ARUNAI PUBLICATIONS

Asian Journal of Applied Research
DOI: http://dx.doi.org/10.20468/ajar.2018.10.01

Research Article

Power Quality Analysis in a Bulk High-tension Industry at Theni, Tamil Nadu

Sahayaraj Arokyasamy[1], S. Venkatanarayanan[2]

[1]Eecutive Engineer, TANGEDCO, Madurai, Tamil Nadu, India, [2]Department of EEE, Anna University, K.L.N College of Engineering, Pottapalayam, Sivagangai, Tamil Nadu, India

ABSTRACT

Maintaining power quality in an industry will be helpful in a number of issues such as reduced failure rate of equipment, malfunctioning of protection equipment, and higher sized equipments such as transformers etc. This power quality issues are created by industries having nonlinear loads. Of late, most of the industries use nonlinear electronic devices in their distribution network to improve their operating efficiency and to increase the energy conservation potential. At the same time, these equipment inject poor quality of power. However, consumers are ignorant about these detrimental aspects and hence do not pay any attention to this aspect. Neighboring consumers also suffer because of these polluting consumers. The Central Electricity Authority, Ministry of Power, India, has prescribed norms for the power quality such as harmonics for bulk industries, i.e., industries above 33 kV. Hence, this study has been conducted in a high-tension bulk industry to study the impact of poor power quality at different load strategic points.

Address for correspondence:
Sahayaraj Arockiyasamy, Executive Engineer, TANGEDCO, Madurai , Tamil Nadu, India.
E-mail: rajsahaya2010@gmail.com

Keywords:
Distribution network of the high-tension service, Harmonics, Measurement, Power quality, Power quality analyzer

Received: 05th February 2018
Accepted: 20th September 2018
Published: 13th October 2018

INTRODUCTION

Of late, power quality in bulk industries has become a hot topic considering the impact it makes in the entire distribution network starting from tail-end equipment to point of common coupling (PCC). In this study, the effect of nonlinear loads on the distribution network has been discussed.[1] Similarly, the effects of harmonics in different industrial environment have been discussed.[2-6] Power quality effects on the utility distribution network have been elaborated.[7,8] Modeling of nonlinear loads and estimation of harmonics[9] and mitigation measures such as design of filters have been discussed.[4,10]

This study has been conducted in a condiment industry which crushes red chillies and after adding some preservatives packs them as packets for subsequent delivery of products.

POWER QUALITY MEASUREMENT

Power quality measurement has been done in a 22-kV bulk industry having a demand of 2400 kVA in Theni, Tamil Nadu. Two measurements were taken; one at PCC and another one at medium voltage (MV) panel. This industry is using a number of nonlinear devices such as variable frequency drives in its distribution network. Power quality analyzer of "Fluke" make has been used for this study.

MV Panel Measurement

The measurement of various parameters of power quality at a medium-voltage (415 V) panel has been described in the following sections (Figure 1).

Voltage measurement

Voltage measurement between phases on the MV side (415 V) reveals that a difference of 12 V exists between the maximum and minimum points. A difference of 2–7 V exists between different phases (Figure 2).

Current measurement

Current varies between 380 and 470 amps. Difference between currents in different phases varies between 20 and 40 amps (Figure 3).

Power measurement

Real, reactive, and apparent power measurements have been taken as shown in Figure 4.

