POWER QUALITY IMPROVEMENT USING DSTATCOM ON PV BASED DISTRIBUTION SYSTEM

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Abstract— *Power Quality factor is major concern for the recent development in electrical utility. Various Flexible Alternating Current Transmission System Devices (FACTS) can be utilized to resolve the power quality utility issues; whereas DFACTS (Distributed FACTS) provides the improved version of FACTS.D-STATCOM is used to improve the voltage regulation thereby the power system stability. DSTATCOM is the one of the power quality compensating device which will rectify the power quality problems such as voltage sag and swell which occurs in high voltage power transmission lines. Here we use pv as a source to DSTATCOM. Whenever an external dc source is connected to DSTATCOM it exchange real power. DSTATCOM is proposed for compensation of reactive power and unbalance caused by various loads in distribution system. This power quality improvement using DSTATCOM is implemented in MATLAB.*

Keywords- FACTS, power quality, DSTATCOM, Compensation of reactive power, voltage sag, swell and unbalances, PV.

I. INTRODUCTION

Power quality is certainly a major concern in the present era. The causes of power quality problems are generally complex and difficult to detect. The lack of quality power can cause loss of production, damage of equipment or appliances or can even be detrimental to human health. It is therefore imperative that a high standard of power quality is maintained. Insufficient power quality can be caused by failures and switching operations in the network, which mainly result in voltage dips, interruptions, transients and network disturbances from loads that mainly result in flicker i.e. fast voltage variations, harmonics, and phase imbalance. Momentary voltage sags and interruptions are by the most common disturbances that adversely impact electric customer process operations in large distribution systems. An increasing demand for high quality, reliable electrical power and increasing number of distorting loads may leads to an increased awareness of power quality both by customers and utilities. The most common power quality problems today are voltage sags, voltage swell, harmonic distortion and low power factor.

FACTS are the devices that are used to reduce the power quality issues and DFACTS(distributed FACTS) are the improved version of FACTS devices. In this proposed system we use Distributed Static Compensator (DSTATCOM). A DSTATCOM is a shunt compensating device that is used in distribution systems. There are also other DFACTS devices like DVR, UPQC etc but DSTATCOM has more advantages than the other devices. In case of DVR it can only mitigate voltage sag and UPQC have high DC-link losses .Whereas DSTATCOM can mitigate voltage sag, swell and also voltage interruptions and additionally when an external DC source is connected it exchange real power and compensate reactive power. By using this external source we can also improve the speed of operation as it continuously charges the capacitor.

The basic operating principle of DSTATCOM is similar to that of the Synchronous machine. The synchronous machine will provide lagging current when under-excited (E_x<V) and leading current when over-excited (E_x>v).It regulates the voltage either by generating or absorbing the reactive power. When under-excited it absorb reactive power and when it is

over-excited it generates reactive power. A DSTATCOM injects current into the system to correct voltage sag, swell and power factor. It is used for voltage regulation.

II.OPERTING PRINCIPLE OF DSTATCOM

DSTATCOM is nothing but a STATCOM but used at the Distribution level. The key component of the DSTATCOM is a power VSC that is based on high power electronics technologies. All above problems in distribution system can be mitigated by using the most cost effective custom power device i.e. Distribution STATCOM.

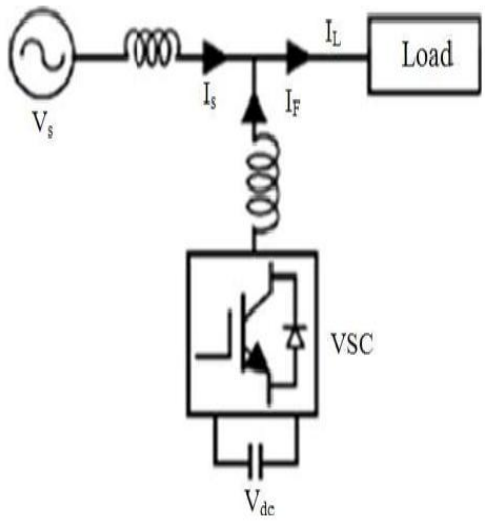

Fig.1: Singleline diagram of DSTATCOM

A voltage-source converter is a power electronic device, which can generate a sinusoidal voltage with any required magnitude, frequency and phase angle. Voltage source converters are widely used in adjustable-speed drives, but can also be used to mitigate voltage dips. The VSC is used to either completely replace the voltage or to inject the missing voltage. The missing voltage is the difference between the nominal voltage and the actual. The converter is normally based on some kind of energy storage, which will supply the converterwith a DC voltage. The solid-state electronics in the converter is then switched to get the desired output voltage. Normally the VSC is not only used for voltage sag/swell mitigation, but also for other power quality issues, e.g. flicker and harmonics. Advantages of DSTATCOM are

- It can provide power factor correction, harmonic compensation and load balancing.
- Ability to generate the rated current at virtually any network voltage.
- Better dynamic response and the use of a relatively small capacitor on the DC bus.

