Journal of Science Engineering Technology and Management Science
Volume 01, Issue 01, December 2024
www.jsetms.com

Industrial Motor Drive Harmonics Mitigation in Cement Plants Using Active Power Filters

Vijay Varma
Department of Electrical and Electronics Engineering, JNTUH, Hyderabad, Telangana
Corresponding Author: vvarmaeee@gmail.com

To Cite this Article
Vijay Varma, "Industrial Motor Drive Harmonics Mitigation in Cement Plants using Active Power Filters", Journal of Science Engineering Technology and Management Science, Vol. 01, Issue 01, December 2024, pp:16-21

Abstract: *In recent years, the increased adoption regarding the application of electronically controlled adjustable-speed drives in manufacturing environments in industrial settings has led to a notable deterioration in power quality within the electric power system. This issue is especially prevalent in cement plants since they use more electric adjustable speed drives. This research examines the harmonic distortions produced by the electric drives with adjustable speeds at Anjani Cement Ltd. in Jaggayapet, Nalgonda, A.P., India. To determine whether harmonic currents or voltages are relevant, harmonic measurements have been done at a number of motor drives using a Fluke 564 power quality analyses. Based on these measurements and further computations, the harmonic content of these motor drives is examined and found to be kept to a minimum within the bounds of international standards. The capacity of power filters to lower harmonics has drawn a lot of attention lately. This study develops an active power filter based on real-time harmonic data readings to minimize harmonic in MATLAB/Simulink.*

Keywords*: Drives with movable speeds, power quality, harmonics, power quality analyzer, active power filter, and harmonic reduction.*

I. Introduction

Power quality has grown to be a significant problem in contemporary power systems as a result of the increasing nonlinear loads. In 1997, nonlinear loads accounted for only 18 percent of overall loads; by 2002, that number had risen to 40 percent. Reactive power burden, enhanced neutral currents, low power factor, energy efficiency at low level, EMI interference, line voltage distortion, and other issues are caused by these nonlinear loads, which also draw no sinusoidal currents from the ac mains and introduce harmonics into the power system. One of the main causes of harmonics and issues with power quality is nonlinear loads, such as variable speed drives. Harmonics are the primary cause of the electrical power system's poor power quality. As a result, the current guidelines and standards for reducing the aforementioned issues [3]. Harmonic suppression is a popular technique for filtering. Harmonics in supply systems are typically suppressed by tuned filters.

By altering (or interfering with) the system impedance, passive "LC" filters tend to resonant with other network impedances and produce excessive harmonic amplification rather than harmonic reduction. Active power filters have received greater attention lately, particularly because they are more appropriate than passive ones and can also be used to lower harmonics. Another method is to remove the harmonic currents by injecting balance compensating currents via the filter [10]. The electric drives of cement factory located at Jaggayapet, A.P., India, a significant supplier of cement to the majority of the Andhra Pradesh region's businesses and organizations, are the subject of this study. Utilizing a Fluke 431A power quality analyzer to measure the harmonics. It is evident from observed data that the motor drive's harmonics must fall within the international harmonic limit ranges. Active power filters have drawn greater attention lately due to their effective harmonic reduction. With the results of %THD with and without the active power filter, this paper proposes the construction of an active power filter to minimize the harmonics.

II. Harmony Analysis in Cement Plant

Very few articles have addressed harmonic distortion in the cement industry; however, those that do discuss how power quality issues impact nonlinear loads, such as variable frequency drives (VFDs). As a result, this research attempts to investigate harmonic analysis in different electric motor drives and its impact on the cement plant (Figure 1). 3400 tons of cement are produced daily at the cement mill under investigation. Regardless of operating loads, motor drives use between 65 and 75 percent of plant electricity, and installing them costs Rs 8 lakh per month in plant

electrical tariffs. Different power ratings of motor drives are utilized in the cement industry for a variety of applications, such as raw mills, kiln cooling systems, cement mill cooling, crushers, belt conveyors, coal mill cooling, cement mill classifiers, coal mill cooling, etc. Depending on the application, the drive motor rating can range from a few KW to several hundred KW. It has been demonstrated that these are the main causes of harmonics in the cement sector. In order to identify the sources of the harmonics, a thorough system assessment was conducted.

