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High Efficiency Control for a Wind Energy Conversion System with Induction Generator

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Abstract— **The control system is the key technology of the wind energy conversion process in order to extract maximum energy from the incident wind and the maximum power point tracking(MPPT) control schemes have been reported which operate by varying the generator speed in order to optimize wind turbine aerodynamic efficiency. Search control and fuzzy-logic control methods have been presented respectively. Neural networks could be an alternative approach for the MPPT control. An optimal torque controller based on a priori knowledge of the turbine characteristics is proposed. Also, a fast tracking control algorithm has been presented in and an adaptive fuzzy-logic-based scheme has been proposed in the appropriate control of the generator excitation is an attractive option in order to improve the efficiency of the whole WECS. A fuzzy-logic control method for the *d*-axis stator current that can lead to maximum efficiency of the induction generator has been presented in however, the response time is long and the system might fail to follow the fast dynamics of the wind. The model-based optimal efficiency control for WECS with induction generator has been investigated. However for the implementation, the accurate wind speed measurement is required. Furthermore, the optimum referenced-axis current depends on the accuracy of loss model parameters that cannot be easily determined in a real application.**

Keywords— WECS(Wind Energy Conversion System), MPPT(Maximum Power Point Tracking)

I. INTRODUCTION

Nowadays, the renewable energy sources are a topic of interest in our society. Wind energy has many advantages facing the fossil fuel which explain why it has grown so fast in the last years. Wind energy is a clean fuel source that does not pollute the air as power plants are doing with combustion of fossil fuels.

The low environmental impact of wind energy makes it a very attractive solution, which in last year's demand has grown a lot. Different configurations can be used for wind turbines. The design of a wind turbine have a gearbox or not, the generator is may be asynchronous or synchronous machine and the connection to the grid can be directly or through power conversion. Two modes of operation can be used in function of the wind turbine MPPT and Fuzzy logice controller. These types of operation are used for fixed speed and variable speed. In the past, fixed speed which can get maximum efficiency for one wind speed was used. But, the power conversion is not efficient for this reason nowadays the topology most used is variable speed. Maximum efficiency over a wide range of wind speed have been achived by this design.

II. PROPOSED WECS WITH HIGH EFFICIENCY CONTROL

Induction generators are often used in wind turbines and some micro hydro installations due to their ability to produce useful power at varying rotor speeds. Meachinical and electrical simplicity is more in induction generator compare to other. Induction generator more rugged, requiring no brushes or commutations. Induction generators are particularly used for wind generating stations.in this case speed is always a variable factor, and the gearbox generator is easy on the generator

The aim of the grid side inverter control is to keep the dc link voltage constant, thereby insuring that the active power generated by the generator is fed to the network. it is possible additionally to control the reactive power fed to the grid. These inverters use dc capacitors in order to generate ac voltage. The aim of the grid side converter control is to keep the dc link voltage constant, there by ensuring the active power generated by the generator is fed to the network. And additionally, it is possible to control the reactive power fed to the grid. The grid side converter is controlled in a synchronous reference frame that rotates synchronously with the grid voltage. The grid side voltage phases are synchronized with the controller reference frame by using the programmable logic controller (PLC).

A programmable logic controller (PLC) obtains wind speed values and, by using turbine characteristics and induction motor speed, calculates the torque value of the wind turbine. This is the reference value to the torque-controlled drive that forces the three-phase induction motor to act like a real wind turbine to the energy conversion system.

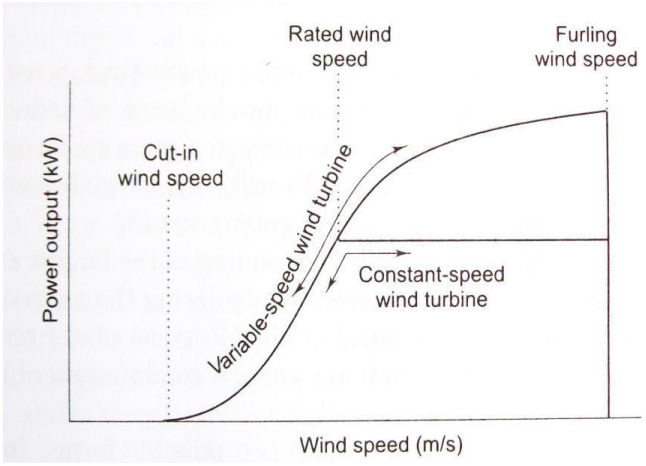

Fig.1 Power versus wind speed characteristics of variable speed wind turbines

III. CONTROL STRATEGY

Different speed control strategies are required for the five different ranges of wind speed.

