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Process of Voltage Mitigation by UPFC

Abhishek Kumar Sahu
Research Scholar
SSCET Bhilai

Om Prakash Verma
Research Scholar
DIMAT Raipur

Rajkumar Jhapte
Sr. Assistant Professor
SSCET Bhilai

Abstract— **This Paper we tend to discuss regarding the non linear masses in trade cause associate increasing deterioration of the ability system voltage and current waveforms. As a result, harmonics area unit generated from power converters or nonlinear masses. This causes the ability system to control at low power issue, low potency, enlarged losses in transmission and distribution lines, failure of electrical equipments, and interference drawback with communication system. So, there's a good have to be compelled to mitigate these harmonic and reactive current parts. Active Power filters area unit a viable resolution to those issues.**

In order to propose solutions to mitigate these adverse effects, a three-phase unified power flow controller (UPFC), with a mix of shunt active power filter and series active power filter with common dc link is employed to eliminate offer current harmonics, compensate reactive power, voltage sag and voltage swell compensation on distribution network. The performance of the active power filter in the main depends on management strategy accustomed generate reference current for shunt active power filter (APF) and generate reference voltage for series active power filter. The management strategy is predicated on the extraction of Unit Vector Templates from the distorted input offer. These templates are going to be then akin to pure curved signal with unity (p.u) amplitude. Simulation was conducted to review voltage sag and swell compensation in massive distribution system. Comprehensive results for the structure of UPFC model area unit bestowed to assess the performance of UPFC as a possible custom power resolution.

Keywords—**FACTS, EHV-AC,** Distributed **Generation, Voltage Sag, STATCOM, UPFC, PSCAD, APF.**

I. Introduction

The power electronic devices as a result of their inherent non-linearity draw harmonic and reactive power from the supply. In three half systems, they could jointly cause unbalance and draw excessive neutral currents. The injected harmonics, reactive power burden, unbalance, and excessive neutral currents cause low system efficiency and poor power issue. to boot to the current, the flexibility system is subjected to varied transients like voltage sags, swells, sparkles etc. These transients would have a control on the voltage at distribution levels. [3]Excessive reactive power of plenty would increase the generating capability of generating stations and increase the transmission losses in lines. So offer of reactive power at the load ends becomes essential. Power Quality (PQ) mainly deals with issues like maintaining a collection voltage at the aim of Common Coupling (PCC) for diverse distribution voltage levels notwithstanding voltage fluctuations, maintaining near unity power issue power drawn from the supply, obstruction of voltage and current unbalance from passing upwards from varied distribution levels, reduction of voltage and current harmonics inside the system. [2]

The power electronic based mostly equipments throughout change ON/OFF of high rated load connected at the purpose of common coupling extremely distorted might result into voltage sags or swells. There area unit many sensitive hundreds, like laptop or micro chip based mostly AC/DC drive controller, with sensible voltage profile requirement; will perform improperly will lose valuable knowledge or in sure cases get broken as a result of these voltage sag and swell conditions. One among the effective approaches is to use a unified power quality conditioner at purpose of common coupling to safeguard the sensitive hundreds.

The economic science concerned in resolution an influence quality downside should even be enclosed within the analysis. It's not continually economical to eliminate power quality variations on the provision facet. In several cases, the best resolution to a retardant might involve creating a selected piece of sensitive instrumentation less sensitive to power quality variations. The amount of power quality needed is that level which is able to end in correct operation of the instrumentation at a selected facility. Power quality, like quality in different product and services, is troublesome to quantify. There is no single accepted definition of quality power. [5]There are a unit standards for voltage and different technical criteria which will be measured, however the last word live of power

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quality is set by the performance and productivity of end-user instrumentation. If the electrical power is insufficient for those desires, then the "quality" is lacking.

