Physical Parameter Analysis of Switched Reluctance Motor by Using Matlab Simulation

Sombir Kundu, Sukhbir Singh
Department of Electrical Engineering, Ganga Technical Campus, Bahadurgarh, Haryana, India

International Journal of Research in Electrical & Electronics Engineering
Volume 3, Issue 4, October-December, 2015, pp. 13-17
ISSN Online: 2347-5439 Print: 2348-0025, DOA: 15112015

ABSTRACT

Nowadays Switched Reluctance Motor (SRM) becomes more popular among the various electric drives available in the domestic and industrial application due to its simple and robust construction. The application of the machine, the operation of SR Motor can be categorised in to the low and medium speed operation and high speed operation. The operation of machine at high speed can exceed the speed of 20,000 rpm for the aerospace applications, which is beyond the speed encountered in wind energy system, which could be low as 200rpm. The control of SRM drive is developed by the convertor circuit which control excitation of phase by SCS (switching convertor switches). The developed SRM circuit suffers from low power factor and high harmonic capacity which affects the performance of SRM drive. In the present work is to design and develop a circuit which gives improved power factor and low torque ripples. From the various convertor topologies, asymmetric bridge convertor is used to analysis the performance of SRM and simulations are carried out in MATLAB. Three phase asymmetrical power convertor using the insulated gate bipolar transistor (IGBT) which is a three terminal power semiconductor device primarily used as an electronic switch which is developed to combine the high efficiency and fast switching and it is used to feedback of motor to control the power factor of motor. In this paper we will find the various types of parameters of SR motor by using MATLAB simulation.

Keywords: *SR Motor, IGBT, MATLAB, Three Phase Convertor, Parameter Analysis.*

I. INTRODUCTION

The switched reluctance motor represents one of the earliest electric machines which were introduced two centuries back in the history. The problems associated with the induction and dc machine together with revolution of power electronics and semiconductors in the late sixties of the last century led to the reinvention of this motor and redirected the researchers to pay attention to its attractive features and advantages which helped in overcoming a lot of problems associated with other kinds of electrical machines such as brushes and commutators in dc machines and slip ring in wound rotor inductions machines besides the speed limitation in both these motors. The simple design and robustness of the switched reluctance motor made it an attractive alternative for these kind of electrical machines for many applications recently specially that most of its disadvantages which are mentioned in this paper could be minimised by use high speed and high power semiconductor switches such as the power thyristors, power GTOs, power IGBTs and power MOSFETs. The availability and the inexpensive cost of these power switches nowadays besides the presence of microprocessors and microcontroller, PIC controllers and DSP chips makes it a strong opponent of other type of electrical machine. Electrical drive is one of the important equipment for any industry 60% of total energy is consumed

ISSN (O) 2347-5439
(P) 2348-0025

by only electric motor. Rotor position of SRM is directly sensed by using sensor is called sensor type SRM. The torque ripples in the SRM are arising, due to phase current commutation. The simulated performance of SRM drive system is presented to analyse the effect of switch angles on transient and steady state performance of the drive in terms of speed, current and torque response. A new analytical representation and simulation of the phase inductance of SRM using MATLAB/Mfile is presented. Simulation methods have following advantages.

- It is free from expression
- Can be applied widely
- Demonstrates inductance profile using motor parameters only
- Saves run time

II. CONSTRUCTION OF SRM CIRCUIT

In switched reluctance motor the torque is developed because of the tendency of the magnetic circuit to attain the minimum reluctance i.e. the rotor moves line with then stator pole thus maximizing the inductance of the excited coil. When a rotor pole is aligned with a stator pole, there is no torque because field lines are orthogonal to the surfaces. If one displaces the rotor of its position, there will be torque production that will tend to bring back the rotor toward the aligned position. If current is injected in the phase when in the unaligned position there will not be torque production. If one displaces the rotor of the unaligned position, then a torque tends to displace the rotor towards the next aligned position. The magnetic behaviour of SRM is highly nonlinear. But by assuming an idealistic linear magnetic model, the behaviour pattern of the SRM can be easily studied without serious loss of integrity from the actual behaviour pattern. SRM, when compared with the other AC and DC machines has some advantages and limitations.