Figure 1: Medium voltage panel measurement

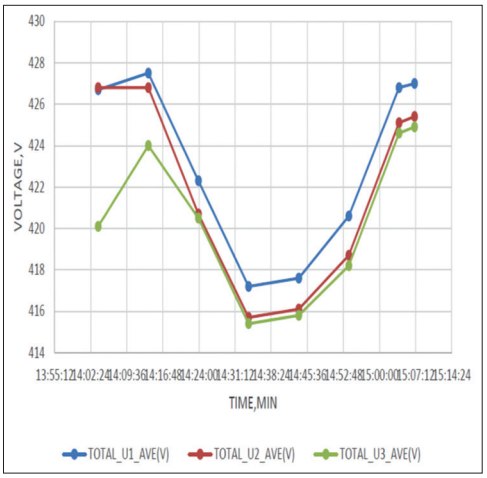

Figure 2: Voltage at 3 phases

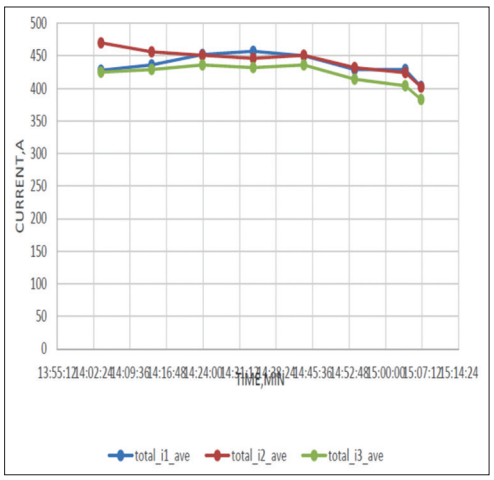

Figure 3: Current measurement

Power factorssssss

Power factor ranges between 0.953 and 0.978 as illustrated in Figure 5.

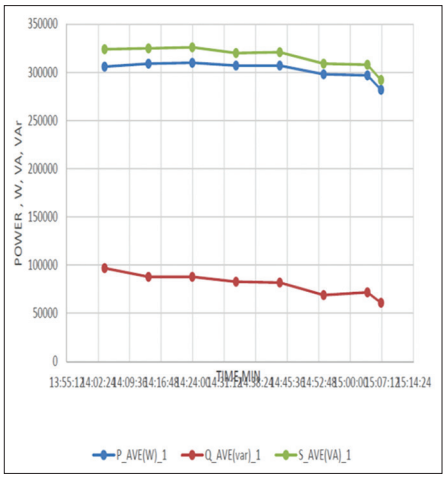

Figure 4: Power measurement

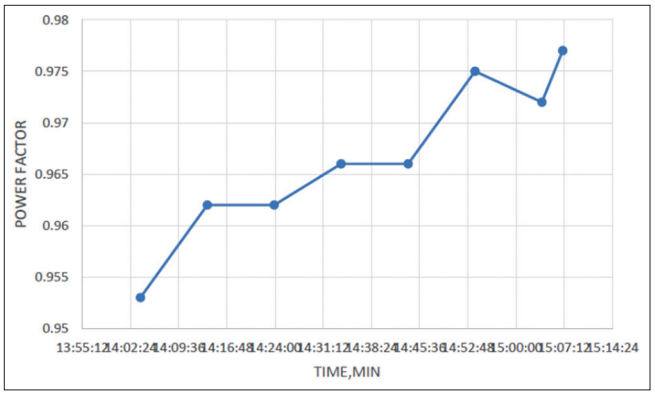

Figure 5: Power factor measurement

Voltage – total harmonic distortion (THD) measurement

Voltage THD varies between 2.2% and 2.7%, which is well within the limit of 3% as per IEEE 519 as depicted in Figure 6.

Current – THD measurement

Current THD varies between 13.6% and 16.2%. All the three phase values denote that the current THD is above the value of 8% as per IEEE 519 (Figure 7).

Order of harmonics

The order of current harmonics is summarized below (Figure 8):

Order of harmonics	Value in %
3rd	16.66
5th	50.125
7th	32.975
9th	4.625
11th	22.125

These values show that all harmonic orders are very high in value.