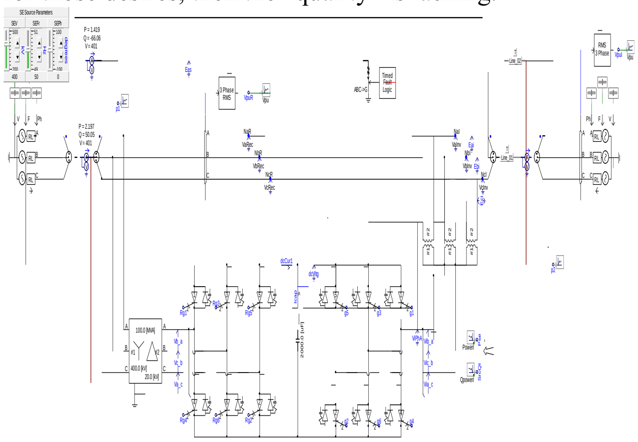

Fig.1. Simulation model for Voltage sag mitigation by UPFC

A unified power flow controller is a combination of shunt and series active power filters, sharing a common dc link. It is a versatile device that can compensate almost all power quality problems such as voltage harmonics, voltage unbalance, voltage flickers, voltage sags & swells, current harmonics, current unbalance, reactive current, etc.

II. Power Quality Issues

Power Quality

A utility could outline power quality as reliableness and show statistics demonstrating that its system is ninety nine.98 p.c reliable. A manufacturer of load instrumentation could outline power quality as those characteristics of the facility offer that alter the instrumentation to figure properly. Any power drawback manifested in voltage, current, or frequency deviations that end in failure or mis-operation of client instrumentation.

Power Quality Disturbances

Power Quality disturbances embody all potential things within which the wave shapes of the provision voltage or load current deviate from the curved waveform at rated frequency with amplitude love the rated rms worth for all 3 phases of a three-phase system. Power quality disturbance covers sharp, short period deviation impulsive and periodic transients, voltage dips (or sags), short interruptions, yet as steady- state deviations, like harmonics and flicker.

Power Quality Problems are:

- Transients
- Impulsive
- Oscillatory
- Short-duration variations
- Instantaneous
  - Interruption
  - Sag (dip)
  - Swell
- Momentary
  - Interruption
  - Sag (dip)
  - Swell
- Temporary
  - Interruption
  - Sag (dip)
  - Swell
- Long-duration variations
- Interruption,
- Under-voltages
- Over-voltages
- Voltage unbalance
- Waveform distortion
- DC offset Steady state
- Harmonics
- Inter-harmonics
- Notching Steady state
- Noise
- Voltage fluctuations
- Power frequency variations

III. Methodology

The voltage at purpose of common coupling could also be or might not be distorted counting on the opposite non-linear hundreds connected at purpose of common coupling. Also, these hundreds could impose the voltage sag or swell condition throughout their shift ON and/or OFF operation. The unified power flow controller is put in so as to guard a sensitive load from all disturbances. It consists of 2 voltage supply inverters connected back to back, sharing a standard dc link. One electrical converter is connected parallel with the load. It acts as shunt active power fitter, helps in compensating load harmonic current, reactive current and maintain the dc link voltage at constant level. The second electrical converter is connected serial with the road

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mistreatment series transformers, acts as a controlled voltage supply maintaining the load voltage curved and at desired constant voltage level. A system configuration for unified power flow controller.

It is designed by combining the series compensator (SSSC) and shunt compensator (STATCOM) not to mention a standard DC electrical device. It provides the flexibility to at the same time management all the transmission parameters of power systems, i.e. phase and voltage, impedance.

Circuit Description: it consists of 2 converters – one connected serial with the conductor through a series inserted electrical device and therefore the different one connected in shunt with the conductor through a shunt electrical device. The DC terminals of the 2 converters square measure connected along with a DC electrical device. The series device management to inject voltage magnitude and phase serial with the road to regulate the active and reactive power flows on the conductor. therefore the series device can exchange active and reactive power.

