Mitigation of the Wind Generation with Active Power Filter

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Abstract: A remarkable appearance is made by renewable energy in today’s technology. The main purpose of renewable energy is to reduce the dependency on petrol based generations. The combination of wind energy, hydro energy, solar power, etc. created certain problems like stability problem, power quality issues in the grid. These problems were reduced by using passive filters, but in today’s technology it is replaced by active filter like Static Synchronous Compensator (STATCOM) and Dynamic Voltage Restorer (DVR).

STATCOM regulates the voltage level while DVR solves the voltage power quality issues. In the existing system DC source, non linear load and PI controller is used. In the propose system the DC source will be replace by solar panel to provide fixed voltage to the system with a Neural network replace PI controller the Neural network overcome the problems of overshoot and remove delay time and inverse response, instability in rise time and settling time. In the propose system non linear load will be replace by variable non linear load.

Keywords: STATCOM, DVR, Wind, Grid, Active power filter.

1. Introduction

Now a day’s power electronic based equipment are used in industrial and domestic purpose. These equipments have significant impact on the quality of supplied voltage and have increased the harmonic current pollution of distribution systems. They have many negative effects on power system equipment and customer such as additional losses in overhead and underground cables, transformers and rotating electric machines, problem in the operation of the protection systems, over voltage and shunt capacitor, error of measuring instruments, and malfunction of low efficiency of customer sensitive loads. Passive filter have been used traditionally for mitigating the distortion due to harmonic current in industrial power systems. But they have many drawbacks such as resonance problem dependency of their performance on the system impedance, absorption of harmonic current of nonlinear load, which could lead to further harmonic propagation through the power system. To overcome of such problem active power filters is introduced. It has no such drawbacks like passive filter. They inject harmonic voltage or current with appropriate magnitudes and phase angle into the system and cancel harmonics of nonlinear loads. But it has also some drawbacks like high initial cost and high power losses due to which it limits the wide, application especially with high power rating system.

1.1 Static Synchronous Compensator (STATCOM):

The STATCOM has been reported to improve the power quality in power systems with DG integration of wind. STATCOM can be implemented to regulate the voltage as a shunt compensator for the WTIG. It is a Battery Energy Storage System (BESS) connected to a DC link capacitor which itself connected to a Voltage Source Converter (VSC).

The STATCOM is shunt connected and uses in this paper a Hysteresis current control method to inject a current in the system to counter the harmonics created by the non-linear load and the WTIG. The basic STATCOM model is shown in Fig.1. It is a solid-state switching converter, capable of generating or absorbing independently controllable real and reactive power at its output terminals when it is fed from an energy source. STATCOM is considered as voltage-source converter that, from a given input of dc voltage, produces a set of 3-phase ac-output voltages, each in phase with and coupled to the corresponding ac system voltage through a relatively small reactance.

Figure 1: Basic STATCOM Model

1.2 DVR Model:

The DVR is used to protect critical or sensitive loads by mitigating the effects of voltage sags or swells on the distribution feeder due to faults in the system by maintaining constant voltage magnitude. It is basically a BESS connected to an inverter which itself is connected to an injected
transformer that is mounted in series with the 3 phase

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BESS-STATCOM:

The battery energy storage system (BESS) is used as an
energy storage element for the purpose of voltage regulation.
The BESS will naturally maintain dc capacitor voltage
constant and is best suited in STATCOM since it rapidly
injects or absorbed reactive power to stabilize the grid
system. It also control the distribution and transmission
system in a very fast rate. When power fluctuation occurs in
the system, the BESS can be used to level the power
fluctuation by charging and discharging operation. The
battery is connected in parallel to the dc capacitor of the
STATCOM. The STATCOM is a three phase voltage source
inverter having the capacitance on its dc link and connected
at the point of common coupling.

1.3 Wind Turbine Induction Generator:

The wind turbine needs a relatively large amount of reactive
power to operate. This power must be fed externally whether
from a capacitor bank, or a controlled inverter, or from the
electrical synchronous grid. The reactive power absorbed by
the WTIG causes the voltage on the bus where the generator
is connected to drop, and the system build up will raise the
voltage again to the nominal voltage of the grid.

2. Grid Coordination Rule

The American Wind Energy Association (AWEA) led the
effort in the united states for adoption of the grid code for the
interconnection of the wind plants to the utility system. The
first grid code was focused on the distribution level, after the
blackout in the United State in August 2003. The United
State wind energy industry took a stand in developing its own
grid code for contributing to a stable grid operation. The
rules for realization of grid operation of wind generating
system at the distribution network are defined as-per IEC-
61400-21. The grid quality characteristics and limits are

3. Proposed System

We have to study our system at the PCC, which is the interest
of this kind of research. Studying at the PCC will give an
idea of the system behavior at any other Bus. Fig. 5 shows
the grid or the infinite bus connected to the PCC, it shows the WTIG, a non-linear load for harmonics generation. The DVR and STATCOM are used for Active filtering. They cancel the effect of voltage sags and swells by injecting a voltage into the system, and remove the harmonic by injecting a current into the system. In a proposed system STATCOM and DVR are used to main power quality and improvement voltage stability. In the propose system the DC source will be replace by solar panel to provide fixed voltage to the system with a fuzzy logic controller replace PI controller the neural network overcome the problems of overshoot and remove delay time and inverse response, instability in rise time and settling time. In the propose system non linear load will be replace by variable non linear load. When the proposed model shows to explain the model first fall connected the three phase voltage source in series RL branch with three phase source. The three phase source block implements a balanced three-phase voltage source with the internal R-L impedance. The three voltage sources are connected in y with a neutral connection that can be internally grounded or made accessible. You can specify the source internal resistance and inductance either directly by entering R and L values or indirectly by specifying the source inductive short circuit level transformer ratio. They are connected three phase voltage and current measurement. The three phase VI measurement block is used to measure instantaneous three phase voltage and current in a circuit. When connected in series with three phase elements, it select the three phase to ground or phase to phase peak voltages and current. Select no if you do not want to measure three phase voltage. Select phase to ground if you want to measure the phase to ground voltages. Select phase to phase if you want to measure the phase to phase voltages. Select yes if you want to measure the three phase current that flow through the block. They are five voltage source measurement are used. One three phase transformer used. This block implements a three phase transformer by using three single phase transformer. And three phase breaker are used three phase breaker connect this block in series with the dialog box or apply an external logical signal. If you check the “external control” box, the external control input will appear. And one universal bridge are used this block implement a bridge of selected power electronics devices. Series RC circuits are connected in parallel with each switch device. One three phase linear transformer are used this block implement three single phase two winding transformer all winding terminals.

Figure 4: Proposed Model

Figure 5: STATCOM Model

4. Simulation Result:

This section deals with the simulation results of the proposed STATCOM result to minimize the problem of undershoot and overshoot. And DVR result to overcome the problems of voltage sage and swell.

Figure 6: STATCOM output waveform
I have concluded with the basic explanations and block diagram. I have concluded the problem of overshoot and find the THD. This paper examined the STATCOM hysteresis control technique for harmonic cancelation with load tracking in a system where a wind turbine is present and it examined the work of the DVR when connected to a critical load from the same system. It used a separate control for the STATCOM and the DVR interchanging their roles. This paper used as variable non-linear loads. And neural network are used to minimize the overshoot and voltage sage and swell and find total harmonic distortion.

### References


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### 5. Conclusion:

The proposed system uses a active power filter and STATCOM and DVR to calculate the FFT analysis and find the problem of total harmonic distortion (THD). And overcome the problem of overshoot undershoot and sage and swell.