

# Simulation of Maximum Power Point Based Stand Alone Wind Generation System

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## ABSTRACT

Electricity in the modern time has become one of the most important need of the world. There are several sources of electricity present, such as petroleum, nuclear energy, and some natural resources, such as wind, tidal and solar energy. Electric power has become one of the most critical requirements in the modern society. Due to many constraints on natural sources of energy input in pollution and environmental damage, as well as lack of resources, there has been a demand in the last decade to employ renewable energy sources. The proposed work shows the reduced harmonic in generated electrical energy by wind connected WRIG system using hybrid active filter with Maximum Power Point Tracking (MPPT). MPPT system is used to track that point or value of wind turbine at which WRIG generates the maximum electrical power. The Grid Side Converter (GSC) and Rotor Side Converter (RSC) also have been used. The model for the proposed work is developed in MATLAB R2018a version. The model is drawn in simulink part of the MATLAB Software.

**Keywords:** Renewable Energy, Wind System, Hybrid Active Filter, Induction Generator

## I. INTRODUCTION

This part details a brief study of background used for the proposed research work focused on reduction of harmonic reduction in wind connected WRIG system output. The detailed scope of proposed research work focused on the use of hybrid active filter to reduce harmonic in case on linear and nonlinear load is also presented in this part. At the end of this part, part wise organization of paper is presented.

### 1.1 Sources of Renewal Energy

#### Renewable Energy Trends across the Globe

Renewable energy has increased in popularity as a consequence of the current economic trend. The current contributions of various sources to our global energy over the past three years, revealing that 81% of our energy is derived from fossil fuels. Recent advances in solar photovoltaic technology or the introduction of dependable projects in countries/regions such as Germany and Spain have resulted in a substantial expansion of the solar photovoltaic market [1, 2]. There are numerous non-fossil fuel sources, including nuclear, hydro (dams with electrical turbines connected to the discharge), solar (both photovoltaic and solar thermal), and others. These non-fossil fuel sources account for approximately 19% of total energy today.

### 1.2 Different Sources of Renewable Energy

#### Wind Power

Wind is a significant renewable energy source. Since ancient times, wind energy has been frequently used in sailing ships and windmills. Wind possesses kinetic energy due to the movement of enormous quantities of air induced by the sun's differential heating of the atmosphere. This energy can be used to power mechanical and electrical devices. Wind turbines can be used to generate power, extract water from wells, and pump water directly. Wind farms can be built in places with high energy demands and large amounts of waste land.

Wind turbines can be used to harness the energy of airflow [3]. The daily output of turbines operated ranges between 600 KW and 5 MW [4]. Power generation is proportional to wind speed and grows as it does. Wind turbines have recently produced advances that are more resourceful and superior than aerodynamic construction.

### Solar Energy

While touring through Africa, the British astronomer John Herschel [4, 5] pioneered the use of solar collectors for heating meals. Solar energy has two applications. First, the recovered heat can be used to heat the atmosphere using solar energy. Another technique is to convert solar energy into electrical energy, the most important source of power. This can be accomplished using solar photovoltaic cells [6-9] or solar-powered power stations.

Solar panels are the medium through which solar energy is converted into electrical electricity. Solar panels can convert energy directly or use induced energy to heat water. PV (Photovoltaic) cells are constructed using semiconductor architectures similar to those used in computer systems. This substance absorbs sunlight and emits electrons from the atoms to which it is linked. This discharge causes a current to flow. Photovoltaic is defined as the process of converting absorbed light into electricity. With a guiding philosophy and distinct components.

### Biomass

Biomass energy, obtained from organic matter, is a renewable and sustainable source of energy that may be used to generate electricity and other forms of power. Manure, forest debris, scrap lumber, mulch, sewage, some crops, and various types of waste residue are examples of common resources that can be utilised to create biomass fuel. Photosynthesis is the process through which plants obtain energy from the sun. When these plants burn, they produce energy. As a result, biomass can be used as a natural battery to store solar energy and produce it when needed.

### Geothermal

Geothermal energy is the heat energy stored in various layers of the earth [10-13]. This source can be used to heat water to produce very hot steam, which can then be utilised to power a gas turbine to generate electricity. Geothermal energy losses are frequently connected with sites near the tectonic plate border, notwithstanding recent technological advances [14-16].

