Analysis of Self Excited Induction Generator Using Gui

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This paper provides a steady state analysis of three phases self-excited induction generator. The problem is formulated as a multi-dimensional optimization problem. The constraint is used to minimize a cost function of the total impedance or admittance of the circuit of the generator to obtain the frequency and other performance of the machine.

***Index Terms*—MATLAB tools, SEIG, Induction Generator, GUI**

I. INTRODUCTION

Induction generators are the most commonly used generator in wind energy application system due to its simplicity and ruggedness, more than 50 years of life time, same machine can be used as motor or generator without modification, high power per unit mass of materials and flexibility in speed range of operation. The main drawbacks in induction generator are its lower efficiency and the need for reactive power to build up the terminal voltage. However, the efficiency can be improved by modern design and solid-state converters which can be used to supply reactive power required. Connection of induction generators to a power system is achieved when the rotor speed of an induction generator is greater than the synchronous speed of the magnetic revolving field. Induction machine modeling has continuously attracted the attention of researchers not only because such machines are made and used in largest numbers but also due to their varied modes of operation both under steady and dynamic states of Self-excited induction generators are growing in popularity due to their advantages over the conventional synchronous generators and ease of use under standalone mode. The essence of simulation of such complex machines such as Self Excited Induction generator involves solving of complex equations of high order. There are two revolutionary methods which can be used for analysis of SEIG the loop impedance method which requires an iterative procedure to solve it and nodal admittance method which is easily solved by simple equations and used online to determine various parameters of the machine.

II. WIND POWER

Wind is the movement of air across the surface of the Earth, from high pressure areas to low pressure areas. The Earth’s surface is heated unsteadily by the Sun, depending upon various factors such as the angle of incidence of the sun's rays at the surface (which differs with latitude and time of day) and whether the land is open or covered with vegetation. Also, large bodies of water, such as the oceans, heat up and cool down slower than the land. The heat energy produced by the sun is absorbed by the Earth's surface is transferred to the air directly above it and, as warmer air is less dense than cooler air, it rises above the cool air to form areas of high pressure and thus pressure differentials. The rotation of the Earth drags the atmosphere around with it causing turbulence. These effects combine to cause a constantly varying pattern of winds across the surface of the Earth.

III. INDUCTION GENERATOR

Typically, small renewable energy power plants rely mostly on induction machines, because they are widely and commercially available and very inexpensive. It is also very easy to operate them in parallel with large power systems, because the utility grid controls voltage and frequency while static and reactive compensating capacitors can be used for correction of the power factor and harmonic reduction.

A. Advantage of Induction Generator

- Simple and robust construction
- Run independently
- Inexpensive as compared to the conventional synchronous generator.
- Minimal maintenance
- Inherent overload protection
- Stand-alone applications, no fixed frequency
- Less material costs because of the use of electromagnets rather than permanent magnets.
- Reduced unit cost and size, ruggedness, brushless (in squirrel cage construction), absence of separate dc source, ease of maintenance, self-protection against severe overloads and short circuits.

IV. STEADY STATE ANALYSIS OF SEIG ADVANCED

Self-excited induction generators seem to be most suitable machines for wind energy conversion in remote and windy areas. For estimating the steady state performances for such machine is must encounter the problems, it can appear under real operating conditions. The steady state analysis and their result of self-excited induction generator is play a vital role for proper implementation of induction machine operation as a

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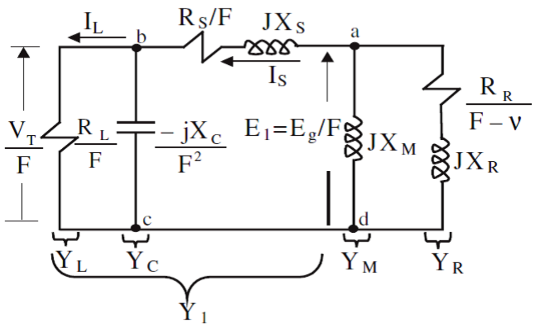
generator in a standalone mode through appropriate modelling of the system.

A. Operating Conditions for Steady State Analysis

- Constant speed variable frequency (CSVF)
- Constant frequency Variable speed (CFVS)
- Capacitance Determination

B. Modeling and Simulation of SEIG

The mathematical modeling and simulation is done for all 3 operating conditions using MATLAB. The essence of simulation of Self Excited Induction generator involves solving of complex equations of high order. It takes lot of time to solve these performance equations manually so for time saving and accuracy we use MATLAB to solve these polynomial equations. The Graphic User Interface has also been modeled for all the three operating conditions which will be described in later chapter.



