EasyChair Preprint

№ 6115

Power Quality Problems & It's Improvement Techniques

Yogesh Bhutla and Rajendra Singh

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July 20, 2021

Power Quality Problems & It's Improvement Techniques

Yogesh Bhutla[1], & Rajendra singh[2]
B. Tech Scholar, Assistant Professor
Poornima Institute of Engineering and Technology sitapura Jaipur.

Abstract:

Power Quality Issues Have Become a Critical Challenge for both electric power utilities and power system Engineers in today's Environment. The equipment utilised in power distribution is extremely sensitive to perturbation in the supply lines. In two-wire (single phase), three-wire (three phase without neutral), and four-wire (three phase with neutral) ac power networks with nonlinear loads, active filtering of electric power has now become an established technology for harmonic and reactive power compensation Harmonic phenomena and their system consequences are assessed by taking into account long-established harmonic sources and problems, as well as detailing new and future sources and their likely implications. This article addresses the issues raised, particularly as they pertain to new energy control, energy conservation, and modern power conversion technology.

Keywords:

Power quality, public power system (PPS), Energy storage system, custom power devices, utility, Power factor, Power definitions, Harmonic.

1. Introduction:

In the last decade, the topic of electricity quality has gotten a lot of attention around the world. Power quality is a component of power Engineering. The cooperation of power with electrical equipment is defined as power quality (PQ)[1-3]. Power Quality is a combination of Voltage profile, Frequency profile, Harmonics contain and reliability of power supply. The Power Quality is defined as the degree to which the power supply approaches the ideal case of stable, uninterrupted, zero distortion and disturbance free supply. A set of electrical boundaries that permits a piece of equipment to work as intended without considerable loss of performance or life expectancy is known as power quality. Consumers of electricity have long been concerned about supply reliability, which refers to the continuation of electric supply. But now a day's power quality too is very important there are very sensitive loads that require clean and uninterrupted power such as air traffic control, processing plants (fabric, food, semiconductor, rayon etc.), hospitals (life support, operation theatre, patient data base system), bank security system etc. [4].

The electric power system includes power generation, transmission, and distribution to customers. The mechanism is extremely complicated [5]. This complicated system, when combined with variations in power output, load demand, weather, and other factors, creates several opportunities for power quality to be lost or sacrificed. We will look at some broad power quality issues and possible solutions in this paper.

2. Power Quality Problems:

Power Quality Problems, Disturbances or Phenomena are terms used to describe voltage or current deviations from its ideal waveform. These disturbances can cause failure of loads or equipment, which is typical since electric power is generated hundreds of kilometers away from the end-users' location[6].

Most power quality problems as are below-

A. Transient:

One of the most damaging voltage disturbances is a transient (or spike). These are brief interruptions that occur as a result of a large variation in the balanced state of current, voltage, or both. The distinguishing characteristic of a transient is the duration. A transient typically occurs with the electrical cycle, which means its duration is less than 1/60th of a second. Transients have the potential to damage equipment with power supplies, especially computers, instruments, and control devices [8].

The source of a transient can be both internal and external to your facility[5,7]. For example:

- Utility switching on the grid.

- Lightning strike.
- Neighboring industrial plant turning on high current arc welders.
- Equipment within your facility cycling on or off.

B. Brownouts:

It is defined as a voltage drop in a power system that is either deliberate or accidental. Intended brownouts are mostly utilized in emergency situations to reduce load. This is a decrease [9]. Lasts a few minutes to several hours.

EFFECTS:-Loss of data, systems can experiences glitches and equipment failure.

C. Blackout:

It can be described as a state of zero voltage that lasts longer than two cycles**.**

D. Voltage Imbalance:

It is defined as the fluctuation in voltage of a three-phase system where both the magnitude and phase difference of the voltages are uneven [11].

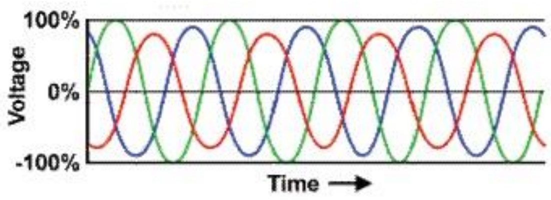

Fig: 1- Voltage Imbalance

E. Voltage Fluctuations:

Voltage fluctuation is a continuous change in the voltage when devices or appliances that require a higher load are extensively used. Extreme cases of voltage fluctuation can cause heavy damage to your life and property [13].

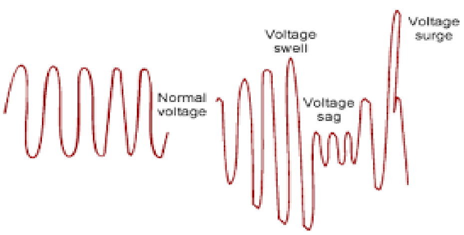

Fig. 2- Voltage Fluctuation

F. Harmonics:

Harmonics (aka noisy/dirty electricity) are distortions to voltage and current sign waves. If equipment in an industrial facility operates by altering sign wave behavior between AC and DC, it will cause harmonic distortion. This equipment includes variable speed drives, furnaces, light ballasts, and DC power supplies in computers/other electronic equipment. In a system with a high harmonic content, nuisance tripping can occur, as well as increased heat in conductors and motor windings. Your power capacity is also reduced by harmonics [10].

G. Power Frequency Variations:

The necessary frequency limit for the proper operation of any network or system is set, and if there is a deviation from that limit, say from 50 Hz to 60 Hz, it is referred to as frequency variation of power system [12].

