Journal of Advances and Scholarly Researches in Allied Education
Vol. 16, Issue No. 9, June-2019, ISSN 2230-7540

Study on Electric Power Quality in Power System

Babita Pal[1]* Ms. Varsha Mehar[2]

[1] Student, Ram Krishna Dharmarth Foundation University, Bhopal

[2] Assistant Professor and HOD, Bhabha College of Engineering, Madhya Pradesh

Abstract – Power supply is not adequate. For smooth running and operation of the machinery, the characteristics of supply voltage at all times are quite important. The efficiency of the power supply is dependent on the voltage characteristics. Power quality is referred to as the extent to which supply voltage characteristics correspond to the appropriate norm. The need to ensure good efficiency has become important in the ever growing usage of electronic power devices in domestic and commercial settings and critical appliances in the automatic production industries. This paper clarifies the quality of power and its challenges. We address the causes and implications of issues of power efficiency. Mitigation methods are presented for issues in power efficiency.

Keywords: Overvoltage, Power Quality, Tracking Power Quality, Stress Quality, Tension Sag, Tension Swell, Under voltage.

---------------------------------X---------------------------------

INTRODUCTION

The efficiency of the supply of energy is especially critical for electricity users in any power network. Power output requires supply, frequency and voltage availability, as well as power supply waves. Power is defined as good if the supply of electricity is constant at appropriate, constant voltage and frequency values and the wave shape is smooth. In reality, however, the varying demand for energy, some machines (home, workplace or industry) and defects trigger power system disruptions, thereby allowing them to depart from usual characteristics.

The output of power is weak if at least one happens

- supply not continuous (outage or breakage),
- if the voltage supplied is smaller than or beyond the appropriate magnitude range,
- If the strength of the control system differs.
- and where the waveform of the supply is skewed by current and voltage.

This allows for the concept of power efficiency, which is the degree of divergence from nominal frequency, power and voltage values. The distinction may be in waveform shape as well. The amount of electricity supplied is often consistent with smooth running of electrical machinery. Power efficiency can also be clarified. In other terms, it is a test of how the power system helps its loads to operate smoothly. From the customer's point of view, the issue of power quality is any power problem that expresses itself in voltage, current or frequency differences, contributing to a power outage or misoperation. For residential, commercial and industrial users, low power quality is a severe concern. In the event of a voltage below or below an appropriate value that may also affect the system, certain domestic appliances and gadget may not perform properly. Poor power quality may lead to or not functioning of bulbs and electrical equipment, which contributes gradually to early failure. For highly automated responsive manufacturing equipment, weak power efficiency is troublesome in industry. Over the last two decades , studies and publications on power quality have been gradually growing because of major issues and problems on power quality primarily induced by the emergence of electronic equipment including electronics, energy-saving lighting, IT equipment, and so on. Most articles explain certain sources of low power efficiency and mitigating strategies. In this article, the focus is on power quality control, as well as on the design of electrical systems and machines, in addition to the presentations of further triggers and their impact. If appliances and control networks are built to cope properly, the power quality problems can be dramatically reduced. Electrical devices, arc furnace, aviation systems, rail systems, renewability, electric motors, manufacturing operations, transmission and distribution systems and many other applications of electrical systems are all associated with the surface of energy efficiency. Electrical energy is a challenge. Power output covers regions with variability in voltage, frequency changes, intermittent, harmonic, mismatch of current and voltage, etc.

Causes of Poor Power Quality

The complexity, coupled with demand fluctuations, environmental factors, unbalanced loading in the phases of delivery transformers and usage by users of complicated and electronic devices and many others, of an electrical power grid to transport electric energy from the point of production to the point of use make for much chance to minimise power supply. Many problems are causing poor power quality. In electricity systems that adjust nominal values of the supply voltage, distorting the sinusoid of waveform that influence the stability of frequencies, can deteriorate the efficiency of energy. Any are mentioned below.

