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Study of Switched reluctance motor : A Review

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Abstract : The switched reluctance motor (SRM) is an electric motor that gets electrical power from the magnetic fields where it is easy to turn, rather than from the loosening and tightening of wires called brush DC motors. Eliminating the need for a commutator in a motor simplifies mechanical design as power does not have to be delivered to a moving part, but it complicates electrical design. Some sort of switching system needs to be used to deliver power to various windings on the motor armature. This paper reviews the concept of the switch reluctance motor.

***Index Terms* – Switched Reluctance , DC Motors.**

I. Introduction

The principles of SR were introduced in the 1970s and have been improved by the likes of Peter Lawrenson going as far back as 1980. Experts at the time thought SR was impossible, but it still remains a difficult technique to achieve. Low production numbers combined with high costs are some of the reasons why it hasn't taken off more. [1]

The SRM has no coils or magnets in the rotor, but instead has field coils in the stator. Windings are not used for torque conversion in a DC motor, which is where induction happens instead. [1]

Fig 1. SRM Motor

When the power is applied to the rotor's coils, a force that attempts to align with the nearest stator pole is created. The magnetic field created by the stators eventually leads the polarity of the rotor so it maintains its rotation. In contrast to the mechanical commutator used in traditional motors, a switched-reluctance motor uses an electronic position sensor to determine the rotor shaft's angle and computerized electronics to switch the stator windings. This dynamic control over pulse timing and shaping makes switched-reluctance motors more efficient than traditional designs. [2]

This differs from induction motors that also energize windings in a rotating phased sequence. In an SRM, the rotor's magnetization remains static (a salient 'North' pole will stay so) while an induction motor has slip (rotate slightly slower than synchronous speed). The lack of slippage makes it possible to know the rotor's position exactly, and to step the motor arbitrarily slowly. [2]

SRM motors, or switched reluctance motors, are unlike the types of typical DC brushed motors. They work by transmitting power to the windings in the stator and not to the rotor. An alternate name for this type of electric motor is VRMs, or variable reluctance motors. Unlike a dc motor, which uses a set of permanent magnets to generate the magnetic field and must be electronically commutated, the switching inverter in an ac motor can handle changes in load on its own. This makes it ideal for use in situations where weight as well as horsepower (hp) to size are both critical. [2]

The motor is simple to design because it restricts the current flow, but complicates things because of the need for a switching system. With this design, the load can be switched toward the coils to provide an even flow of current. So generators that use this type of rotation can also run at higher speeds compared to traditional motors. They have armatures that are made like one-piece magnetic materials, like a slotted cylinder. [2]

II. WORKING OF SRM

The working principle of switched reluctance relies on variable reluctance. The rotor always tries to align through the lowest reluctance lane. There are many different factors that lead to revolution in a rotating magnetic field. One such factor is the electromagnetic reluctance between rotor and stator. By changing the air gap between these two, we can change the electrical circuit's reluctance. [3]

