A Review on Power Quality Issues in Power Systems

Raja Bhaiya Tiwari, Shashi Mishra
Department of Electrical and Electronics Engineering,
Scope College of Engineering, Bhopal mp
tiwari.rajabhaiya05@gmail.com, shashimishra198@gmail.com

***Abstract* - In the era of technology, it is very important to work in efficient system. Now day's electric power is playing main role in electronics and electrical world. But some problems arise in electrical energy such as voltage swell, voltage sag or dip, harmonic distortion, flickers, noise etc. In this paper we are going to discuss different power issues, their causes and consequences with diagram. Further we will graphically present the percentage of these power issues in power system.**

***Keywords*- Power Quality, Voltage Sag, Voltage Swell. THD, Harmonic Distortion.**

I. Introduction

The aim of the efficient electric power system is to generate pure electrical energy and to deliver this energy to the other -user equipment at an accurate voltage. As nonlinear loads [2] draw harmonic and reactive power components of current from ac mains, the quality of power deteriorates. This paper presents a review of the main power quality (PQ) issues with their associated causes and consequences with diagram. This paper concludes with tabular and graphical representation of power issues.

II. TYPES OF POWER QUALITY PROBLEMS

A. Voltage sag (or dip) - It is brief reductions in voltage, typically lasting from a cycle to a second or so, or tens of milliseconds to hundreds of milliseconds.
Causes: Voltage sags are caused by abrupt increases in loads such as short circuits or faults, motors starting, or electric heaters turning on, or they are caused by abrupt increases in source impedance, typically caused by a loose connection
Consequences: Malfunction of microprocessor-based control systems (PCs, PLCs, ASDs, etc) that may cause false tripping of contactors and electromechanical relays. Malfunctioning of electric rotating machines.

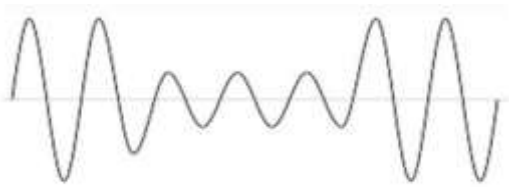

Fig.1 Voltage sag

B. Very Short Interruptions – It is a very short duration interruptions. Interruption like 1 or 2 millisecond in 1 or 2 seconds.
Causes: It occurs due to different kinds of failurity in power system. Failure protecting devices, insulation failure, control malfunction.
Consequences: False tripping of protection [5] devices, loss of information results in malfunction of data processing equipment. Sensitive equipment stops working. Fig.2- shows very short interruptions

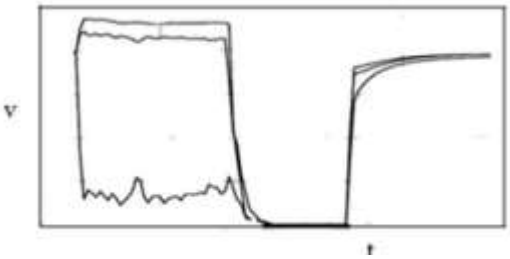

Fig. 2 Very short interruptions

C. Long Interruptions - Total interruption of electrical supply for duration greater than 1 to 2 seconds.
Causes: Equipment failure in the power system network, storms and objects (trees, cars, etc) striking lines or poles, fire, human error, bad coordination or failure of protection devices.
Consequences: Stoppage of all equipment. Fig.3- shows long interruptions

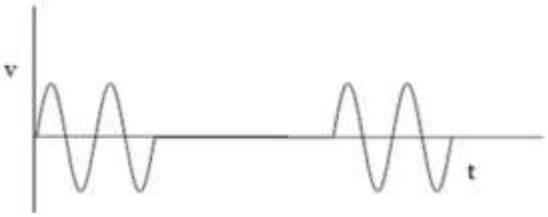

Fig. 3 Long interruptions

D. Voltage Spike - It is the very fast variation [1] of the voltage for durations from a several microseconds to few milliseconds. These variations may reach thousands of volts, even in low voltage.
Causes: Lightning which is a natural cause, switching of lines or power factor correction capacitors ,sudden removal of heavy loads.
Consequences: Damage of components (particularly electronic components) and of insulation materials, data processing errors, electromagnetic interference or information loss.