- Power is not generated by the machine below a cut-in speed. Rotation of the machine may start in this speed range if there is sufficient starting torque. Rotor rotates freely but there is no power is generated.
- Maximum power is extracted from the wind at normal wind speeds. This is achieved at a particular TSR value.for tracking maximum power point, rotational speed is changed continuously proportional to the wind speed.
- At high wind speeds, rotor speed is limited to a maximum value which depends on the design of the mechanical components. Here is lower than the maximum value. Power output is not proportional to the cube of the wind speed.
- At even higher wind speeds, output power is kept constant at the maximum value allowed by the electrical components.
- The power generation is shut down and the rotation is stopped in order to protect the system components.at cut-out or furling wind speed

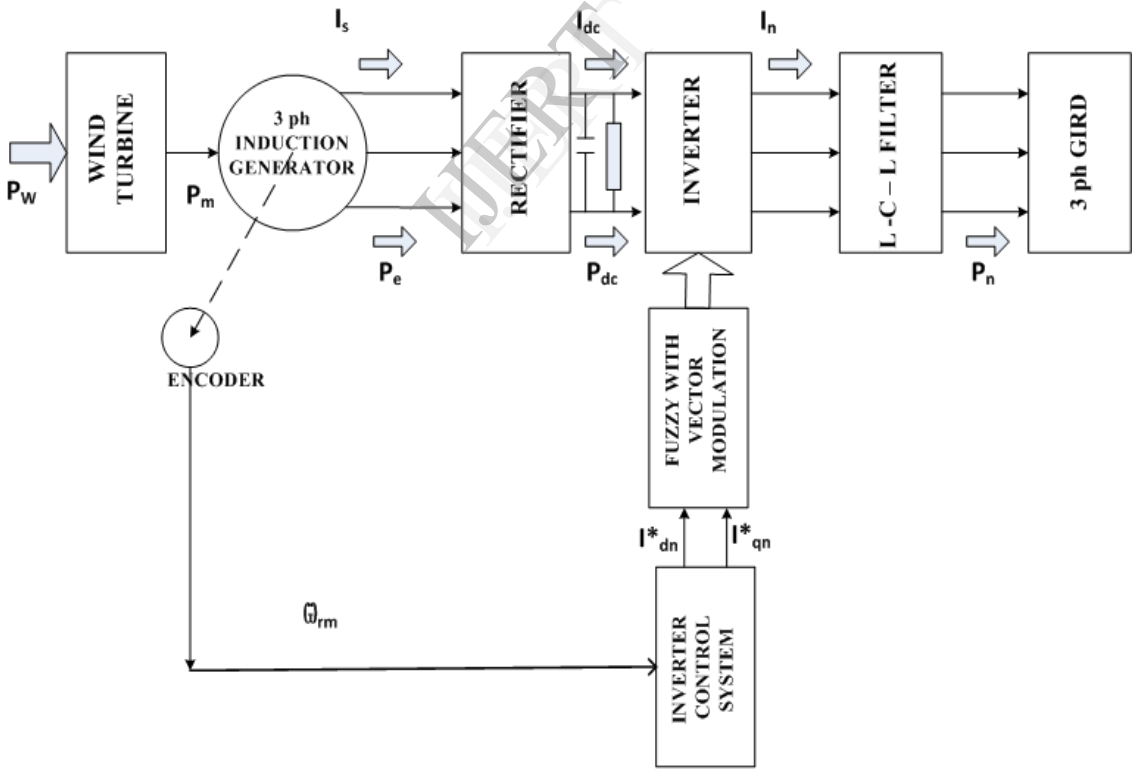

Fig. 2 Proposed block diagram

IV. EFFECT OF WIND GENERATOR ON THE NETWORK

Wind power injected into the network affects the voltage magnitude, its flicker, and its waveform at the *point of common coupling* (PCC). The effect on voltage magnitude depends on the strength of the utility distribution network at the point of coupling as well as on the active and reactive power of the wind generator(s).

The system strength at the PCC under consideration is decided by the short-circuit power, called the *fault level* at that point.the three-phase fault at that point and the voltage of the system. In fact, a power system comprises many interconnected power sources. The transmission and distribution network are fed through load extended. At the point of connection, an equivalent ideal voltage source in series with impedance *Zs* may be assumed to replace the power system. Thus, the higher the fault current, the lower in the source impedance. The induction generator with wind farm receives the reactive power from the network and delivers real power to it.