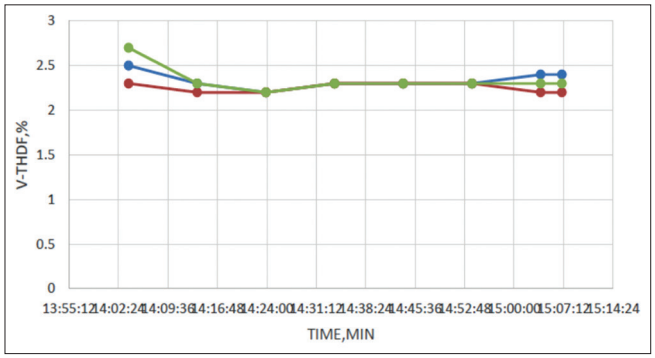

Figure 6: Voltage – total harmonic distortion measurement

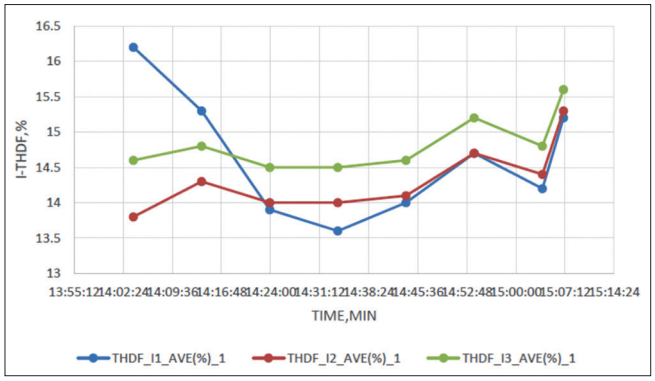

Figure 7: Current – total harmonic distortion measurement

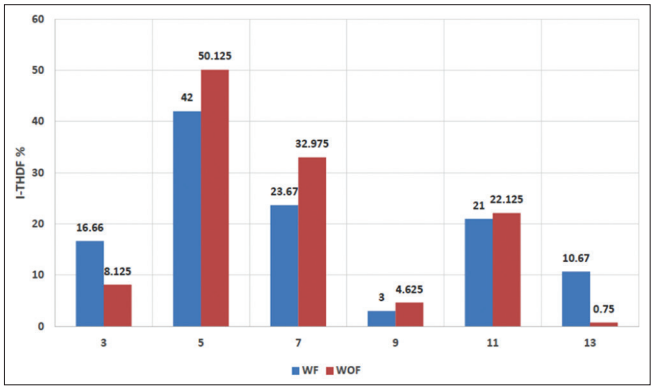

Figure 8: Order of current harmonics

PCC measurement

Voltage measurement

Voltage level varies between 21,920 and 22,800 V, a variation of 0.36–3.6% which is well within the prescribed limit of 8% (Figure 9).

Current varies between 17 and 21 amps on 22 kV side and the variation between phases is 1–3 amps (Figure 10).

Power measurement

The real, reactive, and apparent powers are measured and recorded (Figure 11).

