

Effect of Shunt Active Filters for Reduction of Harmonics in Wind Power Generation System

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Abstract—Nowadays, power generation systems are using renewable energy like solar systems, wind power generation, hydro energy, biomass, and geothermal energy. This renewable energy does not provide a constant output voltage due to fluctuating variable input. For this fluctuating in nature, the electrical components are connected in parallel for the wind power generation system. When the non-current consuming loads are connecting to a grid there the wave gets distorted for this distortion wave. The shunt active and passive filters can be used for this distortion wave. The SPWM control technique could be used to eliminate the harmonics in the SAF. The shunt active filter eliminates the harmonics. This system can be simulated by MATLAB/SIMULINK then the waveforms are to be obtained.

Index Terms— SAF (Shunt Active Filter), SPWM (Sine Pulse Width Modulation), Non-linear loads, Hysteresis-Band Current Controller (HBCC).

I. INTRODUCTION

Wind power generation systems are commonly used nowadays where 10% of power generation has been installed in India up to 20,000MW of wind power is obtained. For the constant output voltage, the shunt is active. filters are used where to reduce harmonics distortion and to efficiently the power quality [1,2]. Wind power generations can be connected through linear loads and nonlinear loads where voltage is equal to the current that are transformers, and motors. capacitors etc. The nonlinear load voltage is inversely proportional to current that are rectifiers, variable speed drivers, and electronic devices [3,7]. From the connection of current consuming loads, the output waveform gets distorted for this distortion technique the shunt filter is used. The filters are both active and passive [4,9]. The unique message signal is converted by the modulated signal which is used in the communication of disturbances to a clear communication signal for various channels known as active filters. In the variable output voltage, the fluctuation of the wind speed can make the generator torque constant [5]. The DFI generators are commonly used in generating systems where electronic devices are to be controlled the rotor currents when interfering with the change speed. This DFI generating system connected directly to the is substation grid through a transformer. When rotor windings are connected through the slip rings then it is known as a back-to-back converter [6]. The generated power from the generating station of the convener is connected to the transformer of tertiary winding. From this generating station if the wave gets

distorted the filters are used [8]. The voltage and current from the system are extracted from the filters in abc coordinates, From abc coordinates and the reference signal of the triangular wave is compared with the sine wave The pulse magnitude and pulse time is changed five the fundamental frequency [9,10].

II. SHUNT ACTIVE FILTER

In the power electronics components, the Shunt active filter is widely used. The power electronic components provide more harmonics for generating power systems. Shunt active filters are connected parallel across the generating station and the grid by a DC-link capacitor, power convener, and inductor filter. To reduce the harmonic generating in the current consuming loads the filters can be used. For the presence of current harmonics, the power quality factor, efficiency, power system voltage fluctuations, and communication interference will be decreased. The active filter is connected parallel to reduce the current disturbances to eliminate distortion, the quality power factor is improved

This SAF reduces the current distortion of current consuming loads to the better compensating network of reactive power as shown in figure 1. The variation of the disturbance currents. The load current senses the SAF and reduces the current disturbance. The reduction of canceling of harmonics can use the active harmonics filters which are like a noise-canceling system for both variable frequencies to reduce harmonics.

abc to dqo block uses a park transformation to transform a three-phase signal to a dqo rotating reference frame. The main reason for the abc-dqo is to excite the DC machine (or) motor of the torque and flux to be controlled separately in the induction machine. To make a computation level very easy the transformer of 3-phase voltage and current should be rotated in the same way as linearly in the dqo frame of rotating reference. The currents of active and reactive components should be operated independently. Three-phase time-varying signals are transformed into DC signals.

