Simulation and Experimental Assessment of the Electromagnetic-Thermal Behavior of an Inductive-Type Fault Current Limiter

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June 8, 2018 (STH57, HP132). The study of the electromagnetic-thermal phenomena of superconducting fault current limiters operating in electrical grids is often neglected in transient simulations due to extensive simulation times or unavailability of commercial software easily addressing the coupling between electromagnetic and thermal phenomena [1, 2]. Recently, in [3], we have presented a fast simulation methodology to predict the dynamical electromagnetic-thermal behavior of an inductive-type limiter, namely: line current, primary linked flux as well as temperature and current in superconducting secondary. Simulations have been compared to experimental results from a laboratory scale prototype, depicted in Fig. 1 [3, 4].

In the developed model, implemented in Simscape Power Systems from Simulink/Matlab, the line current and linked flux are calculated from a methodology based on the maximum hysteresis loop of the limiter, described in [5, 6], whilst current and temperature in superconductor are computed from a thermal–electrical analogy, described in [7, 8]. In this analogy, several thermal-dependent properties of the superconductor have been considered, namely: critical current density, *n*-value, resistivity, thermal conductivity, heat capacity, and convection between the superconductor and liquid nitrogen.

With the developed tool, simulations considering long-term short-circuit faults (e.g., 2 seconds) take less than 5 minutes of computation time. A considerable agreement between simulations and experiments were observed at either normal or fault operation. Results, considering a maximum prospective line current scenario of 30 A, are presented in Fig.2. Simulated and measured results of line current, linked flux, superconducting current and temperature in superconductor, during a transition from normal to fault operation, are compared in Fig. 2 (a), (b), (c) and (d), respectively.

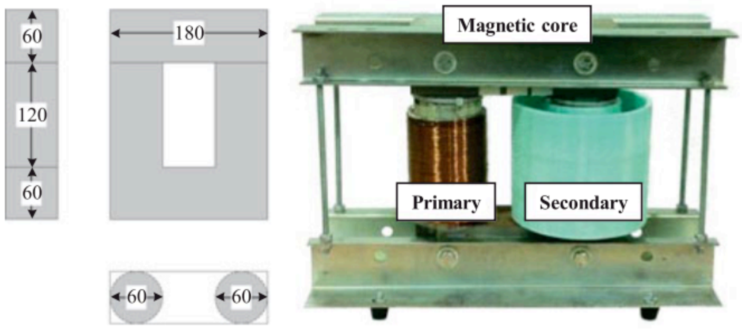
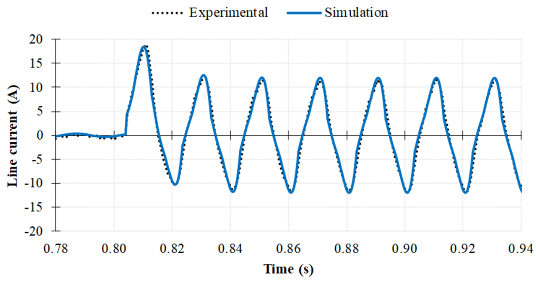
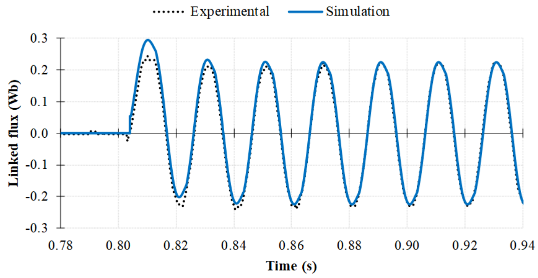


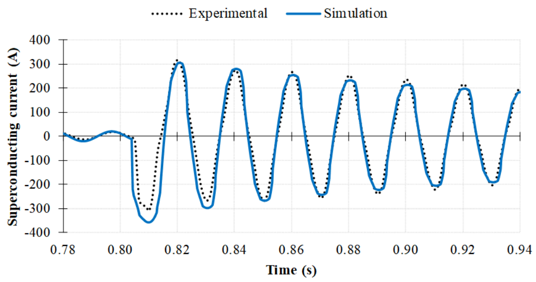
Fig. 1. Laboratory scale prototype (dimensions in millimeters) [3].



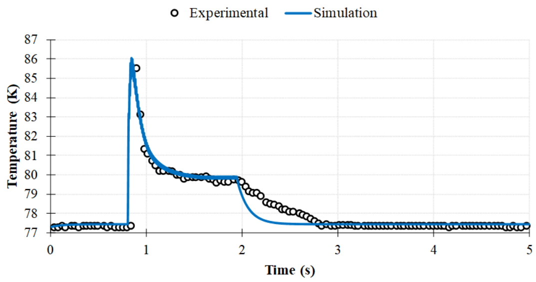
(a)



(b)



(c)



(d)

Fig. 2. Comparison between simulation and experimental results [3]. (a) Line current. (b) Primary linked flux. (c) Superconducting current. (d) Temperature in superconductor.

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