- **Voltage varying** -The typical voltage concerns refer to their magnitudes. Variation of voltage takes several forms and the language of each case is acceptable. Voltage variance is a change from the nominal voltage value, which may be long-lasting (over one minute) or very short (millisecond to second). The difference in short term voltage is often caused by dips or dips, swellings, surges or swells, whereas the variation in long duration voltage is triggered by variations in voltage, under-voltages, overvoltage, and interruptions. At some times, the line voltage may rise or fall below the nominal voltage. Voltage fluctuations are triggered by transmission or delivery grid defects, capacitive load swapping, load issues.

- **Voltage dip or the Sag-** Voltage dip is a short-lived decrease in nominal voltage rms. The tension dip happens as the voltage of supply slips to a nominal voltage of 0.1 to 0.9 pu for a duration of one minute. That is attributed to a line error, electric motor starting or transitioning to heavy load, overloading, wind turbine starting, etc. Image. Fig. 1 implies voltage dip of line voltage reduction to half.

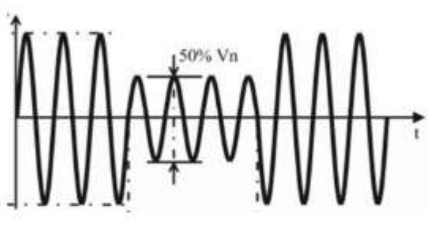

Figure 1. Voltage sag

- **Voltage Swell -**Voltage swell is the other way around voltage slope which raises the nominal voltage momentarily. For half a loop to many seconds, the voltage swell rises to between 1,1 and 1,8 pu of the usual voltage. It happens if heavy load is shut off, generating losses, improperly operated transformers, poor conditions at different points of the AC delivery system, phase underloading when two other phases are over-loaded in a three-stage system. The voltage waveform swell is shown in Figure 2.

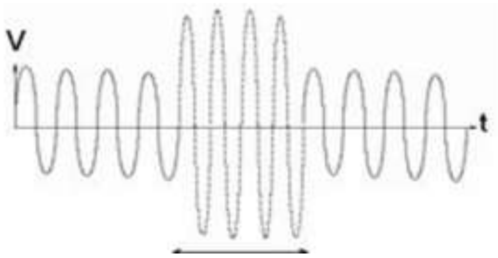

Figure 2. Voltage swell

- **Spontaneous and repeat -**voltage fluctuations between 0.9-1.1 pu are the result of flicker flickering. It contributes to fast observable adjustments in the lighting and dimming of the panel and changes in the light bulb's brightness. The sight of the human being is annoyed. It is triggered by electric generator, pulsing load, arc furnaces and welding equipment turned on and off.

- **Voltage fluctuations and pulses-** are equivalent to a voltage swell, but are typically very strong for very brief times on the nominal voltage. The effect is typically lightning bolts, arches, switching surges or transients when switched to circuit breakers and contactors.

- **Overvoltage-** Overvoltage is a nominal rms voltage rise above 1.1 pu for more than one minute. The effect is a broad load turn off, wrong tap configuration, weak voltation power, line fault.

- **Under voltage-** Under voltage decreases to less than 0.9 pu in nominal voltage for more than one minute. Causes involve high load switching, overloading the circuit, line error.

- **Interruption-** When the voltage of the supply line falls to less than 0.1 pu for a time not longer than 60 seconds, power Interruption happens. If it is more than one minute, this becomes constant interference. Causes involve insulation breakdown, inaccurate / incorrect grounding, and blinking light and insulator. As a consequence, safety devices are opened and immediately repaired in order to isolate the damaged machine part. The interruption in Figure 3 reveals.

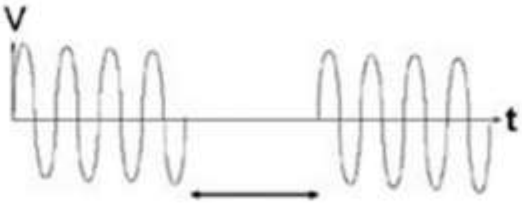

Figure 3. Interruption.

- **Outage-** Power loss is a long-term state of null strain. The omission often includes the usage of loss of power machines. A breakdown of machinery on or touching power lines or foundations, human negligence, incorrectly coordinated or failure of security mechanisms (trees, vehicles, etc.) induces power failure in the power grid system, floods or other artefacts (trees, cars, etc.)

