Volume : 2 | Issue : 3 | Mar 2013 • ISSN No 2277 - 8179

Research Paper

Engineering

KEYWORDS : SRM, Controller, Converter Energy saving.

M. Ravindran	Research Scholar, Rural Energy Centre, Gandhigram Rural Institute Gandhigram, Tamilnadu
V. Kirubakaran	Assistant Professor Rural Energy Centre, Gandhigram Rural Institute Gandhigram, Tamilnadu

ABSTRACT

Energy savings is one of the main factors for each developed countries. Since 75% of electrical energy is consumed by electrical drive. Nowadays energy efficient drive is necessary for energy savings. This efficiency is increased by reducing the losses of drives. This paper introduced new methodology to reduce the losses in Switched Reluctance Motor (SRM). A new energy efficient drive has been designed to improve the efficiency of the motor. This proposed method is compared with existing method. This method is more advantages to reduce the cost of the energy efficient drive. Stored energy in off-condition phase winding is utilized once again for increasing the efficiency of motor.

1. Introduction

The switched reluctance motor attracts more and more attention. It not only features a salient pole rotor [1] and concentrated coil present in stator coil. It is a high speed home appliance like vacuum cleaner etc. SRM is a non conventional motor. Hence it is having some disadvantages like

Operation of SRM is not smooth because it is a non conventional motor.

- Due to high torque ripple it leads to increase the acoustic noise and vibration.
- Wind age losses are higher than smooth cylindrical rotor motor due to salient pole rotor present in SRM. [2] The main aim of this controller is to increase the efficiency of the SRM. It can be summarized as follows.
- To reduce the losses in the core during demagnetization.
- To reduce the switching losses for reducing the acoustic noise present in SRM.
- To change the rate of change of current (di/dt) in stator winding for reducing the acoustic noise.

There are two conditions like No load and Load condition are available for reducing the acoustic noise and core losses. At load condition the current chopping is not necessary because phase winding voltage is higher than the back emf. At this time proposed controller is generate normal current waveform. It helps to reduce the torque ripple. At no load condition the phase winding voltage is less than the back EMF. Hence the controller is used to regulate phase current for reducing the core loss and acoustic noise. In this regard an effort has been made in this work to satisfy the above condition for energy efficient operation.

2. SRM Converter

Switched reluctance motor (SRM) is operated with any one type of controller. Controller selection is very important one for energy efficient operation. A main component for the controller is power electronic switches. Number of switches in existing system is high. In this regard many researches are described about controller. It has been published [3]-[10]. Radial and axial air gap machine designs are explained in [5]. Z.Zhang, N.C.Cheung introduced [11] converter with voltage boosting circuit in selection of converter. Jie Li, Hexu Sun¤, Zhaoming Lei [12] proposed the different types of converters. Design of converter is described by R. Rebbah, A. Bentounsi and H.Benalla [13]. Similarly numbers of converters are introduced for SRM. Analysis of C-dump converter is described by D.H. Lee, J. Liang, T.H. Kim, J.W. Ahn, [14]. Disadvantages of above converter is as follows

- Switching losses in SRM controller unit is high.
- Control circuit cost is very high.

In this paper introduced the new controller for reducing the switching losses for increasing the efficiency of SRM.

3. Proposed Converter:

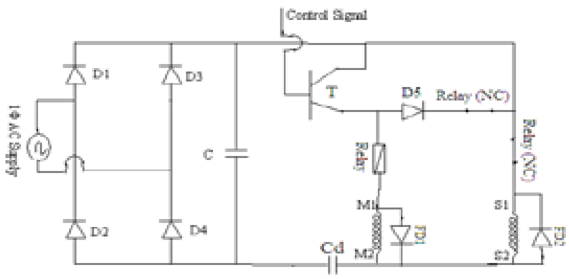

Figure 2 proposed converter circuit for Switched Reluctance Motor

The proposed converter is used to reduce the switching losses and energy efficient operation with low cost. The converter is chosen to work with two phase switched reluctance motor shown in Figure 2. The converter is having two diodes and capacitors C and Cd. C is an electrolytic capacitor for storing the energy.

Control signal which depends upon rotor position drives the Transistor T. The rotor of Switched reluctance motor is in the aligned position with stator coil, control signal turns on Transistor T and hence motor winding S1, S2 and Relay 2 are energized. Under this condition, auxiliary NO(Normally Open) contact and NC(Normally Close) contact of relay 2 are closed and opened respectively. As a result of this Relay 1 is energized this closes NO contact of relay. The rotor of Switched reluctance motor is in the unaligned position with stator coil, control signal turns off Transistor T and hence motor winding S1 and Relay 2 are deenergised.Under this condition, auxiliary NO contact and NC contact of relay 2 are opened and closed respectively. As a result of this motor winding M1, M2 is energized which closes NC contact of relay 2. The stored energy from off-going phase winding S1 is dumped into Cd1. Hence suppressing voltage present in the off-going phase windings are once again reused for the system. Due to changes of rotor position the switch T is once again going to ON position. The same procedure is (same as position 1) repeated. Hence the operation of the Relays and coils in the stator windings are depends upon the position of the rotor.