## II. ANALYSIS OF WIND TURBINE SYSTEM

A wind turbine is a rotating machine that converts kinetic energy into mechanical energy. If mechanical energy is converted into electricity, the machine is called a wind generator, wind turbine, wind power unit (WPU), wind energy converter (WEC), or aero-generator. Wind turbines can be separated into two types according to the axis of rotation of the wind turbine. Horizontal axis and vertical axis wind turbine. Turbines that rotate around a horizontal axis are more common [17-20]. Vertical axis turbines are less used. Some special terms related to wind turbine are given below:

- Power factor: - The power factor is the ratio between the output power produced and the power available in the wind.
- Betz limit: - A wind turbine can convert only 59.3% of the kinetic energy of the wind into mechanical energy to rotate the rotor. This is theoretically the maximum power factor of any wind turbine.
- Peak speed ratio ( $\lambda$ ): - The peak speed ratio, X or TSR for wind turbines, is the ratio between the tangential speed of a blade tip and the actual wind speed, the tip speed ratio is related to efficiency, the optimum varies depending on the design of the blade. For high efficient wind TSR is 6-7.

The wind farm controller's function is power management. It can initiate and shut down turbine operation as well as co-ordinate the operation of numerous wind turbines in response to environmental and operating conditions. The wind turbine supervisory controller manages the individual turbine operation. Including power production, low-wind shutdown, high-wind shutdown, high load limits, and orderly start-up and shut- down Also provides control input to the dynamic controllers for r.p.m. control to maintain an optimum tip-speed-ratio, and blade pitch control.

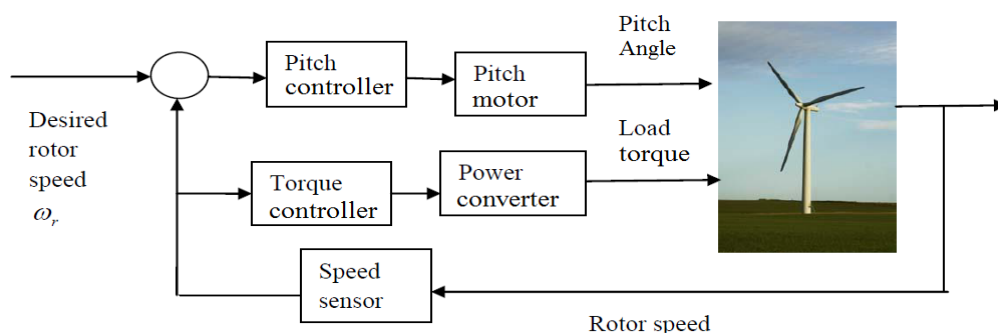


Fig.2 Block diagram of wind turbine closed loop control system

### III. HYBRID ACTIVE FILTER AND CONTROLLERS

#### Hybrid Power Filters

Active power filters are the best solution to improve the quality of electrical power but require high conversion rates. So to overcome the above defect, hybrid power filters are used. The hybrid power filters are the combined device of active and passive filters. They have the advantage of both active and passive filters. There are different hybrid filters according to the composition and order of the circuit.

They are-

- a. Shunt Active Power Filter and Series Active Power Filter
- b. Shunt Active Power Filter and Shunt Passive Filter
- c. Active Power Filter in series with Shunt Passive Filter
- d. Series Active Power Filter with Shunt Passive Filter

#### Shunt APF and Series APF:

This filter is characterized by a coherent set of APFs, for example the elimination of the voltage and current harmonics. This combination can be found in Flexible AC Transmission Systems (FACTS). But the APF control is complex and this mixture contains two APFs, so controlling this filter configuration is more complex. Therefore, this series filters is not widely used. A circuit diagram of shunt active power filter and series active power filter is show in following figure 3;

