Environmental Potentials

Power Quality For The Digital Age

ENERGY LOSS REDUCTION

A Report by Environmental Potentials'
Research & Development Department

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Location

Energy savings test is performed at Environmental Potentials Inc Division 4 Draper UT. Loads used are a VFD with 5 HP motor. Electrical configuration is a three phase 480V Delta.

Tools

PS 4000 power quality meter is used to measure the electrical parameters.

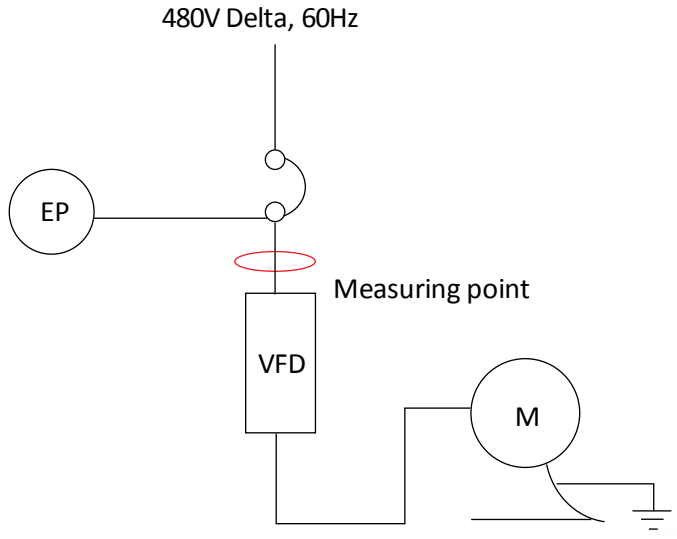
Unit

One three-phase EP-2000 480V Delta

Abstract

Environmental Potentials' research and development tested the efficiency of a three phase motor with a VFD. First we removed all EP waveform correctors, waited two weeks and then measured the VFD and motor for six hours without EP. Next we installed an EP-2500 at the main panel to isolate the facility from outside pollution and waited two more weeks. Then we installed an EP-2000 at the load and measured the VFD and motor for six hours with EP. There load and VFD remained constant through the entire test. Although VFD's are widely used in all industries, it is a nonlinear load and is responsible for energy losses[i]. Nonlinear loads contribute large amounts of noise in the electrical system. Nonlinear loads use nonsinusoidal voltage waveforms. Studies have shown that magnetic losses for non sinusoidal voltage waveforms far exceed the magnetic losses for sinusoidal voltage waveforms[ii]. This noise damages power quality and can affect the performance of loads such as motors.

Testing Diagram



Measurements

Figure 1: Before EP. Currents log on phase 1.

Current Dip

There is an extreme current dip at approximately 14.09 on time scale.Current dips are harmful to the operation of the load in both performance and energy consumption basis. Current dips will cause imbalance in the load distribution and this increases core losses. Current dips also decrease the life time of the armature windings and thus the lifetime of the motor.