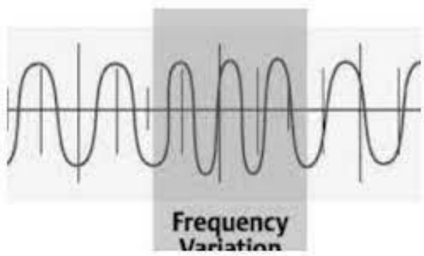

Fig. 3- Power Frequency Variation

H. Long Duration Voltage Variation:

It is defined as a voltage variation that occurs over a period of more than one minute.

Table:1 - long duration voltage variation classification [5-7]

Disturbance Category	Causes	Effects
Over Voltage	System load change, utility faults.	Loss of data, system shutdown, and system halts
Under Voltage	System load changes, utility faults.	Equipment damage, reduced life of equipment.
Sustained Interruption	Utility faults, tripping of breaker, component failure	System shutdown, loss of data and damages.

I. **disturbance of supply power:**

For a good power quality of a power system required completely sin wave of voltage and current. But interruption, distortion, sag, swell, flicker, over voltage, under voltage etc. are the disturbance in supply power which are responsible for various types of power loss in the system. Voltage with a short duration. Overheating in the circuit causes a relay to trip. System, a shouldering power supply, and a shattered semiconductor component and a variety of issues [14].

3. Sources of Power Quality Problems:

The primary sources of power quality problems are-

A. Nonlinear Load:

Voltage and current do not follow each other under a nonlinear load. other in a linear manner. It generates harmonic distortion, which leads to equipment overheats and is subjected to voltage drops if they are not adequately safeguarded [15].

B. Large Motor Starting:

The current induction machines use to start up is around six times that of a conventional current. It causes voltage sag by increasing network loading. Nowadays modern motors uses power electronic converter also called 'drive', which control the motors starting current to a desired level [16].

C. Load Switching:

These are the transient occurs due to switching of massive load of single-phase. Electrical isolation is used to protect equipment from various types of disturbances.

D. Inter-connection of Power System:

The scope of interconnection in the power system has increased in recent years, and this is expected to have a significant impact on power quality**.** And it is very difficult to isolate them. Some power quality issues, such as harmonics and flicker, are passed from one utility to another via connections.

E. Arc Producing Devices:

These are non-linear devices and are main cause of harmonic distortion. Example are- electricity discharge lamps, electric arc furnaces and arc welders etc.

4. POWER QUALITY SOLUTIONS:

A. Power Quality Improvement:

Following devices forms an important part in building the impressive power quality scheme**.**

1) Filters:

a) Noise Filter:

They keep unwanted frequency noise or current from getting to the sensitive equipment. It employs a mix of capacitors and inductors to offer a lower impedance channel to the fundamental frequency and a higher impedance path to higher frequencies, resulting in a lower order frequency pass filter. When there is a lot of noise in the frequency range (kHz), these filters are necessary [17].

b) Harmonic Reduction Filter:

These filters plays a major role in reducing the unexpected harmonics.

2) Isolation Transformers:

It is primarily used to separate or isolate susceptive loads from transients and noise drawn from the main supply. It provides a high level of separation and filtering, as well as noise reduction in both normal and common modes.

3) Voltage Controller or Regulator:

These are designed to automatically maintain a constant voltage level. It maintains control over the output voltage in both typical and severe input voltage changes. These are used in situations where the input voltage changes but the overall power failure is significant [8-10].

4) Motor Generator Set:

M-G set comprise of motor and generator. They are coupled mechanically via same shaft. It give protection from coming disturbances, voltage transients and sags**.**

Motor-Generator sets have disadvantages for some types of loads:

1) The frequency and voltage drop during interruptions as the machine slows. This may not work well with some loads.

2) Noise and maintenance may be issues with some installations [12-14]

B. Custom Power Devices:

Various techniques have been explored to address power quality difficulties, including the use of passive filters, active filters, CVTs, tap changers, and other devices, but many have been abandoned due to their drawbacks. Hence customer power devices are introduced. They provides stable power to the consumers and also raises the service quality of distribution system [9].

CUSTOM POWER DEVICES	
RECONFIGURING TYPE	COMPENSATING TYPE
1).Static Transfer Switch	1). Series (DVR)
2).Solid State Breaker	2). Hybrid (UPFC)
3).Static Current Limiter	3). Shunt (DSTATCOM

Fig. 4- Classification of Custom Power Devices

C. Energy Storage Systems:

These are mostly used for security purposes. It protects vulnerable equipment from being shut down. Batteries, UPS, SMES, and other types of direct and indirect storage are examples. With the help of an electronic switch, their output is temporarily fed into the system via an inverter. In this case, the system is provided enough energy to restore the energy loss [11].

D).Transient Voltage Surge Eliminator or Suppressors (TVSS):

It gives protection from surges which are originated in the high voltage system by shunting them to ground into the low voltage system.

E). Uninterruptible Power Supply (UPS):

On the basis of the technology used, it provides security in the event of a blackout or a power outage, provides regularity in power flowing to the load in the event of transitory interruptions, and also provides protection against noise and surges.

5. CONCLUSION:

This paper presents a review on power quality terms, problems and their corrective methods. Poor power quality can create many serious effect on our power system like overheating in system equipment, over loading, harmonics generations, waveform distortion etc. therefore we have to mitigate these power quality issues. This paper gives an idea about appropriate standards for various power quality issues and also provides solution to major power quality problems. While, it is not possible to completely eliminate the causes of power quality but the quality of power supply can be improved and their effect could be reduced. This paper will be helpful for researchers, users and suppliers of electrical power to get a guideline about the power quality.

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