HARMONICS

Harmonics are the essential frequency of input, AC voltage and current combined multiples. For example, the second harmonic in a 50Hz framework is 2 to 50 = 100Hz, the 3rd harmonic is 3 to 50Hz = 150Hz while the 7th is 350Hz. Interharmonics are frequencies which are not integer multiples of the basic frequency of power. As harmonics and simple frequency are mixed, this contributes to single warped waveform. Normally only odd harmonic (3rd, 5th, 7th etc) exists in a three-phase method. The common source of power quality issues is harmonic frequencies in power systems. Harmonics distorts the supply waveform present and voltage. Causes of harmonics are typically nonlinear electrical loads like UPS, rectifier, inverter, arc furnace, arc furnace, welders, tensile controller and frequency converters. The electrical arc furnace is the key suspect for a deterioration in the level of power of the attached delivery device. In a power delivery system, the non-linear load generates harmonics. As the impedance is attached to supply, the supplied voltage switches and pulls non-sinusoidal current, while the source is sinuous. This voltage distortion affects the non-sinusoidal current with a harmonic content which interacts with the power distribution system, to produce network voltage distortion.

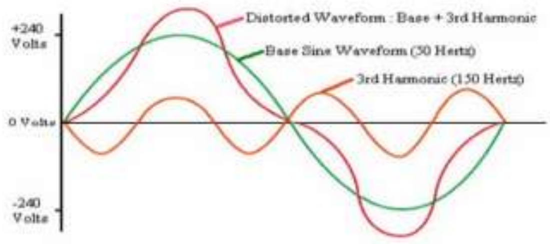

Figure 4. Harmonic

Figure 4 above indicates that the green wave structure is 50Hz, sine-Wave or sinusoid, with the usual ac voltage. The third harmonic is the slightest waveform at 150Hz. Its existence in conjunction with regular sine wave shape distorts the working voltage shape as seen in the figure.

- **Frequency fluctuation** From the appropriate normal value, frequency fluctuation or variance (usually 50 or 60Hz) is a deviation of power device frequency. Even if there is more demand than generation, the frequency could decrease, but if the demand is less than generation, the frequency would begin to increase. Since power generation is not the same. Faults in the transmission line, broad load disconnections, the disconnection or disconnection of major generators may often contribute to frequency variations. Frequency variations outside of tolerance ± 5% for a power grid that could induce a failure of the system are not safe.

- **Supply Interruptions** Unlike in developed nations, the volatility of or an epileptical electricity supply remains a significant socio-economic issue. In reality, in these countries, it is the key power quality problem. This is because of the acute grid crisis, induced by a lack of proper energy investments, to satisfy the need for electricity. The ageing and inadequate management of installed power plants add greatly to problems of power quality.

EFFECT OF POOR POWER QUALITY

The consequence of power quality issue is a voltage waveform distortion or divergence from the nominal value or total loss of the supply from a sinusoid. Power quality problems will last up to hours for milliseconds. The nonlinear features of many electronic energy systems; residential , industrial and bureau electrical power supply linked equipment may contribute to poor electricity efficiency. electric disruptions. Appliance such as photocopiers, laptops, scanners, etc. may cause electric interruption and can affect or in certain situations cause some critical equipment attached to the same supply source. Electrical turbulence is created by industrial drives driven by electronic converters. If disruptions arise or the output of electricity is low, the resultant loss of revenue is financial. Main result of voltage slopping involves early equipment breakdown, lack of productivity in rotary machinery, malfeasance of IT equipment, data loss or stability, disrupt operation, failure of the instruments, etc. Voltage Spike and Swell cause circuitry destruction, isolation content melting, intense light glow, critical system disruption or disturbance, computer transmission failures or the lack of data, electromagnetic interference. Sensitive devices may be overwhelmed. Harmonics induces energy depletion which causes electricity to be consumed inefficiently and easily. It impacts manufacturing machinery's smooth running and induces output stoppages. It may lead to death in hospitals. This affects the data handling of IT facilities, such as lack of banking account management in real time, etc. Cable and electronics overheating are part of harmonic results. Where a wire is parallel to the electrical cables, harmonic frequencies interact with the signal, which contributes to a false signal. This will contribute to a train tragedy. Harmonic can trigger inappropriate safety relay activity. In particular in manufacturing, economic energy quality challenges are immense. Production losses, repairs to pricey machinery, salary expenses, restart costs are included. Non-financial costs include pain, such as not being able to watch news, soccer or TV programmes. This may be calculated in additional money that a consumer has to spend in order to prevent this pain.