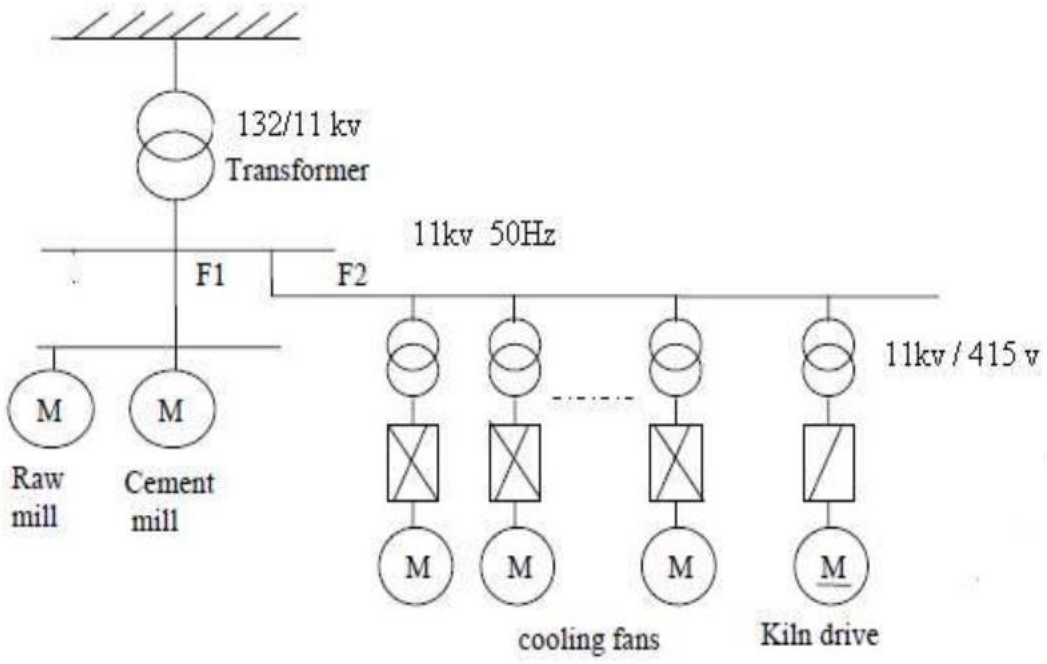


Fig 1: Cement Plant's Electrical layout

Using a power quality analyzer for one to two days will ensure that the right data is gathered to describe the system's functioning and to further enhance the plant's performance. Figures 2 through 10 show the harmonic characteristics for various cement plate motor drivers.