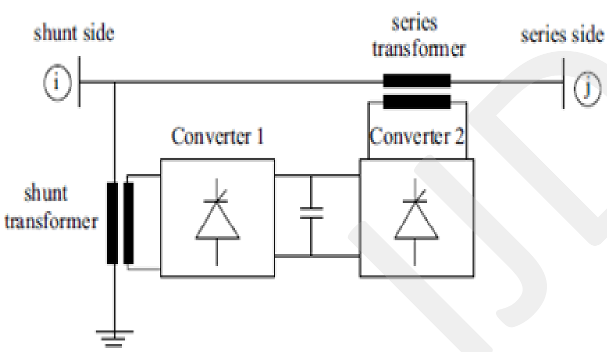

Fig.2 : Circuit Diagram of Unified Power Flow Controller (UPFC)

Characteristic of UPFC: the thought of UPFC makes it doable to handle much all the facility flow management and transmission lines compensation issues mistreatment solid-state controllers that offer purposeful flexibility that area unit typically not obtained by thyristor-controlled controllers. There area unit 2 forms of UPFC's. One may be a general UPFC for power distribution systems and industrial power systems. The opposite may be a specific UPFC for a offer voltage flicker/ imbalance-sensitive load, that is put in by electrical power customers on their own premises. The powers owing to harmonics quantities area unit negligible as compared to the facility at basic part, therefore, the harmonic power is neglected and also the steady state operative analysis is finished on the idea of fundamental part solely. The unified power flow controller is controlled in such some way that the voltage at load bus is usually curving and at desired magnitude. Thus the voltage injected by series active power filter should be adequate to the distinction between the provision voltage and also the ideal load voltage. Therefore the series active power filter acts as controlled voltage supply. The operate of shunt active power filter is to take care of the dc link voltage at constant level. Additionally to the present the shunt active power filter provides the volt-ampere needed by the load, such the input power issue are unity and solely basic active power are equipped by the supply.

The supply voltage, terminal voltage at purpose of common coupling and cargo voltage area unit denoted by VS, Green Mountain State and VL severally. The supply and cargo currents area unit denoted by IS and IL severally. The voltage injected by series active power filter is denoted by VSr, wherever because the current injected by shunt active power filter is denoted by ISh. Taking the load voltage, VL, as a reference phasor and suppose the insulating material power issue of the load is cosΦL.

$$V_L = V_L \angle 0^o \quad (4.1)$$

$$I_L = I_L \angle -\Phi_L \quad (4.2)$$

$$V_T = V_L (1+K) \angle 0^o \quad (4.3)$$

Where factor K represents the fluctuation of source voltage, defined as

$$K = (V_T - V_L)/ V_L \quad (4.4)$$

The voltage injected by series active power filter must be equal to,

$$V_{Sr} = V_L - V_T = - K\, V_L \quad (4.5)$$

The unified power quality conditioner is assumed to be lossless and therefore, the active power demanded by the load is equal to the active power input at point of common coupling. The unified power quality conditioner provides a nearly unity power factor source current, therefore, for a given load condition the input active power at Point of common coupling can be expressed by the following equations,

$$P_T = P_L$$

$$VT = VL * IL * Cos\Phi L$$

$$VL\,(1+K) * IS = VL * IL * Cos\Phi L$$

$$IS = IL / (1+K) * Cos\,\Phi L$$

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The above equation suggests that the source current IS depends on the factor K, since ΦL and IL are load characteristics and are constant for a particular type of load. The complex power absorbed by the series active power filter can be expressed as,

SSr = VSr* IS

PSr = VSr * IS * CosΦS = - K * VL * IS CosΦS

QSr = VSr * IS * SinΦS

ΦS=0 since unified power quality conditioner is maintaining unity power factor

PSr = VSr * IS = - K * VL * IS

QSr ≈ 0

The complex power absorbed by the shunt active power filter can be expressed as,

SSh = VL * ISh

The current provided by the shunt active power filter, is the difference between the input source current and the load current, which includes the load harmonics current and the reactive current. Therefore, we can write,

ISh = IS – IL

ISh = IS - IL ∠ - ΦL

ISh = IS - (IL* CosΦL – j IL * SinΦL)

ISh = (IS - IL* CosΦL) + j IL * SinΦL

PSh = VL * ISh * CosΦS h

= VL* (IS - IL*CosΦL)

QSr = VL * ISh * SinΦSh

= VL * IL * SinΦL

The power transfer capability of long transmission lines is usually limited by their thermal capability. Utilizing the existing transmission line at its maximum thermal capability is possible with UPFC.