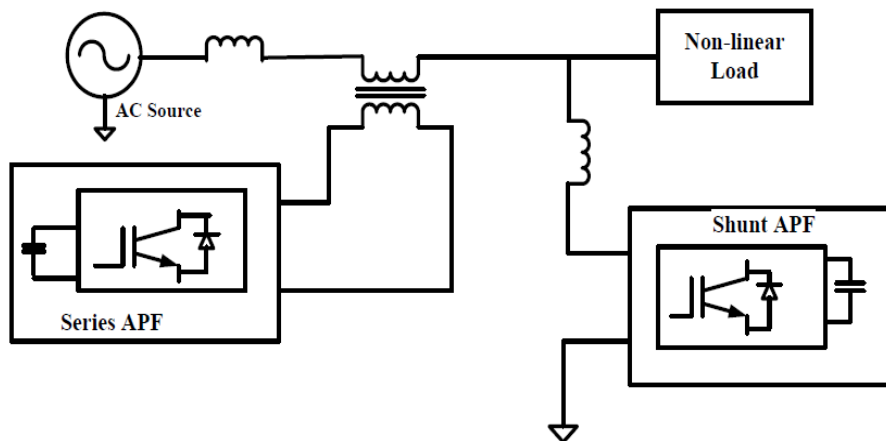


Fig.3 Shunt APF and Series APF

### IV. RESULTS

In this part, we have shown the output voltage, current, and power waveforms during different conditions with a non-linear load and with a non-linear load when the hybrid active filter is applied. To show the distortion a single cycle of the simulated signal is considered. The amount of distortion with a non-linear load become high as 29.33% and after applying the hybrid active filter during non-linear load it reduces up to 1.76%. The output waveforms of voltage, current, power, simulated waveform of the signal and single cycle for distortion analysis under with non-linear load and with hybrid active filter respectively are shown below;

