Enhancement of Power Quality in Grid Connected Wind Energy System

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ABSTRACT: ***In this article consider, Power Quality Improvement for a Grid Connected Wind Turbine Energy System utilize Fuzzy Controllers. The Grid associated wind energy systems are requisite to obey with strict procedural and regulatory frameworks to ensure safe, reliable and efficient operation of overall system. The wide utilize of power electronics based apparatus and non-linear loads at PCC produce harmonic currents, which may depreciate the quality of power. The techniques of harmonic current recompense play a vital part in the presentation of active power filter. Conventionally, active power filters have been inhibited utilizing pre tuned controllers, such as PI-type or adaptive, for the control of current as well as the dc-voltage loops. PI controllers must be designed based on the equivalent linear model. Predictive controllers use the nonlinear model, which is closer to real operating conditions in order to improve the performance and life of the power switches of voltage source inverter (VSI), reduces its switching frequency.***

An active power filter implemented with cascaded multilevel inverter using a fuzzy control scheme is presented in this paper. Fuzzy current control algorithm is based on the system model. The compensation performance of the proposed active power filter and the associated control scheme under steady state and

Transient operating conditions is demonstrated through simulations using MATLAB/SIMULINK. The main aim of the paper is to achieve the maximum benefits with the interfacing inverters when wind turbine energy system is connected to the grid. The proposed methodology improves the quality of power at PCC.

Key Words: Wind Energy Systems, Fuzzy, Power Quality at PCC.

I. Introduction:

Now a day's wide research is going on renewable energy power generation to converge fossil fuels for future generations and to meat present growing power demand due to world industrialization. Among those renewable sources PV and Wind Power generation have considerable role, i.e, wind is one of the best way of power generation among renewable power generations due to its flexibility, less maintenance, cleanness and noise free. The power generation of renewable energy is less compared to non renewable power plants, so the renewable energy inter connected system is known as micro grid. Basically micro grids are operating in two modes, one is grid tied mode of operation and other is Islanded mode of operation. The grid connected mode can facilitates high efficiency, high load demand and wide area of operation due to availability of infinite bus. But in islanded mode BESS system is used for power balance due to its power limitations. The grid integration of wind energy system can perform in two ways one is direct fed another is through transformers. Normally wind is integrated with grid through transformer, here transformer for step up or step down grid and wind ratings. The transformers used are two types one is low frequency and other high frequency or isolated transformers. High frequency transformers can provide isolation between wind and grid. It is heavy wait, large in size and high cost, other considerable one is formation of parasitic capacitance at galvanic isolation, due to this loss are increasing. Recently direct fed or transformer less inverter integration topologies are implemented [1-4].

Framework synchronization calculations are of awesome significance in the control of matrix associated control converters, as quick and precise recognition of the network voltage parameters is pivotal keeping in mind the end goal to actualize stable control systems under non specific lattice conditions. This paper shows another lattice synchronization technique for three-stage three-wire systems, to be specific three-stage improved PLL the enhanced phase-locked loop (EPLL) is a synchronization framework that has demonstrated to give great outcomes in single stage synchronization frameworks. An EPLL is basically a versatile band pass filter, which can change the shorts recurrence as an element of the information flag. Its structure was later adjusted for the three-stage case, keeping in mind the end goal to recognize the positive-arrangement vector of three-stage signals, This paper investigations the execution of the proposed synchronization technique including diverse outline issues. In addition, the conduct of the technique for synchronizing with profoundly uneven lattice is demonstrated by methods for reproduction exhibiting its fantastic execution.

II. PROBLEMS IDENTIFICATION:

At the point when Grid synchronizes with Wind energy distinctive issues are contrasted and conventional brought together power sources. For instance, they are connected to the mains or the loads with voltage of 480 volts or less; and require control converters and distinctive procedures of control and dispatch. These energy innovations give a DC yield which requires power electronic interfaces with the appropriation power systems and its loads. By and large the change is performed by utilizing a voltage source inverter (VSI) with a plausibility of pulse width modulation (PWM) that gives quick control to voltage magnitude. Power electronic interfaces present new control issues, yet in the meantime, new potential outcomes. For instance, a framework which comprises of miniaturized micro-generators and capacity gadgets could be intended to work in both a self-governing mode and associated with the power grid. One expansive class of issues is identified with the way that the power sources, for example, micro turbines and fuel cells have moderate reaction and their inactivity is considerably less. It must be recalled that the present power frameworks have capacity in generators' dormancy, and this may result in a slight decrease in framework frequency. As these generators turn out to be more minimal, the need to connect them to bring down system voltage is fundamentally expanding. Be that as it may, with no medium voltage systems adjustment, this quick extension can influence the nature of supply and in addition people in general and hardware wellbeing since appropriation systems have not been