IV.CONCLUSIONS

In this Paper, the PSCAD is employed to simulate the model of UPFC that is connected to a three phase-three wire line system. This paper presents management and stability and performance of UPFC meant for installation on a line. System is simulated with shunt electrical converter in AC with DC voltage management mode and series electrical converter in open loop phase control mode. Simulation results here show the effectiveness of UPFC for dominant real and reactive power by victimization the road. Thanks to this AC voltage controller, AC voltage regulation are improved. The DC voltage controller that maintains the DC link voltage to the DC voltage set at purpose, 45 kV.

V. SIMULATION RESULTS

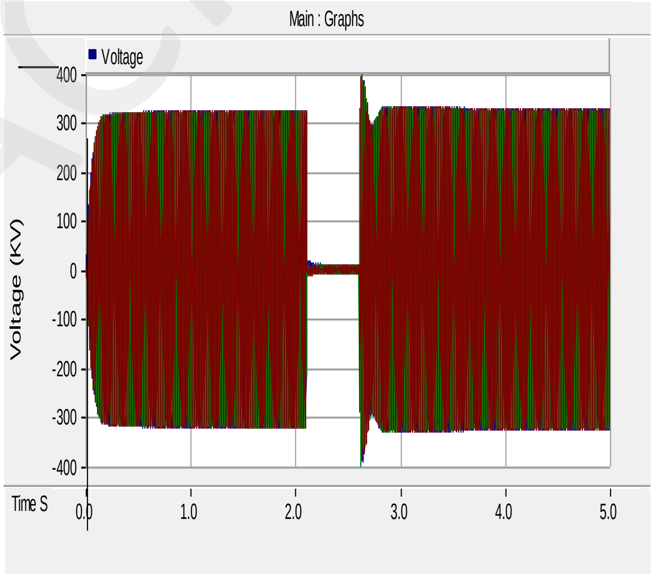

Fig.3 Three phase short circuit voltage

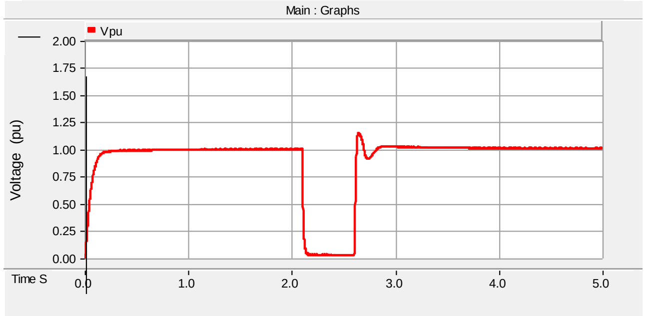

Fig.4. Per unit voltage

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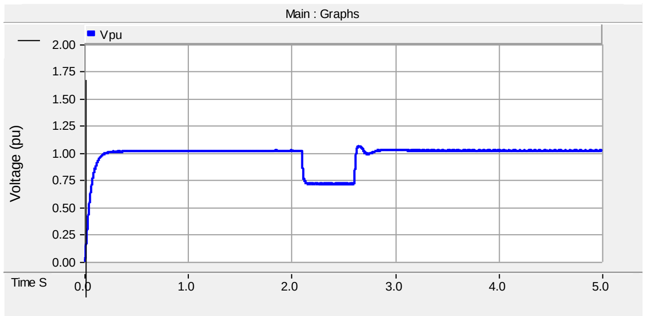

Fig.5.Per unit voltage mitigation

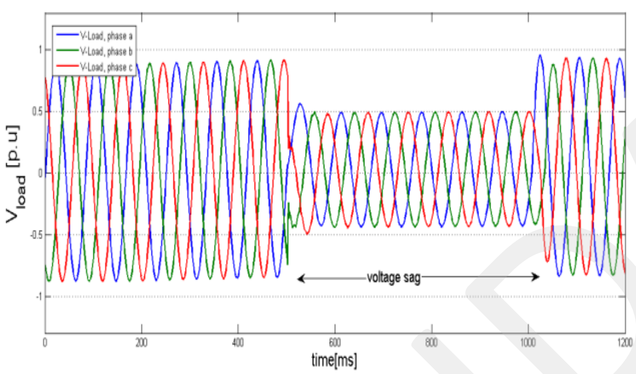

Fig.6. Three-phase load voltage sag waveform

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