V. SIMULATION OF PROPOSED SYSTEM

A. *Simulink block of wind energy system*

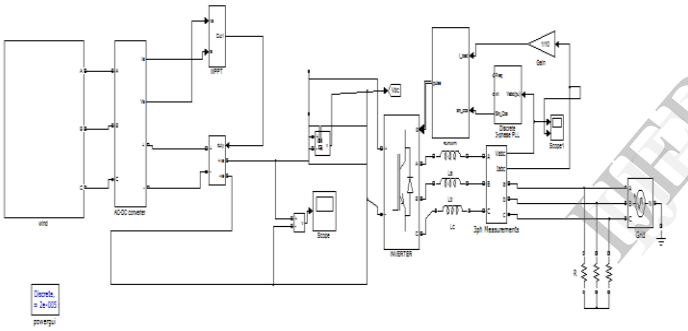

Fig. 3 (a) Simulation of wind energy system

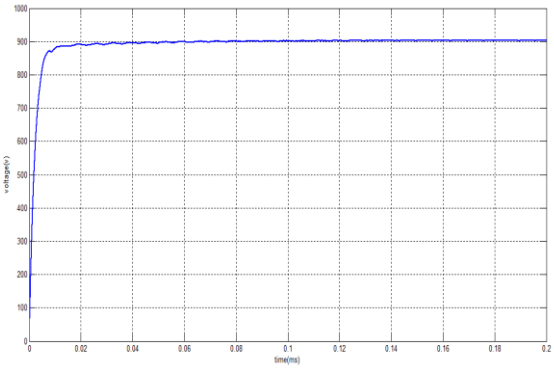

Fig. 3 (b) Measurement of rectifier output

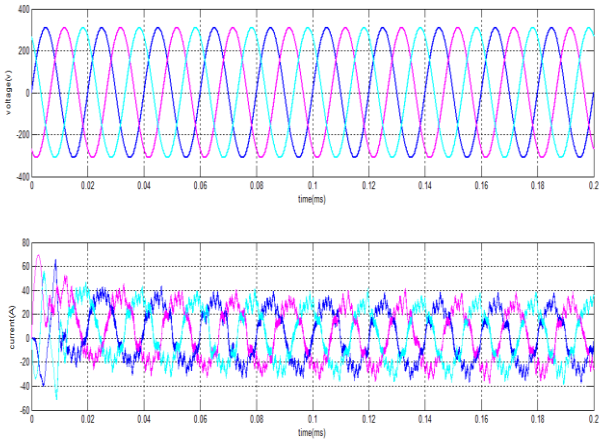

Fig. 3 (c) Measurement of wind output

From figure it indicates that the minimum resistive power loss of the induction generator in combination with MPPT of the wind turbine and the WECS is increased and expansion of the exploitable wind speed region toward the lower speeds can be achieved.

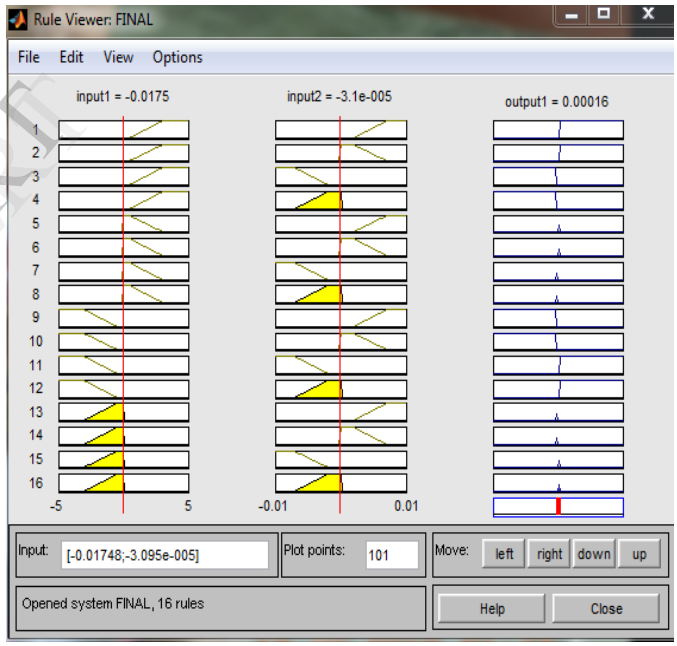

Fig. 3 (d) Rule viewer

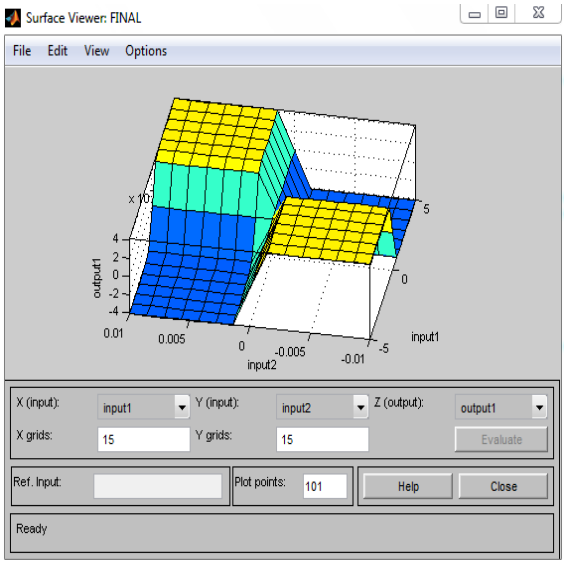

Fig. 3 (e) Surface viewer

VI. CONCLUSION

The control system provides minimum resistive power loss of the induction generator in combination with MPPT of the wind turbine has developed and simulated using MATLAB and the results has been recorded. The simulated result shows that the total ohmic loss in the grid side inverter has been reduced to 5.79% and the power ouput increases for 100w and the efficiency increases 11.5% hence it can be effectively used in the wind energy conversion system.

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