Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 125 (2018) 405–411

Procedia Computer Science

www.elsevier.com/locate/procedia

6th International Conference on Smart Computing and Communications, ICSCC 2017, 7-8 December 2017, Kurukshetra, India

Optimization Techniques for the Analysis of Self-excited Induction Generator

Swarup Kumar Saha[a], Kanwarjit Singh Sandhu[b]*

[a]*School of renewable energy and efficiency,NIT Kurukshetra,*
[b]*Department of electrical engineering, NIT Kurukshetra*

Abstract

Nowadays the renewable energy systems are developing constantly around the whole world especially in backward regions the installation of wind firms increases day by day. Self-excited induction generators are the proper choice to be implemented in these applications because of its several merits. This paper includes the steady state performance of self-excited induction generator (SEIG) feeding balanced resistive load. Three optimization techniques have been adopted to determine the magnetizing reactance and generated frequency of the machine. Simulated results as obtained have been compared with experimental data. Comparative analysis as discussed proves the superiority of GA and PSO.

Peer-review under responsibility of the scientific committee of the 6th International Conference on Smart Computing and Communications.

Keywords: Genetic algorithm(GA); Simulated annealing(SA); Particle swarm optimization(PSO); self excited induction genarator(SEIG).

1. Introduction

The self-excitation mood of induction generator is realised in the late twenties when the researchers understood that if the rotor of the machine is driven by some external source and a suitable amount of capacitor can be connected to the stator than it is possible to generate electrical power from the induction machine [1]. From that, a

* Corresponding author.
E-mail address: kjssandhu@rediffmail.com

1877-0509 © 2018 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the 6th International Conference on Smart Computing and Communications
10.1016/j.procs.2017.12.053

new era of the generating system starts. But because of its poor voltage and frequency regulation, this machine gets backward. But from the last few decades as the pollution level as well as the temperature of the planet earth increases in a rapid way, people all around the world are turning towards renewable sources of energy. Along with the advantage of pollution free environment this renewable energy sources also removes the tension for a continuous depleting level of our conventional energy sources such as coal, petroleum etc. among all the renewable energy sources the solar and wind energy sources are dominating. And the induction machine with the advantage of wide operation range for variable wind speed makes it suitable for the application to convert wind energy into electrical energy. Therefore to know the operation of this machine and also for the design purpose the steady-state analysis of SEIG becomes an important thing [2]. Different researchers take different initiatives for the analysis of self-excited induction generator i.e. SEIG, among them three of the most popular methods are:-Loop impedance method, Nodal admittance method, Iterative method etc. [3-4]. But all these methods of analysis the SEIG required long derivations and highly non-linear equations also have to be solved. As a result, nowadays researchers use different optimization techniques to solve the non-linear equation that appeared in the steady-state analysis of the induction generator. Among all the optimization techniques genetic algorithm (GA), particle swarm optimization (PSO) etc. are frequently used [5-9]. Therefore in this paper, we basically obtained the optimized value of generated frequency and the magnetizing reactance for SEIG by using three optimization techniques and compared their results with the experimental one.

Nomenclature

R_s	Resistance of stator per phase
R_r	Resistance of rotor per phase referred to stator
R	Resistance of load per phase referred to stator
X_m	Magnetizing reactance per phase at rated frequency
X_s	Reactance of stator per phase
X_r	Reactance of rotor per phase referred to stator
X_c	Capacitive reactance in per phase
E	Per phase air gap voltage
V_c	Voltage drop across the Capacitor
I_s	Per phase stator current
I_r	Per phase rotor current referred to stator
I_m	Magnetizing current per phase
I	Per phase load current
I_c	Per phase capacitor current
a	pu Frequency
b	pu Speed
s	Slip of the machine

2. Machine Modeling

At steady state how the machine will operate can find out by analysing the induction machine represented in an equivalent circuit shown in fig 1(a). Here we assume two things i.e. all the circuit parameters like stator and rotor leakage reactance, stator and rotor resistances are constant and the stator and rotor leakage reactance are equal to each other. The second assumption is the magnetising reactance is the only parameter that is going to be affected by the magnetic saturation. Because of variable external driven force which rotates the rotor of the induction machine the stator frequency of the motor becomes also variable. Therefore we represented the induction machine in another circuit shown in fig 1(b) where all the circuit parameters are referred to rated frequency. In doing this we define two variables ‘a’ and ‘b’.