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Power Quality Study in an Educational Institution- A Case Study

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Abstract - *Power Quality issues are becoming more significant in recent times because of increased use of electronics components, non linear loads or the devices which are the sources of harmonics. Both the end user and utilities are highly concerned about the power quality as it has a devastating effect on the power system as well as the devices connected to it.*

The Power Quality Analysis (PQA) will help in understanding the behavior of various loads connected to the power system. Power Quality Study helps us to provide better service. The worldwide customer survey shows that complaints on power quality related disturbances are increasing every year. This paper presents the Power Quality Study done in an educational institution which will help us to understand the behavior of Loads connected to it.

Key Words: Power quality Analysis, Power quality issues, Power Quality Analyzer, Harmonics, Unbalanced loads.

1. INTRODUCTION

Power quality of electrical networks depends upon the types of loads connected to the system and level of electrical disturbance. As per IEC 61000 series Power quality is defined as the ability of a device, equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. Similarly IEEE 1159:2009, IEEE 1100:2005 defines Power quality is the concept of powering and grounding electronic equipment in a manner that is suitable to the operation of that equipment and compatible with the supply system and other connected equipment. Following are the power quality disturbances in the power system: Power frequency variation, Voltage dips, Voltage surges, Voltage fluctuation, Voltage unbalance, Current unbalance, Harmonics, poor power factor, etc.

Due to poor power quality in power system equipment malfunctioning and equipment heating problems arise. It may lead to permanent failure of equipment. Typical electrical loads such as heating and motors are less sensitive to variations in the supply voltage and more sensitive to availability of supply. However electronics /digital equipment are more sensitive to variation in supply voltages. Nowadays in industries and commercial sectors more sensitive electronics equipment are used. So it is important to maintain good power quality.

This paper presents the Power Quality Study done in an educational institution which will help us to understand the behavior of loads connected to it.

1.1 Need of Power Quality Study

The devices and equipment used in industries, commercial and domestic facilities are more sensitive to supply variation than equipment used in the past. It is due to the increased use of power electronics and electronic processor based technologies in equipment and appliances [1]. The increasing penetration of renewable energy sources, electronics equipments, data centers, arc furnaces, VFD drives etc. distort the system voltage and current waveforms. This brings challenges in maintaining the quality of power and ensuring efficacy.

Poor power quality not only causes performance degradation and premature failure of electrical equipment but also results in increased system losses, financial loss etc. Therefore, apart from the reliability i.e. continuous supply the preference of the electricity consumer is now shifting towards quality power supply from the distribution company. Optimum power quality can enhance productivity and reduce losses [2].

2. OBJECTIVE OF THE CASE STUDY

To study the behavior of the electrical parameters like frequency , voltage , current and its variations, Voltage and current harmonics in the power system network of an educational institution and deliberation of possible mitigation techniques to maintain good power quality

2.1 Power Quality Analyzer

In today's market of power quality monitoring, different makes of power quality analyzers are available. In this case study we have used Fluke 435 -II Class A Power quality Analyzer and current measuring clamp up to 300 Amps. For three phase 4 wire systems we have used 4 numbers of current clamp meters, 5 numbers of voltage measuring leads for R, Y, B, N, E. We have used personal protective equipment like helmets, face shield, safety shoes, and insulating gloves while working on the power panel.

Fig 1: Fluke 435 II power quality Analyzer

3. Case Study

In this case study, power quality analysis is done in the main power distribution panel of Government college of Engineering, Dharmapuri, Tamilnadu, India as in fig 2. From this main power panel power is distributed to different loads such as College administrative buildings, hostels and residential loads, street lights. We have taken readings of power quality parameters such as voltage, current, power factors, voltage harmonics, and current harmonics. These values are recorded at an interval of 1 minute for the duration of 4:26:00 hours

