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Nonlinear Design and Performance Analysis of an 8/6 Switched Reluctance Motor(SRM)

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Abstract

The research undertaken takes into account the inherent nonlinear nature of the 8/6 switched reluctance motor (8/6 SRM). Although a generalized approach is used in the early stage of the design of 8/6 SRM based on a magnetic circuit model, the subsequent and consequent computational algorithm to generate magnetization characteristics is always heavily iterative. The algorithm is therefore developed to ensure computational efficiency as in many of the deployment of the SRM drives as an alternative to existinginduction motor drives is often selected on real time basis. The algorithm can be applied to all geometric proportions, including doubly-salient structure with multi-tooth per pole configuration of SRMs. The flux splits into two paths along the stator back-of- core. The flux as a result of Ampere-Turns crosses the air-gap at aligned rotor position and unaligned rotor position respectively.2-D and 3-D end effect areincluded inthe final computationof nonlinear flux-linkage versus currents characteristics at various angles. In fact, the computed flux-linkage profile at all rotor positions leads to computation SRM's torque profile.

Keywords: Reluctance, Switched reluctance motor, flux-linkage, Mean torque.

Nomenclatures

As defined in the text.

Introduction

Research in SRMs has been actively conducted for more twenty years and list researchers can be found in (6). Finch as in (8) had used permeance as a means of analyzing the magnetisation features of doubly salient structure which is fairly ideal and generalized in approach. Miller as in reference 8 dealt with the converter part of the SRM. The approximation of the magnetization characteristics was made in (2). Y. Omar as in (1)based on Miller's work related to generation of flux-linkage profile of SRM at various angles is acceptably more accurate than the direct cosine interpolation, but the method is undeniably more complex. Other Related researches in SRMS had been carried out as in Ref (3, 4, 5, and 7) buthad not been adopting the approach that this paper now presents. Researchers might have overlooked this simple procedure in preference of other approaches such as finite element, permeancemodelling and even AI technique of deriving the performance characteristics of SRM.

The approachshown in (6) does not give direct results and therefore it is not suitable for real-time application. The on-line display for the selection of the most energy efficient drives is crucial. This paper addresses the above requirement, as from raw data the most suitable SRM drive can be selectedgiven that the consideration is the most cost saving drive system which must be deployed. The analysis and the computational algorithm are presented in the next section.

Analysis

Figure 1model SRM's flux path, where Ψ is flux, IN is MMF andR is reluctance.

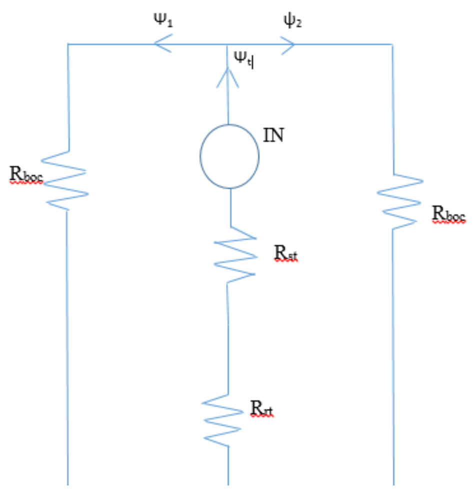

Figure 1: Equivalent circuit for 8/6 SRM

The raw dimensions of 8/6 SRM are supplied as input into the design algorithm as detailed below. The flux from the SRM's poles split into two parts as it flows around the SRM's back of core. With the flux flowing around the SRM as a result of ampere-turn (IN) in the windings, the flux-linkage profile can be computed.

Magnetisation Characteristics

The computed magnetization characteristics of the 8/6 SRM are shown Figure 2. The interpolated values are obtained using Frohlich Model as in (1).

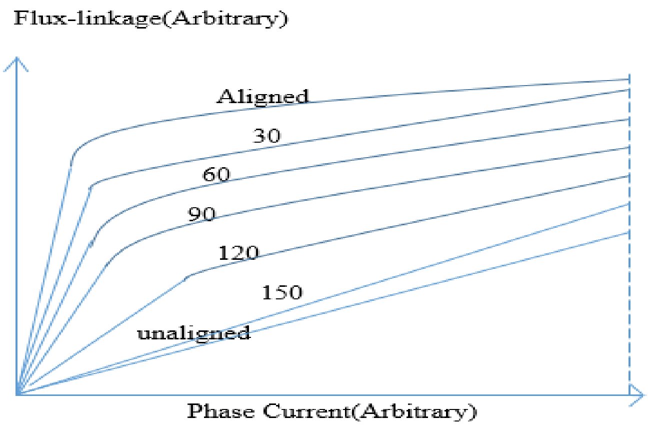

Figure 2: Graph of flux-linkage versus current

Results

The plotted results of the computed magnetization characteristics as in Figure 2 are used to compute the mean torque as shown in Figure 3. Operating this on-line from raw data to choose the optimum design of SRM, the displayed results of torques from various inputs of the SRM's dimensions can be compared with equivalent induction motor. Clearly, the SRM when used with the same amount of supplied power can produce four times as much torque by the equivalent induction motor.

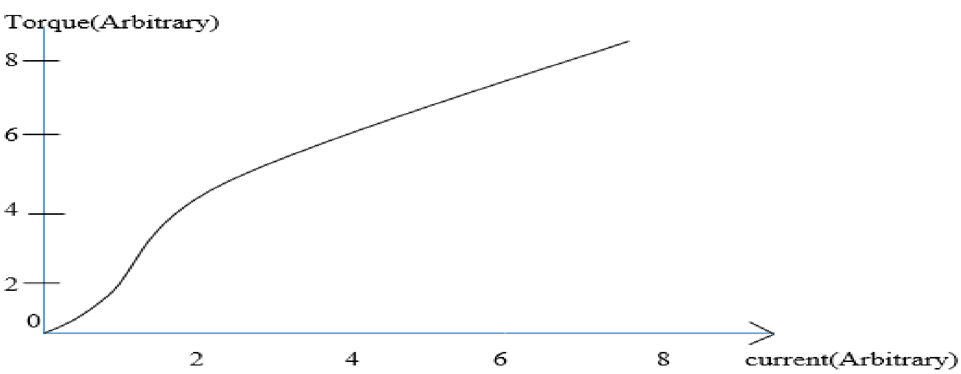

Figure 3: Graph of mean torque versus current

Conclusion

The developed computational algorithm for design and performance selection of SRM as alternative to existing drives is efficient. With this approach, the most energy efficient motor drive system can be deployed resulting in at least 30% energy saving as SRM has this superior feature compared to induction motors. The fast selection of the SRM drive is as result of computational data as output showing the torque comparison. Typically, in water treatment plants electricity bill can be as high as RM2 million per month; this means that the work carried here can save up to RM600,000 per month which is enormous.

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