III. Analysis and Results

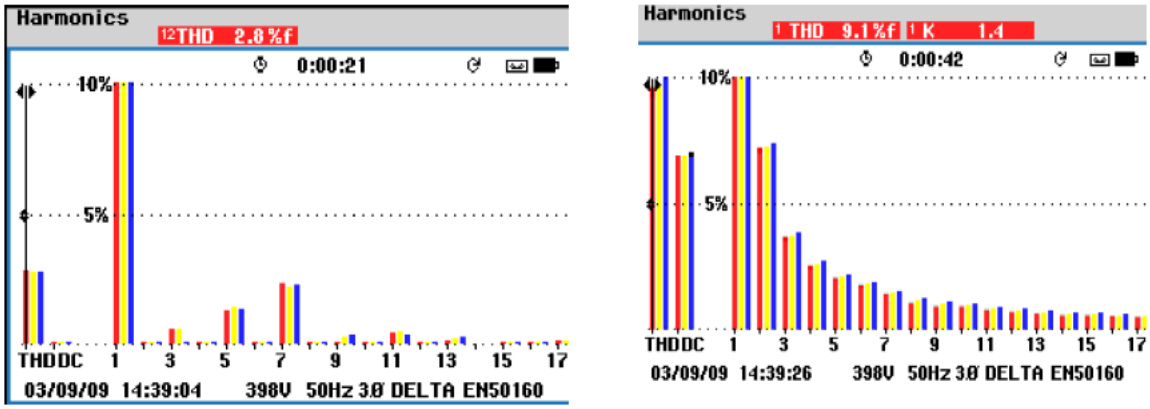


Fig 2: Voltage and Current of cooler ID 132 Kw

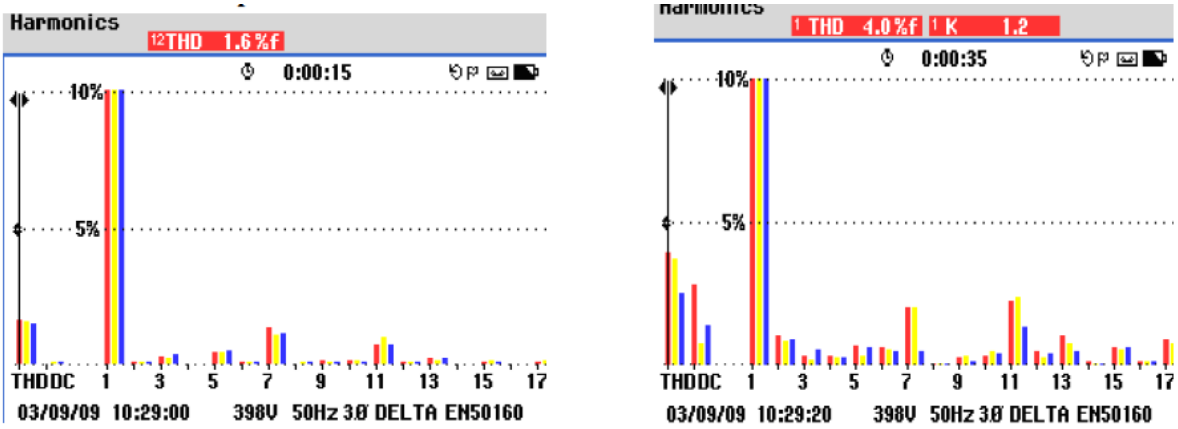


Fig 3: Voltage and Current for harmonic profile 700 Kw

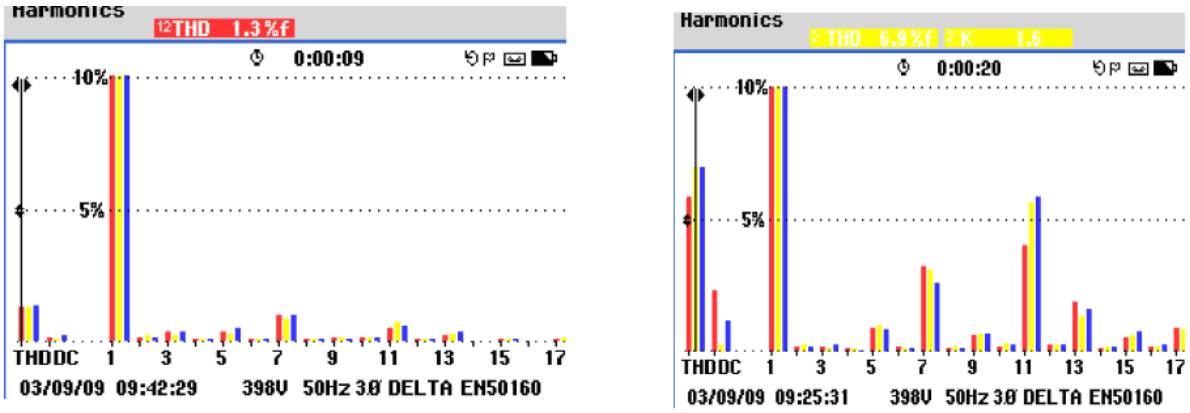