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1) Exchange of reactive power: If the output voltage of the voltage source converter is greater than system voltage then DSTATCOM will act as a capacitor and generate reactive power (provide leading current to the system).

And if the output voltage of the voltage source converter is less than system voltage then DSTATCOM will act as a inductor connected in shut with the distribution system and absorb reactive power (provide lagging current to the system).

2) Exchange of real power: As the switching devices are not loss less there is no need for the dc capacitor to provide the required real power to the switches. Hence there is a need for the real power exchange with the AC system to make the capacitor voltage constant. There is also a real power exchange with the AC system if the DSTATCOM is provided with an external DC source to regulate the voltage in case of very low voltage in the distribution system.

III.DSTATCOM CONTROL

The aim of the control scheme is to maintain constant voltage magnitude at the point where a sensitive load is connected, under system disturbances. The control system only measures the r.m.s voltage at the load point, i.e., no reactive power measurements are required. The VSC switching strategy is based on a sinusoidal PWM technique which offers simplicity and good response. Since custom power is a relatively low-power application, PWM methods offer a more flexible option than the

Fundamental Frequency Switching (FFS) methods favored in FACTS applications. Besides, high switching frequencies can be used to improve on the efficiency of the converter, without incurring significant switching losses. The controller input is an error signal obtained from the reference voltage and the value rms of the terminal voltage measured. Such error is processed by a PI controller the output is the angle δ, which is provided to the PWM signal generator. It is important to note that in this case, indirectly controlled converter, there is active and reactive power exchange with the network simultaneously: an error signal is obtained by comparing the reference voltage with the rms voltage measured at the load point. The PI controller process the error signal generates the required angle to drive the error to zero i.e., the load r.m.s voltage is brought back to the reference voltage.

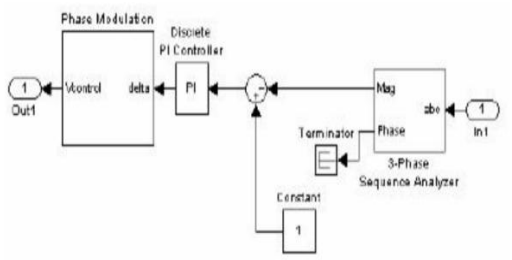


Fig.2: DSTATCOM control diagram

IV. PV or SOLAR PANEL

Due to the decreasing amount of renewable energy resources, the last ten years become more important for per watt cost of solar energy device. It is definitely set to become economical in the coming years and growing as better technology in terms of both cost and applications. Everyday earth receives sunlight above (1366W approx.) This is an unlimited source of energy which is available at no cost. The major benefit of solar energy over other conventional power generators is that the sunlight can be directly converted into solar energy with the use of smallest photovoltaic (PV) solar cells. There have been a large amount of research activities to combine the Sun's energy process by developing solar cells/panels/module with high converting form. the most advantages of solar energy is that it is free reachable to common people and available in large quantities of supply compared to that of the price of various fossil fuels and oils in the past ten years. Moreover, solar energy requires considerably lower manpower expenses over conventional energy production technology.

PV cells Convert Sunlight to Direct Current (DC) electricity. Charge Controller work as control the power from solar panel which reverse back to solar panel get cause of panel damage. Battery System act as storage of electric power is used when sunlight not available (i.e. night).

Merits of using solar panel or pv:

- It is save up to 20% of energy costs.
- It can use in Remote Locations.
- Easy Installation (i.e. does not required any wires, cords etc.).
- Rooftop which means no new space is needed & every domestic or commercials user can generate their own electricity.
- It is widely available of sunlight with free of cost, eco-friendly, renewable resource.
- It has no moving parts and not required any additional fuel, other than sunlight, to produce power.
- No need of water and fuel.

V.PROPOSED WORK AND RESULTS

Proposed system help to resolve the problems regarding with voltage sag, swell, harmonic distortion, voltage unbalances and some power factor issues. MATLAB simulation model is used to represent the proposed model. In simulink model we use various blocks like breaker, scope, powergui. Scope can display signals generated during a simulation. Powergui used to simulate the MATLAB Simulation Model in continuous or discrete time.

