Coupled Transient Electromagnetics-Mechanism Simulation of coil-actuated circuit recloser

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ABSTRACT

Electromagnetic actuators are used within ABB MV reclosers in order to drive mechanical systems and protect the overhead line [1]. A good design of a recloser requires the understanding of different physical phenomena strongly related to each other. Transient electromagnetics, mechanism dynamics, electronic and control system are all crucial aspects of a recloser design. Dissipation and electromagnetic forces in the actuator can be computed in a FE simulation environment by solving Maxwell's partial differential equations. The effects of material nonlinearities, back-EMF and eddy currents in non-laminated structures can be included. Circuit simulation tools can be used for learning how power electronics circuit and its control works. The switching process itself is a mechanical process resulting into fast motions with impact dynamics triggering oscillations. Such mechanism dynamics is suitably analysed with multibody systems and structural methods.

This paper describes the modelling and simulation of the coupled system dynamics of a recloser. The mechanical domain is coupled to the electromagnetic domain through a co-simulation approach using a weak coupling method based on a parallel explicit Jacobi scheme [3, 4]. Control scheme, power electronics and nonlinear effects are included through direct programming of the related equations.

The built model allows for a full transient consideration of mechanism movement and effects of the electromagnetic fields. In particular, a realistic movement of the plunger within the electromagnetic field is three dimensional due to tolerance play, elasticity and friction in the joints [2]. Small displacements of electrical contacts significantly trigger the lateral and rotational movement of the plunger during impact causing feedback to the electromagnetic field. As a consequence the electromagnetic forces can strongly be affected influencing the proper recloser functionality.

The co-simulation model implemented for the multi-physics analysis of the above described electromechanical system is presented and explained in detail. Effects and parameters are studied and results will be presented.

REFERENCES

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