ICEM 2024, Torino, September 1-4 2024

Tutorial Proposal

TUTORIAL TITLE: Influence of Permanent Magnet Synchronous Machines control parameters on acoustic noise and vibrations due to Maxwell forces

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BIOS OF THE PRESENTERS (150 words each):

J. LE BESNERAIS completed an industrial PhD thesis in Electrical Engineering in 2008 on the reduction of electromagnetic noise and vibrations in traction machines with ALSTOM Transport. After working in railway and wind energy sectors, he created EOMYS ENGINEERING in 2013, a company specialized in the analysis and mitigation of e-NVH problems in electrical machines and drives.

Besides participating in EOMYS consulting and training projects, J. LE BESNERAIS coordinates the development of Manatee software, the only CAE collaborative platform dedicated to the assessment and control of magnetic noise & vibrations all along the development of electrified systems. Manatee facilitates collaboration between engineers (electrical, control, mechanical, NVH and test engineers) while standardizing the interfaces between electric machine designers and integrators. Manatee pioneering technology includes predefined multiphysic simulations workflows, root cause analysis tools, and specialized noise mitigation techniques.

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ABSTRACT (200 - 300 words):

Acoustic noise and vibrations induced by electromagnetic forces due to electric motor operation (called e-NVH in automotive application) can be significant in electrified transportation systems, from electric scooters to eVTOL, including electric bikes, electric vehicles, and railway traction motors. Tackling noise issues after manufacturing can be particularly expensive and may degrade electric powertrain performances such as efficiency, cooling, and weight. However, control solutions can be efficient methods to improve NVH performances at late design stage.

After a brief introduction on the physics of magnetic noise and vibrations illustrated with a 48-slot 8-pole IPMSM, this tutorial reviews the control parameters that can modify the NVH response of an Electric Drive Unit. The impact of current angle on magnetic forces and vibrations is first analyzed when going away from Maximum Torque Per Ampere strategy. Then, the impact of current harmonics on magnetic forces and vibrations is presented. This notion is used to introduce the noise control method based on Harmonic Current Injection, illustrated with numerical simulation on the 48s8p machine. Finally, the effect of different Pulse Width Modulation strategies (SVPWM, DPWM, GDPWM, RPWM) and switching frequencies on magnetic noise and vibrations is presented.

The tutorial includes sound files, animations, scientific literature references and numerical simulation examples coming from Manatee® e-NVH simulation software. It is made for control and electromagnetic engineers involved in the development of electric drives.

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