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Review of Power Quality Problem Improvement by Integration of Solar PV Panel and DFIG Wind Farm System with UPQC

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Abstract – *In this paper we introduce a UPQC in a grid connected DFIG wind farm distribution system improving the power quality on the source and load side. The UPQC is further developed with integration of a solar panel (PVA- Photo Voltaic Array) of specific capacity in parallel with DC link capacitor. The PVA injects power into the series and shunt converters which helps the distribution system to maintain the voltage at 1 pu and current of the source with lower harmonic distortion. Results of the test system without UPQC, with UPQC and UPQC with PVA are compared by applying FFT (Fast Fourier Transformation) analysis to depict the THD of the source voltage, source current and load voltage. Effect of UPQC with PVA on DFIG wind farm is also observed with comparative analysis and study. The complete design and analysis is modeled in MATLAB software with self explanatory graphical representations. A tabular comparison of the THD values will be shown as a final result and performance of the system is determined.*

Key Words: **Wind Energy, Power Quality, UPQC, DFIG, PV cell, Fuzzy logic control, etc.**

1. INTRODUCTION

Now-a-days, our technological world has become completely dependent upon the continues availability of electrical power. In most of the countries, the electrical power is provided via nationwide grids interconnecting various generating stations to the loads. The grid must supply the basic power demands of residential, industrial, commercial, medical organizations etc.[8]

But Electrical power generation systems are facing major problems like deficiency of fossil fuel, the need to reduce emissions and power losses in Long transmission lines. And to reduce these losses nonconventional energy generating systems used into the grid by means of Distributed Generation (DG) networks. In the power transmission system some power quality issues are raised, with the integration of nonconventional energy systems into grid. With the help of power electronic converters, Almost all nonconventional energy systems are integrated into grid takes place.[9]PV and wind energy systems are most widely used with power grid, their integration with the grid also increases. Also the integration of large wind farms to power grid yield power quality (PQ) problems such as voltage sag, swell, harmonics flicker, etc. The outcome of PQ problems is data error, equipment failure. Most industrial and commercial load are nonlinear and they produces the harmonics. For the reduction of both voltage sag and current harmonics, custom power technology uses. For reducing voltage related problems Dynamic Voltage Restorer (DVR) is well suited to protect sensitive load from short duration voltage swell. But DVR doesn't take care of load current harmonics, so the device STATCOM is widely used for the prevention of load current harmonics in addition to the addition of reactive power control, but it doesn't take care of voltage related problems. UPQC is only device easily used for the mitigation of both voltage sag and load current harmonics. The selection of suitable controller plays a main role to improve the performance of UPQC [1].

2. UPQC OVERVIEW

Now a day, the advance electronics industry facing the power system problem such power quality problem like voltage sag, swell and it has necessary to solve power system problem. For that it needs to use a dynamic solution. To remove this power quality problem new used the electronics devise such as Unified Power Quality Conditioner (UPQC). It is one of the best solutions to solve problems related to both current and voltage in power system.

The main purpose of UPQC is to solve the problems coming from both source side and load side, such as voltage sag, voltage swell, distortion in the supply voltage, harmonic currents, reactive currents etc. Consists of two series and shunt inverter connected back to back using a common dc bus capacitor. This paper deals with a novel concept of optimal utilization of a UPQC in wind energy conversion system.

3. LITERATURE REVIEW AND RELATED WORK

The connection of wind farms with power grid increases Power Quality (PQ) issues. Most of the commercial and industrial loads are of non-linear type practically which is the starting place of harmonics. As 70% of PQ problems are voltage sag, which is one of the most severe impediments to sensitive loads. Many of custom power devices is used Unified Power Quality Conditioner (UPQC) devices to diminish both voltage sag and current harmonics. In this paper, the author analyses PQ problems, voltage sag and current harmonics due to the interconnection of grid connected DFIG Doubly fed induction generator) based wind turbine and also provides PQ enhancement by introducing UPQC. To improve the performance of UPQC, a new control strategy using Fuzzy Logic Controller (FLC) is proposed

which remove the drawback of using fixed gains in conventional PI controller. The fuzzy controlled UPQC is implemented for PQ enhancement to diminish both voltage sag and current harmonics and simulation result are also compared with conventional PI controller. From the simulation results, by comparing controller performance, the proposed fuzzy controlled UPQC provides effective and efficient mitigation of both voltage sag and current harmonics than the conventional PI controlled UPQC, thus making the grid connected wind power system more reliable by providing good quality of power [1].