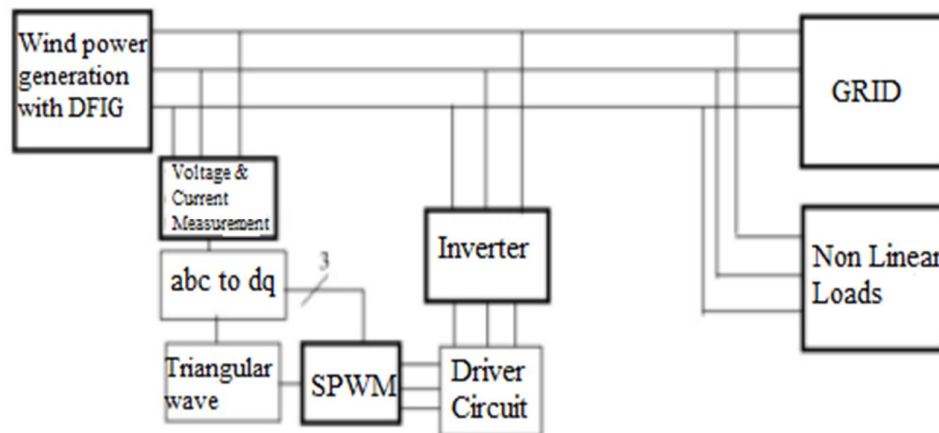


Figure 1: Shunt Active Filter with Wind Power Generation System

III. SINE PULSE WIDTH MODULATION

The triangular wave and sinusoidal reference voltage wave are compared to provide the gate signals for the switches. The non-sinusoidal waveform is known as a triangular wave. The non-sinusoidal waveform generates the capacitor charging and diffusing by a fixed current. The integrator circuit can be connected at the secondary side of generating a square pulse. It is a switching method for the voltage source inverter. For a constant switching frequency voltage source inverter method is used to control. The reference voltage is the same as the output of the voltage source inverter. This fundamental output of the VSI is the same as modulating waveform which can vary the triangular carrier wave. This method obtains the sinusoidal reference voltage and VSI is to be the same as modulating wave the output is same as the reference voltage that is generated by control block and the detection. This technique has a high modulation frequency which can reduce the filters. If the voltage signals lower(or) higher than the varying wave to the inverter output is the same then the +ve and-ve DC voltages are formed at an output. The RMS of both AC and DC voltage should be the same. The PWM should not affect the disturbances when applied output voltage amplitude is controlled by the modulation index. The pulse modulation

generated by the SPWM technique is shown in figure 2. The DC supply should be maximum-output voltage with the reduction of switch lasses and conduction losses.

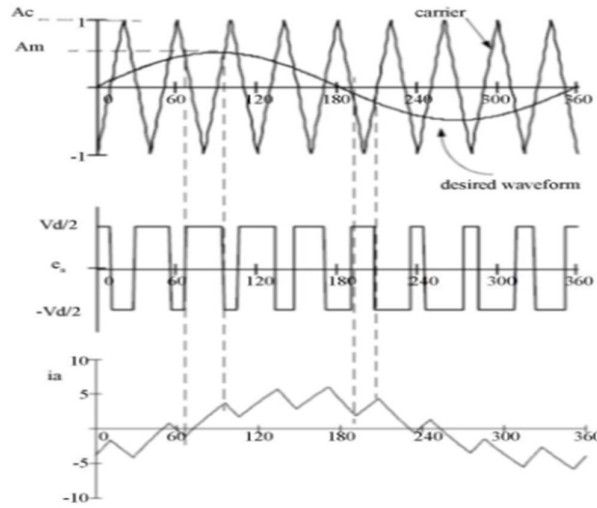


Figure 2: Pulse Width Modulation Technique Control Method

IV. WORKING PRINCIPLE OF SHUNT APF

The block diagram of a single-phase load compensator is a voltage source that powers a nonlinear load is as shown in figure 3 and 6. Since no feeder joins the origin and load points, designate the origin as permanent. This includes the compensating half-bridge inverter and the interface inductor. The representation of the line inductor is due to the losses of its finite Q factor and its inverter. If one end of the compensator is associated across the line inductor at the normal coupling point, the other end is associated with the load ground. The compensator DC side is powered by the DC capacitor. The voltage V_{dc} across the capacitor is maintained by controlling the inverter. Suppose the load consumes load current with non-linearity and poor electrical component. The instantaneous charging current may then drop. the compensator follows the reference current I_C by assuming the compensator operating in the hysteresis current control loop. if the inverter accurately follows this reference current, the source current is equal to the current of the unity power factor consumed by the load. Since the compensator does not consume real current, the average power consumed by the compensator is zero.

V. IMPLEMENTATION OF HBCC

HBCC technique is used for pulse generation in a current-controlled Voltage Source Inverter (VSI). This controlling method provides good stability, gives a very fast response, provides good accuracy, and is a simple operation. For the control of line current in APF, the HBCC technique is employed. It contains the generated error current surrounded by a hysteresis band.

