ABSTRACT

Induction Generators are less expensive, most rugged, self-protected against short circuit, and require less volume and weight. However, these generators need a variable source of VAR to sustain self-excitation and regulate terminal voltage under wide fluctuations in speed and load. With the advent of low cost, high power, improved Power Electronic Devices, the overall cost of static VAR controllers is fast decreasing. These make the Power Generating Systems consisting of induction generators more attractive than the traditional ones in use. The thesis aims at investigating steady state analysis, excitation requirements, performance of generator-converter load system with stand-alone induction generator, and proceeds further to find Load sharing, Capacitance requirement, Voltage regulation of many induction generators operating in parallel to supply a common load thus forming an independent grid.

The steady state analysis is based on voltage and current balance equations derived from relevant circuit models and related phasor diagram, and subsequently solved following a new iterative approach. Capacitance requirement, voltage regulation, variation in terminal frequency etc., have been studied.

Sustenance of self-excitation for stand-alone induction generators depends on appropriate combination of speed, load, excitation capacitance and machine parameters. A detailed analytical study, supported by experimental results, has been carried out to find the excitation requirements of induction generators. Contrary to traditional approach, the inverse-Γ model of the per phase steady state equivalent circuit of induction generator is used. In addition to studies on the interdependency of speed, load and capacitance, an easy

method to test the self-excitation for any combination of load, speed and capacitance is also proposed.

Induction Generators require continuous adjustment in excitation VAR to keep terminal voltage regulated under variation in load and speed. Use of improved power-factor converter (AC/DC) structure is one of the standard approaches to produce regulated load voltage. The thesis proposes a new AC/DC converter, which is a series connection of three half-controlled single-phase bridges, to yield regulated load voltage, and generate controlled lead/lag VAR across the converter input terminals. Performances of such converter, when connected to mains as well as to stand-alone induction generators, are presented.

It has been found that inclusion of a capacitor in series with the load along with the shunt capacitor across the generator terminals helps in maintaining better regulation in load voltage. The thesis brings out new methods to find the value of series capacitor and proposes two different low-cost maintenance-free alternative topologies to yield regulated DC voltage across the load.

Utilization of full potential of energy (for example in case of wind energy), increased energy demand etc. are some of the reasons which justify the parallel-operation of induction generators. Using inverse-Γ model, new algorithms to find load sharing, VAR demand, voltage and frequency regulation have been studied. Influence of generator parameter variation on load sharing, voltage regulation, capacitance requirement has been investigated. It is noted that the rotor resistance is the most influencing parameter. Higher rating generators should have proportionately lower value of rotor resistance to have proper load sharing.

KEYWORDS: *Induction Generator, Self-Excitation, Parallel Operation, Load Sharing, Converters, VAR Demand, Equivalent Circuit, Stand-Alone Systems, Steady State Analysis, Power factor improvement, Wind-Electric Power Conversion.*