intended to interface a lot of age. In this way, another voltage control framework to encourage the association of conveyed age assets to appropriation systems ought to be created. As a rule there are additionally real specialized obstructions to working freely in an independent AC framework, or to interfacing little age frameworks to the electrical distribution network with lower voltage, and the recent research issues includes: 1. Control policy to assist the link of distributed generation resources to distribution networks. 2. Proficient battery control. 3. Inverter manages based on only local information. 4. Synchronization with the service mains. 5. Recompense of the reactive power and higher harmonic elements. 6. Power Factor rectification. 7. Organization protection. 8. Load sharing. 9. Reliability of communication. 10. Requirements of the customer. . DES offers huge research and engineering challenges in taking care of these issues. The schematic outline of grid associated Wind turbine energy framework is appeared beneath fig.1.

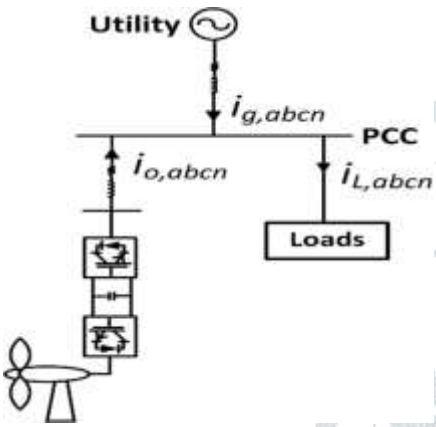


Fig.1. Single Line diagram of Grid connected Wind Turbine energy System

III. Fuzzy Control Strategy:

A few control approaches have been presented in the writing for wind turbine in independent and grid connected frameworks [5], [6]. The machine side controllers are intended to separate greatest power point from wind utilizing hill-climbing control, fuzzy based and adaptive controllers [7], more often than not founded on field-arranged or vector control approach. The framework side controllers are intended to guarantee active and reactive power is conveyed to the network [8], [9]. Controller plan for machine side converter and framework side converter is appeared in fig.2. Also, fig.3 separately.

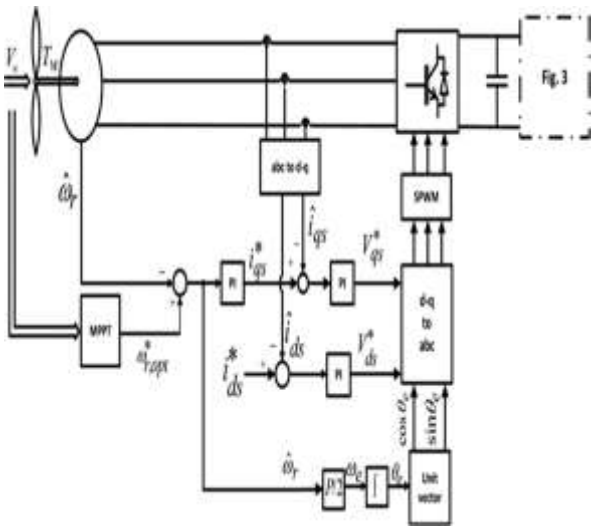


Fig.2. Control scheme of machine side converter.

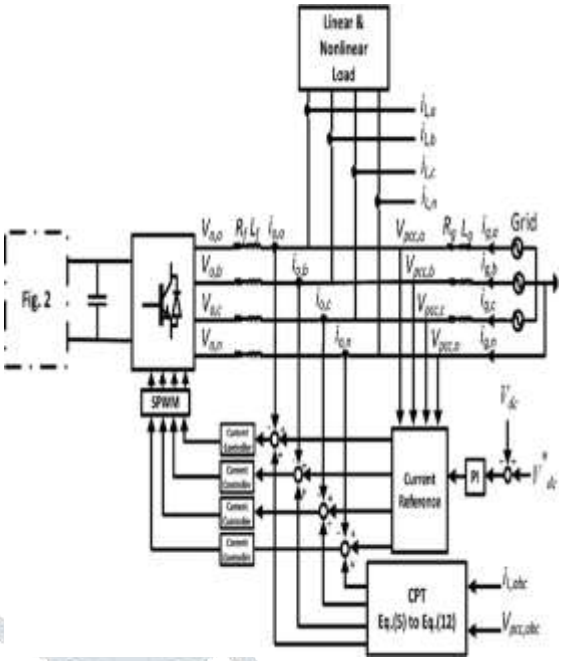


Fig.3. Control scheme of a grid-side converter.

