文章编号：0258-8013 (2008) 06-0092-07　中图分类号：TM 351　文献标识码：A　学科分类号：470·40

电机参数误差对永磁同步电机弱磁性能的影响

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Influence of Inaccuracies in Machine Parameters on Field-weakening Performance of PM Brushless AC Drives

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ABSTRACT: In vector-controlled PM brushless ac drives, the *d*-axis and *q*-axis currents are controlled according to optimal current profiles derived from a mathematical model, usually for maximum torque per ampere in the constant torque operating range and maximum power in the field-weakening range. In this paper, the effect of inaccuracies in the motor parameters which are used to derive the optimal current profiles is investigated experimentally, with particular reference to the field-weakening performance.

KEY WORDS: permanent magnet; synchronous motor; field-weakening; machine parameters; error

摘要：在矢量控制的永磁同步电机控制系统中，*d* 轴和 *q* 轴电流的控制一般是根据电机数学模型推导的最佳性能轨迹，如恒力矩区的每安培电流最大力矩控制和弱磁区的最大功率控制。文中通过大量的实验，研究了当电机模型使用了不精确的各种电机参数后，对永磁同步电机的性能产生的不同影响。

关键词：永磁；同步电机；弱磁；电机参数；误差

0　引言

In vector-controlled PM brushless ac drives, the stator phase currents are usually transformed to *d*-axis and *q*-axis currents in the rotor frame and controlled according to optimal current profiles in order to obtain the required magnitude of flux and torque, respectively. In the constant torque operating range, various current profiles have been proposed depending on the specific optimisation objective, which may be maximum motor/drive efficiency, maximum torque per ampere, maximum output power or maximum power factor etc[1]. In practice, however, maximum torque per ampere control is widely used, due to its simplicity and greater operational significance[2-4]. For PM brushless ac motors with saliency, such as those having interior or inset PM rotors, the *d*-axis inductance L_d is smaller than the *q*-axis inductance L_q, and maximum torque per ampere control results in a negative *d*-axis current in order to realise the reluctance torque component. For non-salient motors, such as those having surface-mounted PM rotors, for which $L_d = L_q$, maximum torque per ampere control results in zero *d*-axis current. In the field-weakening (constant power) operating range, when the motor operates under both supply voltage and current limitations, the optimal current profiles should fully utilise the inverter capability, whilst maximising the output power and torque[2-10].

The optimal current profiles are derived from a mathematical model in terms of the motor parameters：L_d^c, L_q^c, E^c and R^c. However, in general, these will differ from the actual motor parameters：L_d^R, L_q^R, E^R and R^R, due to approximations in their numerical/ analytical prediction or measurement errors, whilst, in practice, the open-circuit flux-linkage ψ_m, and, therefore, L_d and L_q, and the winding resistance R both vary with temperature. Hence, the achieved performance of a vector-controlled drive may be inferior to the performance which it is inherently