Fig 2: Test setup at the site

Site and Location Information: Government College of Engineering- Dharmapuri

Staring Date and time: 12/04/2022 10:26:20 AM

Ending Date and Time: 12/04/2022 02:52: 20 PM

Record Duration: 4:26:00 Hours

Nominal frequency: 50 Hz

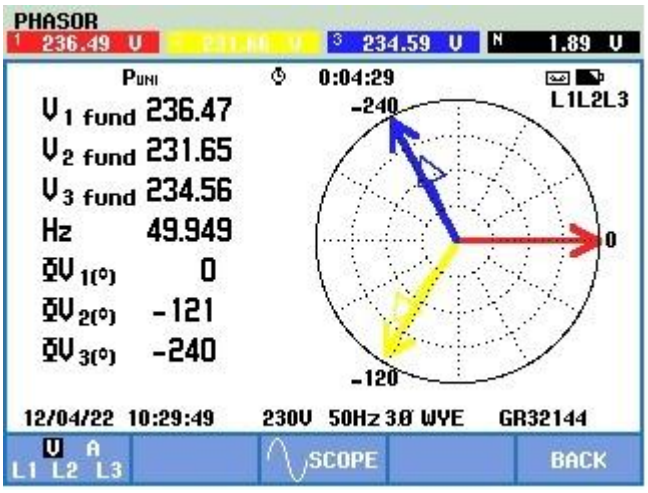

Fig 3: Vector representation of system parameter

3.1 Results and Discussion

With the help of Fluke 435 II power quality analyzer readings are taken. Fig 3 shows the vector representation of the actual system. Readings are presented in the form of graph. Fig.4 presents three phase voltages R (V_1), Y (V_2), B (V_3).

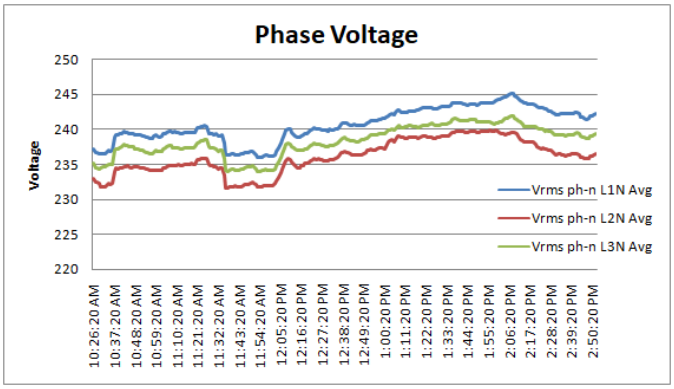

Fig 4: Phase voltage variation

From the observation of the voltage waveforms it is found that phase voltages are well within the limit.

Fig 5 represents the current variation over the period of study. It consists of three phase current. From the figure it is noted that current taken by R phase R is very much lower than the other two phases.

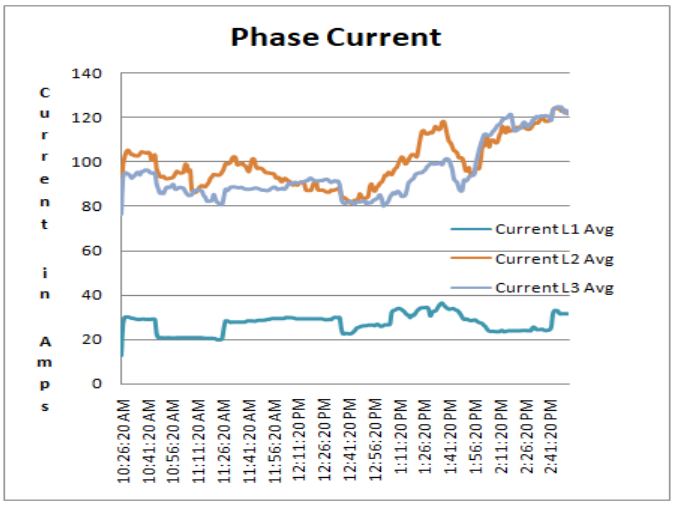

Fig 5: Phase current variation

Because of this huge imbalance in phase current we are able to see flow of very high neutral current as shown in fig 6.

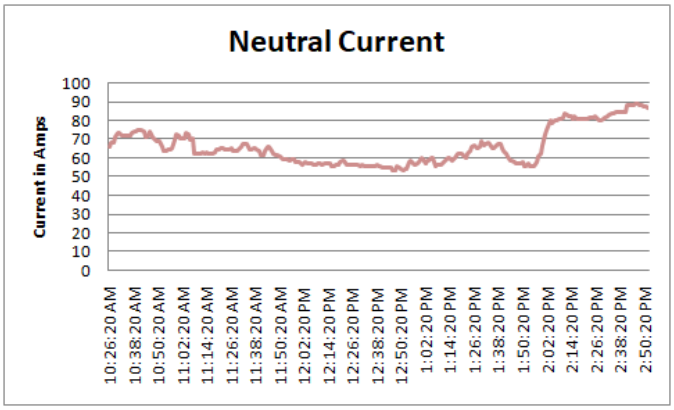

Fig 6: Neutral current variation

Power factor variation in the system over the period of study is presented as shown in fig 7. Power factor is having minimum value of 0.87. it is to be improved for better quality of power.