V. ANALYSIS AND RESULTS OF SEIG USING MATLAB GUI

A. Graphical User Interface (GUI)

A graphical user interface (GUI) is a graphical display that contains devices, or components, that enable a user to perform interactive tasks.
To perform these tasks, the user of the GUI does not have to create a script or type commands at the command line.
You Can Either Create GUI Programmatically or Use GUIDE.

a. Steps Of Computing The GUI

- Draw the GUI on a piece of paper
- Create the GUI using GUIDE
- Create the code of the GUI (call back functions)
- DEBUG the GUI by using it in various scenarios

Use GUIDE command to create a GUI Graphical User Interface Development Environment as shown in Figure 1.

B. Constant Frequency Operation

In SEIG, terminal voltage and frequency varies with operating conditions. However these may be control by proper control of operating parameters such as excitation capacitance, speed etc. Rotor resistance appears to be another control parameter in case of wound rotor induction generator. Under the constant frequency mode the SEIG working in constant frequency operation. The main window for this:

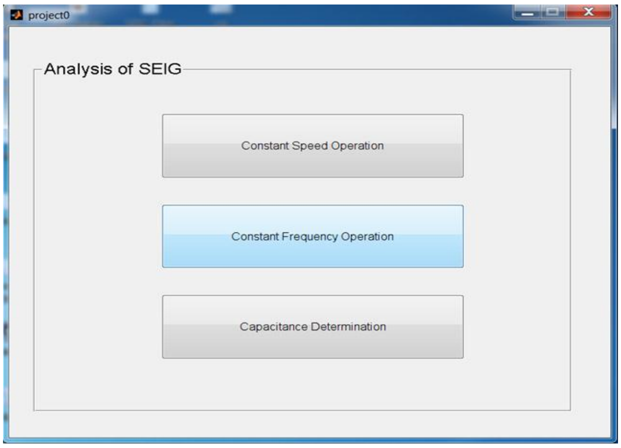


FIG. 1 Terminal Voltage Vs Speed

As we increase the speed of prime mover the terminal voltage across the load decreases. This indicates the need to control the speed of induction machine in a specific manner to generate constant frequency supply to accommodate the load variations

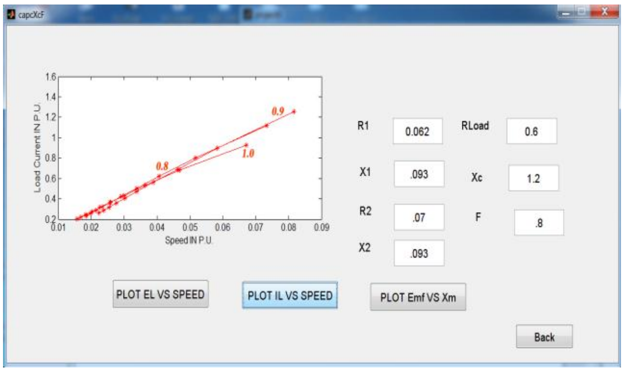


Fig. 2 Load Current Vs Speed

As the speed of prime mover increases per unit current of SEIG also increases linearly.
As the magnetizing reactance increases, the terminal voltage per unit decreases. From the result that are obtained from the theoretical values the conclusion made for constant frequency operation-

- It has been observed that the operating speed of machine is almost linearly related to generated frequency, for a given set of operating conditions. Thus any change in the speed affects the generated frequency and plays and important role to control it.

Further any change in generated frequency affects the effective value of excitation reactance. The effective value of excitation reactance decreases with any increase in the frequency, which in turn increases with an increase in the operating speed. Thus any increase in the speed will result in to a reduction in the excitation reactance. This in turn is equivalent to the effect due to an increase in the capacitance. Therefore an increase in the operating speed with constant excitation capacitance and load resistance will result in to an increase in the terminal voltage.

VI. CONCLUSION AND FUTURE SCOPE

In isolated systems, the use of a SEIG offers many advantages over a synchronous generator. It is desirable that the cost of an isolated system should be very low so that the cost of power produced from it can be afforded by the poor community residing in an isolated area. Use of the SEIG compared to the synchronous generator can reduce the system cost considerably. This project has presented a comprehensive literature review on important aspects of SEIG such as the process of self-excitation and voltage build up, modelling, steady-state and transient analysis, reactive power/voltage control, and parallel operation. SEIGs have been mainly analyzed in a single system like wind or micro hydro, etc. and contributions in dual or multi systems such as wind–diesel, wind–diesel–micro hydro, etc. are almost negligible. It is expected that better methods of reactive power/voltage-control techniques will make the SEIG more suitable for isolated applications.

APPENDIX

The details of the machine used to obtain simulated results are-

Specifications

3-phase, 4-pole, 50 Hz, Squirrel Cage Induction Machine 7 kW, Stator - 400/231 V, 14.7/25.4 A Rotor (Y) - 220 V, 19.5A

Parameters

R1=0.062 ohm, R2=0.07 ohm, X1=X2=0.093 ohms

Base values

Base voltage=231 volt
Base current=14.7 A
Base impedance=48.52 ohm
Base capacitance=230µF
Base frequency=50 Hz
Base speed=1500 rpm

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