In these machine side converter and grid side converters optimized PI controller values are calculated by using fuzzy controllers.

The Fuzzy control is a methodology to represent and implement a (smart) human's knowledge about how to control a system. A fuzzy controller is shown in Figure.8. The fuzzy controller has several components:

- A rule base that determines on how to perform control
- Fuzzification that transforms the numeric inputs so that the inference mechanisms can understand.
- The inference mechanism uses information about the current inputs and decides the rules that are suitable in the current situation and can form conclusion about system input.
- Defuzzification is opposite of Fuzzification which converts the conclusions reached by inference mechanism into numeric input for the plant.

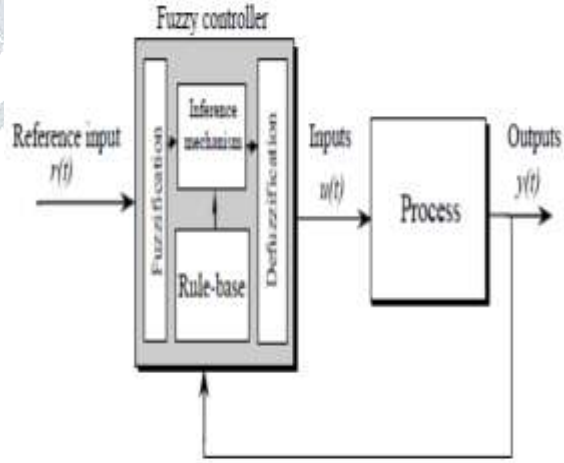


Fig.4. Fuzzy Control System

Fuzzy logic is a form of logic that is the extension of boolean logic, which incorporates partial values of truth. Instead of sentences being "completely true" or "completely false," they are assigned a value that represents their degree of truth. In fuzzy systems, values are indicated by a number (called a truth value) in the range from 0 to 1, where 0.0 represents absolute false and 1.0 represents absolute truth. Fuzzification is the generalization of

any theory from discrete to continuous. Fuzzy logic is important to artificial intelligence because they allow computers to answer 'to a certain degree' as opposed to in one extreme or the other. In this sense, computers are allowed to think more 'human-like' since almost nothing in our perception is extreme, but is true only to a certain degree.

Table 1: IF-THEN rules for fuzzy inference system

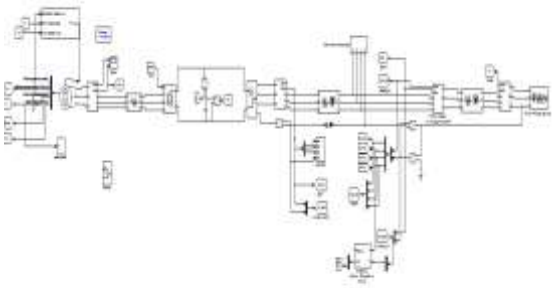
u(t)		e(t)						
		NB	**NM**	**NS**	**ZO**	**PS**	**PM**	**PB**
Δe(t)	**NB**	NB	NB	NB	NB	NM	NS	ZO
	NM	NB	NB	NB	NM	NS	ZO	PS
	NS	NB	NB	NM	NS	NS	PS	PS
	ZO	NB	NM	NS	ZO	ZO	PM	PM
	PS	NM	NS	ZO	PS	PS	PB	PB
	PM	NS	ZO	PS	PM	PM	PB	PB
	PB	ZO	PS	PM	PB	PB	PB	PB

The fuzzy rule base can be read as follows:

IF e (t) is NB and Δe(t) is NB **THEN** u(t) is NB
IF e(t) is <negative big> and Δe(t) is <negative big>**THEN** u(t) is <negative big>

IV. Simulation Results:

The MATLAB Simlink diagram of grid connected Wind turbine energy system is shown in below figure .5