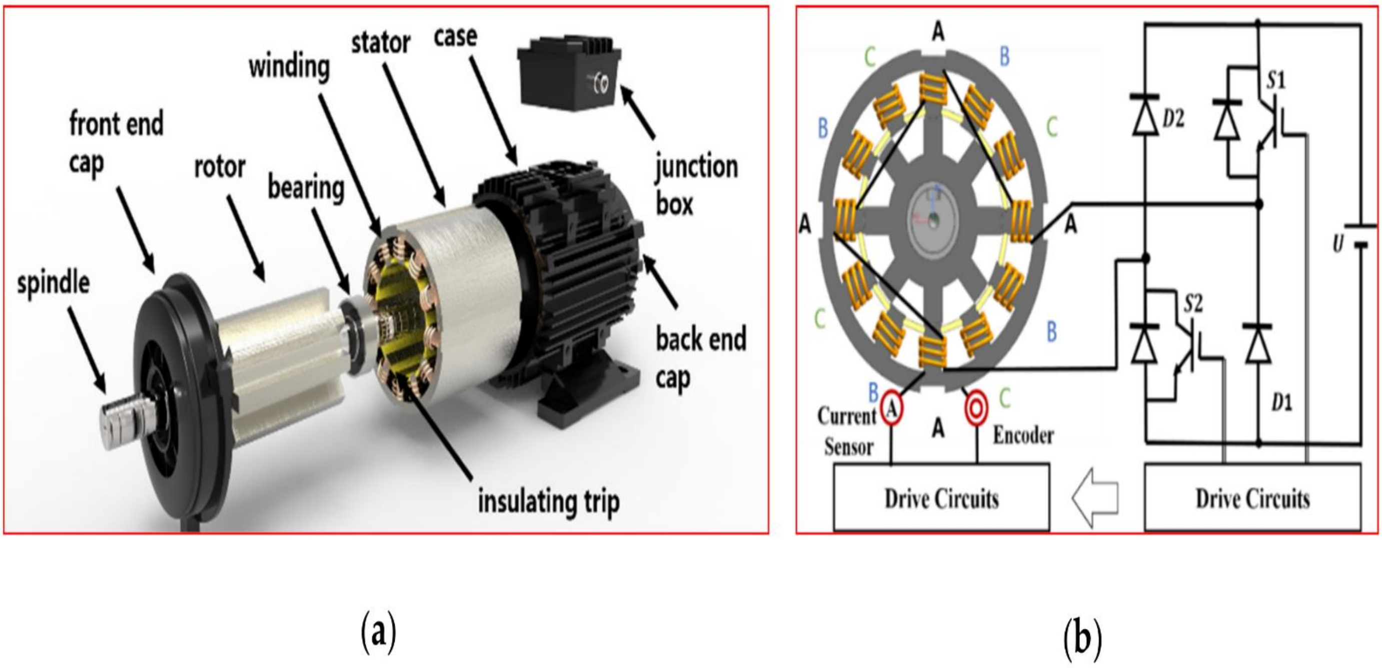

Fig 2 SRM General Diagram and Circuit

When the poles are the same and opposite, then the field coils are connected in parallel. When there is a single coil, the windings will be in series (if there's more than one coil, they can be either parallel or series). The magnitude of magnetomotive force is additive when connected in this way and these windings are called phase-wound coils. Connecting a motor terminal to each coil will enable them to uniquely drive each other and deliver power through any input circuitry with an appropriate voltage like that of a DC supply.[3]

You can design a rotor using metal stampings made of Si steel. The pole design is different than the stator pole design. In most of the motors that exist, there are 4 or 6 poles in the rotor, depending on how many stator poles there are. The shaft of the rotor has a position sensor- this controls the functioning of various devices in power semiconductor circuitry. [4]

In this motor, both the stator and the rotor include a projection pole that is made with a conductive metal such as soft iron or silicon. The pole is used to prevent electrical losses due to magnetic hysteresis. In the stator, the winding is the series like in a transformer but the polarities are reversed on each electron thus increasing their efficiency. The rotor doesn't contain any windings because it just rotates itself. [4]

III. ADVANTAGES OF SRM

A switched reluctance motor is a type of stepper motor that has fewer poles and so is less expensive to make. The most elementary form of an SRM only costs the same as any other electric motor because it has the simplest structure. Sometimes industrial motors also have cost reduction because they lack rotor windings or permanent magnets. The main use of SRMs is in applications where the rotor must be stationary for long periods, especially in potentially explosive environments like mining. [5]

SRM offers various advantages:-

- A switched reluctance motor has many advantages over other types of motors because it has a high efficiency relative to its simplicity and cost. [5]

- Unlike other motors, an SRM has no permanent magnet on the rotor. This makes it ideal for high-speed applications, and also means that it can withstand high temperatures. It's low cost and simple design make it practical for a wide variety of devices. [6]

- In other words, a single broken winding or phase can cause the motor to still function but with reduced power. Fans, pumps, and electric vehicles all rely on SRM for torque and speed control. Unfortunately, because of its non-linear characteristics and magnetic saturation, it's challenging to accurately predict the torque generated by an SRM. [6]

IV. Applications SRM

In some cases, an induction motor just won't do. That's why Switched Reluctance Motors and Drives offer an affordable alternative that can work in a variety of situations where other motors might not. [7]