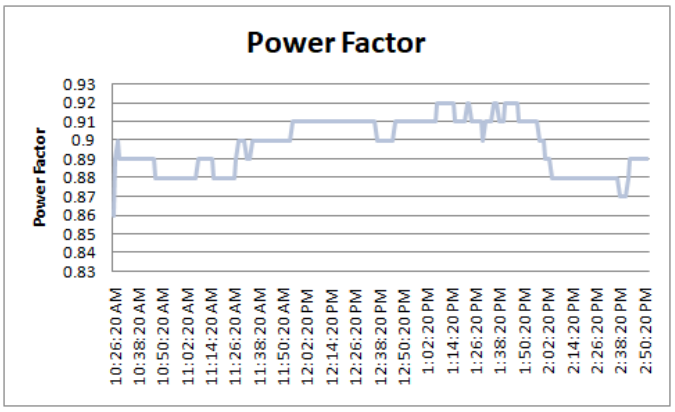

Fig 7: Power factor variation

Frequency variation of the system for the period of study is shown in fig 8. Frequency changes are well within the limits of specified limits of 49.7 Hz - 50.2Hz

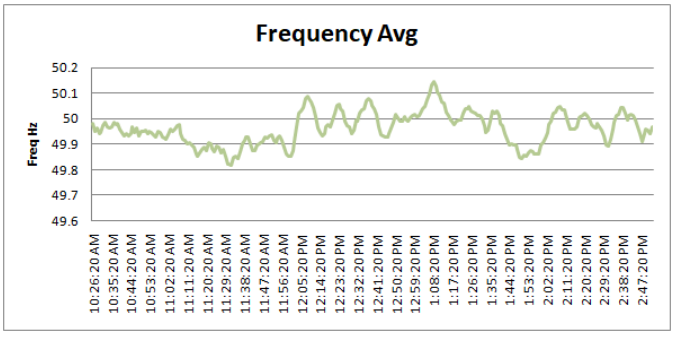

Fig 8: Frequency variation

Total Harmonic Distortion (THD) of Voltage and Current are shown in fig 9, 10. We can observe that the voltage harmonics are within the specified limits of 8% and current harmonics are more than the specified limits of 5% most of the time [3] . This may leads to the degradation of the system performance.

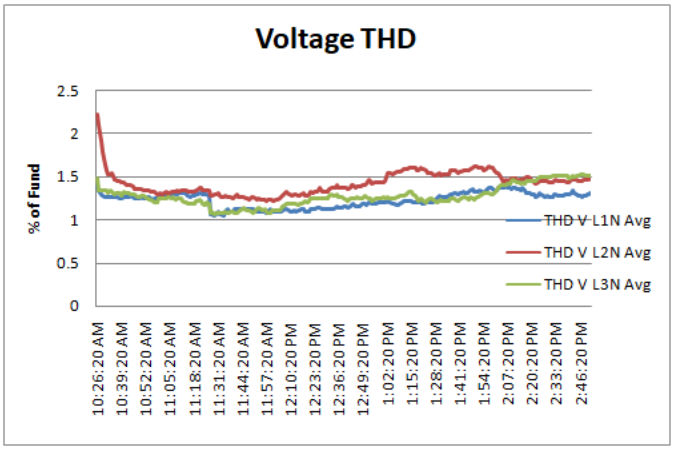

Fig 9: Voltage Total Harmonic Distortion

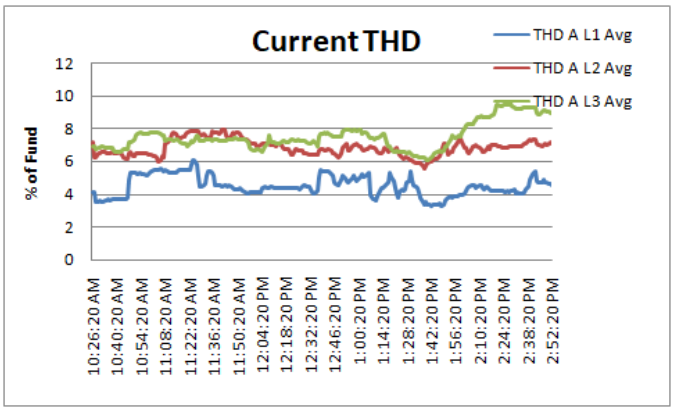

Fig 10: Current Total Harmonic Distortion

3.2 Suggestion to Improve Power Quality

●Uniform distribution of loads in three phases will reduce the unbalance in phase current. In turn it will reduce the neutral current.

●Implementation of power factor correction capacitor bank will improve the power factor of the system [4].

●Reduction in current harmonic distortion using harmonics filters will help to improve the system performance.

4. CONCLUSION

This paper discussed analysis of Power quality study carried out in power system networks of Government college of Engineering, Dharmapuri, Tamilnadu, india. Here it is identified that the Load current unbalance is very high in the three phase wire system. It leads to high current flowing through the neutral conductor. Also it is observed that the power factor of the system is poor. So it is recommended to redistribute the loads across the phases evenly as well as install Power factor correction capacitor bank in the system.

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