Without using DSTATCOM we get various power quality issues like voltage sag, voltage swell, voltage fluctuations, voltage unbalances etc.

Fig.3 shows various power quality problems whereas in fig.5 we can observe that the power quality

problems have been reduced due to the use of DSTATCOM.

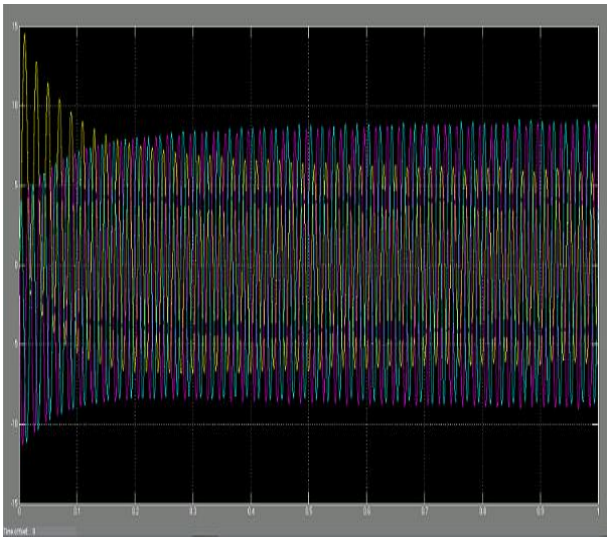


Fig.3: Voltage of inverter without using DSTATCOM

To reduce these power quality issues from fig.3 we are using DSTATCOM in our proposed model. DSTATCOM is the main component in our proposed work . DSTATCOM is a distributed FACTS device used to reduced all the power quality problems.

Fig.4: Input voltage to the inverter

As the input given to a inverter is DC voltage we can see the input square waveform in fig.4. The basic principle of inverter is to convert the DC voltage to AC voltage. Hence, the output waveform is a converted AC voltage in fig.6

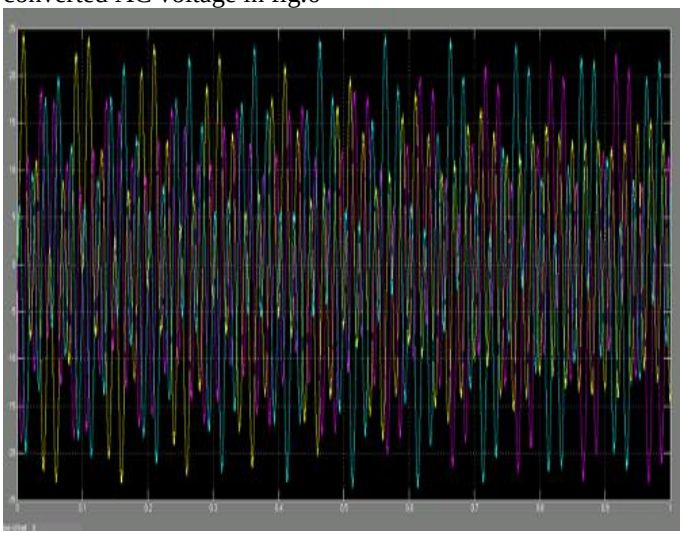


Fig.5: Input current at the inverter

The above figure shows the input current wave of the inverter. Here in our project we are not reducing the distortions in the current it can be reduced by using a multi-level inverter in future.The voltage unbalances and voltage errors have been clearly reduced in our output waveforms.

Here we have connected a PV as a source to the DSTATCOM. As a DSTATCOM can exchange real power and compensate reactive power when an external DC source is connected to it. And it also mitigates voltage sag, swell and improve power factor.

Active filters are relatively new types of devices for eliminating harmonics. This kind of filter is based on power electronic devices and is much more expensive than passive filters. They have the distinct advantage that they do not resonate with the power system and they work independently with respect to the system impedance characteristics. They are used in difficult circumstances where passive filters don't operate successfully because of resonance problems and they don't have any interference with other elements installed anywhere in the power system.

The active filters present many other advantages over the traditional methods for harmonic compensation such as:

- Adaptation with the variation of the loads.

- Possibility of selective harmonics compensation.
- Limitations in the compensation power.

Possibility of reactive power compensation.