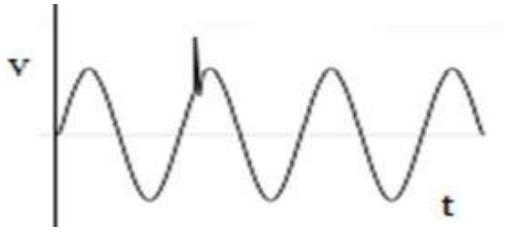

Fig. 4 Voltage Spike

E. Voltage Swell - Voltage swells are brief increases in voltage over the same time range.
Causes: Voltage swells [17] are almost always caused by an abrupt reduction in load on a circuit with a poor or damaged voltage regulator, although they can also be caused by a damaged or loose neutral connection.
Consequences: Data loss, flickering[6] of lighting and screens, stoppage or damage of sensitive equipment, if the voltage values are too high [4].

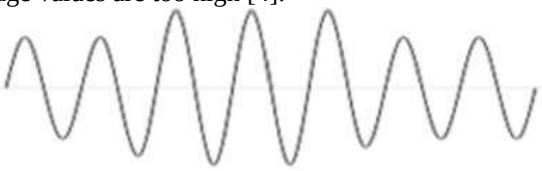

Fig. 5 Voltage swell

F. Harmonic Distortion – It is periodically distortion in voltage or current waveform. Harmonic distortion occur in sum of different sine-waves with different phase and magnitude.
Causes: All nonlinear loads like Arc furnances electric machines working above the magnetic saturation, welding machines, rectifiers, and DC brush motors. All non-linear loads, such as power electronics equipment including ASDs, switched mode power supplies, high efficiency lighting, data processing equipments.
Consequences: Probability of occurrence severe resonance increases, neutral overloading in 3-phase systems, overheating of all cables and equipment, loss of efficiency in electric machines, electromagnetic interference with communication systems, errors in measures when using average reading meters, nuisance tripping of thermal protections ,can induce visual flicker in arc lighting.

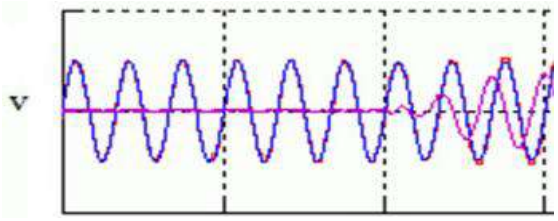

Fig. 6 Harmonic distortion

G. Voltage Fluctuation – It is changes in voltage. If voltage level increases or decreases from reference supply then that difference is known as voltage fluctuation.
Causes: random changes in supply, changes of load, due to variation of devices voltage fluctuation occur.

Consequences- Flickers in display screen is main issue of voltage fluctuation.

Fig. 7 Voltage fluctuation

H. Noise – Noise is undesired signals, it is the Superimposing of high frequency unwanted signals on the waveform of the power-system frequency.
Causes: Electromagnetic interferences [3] annoyed by microwaves, TV diffusion, and radiation due to welding machines and electronic equipment. Improper grounding may also be a cause.
Consequences: Noise always propagate error in power system. It is kind of disturbance which can be damage system.

I. Voltage Unbalance - A maximum voltage variation in a three-phase [3] system in which the three voltage magnitudes or the phase angle differences between them are not equal.
Causes: Incorrect distribution of all single-phase loads by the three phases of the system (this may be also due to a fault). Large single-phase loads (induction furnaces, traction loads)
Consequences: It mostly affects three-phase induction machines. Unbalanced systems imply the existence of a negative sequence that is harmful to all three phase loads.

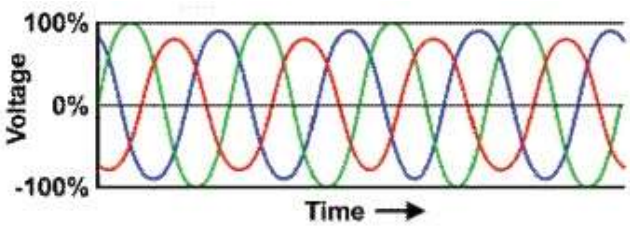

Fig.8 Voltage Unbalance

III. COMPARISON OF MAIN EFFECTIVE PROBLEMS

It has found that among all the PQ issues voltage sag and swell are the most occurring problems at the distribution end [1]-[2]-[3],as shown in fig.9. Showing the occurring percentage of various PQ issues. From fig.9 we can see that the voltage sag swell issues cover almost 89% of the graph area. That means they are the most responsible issues for decreasing power quality.