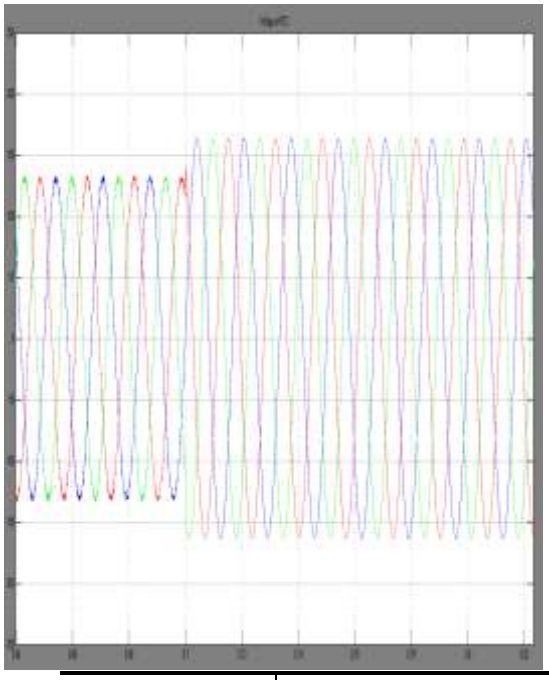


Fig.6. Voltage measurement at PCC

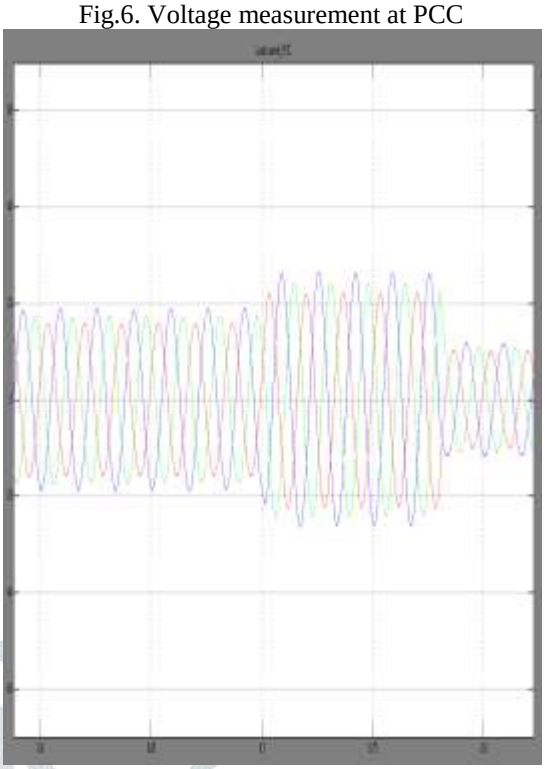


Fig. 7. Load current

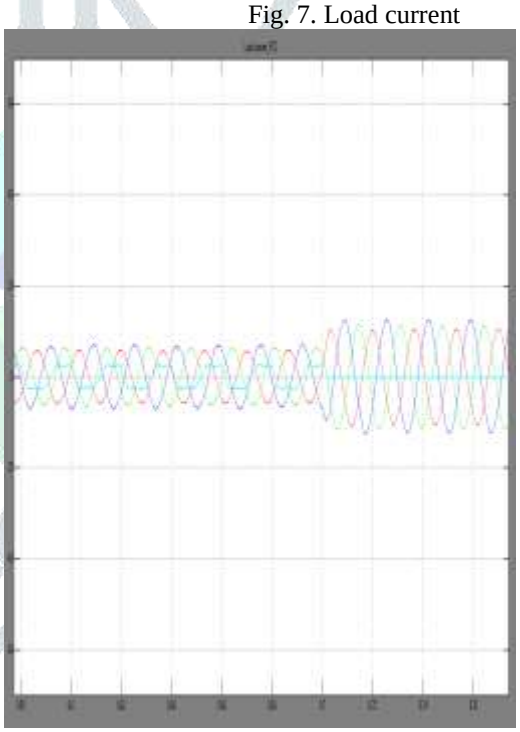


Fig.8. PCC current

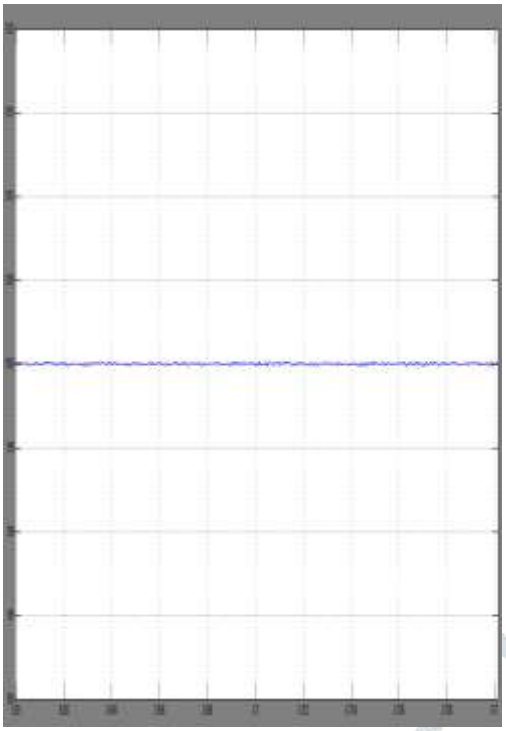


Fig.10. DC voltage

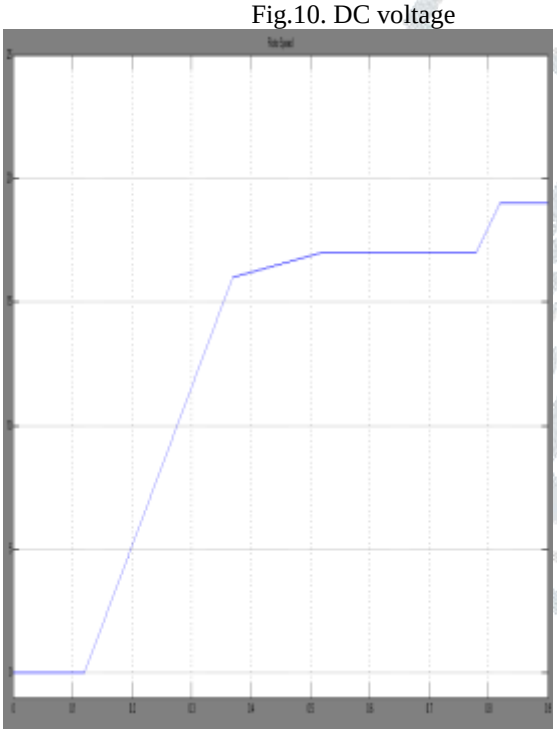


Fig.11. Rotor speed

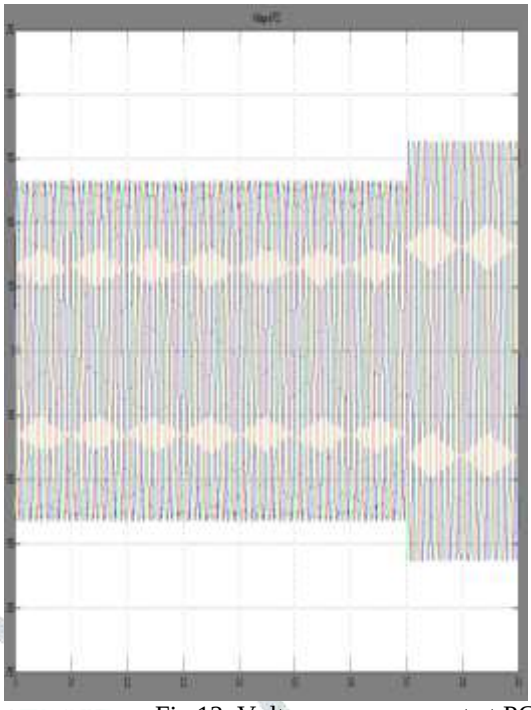


Fig.12. Voltage measurement at PCC

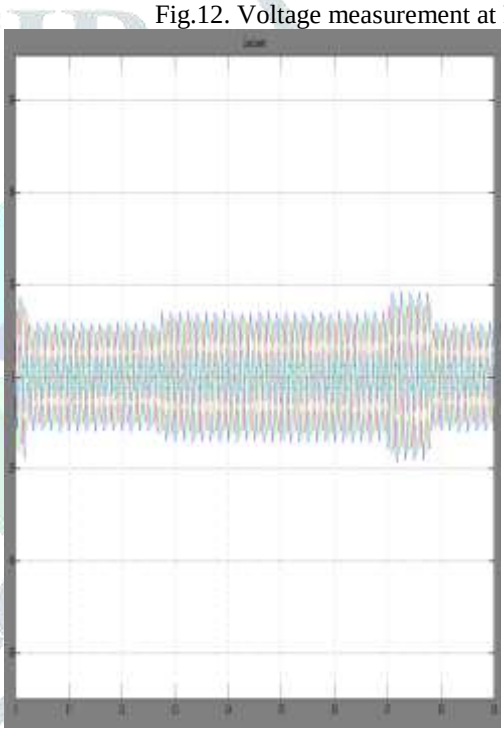


Fig.13. Load current