Fig 4 and Fig 5: Voltage and Current of cement and raw mill 1 for 700 Kw

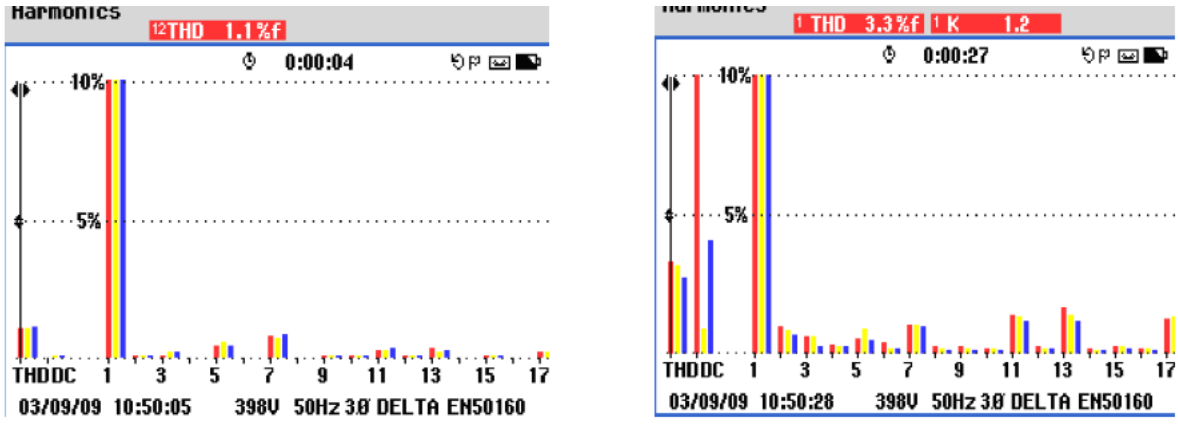
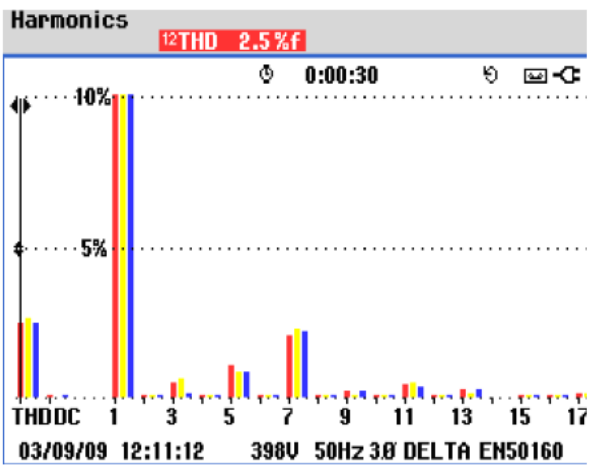


Fig 6: Voltage and Current of cement mill 2 for 800 Kw



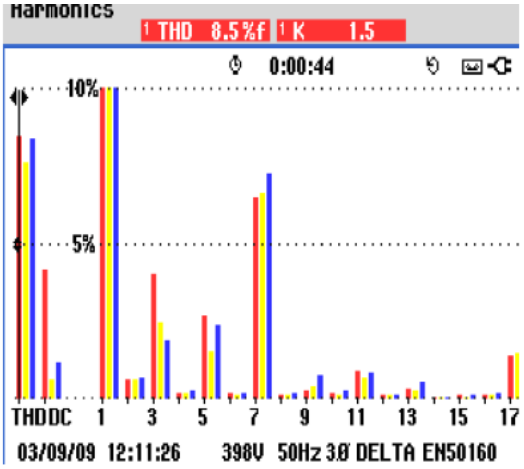
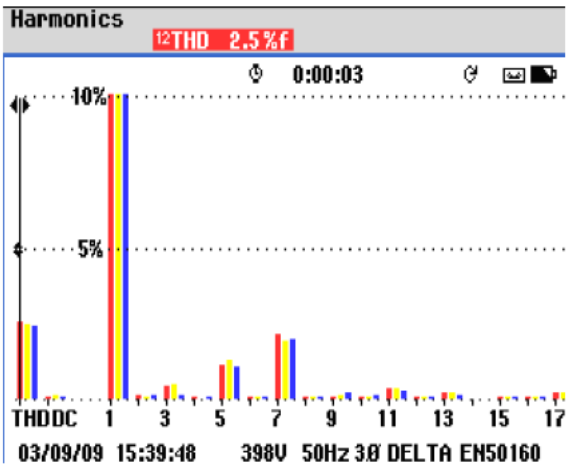