After subtracting the actual filter current from the reference current, the current error is obtained. From Synchronous Reference Frame (SRF) method, the reference current is obtained and the same can be used here.

VI. RESULTS AND DISCUSSION

The wind power generating system of a doubly-fed induction generator is simulated MATLAB SIMULINK. Where the wind energy is variable speed energy that does not provide a constant output. The variation in speed causes a distortion. The harmonic distortion is measured in the fast-Fourier transformer method as shown in Fig 4. The wind power systems provide real and reactive power that should be connected by a grid as shown in Fig 5, 11. Where the active filter should be connecting parallel for reactive power and disturbances distortions. For reducing the harmonic distortion in current consuming loads, the SAF should be preferred. The SAF is to be controlled by the SPWM control method. The SPWM technique is used to switch the drives for the inverter. The voltage and current in abc coordinates are pinned to a common coupling point. The abc coordinates are transformed into dq transformation. the park's transformation is known as dqo transform. The 3-phase AC quantity is converted into two DC quantities to control the three-phase inverter. The calculation is obtained for

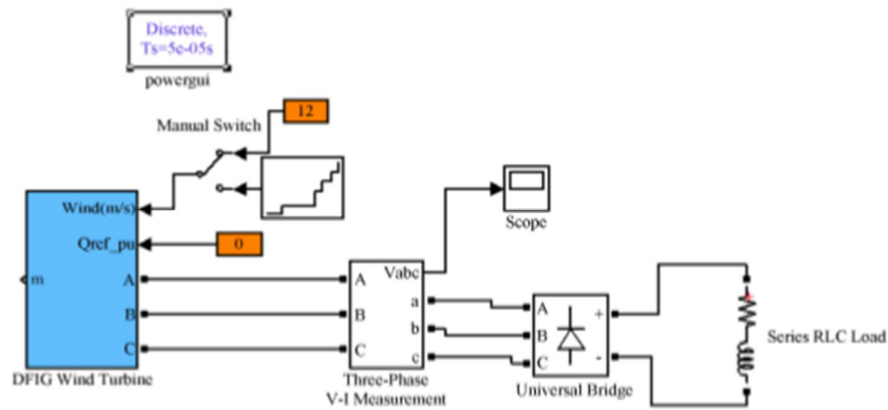


Figure 3: Nonlinear load is connected to wind power generation

the transformation of abc to dqo transform, after the dq transform the sine pulse width modulation controller generates the pulses for an inverter by a driven circuit for a zero-voltage switching technique and soft switching techniques for reducing the distorted waveform. The simulation results of the HBCC is set above and below the generated error signal as shown in figures 4,5 7, 8, 9, 10 and 11.

