Pluses and Minuses of Energy Efficient Upgrades

Installing energy-efficient equipment and monitoring its performance and usage can dramatically reduce a facility's energy costs. Unfortunately, not all energy-efficient equipment performs as advertised. While there are many devices that are effective in cutting energy costs, there are some that are worth a second look. For example, you may achieve energy savings at the cost of increased susceptibilities to power quality phenomena. Sometimes the devices themselves contribute to power quality problems. Or, these devices may not really save energy, can decrease your power factor, or even cause potentially damaging transients.

Both adjustable speed drives (ASD’s) and electronic ballasts in fluorescent lighting have resulted in improved energy efficiency. ASD’s have a rectified-front end that converts AC in DC through diodes and/or SCR’s. On a three phase full wave rectified system, this results in six paths or poles of conduction, (3 * 2). This results in harmonic currents of the 5th, 7th, 11th, 13th, 17th, 19th, etc. These follow the rule of $h = n \times p +/- 1$, where $h$ is the harmonic number, $n$ are integers of 1,2,3,4,5,…, and $p$ are the number of poles. These harmonic currents can produce harmonic voltage levels (if the harmonic source impedances are large enough) that exceed IEEE 519 recommendations, while compromising the performance of other equipment on the same circuits (see figure below). ASD’s are also known to be susceptible to tripping off-line from PF correction switching transients. While the ASD didn’t cause the transient, the motor probably wouldn’t have experienced any problems if it were powered off the line, instead of the ASD.

![ASD Harmonic Currents](image.png)

- Total RMS: 1.52 Amps
- DC Level: -0.29 Amps
- Fundamental(H1) RMS: 0.96 Amps
- Total harmonic distortion (H02-H50): 1.28 Amps RMS
- Even contribution (H02-H50): 0.14 Amps RMS
- Odd contribution (H03-H49): 1.27 Amps RMS
Next we take a look at harmonic currents from fluorescent lighting, which have taken on new dimensions since the introduction of electronic ballasts. Distortion current levels of 15-20% can become 60-80% as a result of this upgrade. For example, at a manufacturing/research facility a contractor suggested replacing all of the existing ballasts with new magnetic ballasts to save the company more in energy costs than the old lighting consumed. While it sounded like a "no brainer," the company decided to investigate further and found that the ballast had 85% harmonic current. Placing hundreds of these high harmonic emitters through the facility would have compromised the low-level signal tests being conducted in the research lab, and possibly overloaded the service transformer.

Fluorescent light current and voltage waveforms
Finally, we look at compact fluorescent lamps. Tests on a number of different bulbs uncovered one with some interesting characteristics. The "equivalent light output of a 100W incandescent bulb" consumed 100W at a power factor of 0.55. If zero watts savings with reduced power factor weren't enough, there were transients during the warm up phase of nearly 400V, as shown below. Plus, there are the infrared emissions during start-up of the bulbs that can make TV and other infrared remote control temporarily inoperable.

Clearly, not all energy-efficient devices have such results. Many live up to their claims and can produce significant cost savings. By conducting a few simple tests on sample devices before signing a contract you will achieve the greatest savings without sacrificing performance. And monitoring the impact of this new equipment will ensure that you are getting the most from your investment, identifying new opportunities for energy reduction and maximizing your savings.