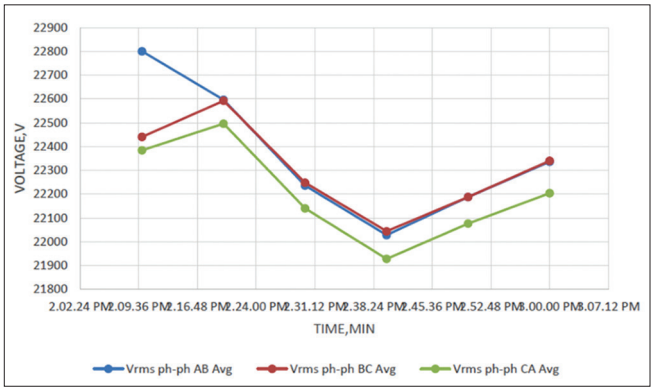

Figure 9: Voltage measurement

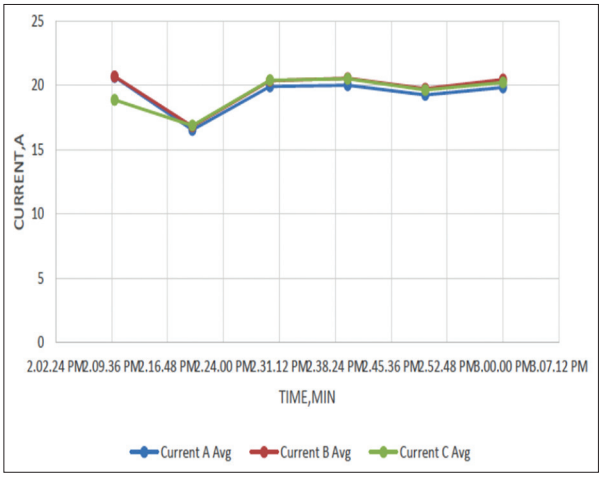

Figure 10: Current measurement

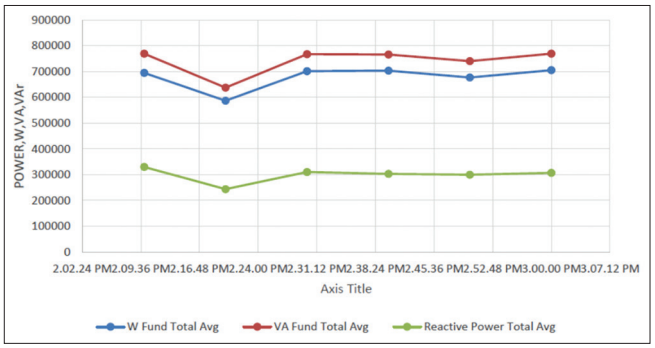

Figure 11: Power measurement

Power factor measurement

Power factor ranges between 0.89 and 0.91, the value of which is less than the utility prescribed limit of 0.95 for high-tension services (Figure 12).

Voltage – THD measurement

Voltage THD variation is between 1.1% and 1.4%, which is well within the prescribed limit of 3% as per IEEE 519 (Figure 13).

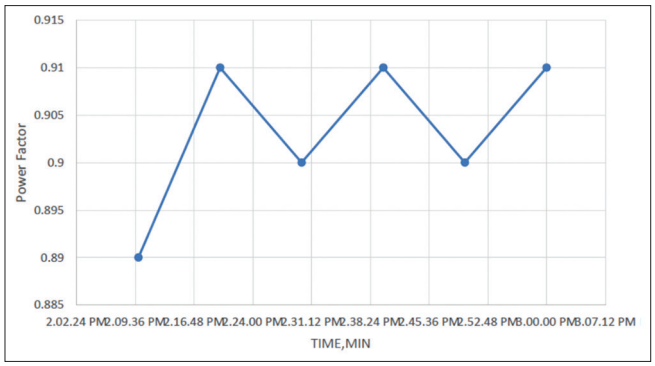

Figure 12: Power factor measurement

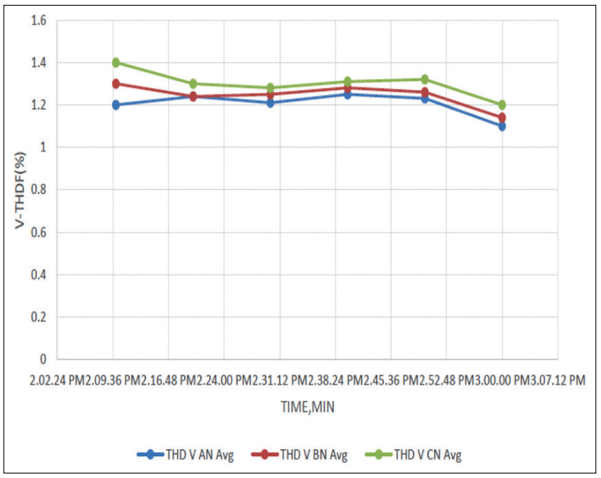

Figure 13: Voltage – total harmonic distortion measurement

Current - THD measurement

Current THD varies between 14.5% and 19%, which is well above the limit of 8% prescribed by IEEE 519 (Figure 14).

Order of harmonics

The order of harmonics is as follows (Figure 15):

Order of harmonics	Value in %
3rd	1.996
5th	14.695
7th	7.66

The values of the 5th and 7th harmonics are very high as per IEEE 519.

CONCLUSION

On comparing the values recorded in the MV panel and PCC, the following are observed.

a. Power factor value at MV panel is above 0.95, whereas its value is around 0.9 at PCC.
b. Voltage THD value at MV panel is between 2.2% and 2.7%, whereas its value is between 1.1% and 1.4% at PCC.
c. Current THD at MV panel is between 13.6% and 16.2%, whereas its value at PCC is between 14.5% and 19%. Thus, the current THD value has increased at the PCC.
d. The order of current harmonics recorded at MV panel are the 3rd, 5th, 7th, and 11th, whereas the order recorded at PCC are the 5th and 7th.
e. Based on the above, it is suggested to have passive filters for the 3rd, 5th, 7th, and 11th harmonics at MV panel level toward mitigation of harmonics.
f. Another option is to design a passive filter for the 5th and 7th harmonics at MV panel end, which are dominant, and an active filter for other order of harmonics at MV panel.

