Next Generation Advanced Core Material for Reluctance Machine

K Vijayakumar[1*], A Joseph Basanth[2], R Karthikeyan[3], S Kannan[4]

Electrical Engineering, SSMIET[1], AU Dindigul Campus[2], SVCE[3] and GESS[4], Dindigul, Chennai, Tamilnadu and Puducherry

✉ k.vijaymec@gmail.com

ABSTRACT

The field of manufacture of electrical machines has advanced significantly in recent years due to the introduction of new materials. New electrical steels have reduced losses and rare-earth permanent magnet materials have provided a 'lossless' source of magnetic flux. The soft magnetic materials most predominately used in electrical machines are silicon steels and ferrites. In the world of Permanent magnet materials (PM) the choice of laminated stack is Soft Magnetic Composite (SMC) iron powder. Here it is the iron powder grains which are separated from one another by electrically insulating layer using phenolic or silicone resin. As compared with laminated stacks, SMC materials offer a greater resistance to eddy current formation, as well as presenting designers with the advantage of magnetic properties which are isotropic in nature, instead of being confined to two dimensions as within the case of laminates. This reveal exposes the possibility of creating complicated 3-D flux paths, which would be impossible or prohibitively expensive to fabricate from conventional laminated sheet. This paper presents option of research the SMC iron powder as core material in a switched reluctance machine that might run as a motor or generator mode of operation. Results of in-depth finite element analysis and experimentation of the proposed prototype are delineated.

Keywords : Switched reluctance motor; Switched reluctance generator; Pre-form blanks; Finite element analysis; Prototype.

INTRODUCTION

Soft magnetic composite material (SMC) comprises particles of iron powder wherein every particle is insulated by an oxide layer. Compaction of iron powder particles with a binder and a lubricant, at high pressure results a bulk

material [2]-[3]. Lubricant ease compaction and the ejection of component. The binder strengthens the material. The insulation between particles is rendered by the lubricant and the binder. Internal stresses generated during compaction can be relieved through the heat treatment process of curing. Compared to lamination material lower permeability (850(SMC)) and higher iron losses are major shortcomings of SMCs [2]. Even though the SMC material has inferior permeability it has the following advantages: Improved overall thermal loading of the motor, reduced vibration due to the cushioning nature of insulation (lubrication) binder between the iron powder particles of the material and a prospect for greatly reduced production cost.

SMC materials find application in the design and fabrication of complex geometry electrical machines such as claw pole alternator and transverse flux motor. Switched Reluctance Machines are characterized by simple and rugged construction, high power density, wide speed range and high speed operation owing to lack of magnets and winding on the rotor [1]. The switched reluctance motor (SRM) can be a feasible substitute to generate high torque or thrust and power density at relatively low speeds, thereby eliminating the need for a speed reducer between the motor and the washer or pump drive applications. Switched reluctance generator (SRG) can be a cost effective alternative in variable speed wind generating systems that normally employ permanent magnet generators or field wound synchronous generators. The SRG is also characterized by maintenance free and highly reliable operation [4]. This paper work delineates the fabrication of a switched reluctance machine using pre-form soft magnetic composite material Somaloy 1000 3P and along with the presentation of some of the test results.

SWITCHED RELUCTANCE MACHINE

The switched reluctance machine is a doubly salient but singly excited machine wherein the stator carries the winding while the rotor is simply made of stacked silicon steel laminations [1] as evidenced from the Computer Aided Design (CAD) model of a 6/4 switched reluctance generator shown in **Fig. 1**.