4.1 When non-linear load is connected to the line

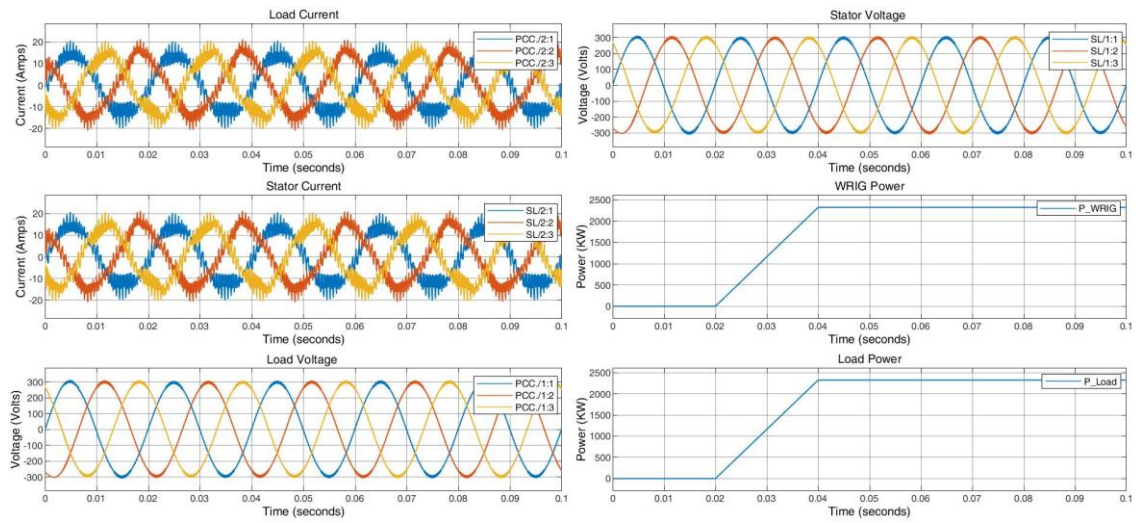


Fig.4 Current, Voltage and power waveforms of Stator and Load

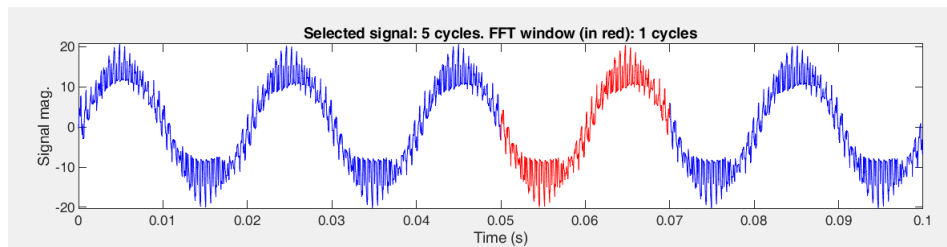


Fig.5 Simulated waveform

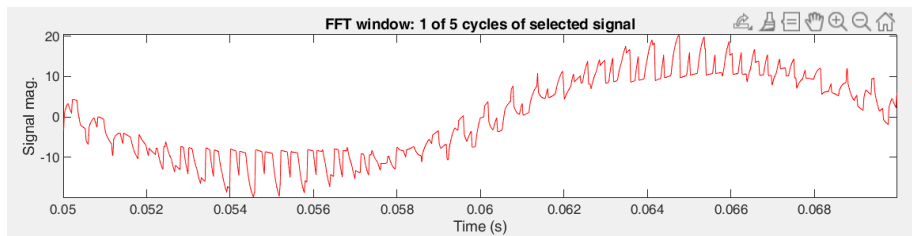


Fig.6 Single cycle for distortion analysis

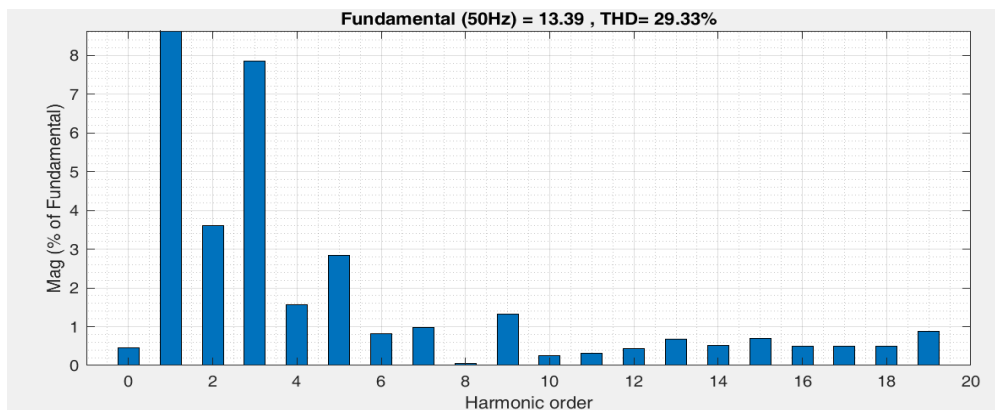


Fig.7 Harmonic spectra when non-linear load was connected

4.2 When hybrid active filter is applied

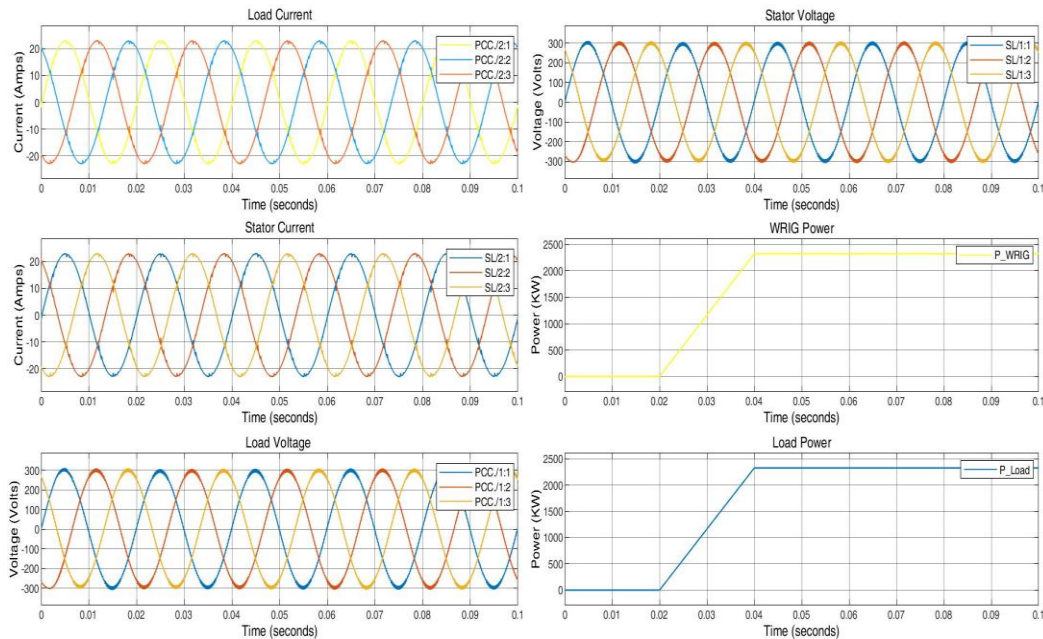


Fig.8 Current, Voltage and power waveforms of Stator and Load

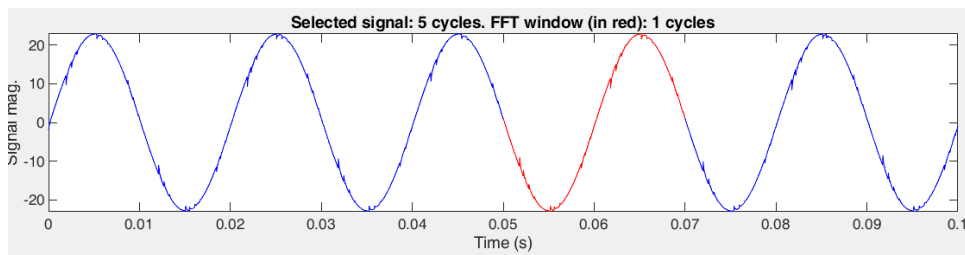


Fig.9 Simulated waveform