- Changing the shape and size of stator and rotor
- Dimensional variations for stator and rotor poles

Rotor poles for the 3-phase, 6/4 poles SRM. After gathering the results of the highest developed torque for the stator, and the rotor poles, a new SRM optimized design is obtained.

The base design and the optimized design for 3-phase, 6/4 poles SRM. The stator pole arc/pole pitch ratio (β) for the optimized SRM is 0.5; the rotor pole arc/pole pitch ratio γ for optimized SRM is 0.38. Fig.1 shows the flux density through the stator pole, air gap, and rotor for 3-phase, 6/4 poles base and optimized cross section design SRM. Fig.2 shows the graphical results for developed torque for the 3-phase, 6/4 pole reference base and optimized SRM design. Developed torque is analysed when rotating the rotor from 0 to 45 degree for the optimized and base designs.

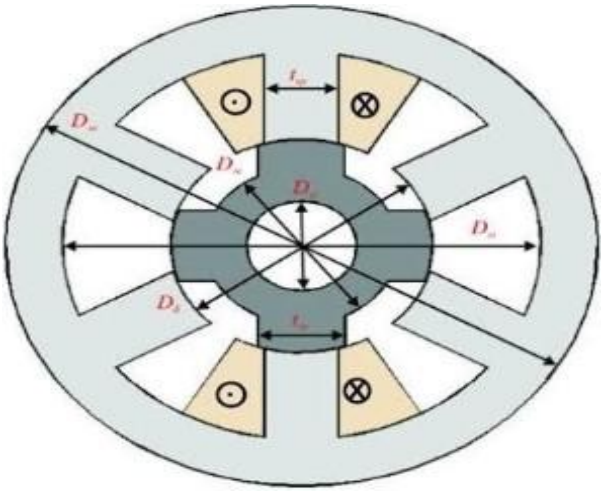

Fig.1 Shows Flux Density of 6/4 Pole SRM and Base Design of SRM

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(P) 2348-0025

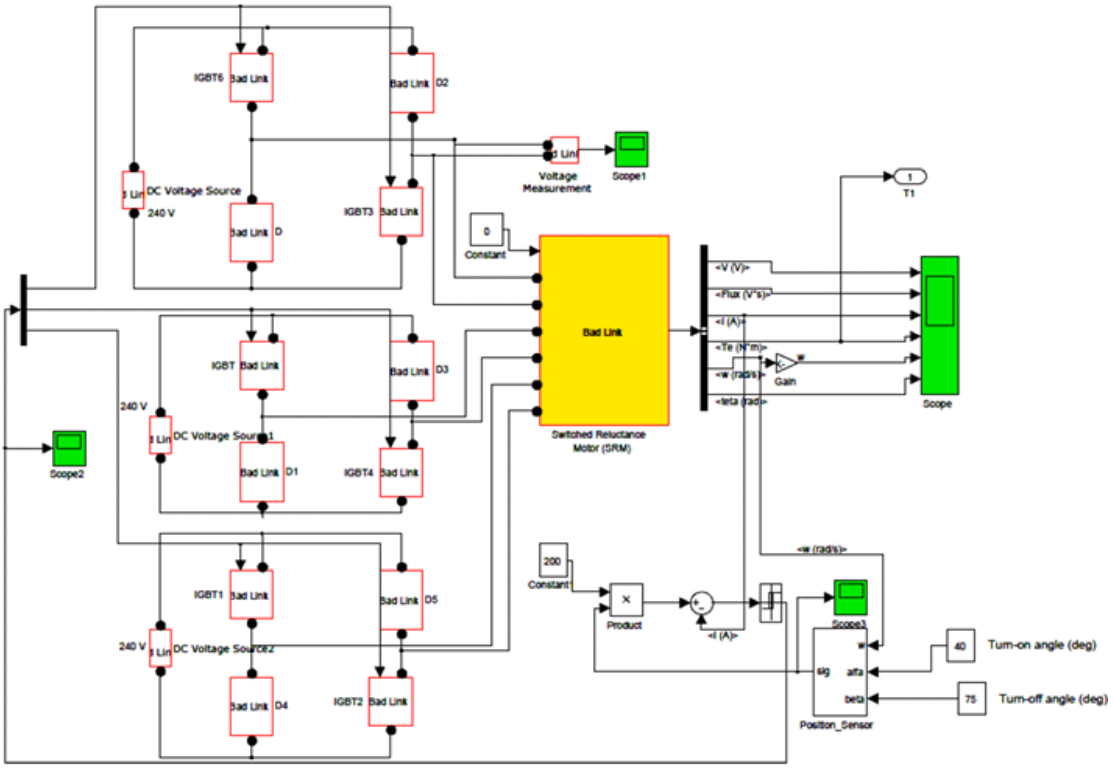