Fig 7 and 8: Voltage and Current of Clinker breaker



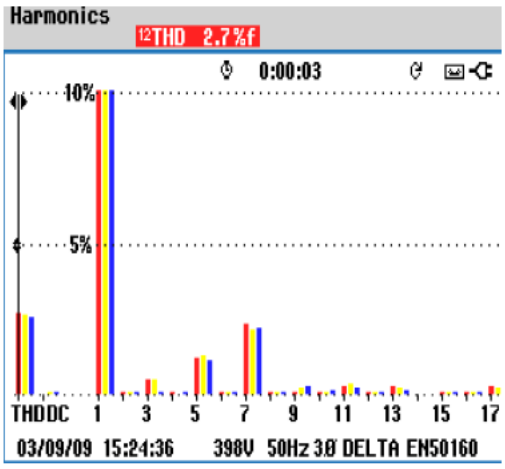


Fig 9 and 10: Voltage of cooler fan 1 and fan 2

IV. Reduction of Harmonics with Active Power Filter

Finding out how much of these nonlinear loads in the cement plant contribute to harmonic distortion and determining whether some of those locations that present a high level of harmonic distortion could cause electrical issues in the near future are the primary goals of this case study. This study conducts an investigation of harmonic level and its impact on the plant distribution system and harmonic injection into the grid. Generally speaking, the distribution system of a plant should have total harmonic distortion (THD) of less than 5%. Anjani Portland Cement Ltd.'s electric drives harmonic profile. We find that some electric drives have extremely high THDs and fall short of international norms. In certain instances, the low voltage VFD in the cooling fans produces harmonics that are higher than 8%. As stated in the preceding sections, cooling fan-2 with thyristor-controlled drives has a current THD of up to 89%, which must be decreased to prevent issues connected to current harmonics. Thus, harmonics should be reduced. There are several ways to do this, including adding line reactors, passive harmonic filters, and the more popular active power filter. If you want to reduce harmonics effectively (for example, even in non-ideal supply voltage, such as unbalance, voltage pre-distortion, etc.), these harmonic filters guarantee that total harmonic distortion (THD) is effectively minimized.