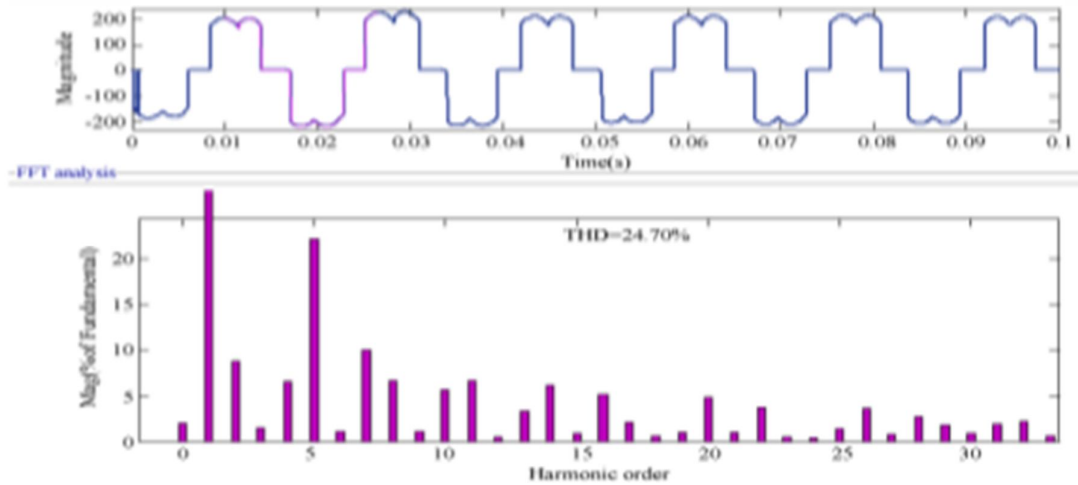


Figure 4: Compensation Network without a THD System

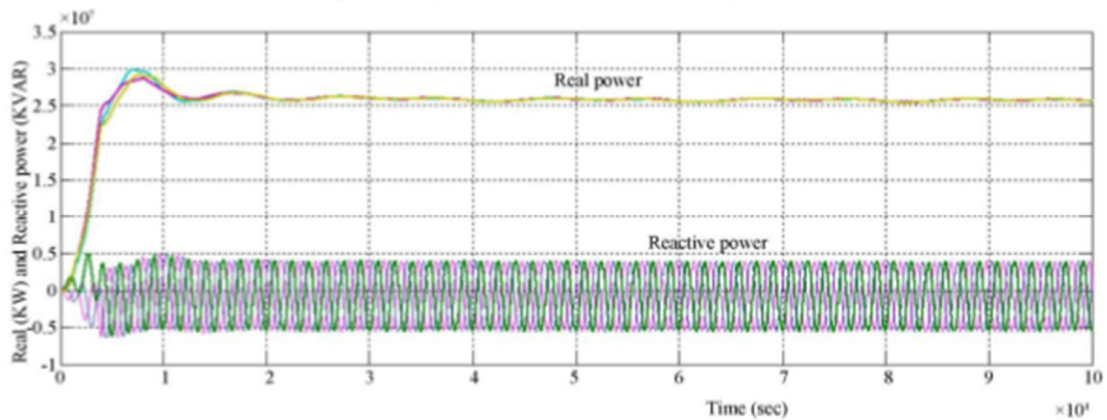


Figure 5: Compensation Network before the active and reactive power

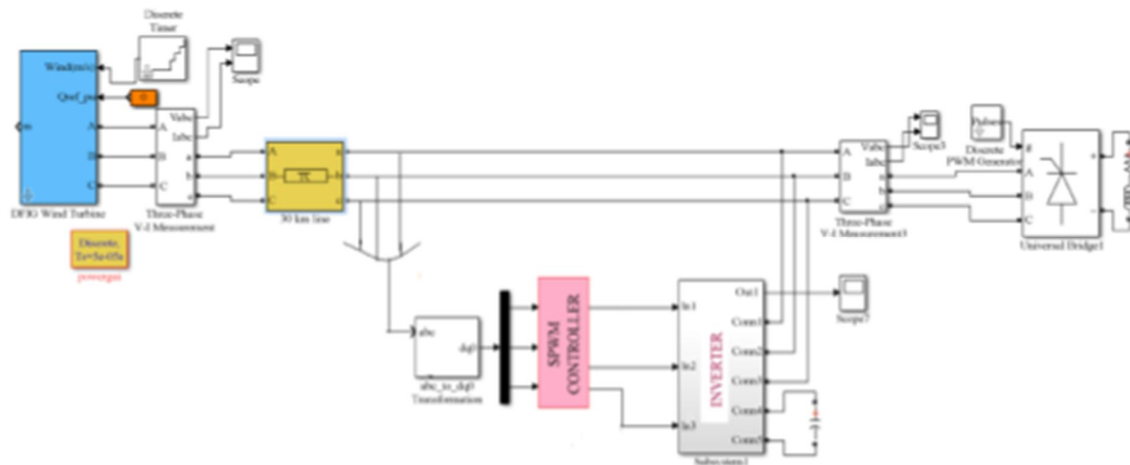


Fig 6: Compensation with Wind generation System

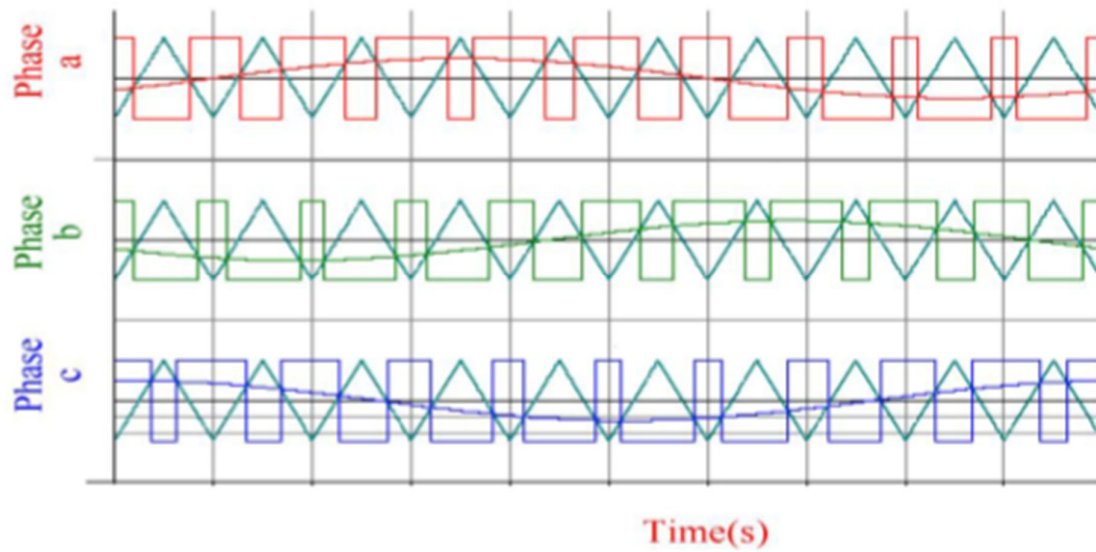


Fig 7: SPWM Pulse of Inverter

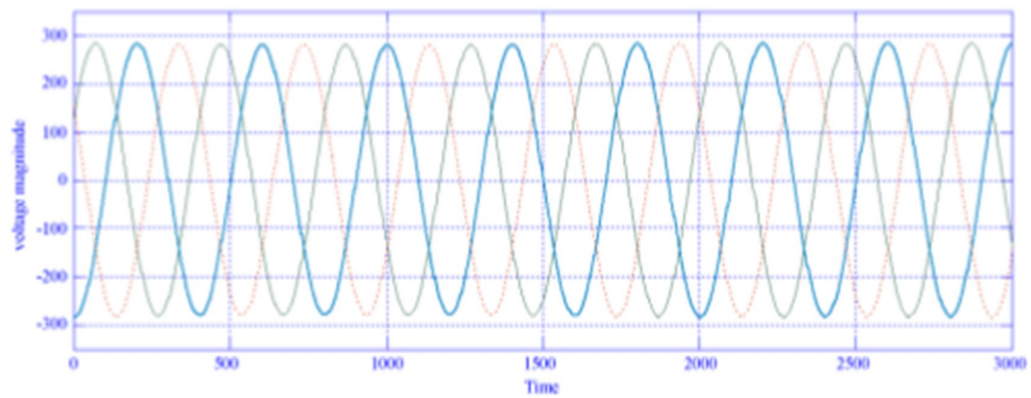


Fig 8: Voltage waveforms with active filter

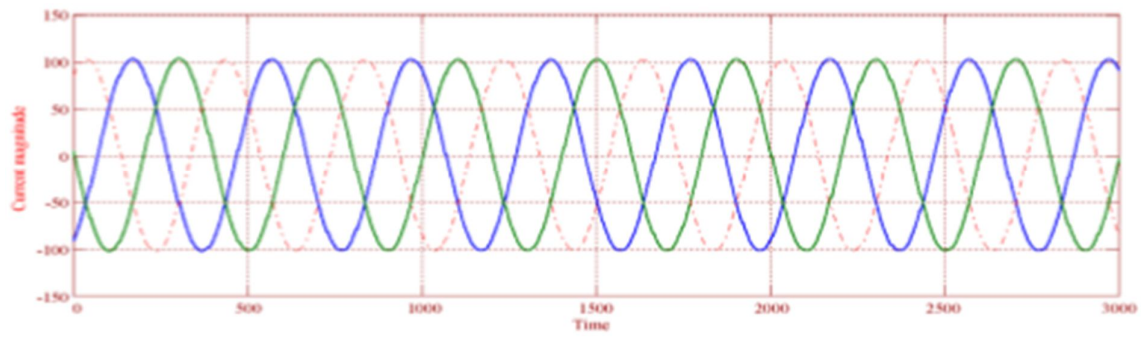


Fig 9: Current waveforms with active filter