This paper delivers the regulation of voltage at wind farm (WF) terminals and the improvement of power quality and WF stability in a WF to Weak-Grid connection. The WF is connected through medium voltage (MV) distribution lines, in facilities with moderated power generation. A situation commonly found in such scheme is that the power generated is comparable to the transport capacity of the grid. This case is known as Wind Farm to Weak Grid Connection, and the main problem is the poor voltage regulation at the point of common coupling (PCC). Thus, the combination of weak grids, wind power fluctuation and system load changes produce disturbances in the PCC voltage, worsening the Power Quality and WF stability. This situation can be improved using Custom power devices technology (CUPS), the Unified Power Quality Compensator (UPQC). The internal control strategy is based on the management of active and reactive power in the series and shunt converters of the UPQC, and the exchange of power between converters through UPQC DC–Link. Simulations results show the effectiveness of the proposed compensation strategy for the enhancement of Power Quality and Wind Farm stability.[2]

In this paper a hybrid fuzzy logic controlled based improved power quality conditioner used to balance for harmonic distortion in three-phase system. The IPQC uses a very simplest methodology for the calculation of the reference compensation current based on FFT Analysis. The produced improved power quality conditioner is able to operate in different load conditions (balanced, unbalanced, variable). Classical filters may not have sufficient performance in fast varying conditions. But auto tuned active power filter gives out performance results for harmonic minimization, power factor improvement and reactive power compensation. The proposed auto tuned shunt active filter maintains the THD well within IEEE-519 standards. The proposed methodology is briefly tested for wide range of different Loads with improved dynamic behavior of IPQC using hybrid fuzzy logic controller. Thus, the transient response of power system network has been improved greatly and the dynamic response of the same has been made faster by using hybrid-fuzzy controller [3].

In this paper, the author analyses Photovoltaic systems and wind energy systems are distinguish as most clean and cost efficient renewable energy sources. These energy systems have been increasingly used in the generation of electrical energy where there is no grid connection (standalone systems), or by providing electricity to the grid these energy system provide electricity in that areas.. For flexible interconnection to the grid, both the energy systems often rely on power electronic converters due to the requirement of inverters for the integration of these energy systems into the grid, Power quality problems are increases. The power quality problems associated with the Photo Voltaic (PV) and wind energy systems integrated into the grid and also discuss the role of Unified Power Quality Conditioner (UPQC) in the mitigation of those power quality problems and enhancing the integration of renewable energy sources [4].

In wind farms, there are many power quality issues. The voltage fluctuations can be remove with the help of advanced reactive power compensation devices such as SVC (Static Var Compensator), STATCOM (Static Synchronous Compensator) and DVR (Dynamic Voltage Restorer). To reduce these power quality issues, it is need to design, model and analyze the FACTS (Flexible AC Transmission line) device. In this paper, the author used STATCOM as a compensating device. STATCOM is a static synchronous generator operated as a parallel connection static reactive compensator. It is capable to generate or absorb real and reactive power. Also, the performance of compensator is analyzed with the help of Proportional Resonant (PR) controller device. The STATCOM is parallel connected with the transmission line. It will inject or absorb the reactive power to the line through the transformer according to the voltage requirement, when fault occurs. The whole system is simulated through MATLAB/SIMULINK application. The simulation gives the effective influence of STATCOM on the improvement of voltage profile as well as reduction of Harmonics in grid connected Wind Energy Conversion System [5].

The unified power-quality conditioner (UPQC) is used to mitigate the current and voltage-related power-quality (PQ) problems simultaneously in power distribution systems. Among all of the PQ problems, voltage sag is a crucial problem in distribution systems. In this paper, a new methodology is proposed to mitigate the unbalanced voltage sag with phase jumps by UPQC with minimum real power injection. To obtain the minimum real power injection by UPQC, an objective function is derived along with practical constraints, such as the injected voltage limit on the series active filter, phase jump mitigation, and angle of voltage injection. Particle swarm optimization (PSO) has been used to find the solution of the objective function derived for minimizing real power injection of UPQC along with the constraints. Adaptive neuro-fuzzy inference systems have been used to make the proposed methodology online for minimum real power injection with UPQC by using the PSO-based data for different voltage sag conditions. The proposed method has been validated through detailed simulation and experimental studies [6].

4. CONCLUSIONS

From the above discussion, it can be seen that the wind power is characterized by fluctuation due to intermittent primary source, which can damage the electrical network stability because of the imbalance between production and consumption. It is necessary to meet the energy needs by utilizing the renewable energy sources like wind. It is also concluded that the voltage variations and load current harmonics are the two main issues arising when the wind farm is connected to the grid. So it must be mitigated using various techniques also this paper shows UPQC plays a main role mitigate the power quality problem.

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