Abstract of PhD Study

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Title : Performance Improvement of A Grid- Interactive Wind Energy Conversion System (WECS)

ABSTRACT

The recent sensitive issue of climate change is due to the extensive amount of carbon emission through the consumption of fossil fuel as the primary option for energy demand. Due to the negative impact of green house effect, the alternative and renewable energy options have received significant attention on global scale. The two branched approach of renewable energy projects including the reduction in the global greenhouse gas emissions and encouragement to the development of alternate green energy options like wind energy. Wind energy has become one of most acceptable solution among the different renewable energy resources because of the application of power electronic based controllers that allows the wind energy conversion system (WECS) to generate quality electric power irrespective of variable wind profile.

In this work, the continuous flow of quality power from WECS to connected power grid is insured for wider range of wind speed. Doubly fed induction generator (DFIG) used in WECS having power electronic converter which requires very small friction of power in comparison to the total generation capacity. This thesis brings out the analysis of a DFIG system in terms of its stator and rotor currents and real and reactive power balance when the machine is operating with varying wind velocity conditions. Various possible maximum power point tracking techniques are analyses and discussed in this work. The suitable Maximum power point tracking (MPPT) technique has also been proposed to harness maximum available power for a given wind velocity to ensure the continuous power flow from WECS to the power grid. With the change in the wind profile, the speed of doubly fed induction generator (DFIG) of wind energy conversion system (WECS) changes from super synchronous to sub synchronous range and vice versa. DFIG is operated to generate quality power; hence, power at rotor side is controlled using matrix converter taking power from grid and feding back power to the grid depending on the wind profile. Input voltage required to be fed to the rotor side of DFIG is always changing and depends on the speed of the available wind. During the operation when power is fed from grid to rotor of DFIG, a high voltage stress continues across the switches of power electronic converter

(PEC). Matrix converter is generally preferred in this configuration. In existing topologies of the matrix converter used with the DFIG in WECS the constant voltage stress at the power electronic switch (PES) is available which causes the higher losses across the switch. This also causes common mode voltage (CMV) which leads to the over voltage stress. This may cause winding insulation damage and bearing failure of the DFIG. Further, higher dv/dt of CMV raises the leakage current which causes the thermal stress and electromagnetic noise to the equipments installed near the matrix converter. In this thesis, the work done is also focused on the mitigation of operational losses in matrix converter fed doubly fed induction generator for wind energy conversion system. The overall loss in the matrix converter and mitigation of common mode voltage is achieved, which improves the overall efficiency and the performance of the wind energy conversion system.

An efficient and well controlled wind energy conversion system with DFIG and modified power electronic converter is proposed to achieve the continuous flow of power from WECS to the grid with improved performance. Therefore, the development and realization of functional control of DFIG for variable speed operation is achieved.

The whole work done which is being presented in the thesis is summarized below:

1. Overview of the renewable energy with electric energy consumption status is presented. The Indian and global energy scenario has also been discussed.
2. Literature survey of wind energy conversion system with respect to the classification, efficiency, application of power electronic converters and topologies is presented.
3. The selection of suitable wind generator for variable wind profile is carried out.
4. The selection of suitable power electronic converter with identified wind generator for variable wind conditions is carried out to achieve the optimal quality power generation.
5. The selection and application of the best suited MPPT technique with the selected generator and power electronic converter combination for the above conditions is carried out to ensure the continuous quality power for the wider range of wind velocity.
6. The net operational power electronic converter losses and the thermal stress across the switches are reduced.
7. The proposed scheme is used to reduce the common mode voltage peak value due to which the leakage current through parasitic capacitor between stator core and stator winding is reduced as result the low thermal stress in DFIG windings is obtained.
8. The input and output current wave forms of matrix converter obtained from the proposed scheme implementation reported no significant deterioration. Therefore, the overall performance of the wind energy conversion system gets improved and ensures reliable and quality power delivery to the connected power grid.