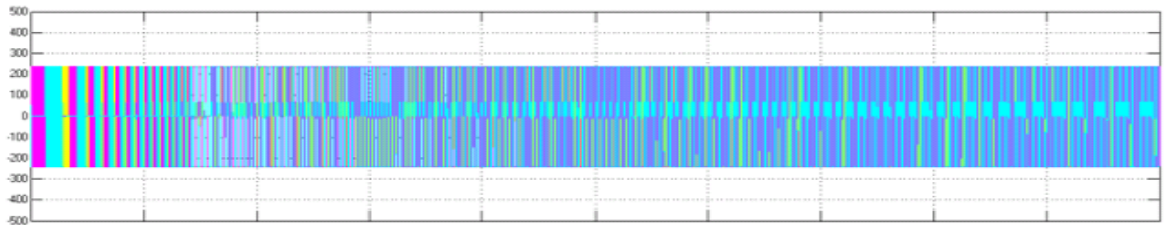
Fig.2 SRM Circuit Model in MATLAB/Simulink

III. PHYSICAL PARAMETER ANALYSIS

Experimental investigation based on a DC supply voltage of 240V is used. The convertor turn-on and turn-off angles are kept 45deg and 75deg, respectively over the speed range. The reference current is 200A and the hysteresis band is chosen as +10A. The SRM is started by applying the step reference to the regulator input. The acceleration rate depends upon on load characteristics. These are the following parameters used in SRM Drive:

a. Stator voltage, V (volt)
b. Flux linkage, flux (in V.s)
c. Stator current, I(in Amp)
d. Torque, Te (N.m)
e. Rotor speed, w (in rad/sec)
f. Rotor Position, Θ (in rad.)

The output characteristics for the following are obtained from the simulation using MATLAB/Simulink model.



Graph 1: Shows Stator Voltage, V (Volt) V/S Time, T (Sec)

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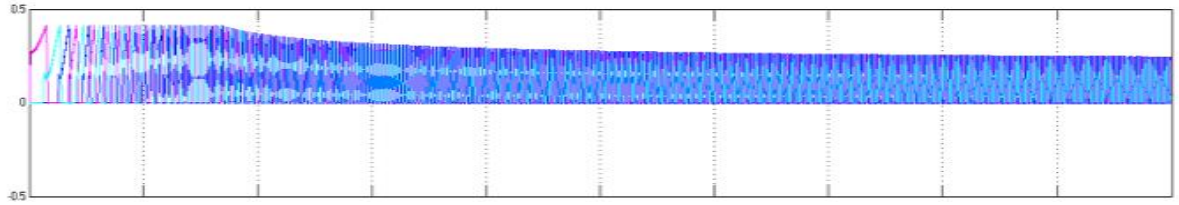
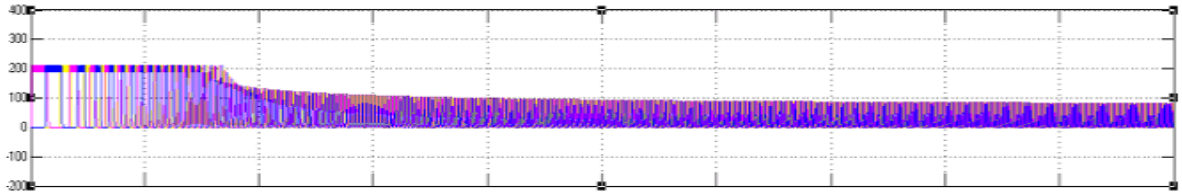
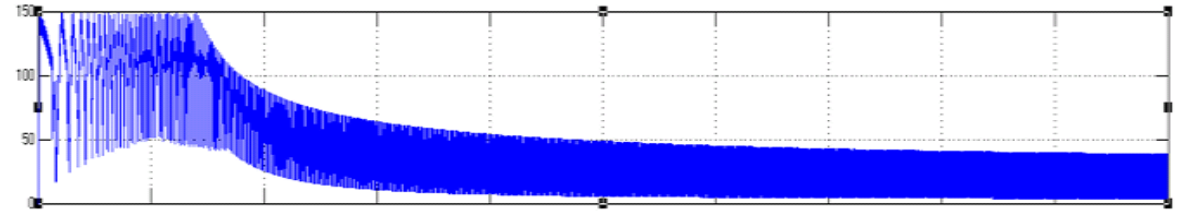
(P) 2348-0025



