Low-Power Induction and Synchronous Reluctance Machines: From Semi-Analytical Analysis towards Practical Application

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Project aim
The increasing energy-efficiency requirements for electric motor-driven systems are pushing motor manufacturers to improve the efficiency of their products. Such improvements can either be obtained by reconsidering the design of conventional motor technologies, such as Induction Motors (IMs) or by considering less conventional motor technologies, such as Synchronous Reluctance Motors (SynRMs). To explore the design space of such motor technologies, fast, accurate and reliable calculation models, together with a proper understanding of the material characteristics and model limitations, are required. Therefore, the aim of the project is to investigate and develop semi-analytical analysis tools for IM and SynRM design.

Progress
A semi-analytical method called Harmonic Modeling Technique (HMT) has been investigated and implemented for IM and SynRM analysis. For IMs, the developed models (Fig. 1) extend previous model implementations by considering a direct coupling between the magnetic and electric domains. Also, a new method to calculate leakage and fringing flux effects in IMs is proposed. The results of the semi-analytical calculations are validated against measurements performed on four existing IMs and it is found that the discrepancies are generally within 5-10%. Furthermore, for SynRMs, HMT is extended to include material property variations, such that saturation effects can be taken into account. Two prototype SynRMs have been designed and tested in order to validate the models. Currently, the validation of the SynRM models and the PhD thesis are being finalized.

Scientific publications