REGULATING STANDARDS ON POWER QUALITY

There are several technical standard force quality agencies, many of which are national and few transnational. These normative organisations have the minimum required benchmark, appropriate professional practise, and guidelines on electrical and electronic engineering questions are the International electrotechnical Commission (ITEC) and the IEEE Institute of Electric and Electronic Engineering Institute (IPEE). Table 1 offers globally recognised guidelines on particular concerns relevant to power efficiency.

Table 1. IEC and IEEE standard on power quality issues

Power Quality Issues	Appropriate Standards
1 Voltage sag/swell	IEC 61000-4-11, IEC 61000-4-31 IEEE P1564
2 Flickers	IEC 61000-2-2, IEEE P 1453
4 Harmonic	IEC SC 77 A, IEEE 1346, IEEE SA - 519-2014
5 PQ test, measurement and monitoring	IEEE 1159, IEC SC 77 A/WG 9, IEC 61000-4-1, IEC 61000-4-30

POWER QUALITY STANDARD FOR IT EQUIPMENT

ITI curve is issued by the ITI Producers Association (CBEMA), the Information Information Business Council (ITI). The curve represents the input tensile range that most information technology equipment ITE can withstand (Voltage sag, swell, interruption)[1, 15]. The curve should be specially built for the standard U.S. supply line of 120V 60Hz, but it can be used with any other power supply (e.g. 240V, 50Hz) since it is not scaled in the voltage per cent. The ITI curve indicates that the IT devices can work safely and withstand under-voltage, overvoltage, sag and swell at a defined nominal voltage (vertical axis) for milliseconds or period (horizontal axis) durability[16]. The following figure provides more information on the IT IT curve, i.e. over an indefinitely long period at 90-110% of the nominal voltage. It operates reliably for 25 cycles at 120 per cent of nominal voltage (swell), which is 0.5 seconds, until the heavy load is turned off.

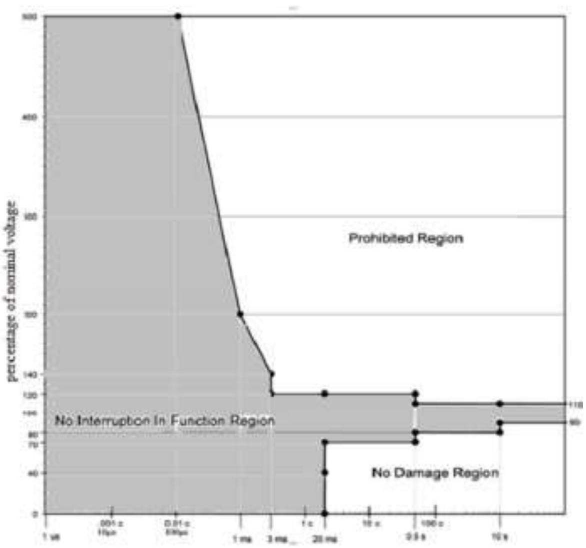

Figure 5. ITI Curve

The equipment will handle the nominal voltage of 200% for a cycle of 0.05 if it crosses into the prohibition zone longer than that duration. It will only run for 500 per cent of the nominal voltage at 0.2ms or 0.01 cycles; in brief, the system can operate or function normally while the voltage is under the restriction imposed by the shaded field. If the voltage drops below the shaded area , i.e. no harmful area, the device may stop running or failing, but damage does not occur. The equipment can harm when the voltage falls in the region above and outside the shaded area (prohibited area), even if it is covered by a fuse or some other protective apparatus.

