Mathematical modelling of the electrical drive (inverter – permanent magnet brushless motor) with the account of inverter asymmetry

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Abstract

Try to imagine a train failure on the main rail route. What kind of effects will it cause? Enormous financial looses, customers' dissatisfaction, delays etc. Do you think it is possible to avoid such a failure? Can we predict it without sensors and without periodic tests? The future of diagnosis is based on models. How does it work? The paper about *Mathematical modelling of the electrical drive with the account of inverter asymmetry* is the answer.

The studies considered the model of the electrical drive with the permanent magnet synchronous motor supplied from the voltage inverter with the use of Lagrange energy method. This method allows modelling any electromechanical energy converters for diagnosis purposes. Building the model follows certain steps:

- decomposition of the motor and inverter structure into lumped elements,
- determination of lumped elements' state functions,
- determination of particular coenergies of conservative elements and Rayleigh dissipative function of elements with energy looses in the nongeneralized coordinates
- formulation of Lagrange's function in local coordinate system
- formulation of equations of constraints
- formulation of Lagrange's equation in the generalized coordinates

State functions of lumped elements (model parameters) were calculated by using FEM simulations (Maxwell), laboratory measurements and nominal values of the motor. Voltage inverter control is composed of the Space Vector Pulse Width Modulation and the scalar speed control (U / f = const).

The model is described with the derivative system of equation with variable coefficients (dependent from rotor position, speed, time). Simulation of the model needs an advanced solver. The scope of the thesis included also a preparation of a MFC application using Visual C++. The application PMSMsimulator enables simulation of the drive in case of

malfunctions set by a user. Time duration of 0.1 second simulation varies from a few seconds to a few minutes depending on program settings (a user has possibilities to simplify calculations) and computer speed.

The model enables further development. More detailed studies will cause more realistic results. 'Realistic' means possible to use in industry.

Keywords

Permanent magnet synchronous motor, voltage inverter, Lagrange energy method, FEM, Maxwell, Visual C++, Mathcad, modelling, simulation, diagnosis.