Parameter Identification of IPM Motor Focusing on Current Norm
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1. Introduction
This paper proposes a new approach to identify the q-axis inductance $L_q$ of an interior permanent magnet synchronous motor (IPMSM) focusing on the current norm characteristic. The current norm depends on the mismatch of $L_q$, and the minimum or the maximum value of the current norm is obtained when the parameter is properly tuned. Using a simple method to search the minimum point of the current norm, it is possible to achieve the off-line parameter identification. This paper describes an improved identification technique to identify $L_q$ of the motor, which introduces a PI controller and a PI controller to the current loop of the field-oriented controller. The current norm characteristic is examined through computer simulations and experimental tests.

2. Identification System
Fig.1 presents the proposed $L_q$ identification technique. This identification system tunes $L_q$ in the decoupling controller. The PI controller with a small gain is employed in the d-axis loop to get the current variation caused by the mismatch between $L_d$ and $L_q$. On the other hand, the PI control is used in the q-axis loop to reduce interference by the unidentified $L_d$ and $\Psi$. The PI controller has the following time constant and loop gain to obtain the optimum response:

$$\tau_q = \frac{L_q}{R} \quad (1)$$

$$K_q = \omega L_q \quad (2)$$

Setting $i_d^* = 0$, $i_q^*$, and the current norm can be obtained as follows:

$$i_d^* = \frac{i_q^* K_q (1 + s\tau_q) \alpha (L_q - \hat{L}_q)}{(K_q + R)(K_d + R)\tau_q} \quad (3)$$

$$i_q = \frac{i_q^* K_q (1 + s\tau_q)(R + K_d)}{(K_q + R)(K_d + R)\tau_q} \quad (4)$$

$$i_n = \sqrt{i_d^2 + i_q^2} = \frac{i_q^* K_q (1 + \tau_q)}{(K_q + R)(K_d + R)\tau_q} \sqrt{(L_q - \hat{L}_q)^2 + (R + K_d)^2} \quad (5)$$

From (5), it is found that the current norm is varied by the mismatch between $L_q$ and $L_q$. The current norm has a convex parabola characteristic and has the minimum value when $L_q = \hat{L}_q$.

3. Simulation and Experimental Results
The proposed technique is tested through computer simulations using PSIM software and experimental tests with a real IPMSM shown in the Table1. It can be seen in Fig. 2 that when the speed is stable and $L_q$ is equal to a real value of $L_q$, the current norm becomes the minimum. While the mismatch between $L_q$ and $L_q$ is observed, the current norm is greater than the minimum value.

4. Conclusion
The current norm characteristic with respect to $L_q$ mismatch has been confirmed. The experimental and simulation results show that the identification of $L_q$ can be achieved by using the current norm characteristic.

References