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An Isolated Three Phase Induction Generator System With Dual Stator Winding Sets Under Unbalanced Load Condition

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ABSTRACT

This paper presents a detailed modeling and the analysis of a dual-stator windings self-excited induction generator. The mathematical model has been developed in synchronous reference frame; in this one, the effects of the common mutual leakage inductance between the two three-phase windings sets have been included. Dynamics of self-excitation process, and step application of load are simulated.

INTRODUCTION

Environmental concerns international policies are supporting new interests and developments in small-scale power generation during the last few years. Therefore, the study of self-excited induction generator has regained importance, as they are particularly suitable for wind and small hydro power plants. The primary advantages of self-excited induction generator are less maintenance cost, better transient performance, without dc power supply for field excitation, brushless construction (squirrel-cage rotor), etc. Since the late 1920s, dual-stator ac applications, for their advantages in power segmentation, reliability, lower torque pulsations, less dc-link current harmonics, reduced rotor harmonics currents and higher power per ampere ratio for the same machine volume, etc. The excitation can be provided by a capacitor bank to the stator windings of the induction generator.

Magnetizing inductance is the main factor for voltage buildup and stabilization of generated voltage for the unloaded and load conditions of the induction generator. The terminal capacitor is such a machine must have certain minimum and maximum value for self excitation to take place. This value is affected by machine parameters, speed and load conditions. While being based on the theoretical and experimental works done in which the evolution of the magnetization current is not represented, this article comes to reinforce the results gotten previously by the reference quoted and to bring the thinning on the evolution of the magnetization current seen its fundamental importance. This paper presents a detailed modeling and the analysis of a dual-stator windings induction generator. Dynamics of self-excitation process, and step application of load are simulated. Environmental concerns and international policies are supporting new interests and developments in small-scale power generation during the last few years. Although the induction generator is mostly suitable for hydro and wind power plants, it can be efficiently used in prime movers driven by diesel, biogas, natural gas, gasoline, and alcohol motors. Induction generators have outstanding operation as either motor or generator; they have very robust construction features, providing natural protection against short circuits, and have the lowest cost with respect to other generators. Abrupt speed changes due to variations in load or primary source is usually expected in small power plants.

An induction generator, with its solid rotor easily absorbs these variations and any surge in currents is damped by the magnetization path of its iron core without fear of demagnetization, as opposed to permanent magnet based generators. Therefore, the study of self-excited induction generators has re-gained importance, as they are particularly suitable for generation below 15 kVA for wind and small hydro plants. A stand-alone self-excited induction generator (SEIG) is unlikely to supply energy demand for ordinarily growing loads for long time. Thus, multiple generators operating in parallel may be required to harvest the maximum energy available at a site. Also, in the last few years, the trend has shifted from installing a few wind turbines to planning large wind farm installations with many induction generators connected electrically in parallel. Hybrid power plants that integrate wind farms with diverse storage devices to allow for the control of the power output of the ensemble further support the possibility of large-scale installations.

EXISTING SYSTEM:

Renewable power generation is a suitable technology used to deliver energy locally to customers especially in remote regions. Wind energy based on induction generator situates in a foreground position in the total energy produced using renewable sources. In the last few decades, a new self-excitation generator was based on multi-stator induction strongly emerges.

This article presents a systematic modeling, a detailed analysis and the performance analysis of self-excitation dual stator winding induction generator (SE-DSWIG). The modelling of the SE-DSWIG was done with taking in account the common mutual leakage inductance between stators and the magnetizing inductance, which played a principal role in the stabilization of the output voltage in the steady state.

The generator feeds the end user emulated by an inductive-resistive load. In order to simulate the weather conditions' variation, a step change of the prime mover speed was applied on the SE-DSWIG. A passive series and shunt compensator was used to mitigate the voltage sag and swell appeared in the power system due to wind variation and the lack of reactive power consumed by the inductive load.

PROPOSED SYSTEM

A three-phase machine made to work as a single-phase generator has advantages of lower size and cost than their single-phase equivalent in almost all ratings except in the lower fractional kilowatt (kW) ranges. The three-phase windings are configured as isolated two equivalent phases in the proposed system for this purpose. The machine uses photovoltaic (PV)-assisted single-phase inverter to one of its two phases for variable excitation requirement to cater dynamic loads at different rotor speeds besides having a fixed capacitor to provide bulk excitation.

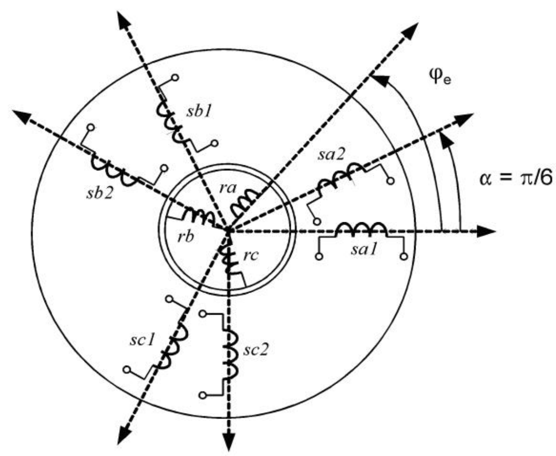

Fig 3.1 : Dual-stator windings induction machine.

A schematic of the stator and rotor windings for a dual-stator windings induction machine. The six stator phases are divided into two wye-connected three-phase sets, labeled (sa1, sb1, sc1) and (sa2, sb2, sc2), whose magnetic axes are displaced by an arbitrary angle. The windings of each three-phase set are uniformly distributed and have axes that are displaced 120 apart. The three-phase rotor windings (ra, rb, rc) are also sinusoidally distributed and have axes that are displaced by 120 apart.

A two modeling approaches and general methods of analysis of dual stator squirrel-cage induction motor have been considered: $ Model I – the DSIM motor is treated as two independent three-phase motors coupled together by a common rotor winding. This approach is based on modeling principles used for classical three-phase induction machines.

$ Model II – the DSIM motor is considered as a six-phase induction motor. This approach is based on modeling principles used for multi-phase induction machines. The both mathematical models of DSIM will be first formulated in phase variable form. These models are then transformed to arbitrary common reference frame in order to obtain more useful general forms.

CONCLUSION:

A stator-flux-oriented control strategy is proposed for the operation of a three-phase induction machine as a single-phase generator catering off-grid domestic loads. The generator can effectively maintain constant load voltage at constant frequency under both load and speed transients giving better transient response than existing schemes.

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