4. Experimental Setup and Results:

The experimental results are obtained and tabulated in table 1. The torque of Switched reluctance motor for various turn-on and turn-off are tested. The results are shown in figure 3.

Table: 1 Analysis of Torque at different rotor position angle.

S.No	Rotor position in θ	Torque in Nm

1	0	0
2	5	0
3	10	0
4	15	0.1
5	20	0.2
6	25	0.2
7	30	0
8	35	0
9	40	0
10	45	0.1
11	50	0.2
12	55	0.2
13	60	0

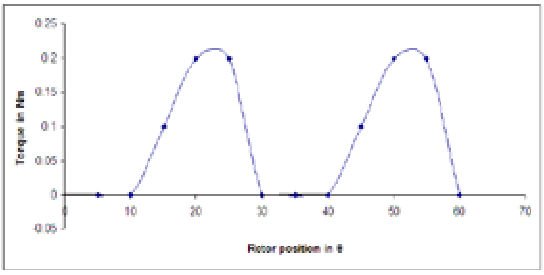

Figure 3 Torque-rotor position characteristics of SRM.

5. Conclusion:

A new proposed controller with single switch was presented to SRM for energy efficient operation. This proposed controller is proved with experimental work. The existing work is having (n+1) switches for switched reluctance motor operation. But this proposed method having only one switch for sense the rotor position. Due to reduction of switches, switching losses and losses in the core are reduced. Hence vibration and noises are also reduced. The proposed controller is better choice for energy efficient operation of SRM with low cost.

REFERENCE

[1] Mehradad Ehsani, Iqbal Husain,Ramani and James H.Galloway “Dual-Decay Converter for Switched reluctance motor Drives in low voltage Applications” IEEE Transactions on Power Electronics Vol.8 No. 2 1993 pp 224-230. | [2] Gabriel Gallegos-Lopez, Philip c. Kjaer and Timothy J.E. Miller” A New sensorless method for Switched reluctance motor Drives” IEEE Transactions on Industry applications,Vol 34 No.4 July/August 2008 pp 832-840. | [3] A. M. Hava, V. Blasko, and T. A. Lipo, “A modified C-dump converter for variable reluctance machines,” IEEE Trans. Ind. Applicat., vol. 28, pp. 1017–1022, Sept./Oct. 1992. | [4] S.Mir et al., “Energy-efficient C- dump converters for switched reluctance motors,”IEEE Trans.Power Electron, vol. 12, pp. 912– 921, Sept.2007. | [5] V. R. Stefanovic and S. Vukosavic, “SRM inverter topologies: Acomparative evaluation,” IEEE Trans. Ind. Applicat., vol. 27, pp. 1034–1047. | [6] G. H. Rim et al., “A novel converter topology for switched reluctance motor drives improving efficiency and simplifying control strategy,” in Proc. IEEE PESC’94, vol.1, 2004, pp. 937–942. | [7] R. Krishnan, “Novel converter topology for switched reluctance motor drives,” in Proc. IEEE PESC’96, vol. 2, Baveno, Italy, 1996, pp. 1811–1816.Nov./Dec.2011. | [8] M. Barnes and C. Pollock, “Power electronic converters for switched reluctance drives,” IEEE Trans. Power Electron, vol. 13, pp. 1100–1111, Nov. 2008. | [9]. Muhammad Rafiq, Saeed-ur-Rehman, Fazal-ur-Rehman, Qarab Raza “Power Efficient Higher Order Sliding Mode Control of SR Motor for Speed Control Applications” IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 3, No. 1, ISSN (Online): 1694-0814 www.IJCSI.org 378, May 2011. | [10] M. Rafiq, S.U Rehman, F. R. Rehman, Q.A. Butt, ”Performance Comparison of PI and Sliding Mode for Speed Control Applications of SR Motor”, European Journal of Scientific Research, Vol. 50, No. 3, pp. 368-384, 2011. | [11] Z.Zhang, N.C.Cheung.Analysis and design of cost effective converter for SRM drives using Component sharing. In 4th International conference on power electronics system and Applications. p. 099 - 104. 2011 | [12] Jie Li, Hexu Sun¤, Zhaoming Lei “Harmony optimization Design of Switched Reluctance Motor Drive” International Journal of Intelligent Engineering and Systems, Vol.3, No.3, pp 10-17,2010. | [13] R. Rebbah, A. Bentounsi and H.Benalla “New Approach for Optimizing Control of Switched Reluctance Generator” International Journal of Computer and Electrical Engineering, Vol. 2, No. 2, April, 1793-8163, 2010. | [14] D.H. Lee, J. Liang, T.H. Kim, J.W. Ahn, “Novel passive boost power converter for SR drive with high demagnetization voltage,” International Conference on Electrical Machines and Systems, 2008, pp.3353- 3357, 17-20 Oct. 2008. |