and hybrid electric vehicles gets offered. The same facts drive the need for optimizing already existing solutions to achieve higher torque density, better efficiency with respect to a given load cycle and lower losses to achieve increased cruising range with the same or even reduced energy storage. For the electric drive, there are mainly two state-of-the-art designs:

- Induction machine with squirrel cage
- Permanent magnet synchronous machine

Due to the machine design, the asynchronous induction machine with squirrel cage is a robust solution, but with the disadvantage that the electric field has to be excited by stator currents which cause additional ohmic losses.

The permanent magnet synchronous machine uses components that are more sensitive with respect to temperature and mechanical stress, but on the other hand the magnets offer a source of magnetization without additional losses.

For both machine topologies the induced voltage depends on the magnetic field and the speed. If speed gets high enough, the magnetic field has to be reduced in order to keep the induced voltage under a level that is available from the battery. In case of an asynchronous induction machine, the field current is just reduced. In case of a permanent magnet synchronous machine, the field current has to weaken the field excited by the permanent magnets to meet the voltage requirements. For the latter, the question investigated in this paper can be formulated as follows: Is it possible to determine an optimal field current, to minimize either total current consumption or losses? Current consumption is a limiting factor for designing the power electronics, whereas losses influence efficiency and cruising range.

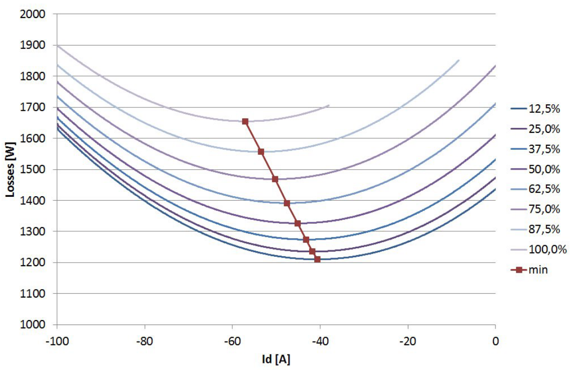

Figure 1 Losses at nominal torque and var. speed

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