POWER QUALITY MONITORING

The method of storing, processing or understanding raw power metric details in useful knowledge is Power Quality Management (PQM). This means the voltage and current calculation method and the study of its waveform over a span of time, however the research is not restricted to these two amounts. Which involves cable examination, grounding, connexions to appliances. Monitoring the energy source helps diagnose existing and future faults in power efficiency that may eventually shorten the equipment life. PQ testing leads to enhancing the power quality efficiency of installations. Power providers must ensure that the supply of electricity supplied complies with defined and appropriate requirements and that any technological problems concerning the quality of power supplied are prepared to be regularised. New innovations in electronics and communications technology give opportunities to effectively track broad and dynamic power networks. Providers may benefit from this by gathering data on various power networks, evaluating the output of the grid and acting in compliance with them as well as answering concerns by the electricity users. Examples include: the in-power display that provides the voltage profile and wave form of the stress, the swelling, the difference in tension and the harmonic degree assessment. At the time of the failure to conduct the study, the wireless fault DFR logs, fault event causes and records strength, voltage and waveform. Disturbance Analyzer can evaluate a range of control fluctuations from a very brief temporary stress to long-term subtensions and faults. Flicker Meter is a monitoring instrument that assesses voltage flicker irritation intensity. The Flicker Meter is a special analyzer modelling reaction from a chain made up of the normal observer's 60W incandescent lamp brain. The second section focuses on statistical analysis of the instantaneous flicker perception Circuit Display offers precise, consistent, rapid warning detection, and several levels of knowledge on each power quality issue to determine the origin and cause of a concern, including harmonic power flows. Oscilloscope tests voltage and current, and may be used in any power quality case to show harmonics. Power Quality Meter and Analyzer is an oscilloscope-like device, but more appropriate and flexible for monitoring of power quality. It tracks frequency, stress, current, rotation, evident and true strength, is compatible and can also store and analyse data with PC applications. It can also monitor and analyse data.

MITIGATION TECHNIQUE

Many steps are in effect to guarantee a good delivery of power quality. At the power plant, transmitters and stations, main and secondary delivery networks, as well as utility infrastructure and consumer building cabling, mitigation may take place at various stages of the power grid. It is necessary to remember that no power quality issue can be entirely solved until such components can be replaced or whether a lightning strike can be avoided or faults removed. The influence of power efficiency may therefore be decreased dramatically to virtually nil.

- **Availability** Ensure that the grid has sufficient power. The grid is adequate to satisfy the consumers' demand and electricity requirements for the power plant and transmission lines. In order to meet electricity demand, the device relates to adequate production, transmission and distribution facilities. This is required to mitigate problems of power efficiency.

- **The Device Manufacturer's** design should be well informed of concerns relating to power efficiency and equipment design to avoid any problems of energy quality generated by the equipment itself. The devices could also be equipped to avoid and less vulnerable to power device disruptions. The impact of power quality concerns would be minimised.

- **Interfacing Equipment** Amount of power electronic devices may be used to interface the supply socket with critical devices. This prevents the supply from reaching the equipment with problems of energy quality. An illustration is the use, in lieu of some voltage sag , swell, and any type of under- or over voltage, of automatic AVR voltage regulator in sensitive equipment. The UPS often retains the supply of computers while the power loss is momentary. Another is the Dynamic Voltage Restorer DVR, which restores smooth line voltage even with a reduced or skewed source voltage. DVR is a converter to voltage source. For interface of power source and critical load to be secured, DVR is typically used.

- **Filter** Filters are used so as to enable the frequency to pass and to block the undesirable signal to the covered unit. Filter is designed using the inductor and resistance condensers to provide the appropriate fundamental frequency with a low impedance and a high impedance direction for the frequency to be disposed of. Cancel Harmonic philtre harmonics generated by the injection of nonlinear loads through an exact complimentary harmonic present. Active harmonic philtres, passive harmonic philtres, line-reactors, electronic feedback philtres and special transformers that are used to minimise harmonic winding out of phase philtres are different philtre types.

- **Adequate Electrical Device** Grounding Electrical system Proper grounding not only protects systems, devices and customers, it is also necessary to enhance the system's efficiency. Poor land is one of the factors leading to poor quality of electricity, particularly at the end of consumers.

- **Equipment and systems** mitigation Devices and facilities are used to address issues of the power efficiency.

- **Tap Shifting Transformer** The transformer is control transformer that requires a tap changer. Once an incoming tension falls below the planned range, it adjusts the transformer's winding ratio primary-secondary in order to produce the optimal secondary-tension values. The style of electronic transformer is extremely powerful and performs much quicker, with a low impedance (in millisecond). It is made up of electronic sensing circuit and solid state (thyristors) switches that adjust the rotation ratio.