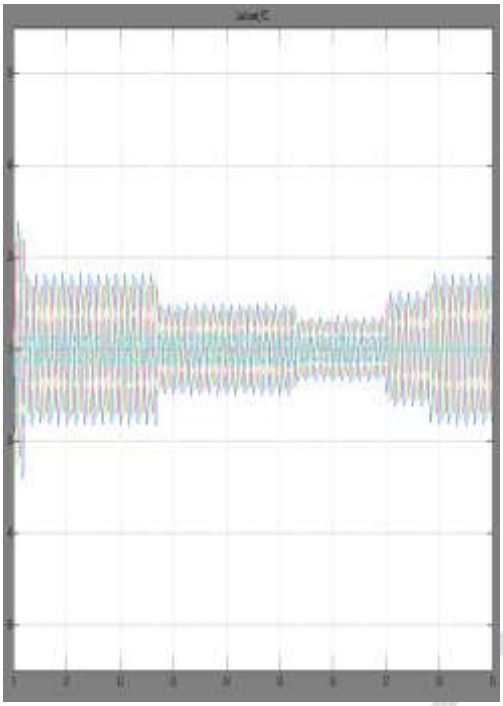


Fig.14. PCC Current

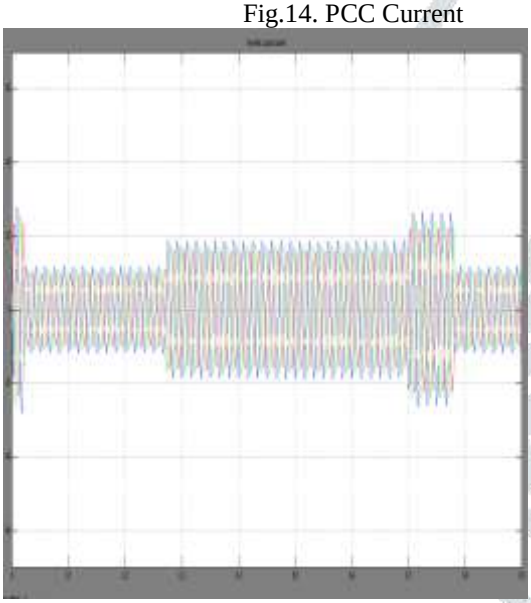


Fig.13. Inverter Current

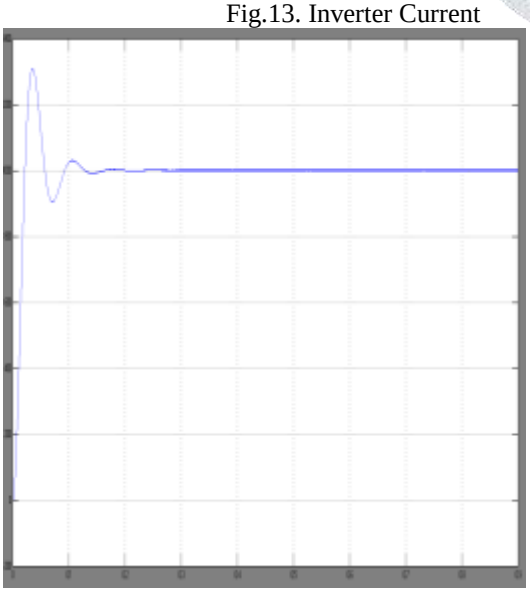


Fig.14. DC voltage

V. Conclusion:

The proposed Fuzzy control scheme based grid connected wind energy system has more advantages like simplicity, implementation and modeling. The use of a fuzzy control algorithm for the converter current loop proved to be an effective solution for improving current quality of the distribution system (Grid side and Machine side). The system tracking capability and transient response is improved. Proposed fuzzy current controller scheme is a stable and robust solution. The proposed algorithm mitigates the system harmonic currents and reactive power compensation simulated results have been shows the compensation effectiveness of the proposed active power filter.

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