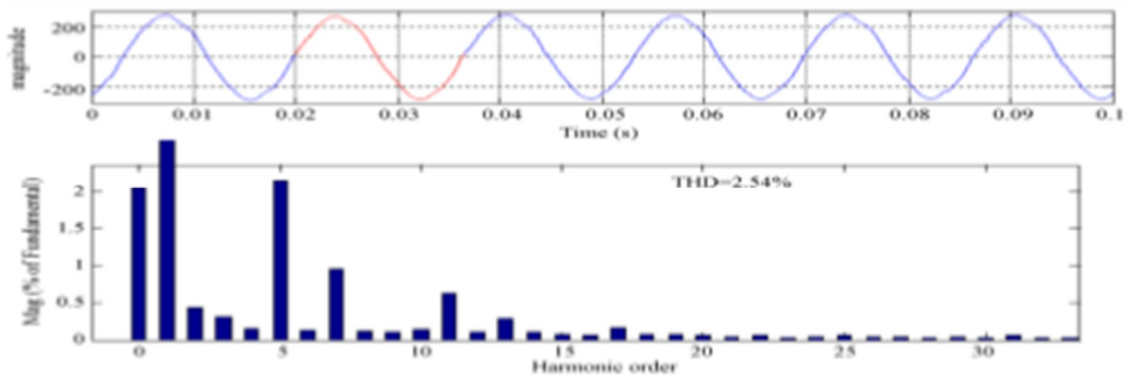


Fig 10: THD with compensation network

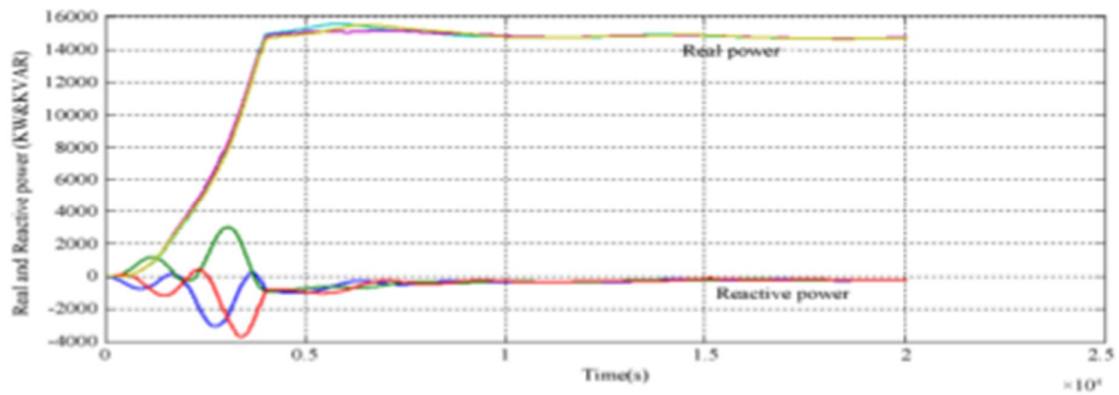


Fig 11: Active and Reactive power after compensation systems

TABLE I: THD BASED ON HARMONICS ORDER

Sl. No.	Harmonics Order	Before Compensation	After Compensation
1	3 rd	0.19%	0.31%
2	5 th	22%	2.15%
3	7	8.46%	0.96%
4	11 th	5.79%	0.63%
5	13 th	3.3%	0.29%

TABLE II. HARMONIC DISTORTION AND POWER FACTOR COMPARISON

Sl. No.	Particulars	Without Filter	With Filter
1	Total Harmonics	24.70 %	2.54%
2	Power Factor	0.815	0.992

VII. CONCLUSION

The wind energy is not a constant input for the power generating systems and provides the harmonics distortion waveform when it is connecting non-linear loads. The paper analyses the generating system connected with a power grid in MATLAB/SIMULINK. The SAF with SPWM method technique is performed to reduce the harmonic distortion which is connected to the non-linear loads. By a sine pulse width modulation method, the reduction of switching losses is obtained. The linear voltage and current waveform are obtained.

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