Table for different problem percentage

Sr. No.	Problem	%
1	Voltage Sags	60
2	Voltage swells	29
3	Transients	8
4	Interruptions	3

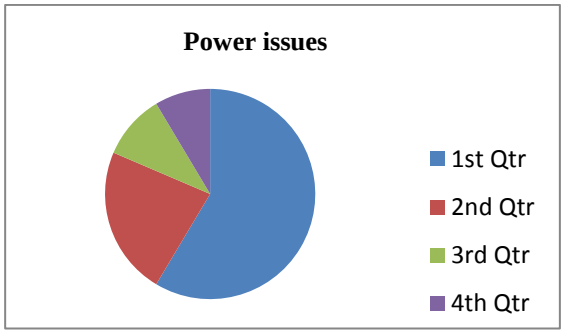

Fig. 8 Pi-chart for the occurring percentage of Various PQ issues

IV. CONCLUSION

In this paper, we have reviewed different kind of power issues, which we are facing in power system. After the study of different publication we got many number are of problems. Some are discussed in this paper, which are mainly cause of power losses. In this paper we gave a brief introduction of power issues, causes and their consequences.

REFERENCES

[1] R. K. Rojin "A Review Of Power Quality Problems And Solutions In Electrical Power System"

[2] Fatehbir Singh & Preetmani Singh, "A Review on Power Quality Problem and their Solutions " Internatinal Journal of Research, 2015,p-ISSN:2348-6848 e-ISSN: 2348-795X Volume 02 Issue 11 Nov 2015.

[3] Delgado, J."Gestão da Qualidade Total Aplicada ao Sector do Fornecimento da Energia Eléctrica", Thesis submitted to fulfilment of the requirements for the degree of PhD. in Electrotechnical Engineering, Coimbra, September 2002.

[4] Ferracci, P."Power Quality", Schneider Electric Cahier Technique no. 199, September 2000.

[5] Ribeiro, P., Johnson, B., Crow, M., Arsoy, A., Liu, Y., "Energy Storage Systems for Advanced Power Applications", Proceedings of the IEEE, vol. 89, pp.12, 2001.

[6]http://www.learnemc.com/tutorials/Transient_Protection/t-protect.html

[7] Styvaktakis, M., Bollen, H.J. , Gu, I.Y.H. , "Classification of power system events: Voltage dips," 9th International IEEE Conference on Harmonics and Quality of Power, Orlando, Florida USA, Vol. 2, pp. 745- 750, 2000.

[8] Domijan, A., Heydt, G.T., Meliopoulos, A.P.S., Venkata, S.S. , West, S., "Directions of research on electric power quality," IEEE Transactions on Power Delivery, Vol. 8, pp. 429-436, 1993.

[9]http://www.power-solutions.com/power-quality

[10] Shailesh M. Deshmukh1, Bharti Dewani, S. P. Gawande, A review of Power Quality Problems-Voltage Sags for Different Faults. International Journal of Scientific Engineering and Technology, Volume No.2, Issue No.5, pp. 392-3971, 2013.

[11] ttp://en.wikipedia.org/wiki/Brownout

[12] Steven Warren Blume, Electric power system basics: for the nonelectrical professional. John Wiley & Sons, pp. 199,2007.

[13] Bollen, M. , "Understanding Power Quality Problems – Voltage Sags and Interruptions", IEEE Press Series on Power Engineering – John Wiley and Sons, Piscataway, USA (2000).

[14] McGranaghan, M., "Costs of Interruptions", in proceedings of the Power Quality 2002 Conference, Rosemont, Illinois, pp 1-8, 2002.

[15] Suzette Albert, "Total Power Quality Solution Approach for Industrial Electrical Reliability", August 2006 issue of Power Quality World.

[16] Narain G. Hingorani, ―Understanding FACTS, Concepts and Technology Offlexible AC Transmission Systems, by IEEE Press USA

[17] www.google.com

[18] www.wikipedia.org

[19] www.power-solutions.com

[20] Power quality issues and solutions google book.