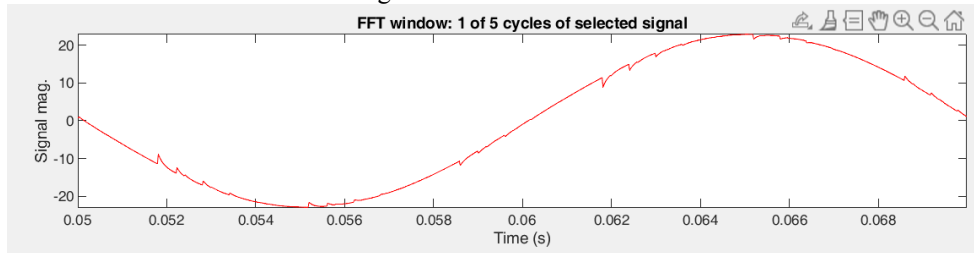


Fig.10 Single cycle for distortion analysis

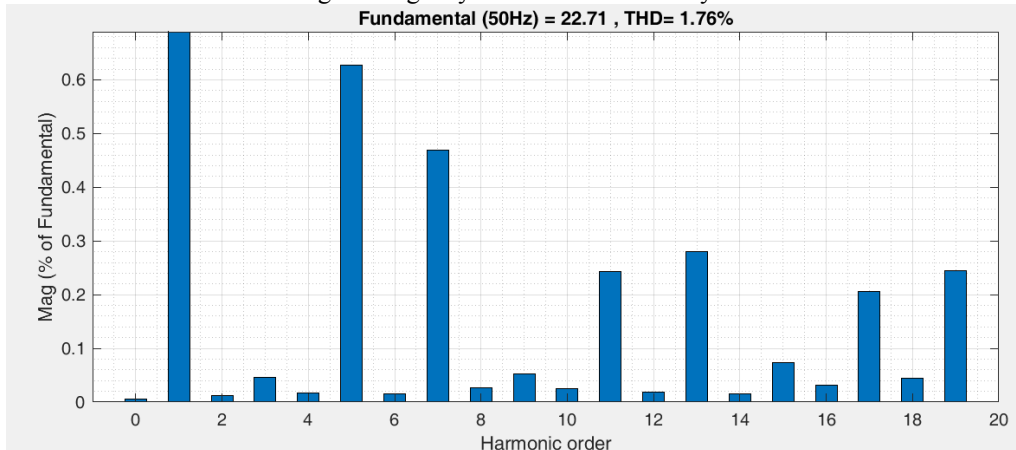


Fig.11 Harmonic spectra when hybrid filter was applied



## V. CONCLUSION

With the proposed methodology, we conclude that the when non-linear load was present in the system total harmonic distortion was 29.33% which not in acceptable limit, therefore we have used hybrid active filter for controlling total harmonic distortion to 1.76%. Mechanical output torque and power of wind turbine was become smooth when hybrid active filter is connected with nonlinear load.

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