- **Static Var Compenser** SVC Used by the transmission grid, which is typically used to improve the reactive power and voltage supply. SVC is the reactor and condenser shunt link for voltage management, avoidance of fault slip and increase the transmitting power of longer transmission lines.

- **TVSS Transient voltage suppressor** is a system that clamps transient voltage and restricts excess voltage with a nonlinear resistance preventing harmful voltage from touching devices and appliances. It can be mounted on the key customer electrical utility pane as an interface between power socket and critical appliances.

- **Lightning Arrester** Lighting arresters are commonly used in power transmission and delivery networks to stop extremely high voltage illumination by trapping the voltage and diverting it from the Earth's total mass via the Earth's electrode. The device and the devices guard against harm caused by voltage spikes, normally millions of volts. Some air-reduction appliances are insulation transformers, CVT constant voltage transformers, HTC transformers, etc.

OBJECTIVES OF THE STUDY

- To clarifies the quality of power and its challenges.

- To ensure good efficiency has become important in the ever growing usage of electronic power devices.

CONCLUSION

In depth, this article has correctly clarified the consistency of electricity. It illustrates issues of the power quality as insufficient grid, shifts in voltage / diversion, variations in frequency and waveform distortions. The influence of power quality issues involves inefficiency, overheating and shortening of equipment's service life, data loss, operation disruption, isolation failure. Although the triggers cannot be entirely eliminated, the efficiency of energy consumption can be increased and the remainder of the supply can be decreased. Suitable grid energy availability, use of controller devices (UPS, AVR, DVR etc.), use of control enhancement devices (tap changer, flash arrester, SVS), use of philtres to suppress harmonics, and adequate grounding for electrical installations are the demonstrated mitigation strategies.

REFERENCES

1. R. Dugan, M. McGranaghan, A. Santoso and H. Beaty (2012). Electrical Power Systems Quality, 3 rd edition, McGraw-Hill, New-York.

2. S. Gazafrudi, A. Langerudy, E. Fuchs and K. Al-Haddad (2015). Power Quality Issues in Railway Electrification: A Comprehensive Perspective IEEE Transactions on Industrial Electronics, Vol. 62, No. 5.

3. Nicolás L. Pérez, Manuel P. Donsión (2003). Technical Methods for the Prevention and Correction of Voltage Sags and Short Interruptions inside the Industrial Plants and in the Distribution Networks, International Conference on Renewable Energy and Power Quality (ICREPQ 2003)

4. A. Almeida, L. Moreira and J. Delgado (2016). Power Quality Problems and New Solutions Available at: http://www.icrepq.com/pdfs/PL4.ALMEIDA.pdf Assessed on 15th June 2016

5. R. Fehr (2016). Harmonics Made Simple Jan 2004 Available at: http://ecmweb.com/archive/harmonics-made-simple Accessed on: 15 April 2016

6. Janusz Mindykowski, Power Quality on Ships: Today and Tomorrow's Challenges. International Conference and Exposition on Electrical and Power Engineering (EPE 2014), 16-18 October, Lasi, Romani

7. Deepak C. Bhonsle and Ramesh B. Kelkar (2016). Performance evaluation of composite filter for power quality improvement of electric arc furnace distribution network. International Journal of Electrical Power & Energy Systems Vol. 79, page 53–65

8. I. A. Ahmed, A. F. Zobaa and G. A. Taylor (2015). Power Quality Issues of 3MW Direct-Driven PMSG Wind Turbine. 50th International Universities Power Engineering Conference (UPEC), Sept. 2015

9. What are non-linear loads and why are they concern today? Available at http://www.mirusinternational.com/downloads/hmt_faq01.pdf Assessed on 15th April 2016.

10. S. khalid and B. Dwivedi (2011). Power Quality Issues, Problems, Standards & Their Effects in Industry with Corrective Means. International Journal of Advances in Engineering & Technology, 1 vol. 1, issue 2, pp. 1-11.

Corresponding Author

Babita Pal*

Student, Ram Krishna Dharmarth Foundation University, Bhopal