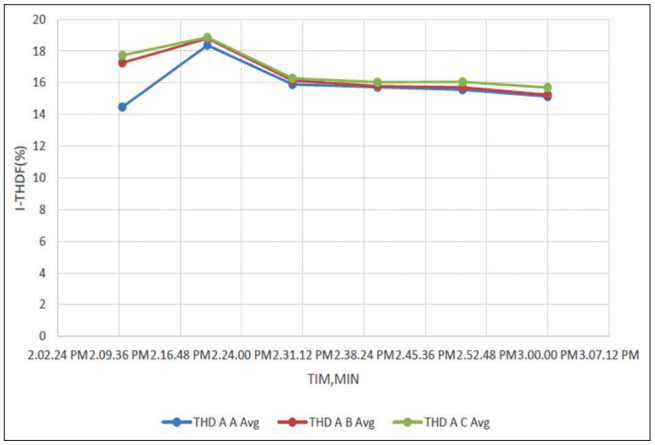

Figure 14: Current – total harmonic distortion measurement

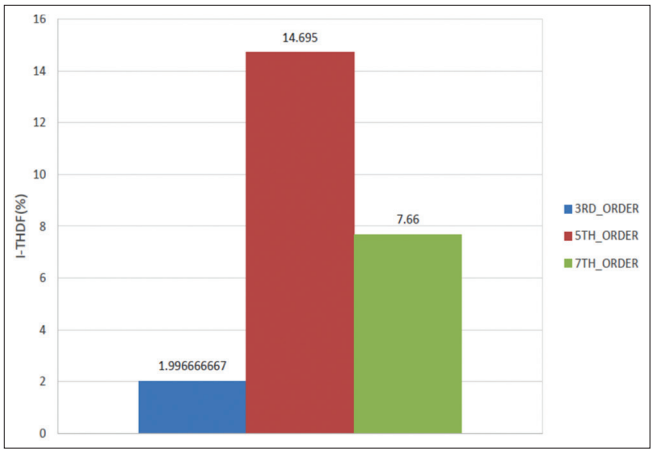

Figure 15: Order of harmonics

REFERENCES

1. Farooq H, Zhou C, Farrag ME. Analyzing the harmonic distortion in a distribution system caused by the non-linear residential loads. Int J Smart Grid Clean Energy 2013;2:46-51.
2. Bompard E, Carpaneto E, Napoli R, Ribaldone P, Vercellino C. Survey of Harmonic Distortion in LV and MV Networks-Results and Corrective Strategies. Italy: Dipartimento di Ingegneria Elettrica Industriale; 2001.
3. Rao U, Singh SN, Thakur CK. Power Quality Issues with Medical Electronics Equipment in Hospitals. Internal Conference on Industrial Electronics, Control and Robotics; 2010. p. 34-8.
4. Jahnavi M, Rajesh G, Sarvesh B. Harmonic Analysis and its Mitigation Technique in Industrial Environment. Andhra Pradesh, India: Department of EEE, JNTU, Anantapur.
5. Mohitkar SS, Dhend MH. Harmonic Measurement and Analysis

of Variable Frequency Drive (vfd) in Industry. Int J Res Adv Tech 2014;2:309.
6. Mirajkar NB, Dharaskar R, Kolhe P. To Perform Electrical Harmonic Analysis in Industry. Int J Emerg Technol Eng Res 2017;5:73.
7. Hunter I. Power quality issues a distribution company perspective. Power Eng J 2001;15:75-80.
8. Abozaed MI, Elrajoubi SM. Power quality evaluation of electrical distribution networks. Int J Electric Comput Eng 2014;8:1580.
9. Venkatesh C, Kumar DS. Student Members, IEEE, D.V.S.S. Siva Sarma, Senior Member, IEEE, Modelling of Nonlinear Loads and Estimation of Harmonics in Industrial Distribution System. 50th National Power Systems Conference (NPSC), IIT Bombay, December; 2008.
10. Hsiao YT. Design of filters for reducing harmonic distortion and correcting power factor in industrial distribution systems. Tamkang J Sci Eng 2001;4:199.

Cite this article: Arokyasamy S, Venkatanarayanan S. Power Quality Analysis in a Bulk High-tension Industry at Theni, Tamil Nadu. Asian J Appl Res 2018;4(2):1-5.

Source of Support: Nil, **Conflict of Interest:** None declared.