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Optimization Design of a Permanent Magnetic Actuator for 126kV Vacuum Circuit Breaker

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Permanent magnetic actuators (PMAs) have been widely used in driving mechanism of medium-voltage vacuum circuit breakers (VCBs) due to their high reliability and controllability. Different from the applications in medium-voltage situations, the PMA used in high-voltage power system has much longer stroke and requires a much higher velocity, which limit the application of traditional PMA in high-voltage field. In the available literature a bistable PMA with separated magnetic circuits has been proposed. The PMA consists of holding and driving components whose magnetic circuits are separated, which helps to improve the efficiency of coil currents to drive the movable contact. This PMA exerts a good closing performance, however, its breaking performance is not satisfactory due to the fact that coil inductor prevents the rapid growth of current during the initial phase of breaking operation. This paper focuses on the optimization of a monostable PMA with separated magnetic circuits, in which the breaking operation is completed by the spring. This paper divides the whole optimization into three sub-optimization modules, including the optimization of permanent magnetic holding mechanism, breaking spring mechanism and closing driving mechanism. These three sub modules are optimized sequentially and recurrently until the overall performance reaches the best. The average velocities of closing and breaking operations are set as the constraints to make them within the specified range, which is critical to successful operation of VCBs. Final velocities, time durations of both operations and the volume of the mechanism are selected as the optimization goals. As design variables, parameters of excitation circuits and spring, and dimension parameters will be optimized through transient analysis, which is realized by finite element method. The optimization model and algorithm will be studied and the performances in the initial model and the optimized model will be compared in the full paper.

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