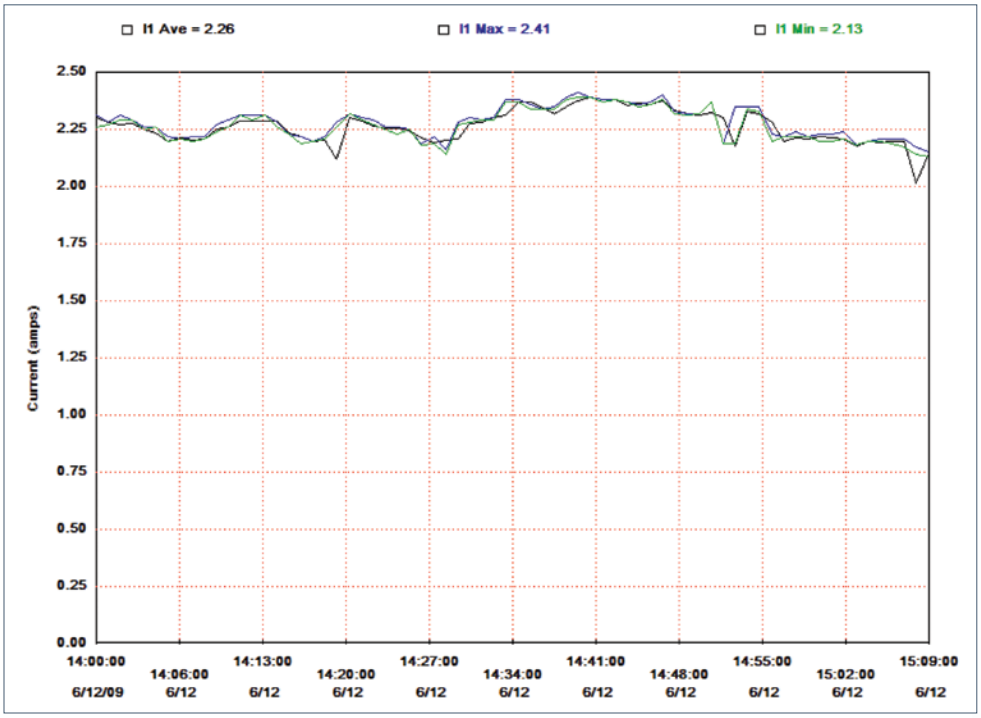


Figure 2: After EP. Currents log on phase 1.

Figure 2 clearly shows no major major current dips after EP is installed. EP suppression filter attentuated the current dips at load center. This indicates that the load is running with equal load distribution this reduces energy losses.

LOG SCALE

Measurement	Before	After	Units	Change	%Change
Voltage, Phase 1, Ave:	463.3	483.5	volts	20.2	4.4 %
Voltage, Phase 2, Ave:	465.5	486.0	volts	20.6	4.4 %
Voltage, Phase 3, Ave:	463.5	482.8	volts	19.3	4.2 %
Current, Phase 1, Ave:	**2.8**	**2.3**	**amps**	**-0.6**	**-19.9 %**
Current, Phase 2, Ave:	**3.6**	**2.9**	**amps**	**-0.7**	**-19.1 %**
Current, Phase 3, Ave:	**3.6**	**2.6**	**amps**	**-1.0**	**-26.8 %**
Energy, Total Elapsed:	1.36520	1.10647	KWH	-0.25873	-19.0 %
Cost, estimated per month: (at $0.09000/KWH)	**$119.67**	**$96.99**		**$-22.68**	**-19.0 %**

The log scale was taken with and without the EP unit installed. Before and after readings were compared to analyze the reduction of energy losses. The log scale shows the current magnitudes on all the phases are significantly reduced in addition to their balance in magnitudes.

Explanation

Both the load and supply have the rated voltage of 480V. The load is a VFD and motor and has a standard wattage range. According to power equation P=V*I, for constant power (wattage), a decrease in voltage will cause an increase in current and vice versa. This test increases the voltage magnitudes thereby decreasing current magnitudes. This lowered the amount of current feeding armature windings and this decreases the i2R losses. *To decrease load losses, the magnitudes of currents feeding its armature must be decreased.*

Before installing EP, there were heavy imbalances in the current magnitudes with a current dip of 1.2A. After installing EP, all the current dips are removed and the current magnitudes were decreased.

Before EP, the voltage magnitudes on all the phases were in the range of 460V, the nominal voltage is 480V. The decrease in the voltage magnitudes will cause current magnitudes to increase and lead to ohmic (i2R) and other core losses.

Conclusion

EP decreased the magnitudes of current on all the phases resulting in less armature winding losses and ohmic losses. After installing, EP reduced the energy losses by **19%**. This test was performed in Environmental Potentials' R&D lab which has better power quality than most real world facilities; therefore, the energy reduction is expected to decrease in the real world. Facilities should expect a **3-12%** reduction of energy losses after EP installation.

[i] P.Preecha, J.Dejvises, S. Chusanapiputt, and S. Phoomvuthisam, 2004 Intematlonal Conference on Power System Technology - POWERCON 2004 Singapore, 21-24 November 2004; A Temperature Calculation and Prediction of A Three-phase Induction Motor with Non sinusoidal Voltage Supply

[ii] Waseem A. Roshen, IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 21, NO. 4, JULY 2006 Magnetic Losses for Non-Sinusoidal Waveforms Found in AC Motors