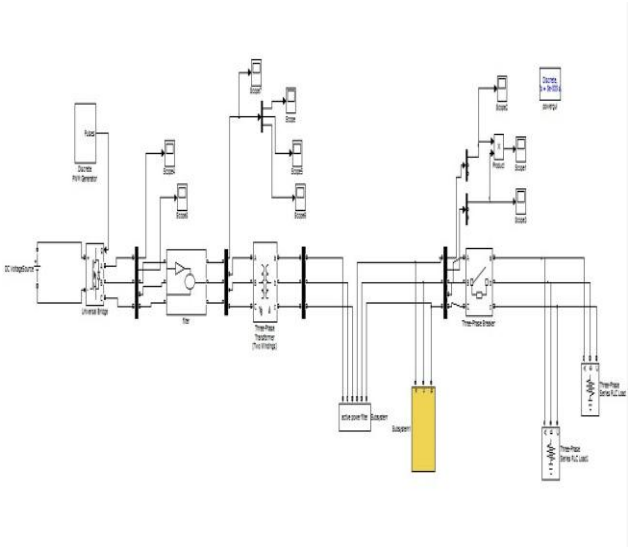
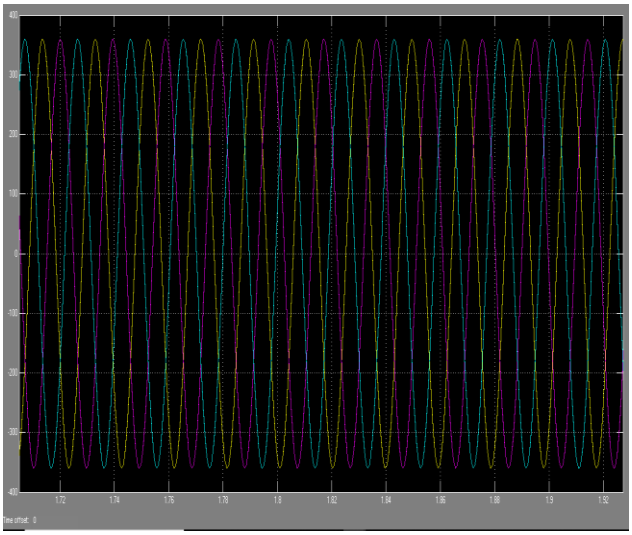


Fig.6: Simulink model for proposed work

Here PWM pulses controls the working of inverter devices. Load can be linear or non linear for this proposed system. Load utilizes the active power. Active power calculation is important for power issues measurements with good quality of power. Although system provides fewer amounts of harmonics, it is important to handle the voltage and current fluctuations in the system. Synchronization can be done by controlling the PWM pulses provided to the power devices.

From fig.7 we can clearly observe that the power quality problems like voltage sag, voltage swell, voltage fluctuations and voltage unbalances etc.. have been reduced .



. **Fig.7: voltage of inverter**

Power utilized by the load helps to run the load whereas unutilized power return to the load. DSTATCOM is connected with the solar panel to charge the capacitor and also for the exchange of real power and compensate the reactive power. When a voltage is placed across the capacitor the potential cannot rise to the applied value instantaneously. As the charge on the terminals builds up to its final value it tends to repel the addition of further charge.

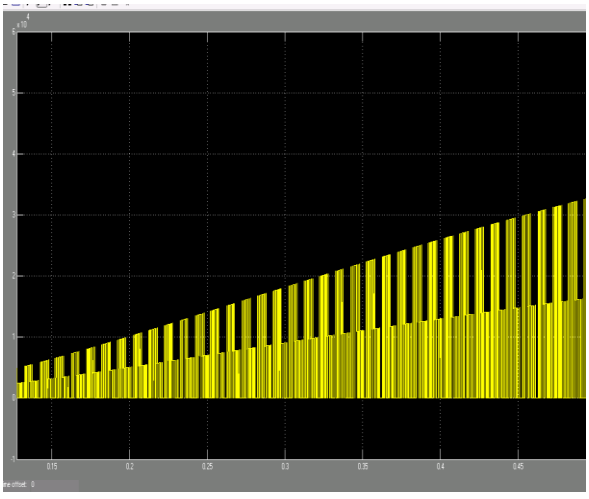


Fig.8: Power used by load

By using the DSTATCOM the harmonics and voltage unbalances have been reduced in the output waveform. An active power filter is used to reduce the harmonic distortion.

VI. CONCLUSION

This research work focused on the design and validation of DSTATCOM controller for voltage regulation, reactive power compensation, power factor improvement and unbalanced load compensation. The work mainly focused on various power quality improvements using DSTATCOM. Active power filter is also used to reduce harmonic distortion. In order to reduce voltage unbalances, error voltage, and compensate the reactive power it is necessary to use of DSTATCOM. Distributed STATCOM helps to inverter to maintain the power quality of output voltage across load. Presented MATLAB Simulation helps to improve the power quality of inverter due to use of DSTATCOM.

VI. REFERENCES

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