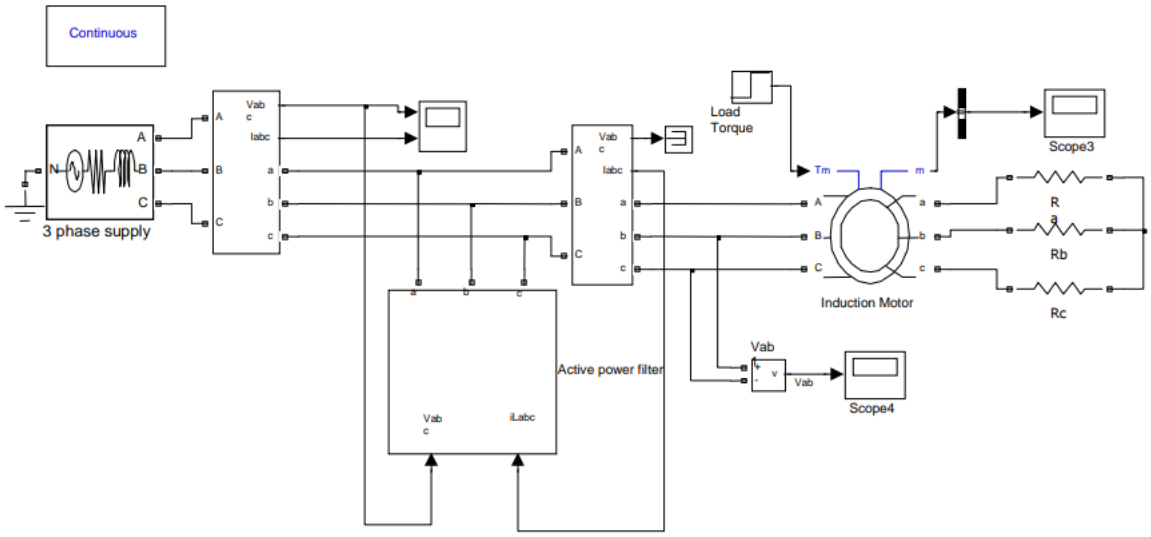


Fig 11: Diagram of a first group dryer drive with filter in Simulink

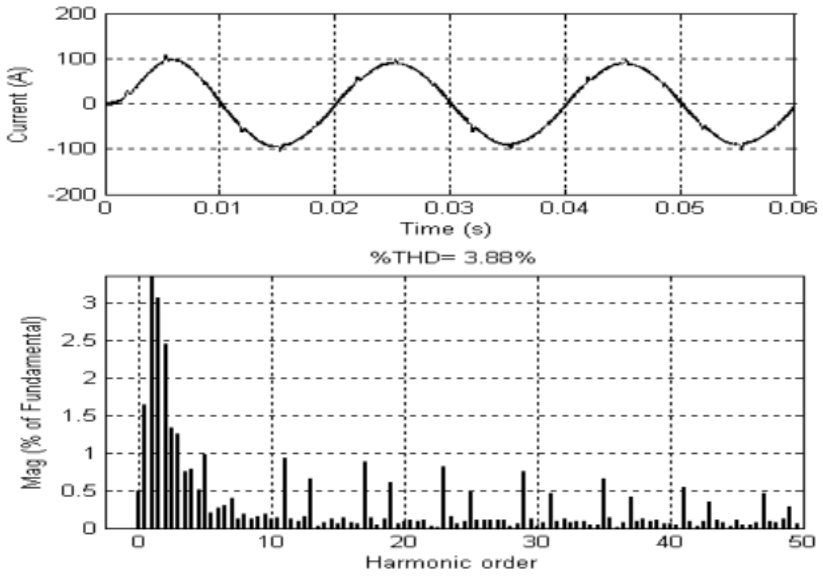


Fig 12: Active filter with current waveform

V. Conclusion

Using a case study, a harmonic analysis of electric drives was conducted at M/S Anjani Portland Cement Ltd. Using a Fluke 434 power harmonic analyzer, findings for both voltage and current harmonics at the supply side are practically measured and reported. The %THD of current is extremely high, at 87%, since only the motor exported by the variable frequency drive is a motor out of the four cooler fans, but these investigations show that there is higher harmonic content in cooler fan-2 in particular. The results are presented in %THD with and without the filter. An active filter has been constructed and simulated in MATLAB/Simulink to cool the fan motor and reduce harmonic content. Current's %THD has significantly decreased, going from 80.4% to 4.56%.

References

[1] David, Mohammed khan and Albert, "Study of cooler fans in cement factories and installing of electrical equipment", IEEE conference, Saudi, 2000.
[2] Gnanavel, Kumaran swamy, Vadivel and Pandian, "Study and solving problems in cement factory using harmonic mitigation, IEEE, Chennai, 2010.
[3] Ganesan, Anil Kumar and Venkateswar, "Implementation harmonic distortion in cement factory at different Kilowatts", IEEE standards 1998.
[4] Xing lee, Md Yusuf khan and Sohail khan, "Study of harmonic mitigations in factory with different power", Springer conference 2002.
[5] Daniel lee, Ayub singh and Rajasekhar, "Implementation of power in various fans at different power factors", Springer conference, vol 10, issue 3, pp" 231-239, 2000.
[6] Anil kumar Yadav, Murali Krishna and Ahmed Maswood, "Harmonic mitigation in power generation sector", conference, vol 8, Issue 2, pp:98-110
[7] Niharika, Hima Bindu, Sri Sai and Lakshmi, "Applications of different practices in power sector", IEEE conference, vol 10, issue 4, pp: 34-45.