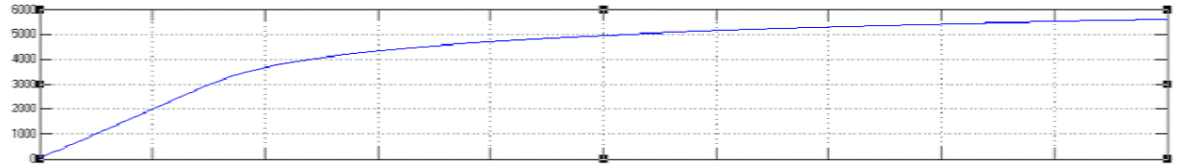
Graph 2: Shows Flux Linkage, (V.S) V/S Time, T (Sec)



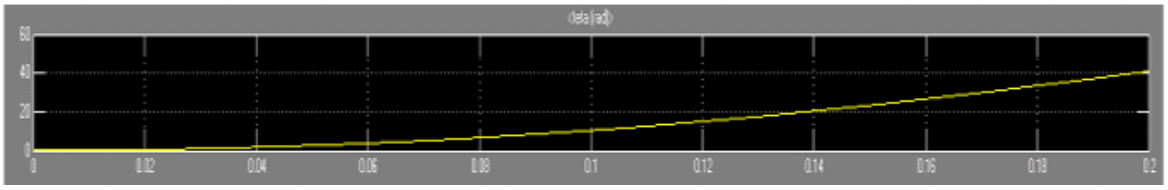
Graph 3: Shows Stator Current, I (Amp) V/S Time, T (Sec)



Graph 4: Shows Torque Developed, Te (Nm) V/S Time, T (Sec)



Graph 5: Shows Rotor Speed, W (Rad/Sec) V/S Time, T (Sec)



Graph 6: Rotor Position, Θ (rad) v/s Time, t (sec) at Torque Settling

IV. RESULT AND DISCUSSION

SRM circuit model simulate in MATLAB/Simulink the following parameter analysis results were obtained for the many iterations, in each iteration new position of stator and rotor is assigned.

1) Graph 1 shows the stator voltage of SRM which is the voltage v/s time graph. There is a small delay in triggering ON of the power switch, hence the waveform starts from near to the zero point and no other delay period is observed in the whole graph of the voltage. The magnitude of the voltage is approx. 240V.

2) Graph 2 shows the flux linkage of SRM, where the variation of flux linkage in the stator winding. Is plotted with respect to time. The three colours waveform shows that the flux linkages in 3-phases.

3) Graph 3 shows the variation of stator current v/s time. The max. Value is 200A. The graph signifies that during the initial stage the starting current is high and it finally comes to a lower and steady value after 0.18 sec. The different colour shows different type of phase current.

ISSN (O) 2347-5439
(P) 2348-0025

4) In Graph 4 shows the torque at starting period is high but after 0.15 sec. it gradually reduces and becomes constant. The maximum is achieved is 150 N-m at starting and after 0.15 sec and it is approx. 80 N-m.

5) Graph 5 shows the developed torque depends upon the angle Ɵ. The maximum angle is approx.100. The variation of rotor angle Ɵ v/s time.

6) Rotor position v/s time graph shows the rotor position of SRM, where rotor position shown vertically and time shown horizontally. The max. value of rotor position reach 40 rad. And after a gradually increment the rotor position constant at 0.20 sec.

V. CONCLUSION

Conclusion made on performance of SRM drive is the torque ripples induces due to changing of position of rotor and stator which sets into optimal position then torque ripples are reduced.

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