- Textile Machinery: Textile machinery for weaving includes the rapier weaver and towel weaver. Plus, switched reluctance motors offer low starting torque and high torque with a fast-dynamic response. This allows for weaving at variable speeds which offers enhanced weaving processes. The SRM motor is connected to the weaving machine spindle with no clutch required and thus reducing the need for maintenance. A control system algorithm makes it possible to run without start and stop marks in the fabric that is made possible through the control system. [8]
- Oilfield machinery: Many oil fields are still using beam pumping units, otherwise known as nodding donkeys. These units can account for more than 25% of the cost of oil production, and the stroke is not optimal. Considering increasing cost and lower revenue, reducing energy usage is a high priority. An energy efficient pump could be beneficial due to simple speed control system. Simplified transmission also benefits overall efficiency greatly when compared with original pumping unit including maintenance-free motor. This can be ideal for tough environment in many oil fields and easy to commission too. [9]
- Presses: The SRM has been designed to deliver the power you need. And with a switched reluctance motor, your motors can have high starting torque, low winding/coil losses, and they can also be rapidly turned on and off without damaging any of the components. It has software in place to ensure safe operation, but if something does go wrong, it's easy to disable the system altogether thanks to safety grating. [10]
- Mining machinery: A Switched Reluctance Motor is specially made for coal mining equipment, such as cutters, conveyors and coal ploughs. It provides a low starting current and a high torque (30% of the rated current gives enough starting torque up to 150%). The simple winding-free rotor is great for high speeds, and the mechanical strength of the stator makes it resistant to impacts. Without overlapping windings, short circuits are unlikely. [10]

V. Conclusion

The switched reluctance motor is gaining popularity in industrial applications such as electric vehicles and wind energy systems due to its durability and speed, along with its lack of sensitivity to different temperatures. This type of motor works well within a variety of different coal mining applications, including cutters, conveyors and coal ploughs. The motors offer low starting current and a high torque (30% of rated current gives starting torque up to 150%). The motors in this motor design have higher power densities than conventional designs, which means they operate more smoothly with lower torque ripple. SMC hardware has fewer parts and no rotor current, so there is no energy wasted in the rotor.

References

1. C. S. Kim *et al*., "Design of Π core and Π2 core PM-aided switched reluctance motors," *2012 IEEE International Electric Vehicle Conference*, Greenville, SC, 2012, pp. 1-6..
2. G. K. Ptakh, D. A. Zvezdunov and R. R. Mustafaev, "Selection of stator yoke height of traction switched reluctance motor," *2016 2nd International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM)*, Chelyabinsk, 2016, pp. 1-4.
3. N. Niguchi, K. Hirata, A. Kohara, K. Takahara and H. Suzuki, "Hybrid Drive of a Variable Flux Reluctance Motor and Switched Reluctance Motor," *2018 XIII International Conference on Electrical Machines (ICEM)*, Alexandroupoli, 2018, pp. 238-242.
4. S. Kannan, "Novel rotor and stator swapped switched reluctance motor," *2012 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, Bengaluru, 2012, pp. 1-4.
5. M. M. Alaee, E. Afjei and S. Ataei, "A New Resonant Driver for Switched Reluctance Motor," *2007 International Conference on Electrical Engineering*, Lahore, 2007, pp. 1-3.
6. K. R. Chichate, S. R. Gore and A. Zadey, "Modelling and Simulation of Switched Reluctance Motor for Speed Control Applications," *2020 2nd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA)*, Bangalore, India, 2020, pp. 637-640.
7. Zheng, X. Zhu, L. Dong, Y. Deng and H. Wu, "Performance optimization of dual channel fault-tolerant switched reluctance motor," *2016 IEEE International Conference on Aircraft Utility Systems (AUS)*, Beijing, 2016, pp. 938-944.
8. A. Siadatan, N. Fatahi and M. Sedaghat, "Optimum Designed Multilayer Switched Reluctance Motors for use in Electric Vehicles to Increase Efficiency," *2018 International Symposium on Power Electronics, Electrical Drives, Automation and Motion (SPEEDAM)*, Amalfi, 2018, pp. 304-308.
9. H. Chen, "Switched Reluctance Motors Drive for the Electrical Traction in Shearer," *2006 CES/IEEE 5th International Power Electronics and Motion Control Conference*, Shanghai, 2006, pp. 1-4..

10. P. Somsiri, K. Tungpimonrut and P. Aree, "Three-phase full-bridge converters applied to switched reluctance motor drives with a modified switching strategy," *2007 International Conference on Electrical Machines and Systems (ICEMS)*, Seoul, 2007, pp. 1563-1568.

11. C. Chiang, M. Hsieh, Y. Li and M. Tsai, "Impact of Electrical Steel Punching Process on the Performance of Switched Reluctance Motors," in *IEEE Transactions on Magnetics*, vol. 51, no. 11, pp. 1-4, Nov. 2015, Art no. 8113304, doi: 10.1109/TMAG.2015.2449661.

12. A. P. Khedkar and P. S. Swami, "Comparative study of asymmetric bridge and split AC supply converter for switched reluctance motor," *2017 International Conference on Computation of Power, Energy Information and Commuincation (ICCPEIC)*, Melmaruvathur, 2017, pp. 522-526.