

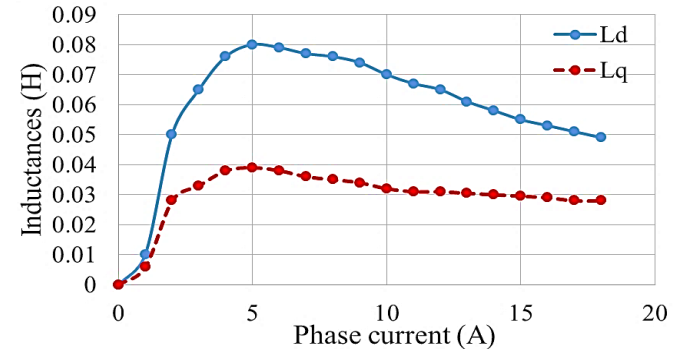
Generator Applications of Synchronous Reluctance Machines (SynRM)



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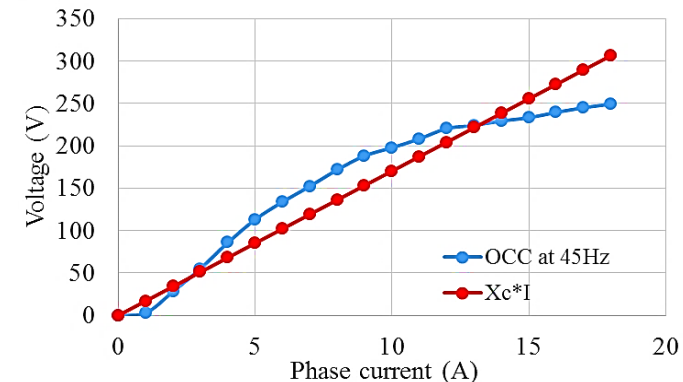
Background

- SynRM have several advantages over PM machines and Induction machines, which are low cost, high efficiency, fast dynamic response, low maintenance cost, and robust and simple structure.
- The synchronous reluctance generator (SynRG) can operate in stand-alone or in grid connected mode.
- In the stand alone mode, a properly sized capacitor bank must be connected to the phase windings to make self-excitation possible and supply the reactive power to the generator and the load.
- The self-excitation phenomenon in induction generators and the SynRG relies on the nonlinear characteristic of the ferromagnetic core, as well as the initial conditions which can be either the capacitor initial voltage or the residual flux in the machine's core.
- In order to choose the appropriate size of the capacitors, the machine characteristics mainly d -axis inductance L_d , and q -axis inductance L_q must be measured.



D-axis and q-axis inductances of the synchronous reluctance machine

- The operating point of the SynRG is set based on the capacitor size, rotor speed and the nonlinear part of the open circuit characteristic of the machine.

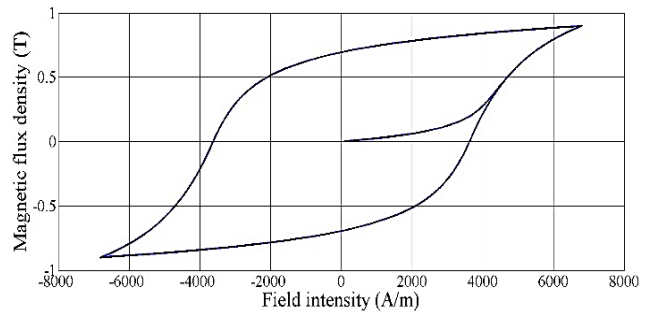


Open circuit characteristic at 45 Hz with 120 μ F capacitors



Objective

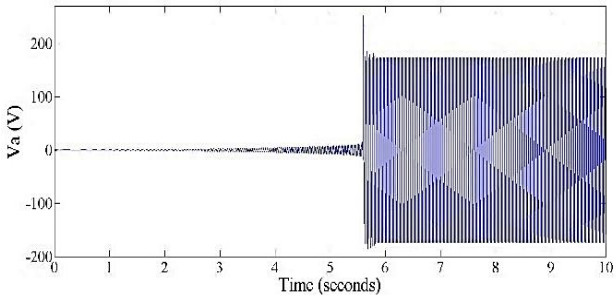
- To ensure self-excitation, usually capacitors are pre-charged.
- The aim of this project is to study the ferromagnetic core of the machine and determine the amount of residual flux required to ensure the self-excitation.
- The ferromagnetic core analysis is performed using the energetic model.



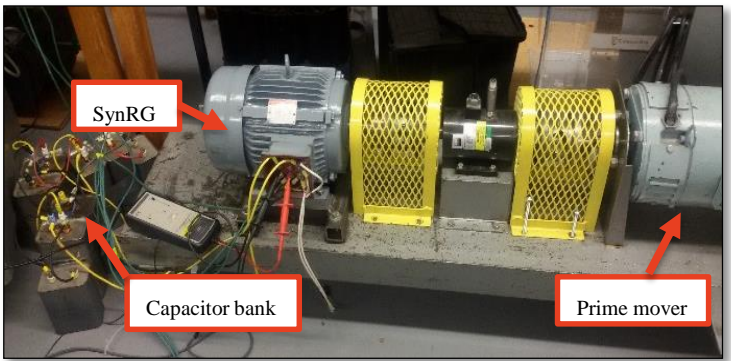
The BH loop of M45 G29 using the energetic model

d-q Simulation and Experimental Results

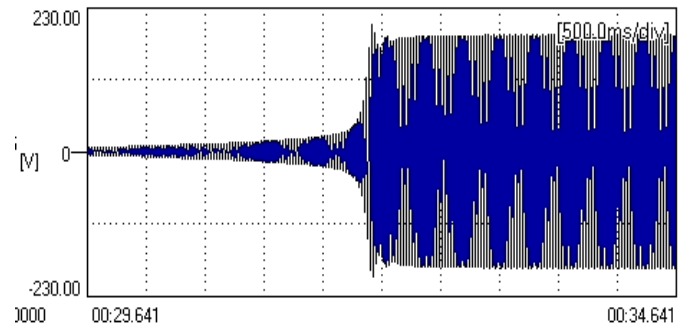
- The *d-q* model is used to study the self-excitation phenomenon and the generator operation of the SynRM.



Simulation results, Phase A voltage



Experimental test setup of the SynRG



Experimental result of the phase A voltage

- The minimum residual flux in the ferromagnetic core is determined using the *d-q* model simulation and later verified by experimental results.

