Power Quality & Power Factor

by Leon Wasser, MBA, P.Eng.

Recently, Canadian manufacturers have become more conscious of their utility expenses. In Ontario in particular, electrical prices have seen steep increases, and as the province enters a period during which much of our power production capacity needs to be renewed or replaced, utility costs can be expected to increase even more quickly. Historically, most government and utility energy conservation programs have focused on the residential, institutional and commercial building sectors. The specific energy conservation needs of the manufacturing sector have been largely ignored despite the challenges that face Canadian industries especially global competition. To date, one government policy approach used has been to offer energy subsidies to vulnerable sectors such as the struggling forestry industry, but obviously this does not constitute a sustainable energy strategy, and as in other sectors a real energy conservation strategy is needed.

At the company level, electricity is one of the largest single expense items in most industrial processes. Because utility costs are often viewed as largely fixed expenses, corporate conservation strategies are not given the priority which they deserve. Given that most manufacturers operate on rather fine operating margins, even a small reduction in power expenses can have a massive impact on a company' bottom line. As noted recently by Perin Beaty, President of the Canadian Manufacturers Association, a 10% reduction of a manufacturer's energy consumption can often translate into the doubling the doubling of profit margins for a manufacturer because energy costs are often largely fixed expenses. It is therefore time for manufacturers to take a far harder look at their energy consumption and the opportunities for savings

Two Types of Electrical Loads

All of the electrical power consumed in a manufacturing plant falls into two categories, resistive loads and reactive loads. Resistive loads are devices that simply convert power into a usable form through a direct conversion to light and/or heat such as incandescent lights, electric ovens or drying units. In most plants, the vast majority of devices are reactive loads. Almost all manufacturing equipment, including all motors and compressors, as well the base building's HVAC system constitute major inductive loads. Computers, florescent lights and HID lights are also reactive loads.

Power Factor and Power Consumption

Power factor is defined as the ratio between Apparent Power expressed in KVA and Real Power expressed in KW. Power is generally supplied by utilities to their customers at close to 100% power factor. The presence of reactive loads in manufacturing plants automatically reduce the plant's power factor. Generally, the greater the amount of the reactive load, and the greater the proportion of reactive load to the overall load, the lower the power factor. Every manufacturing plant's power consumption is unique, although there are some commonalities within industry sectors. What is almost universal, however, is that manufacturing plants as a whole have far lower power factor than any other category of buildings due to their intense application of mechanical equipment required for production and packaging processes. Many manufacturing plants typically operate in the range of power factors of 70% to 80%, but it is not unusual to see even lower power factors in plants with a small number of large mechanical loads. Historically these losses have been viewed as inevitable power inefficiencies, but recently, new technologies have emerged which can recapture and recycle the previously wasted lost power factor back into the building's power stream to allow the building to operate at near 100% power factor. This technology is called power factor correction.

How Utilities Charge for Power

In Ontario, the Ontario Energy Board is responsible for establishing energy prices. Ontario Local Distribution Companies (LDCs), the local utilities, charge for electrical power by a combination of power consumption over a period expressed in Kilowatt Hours (KWh), peak demand during the period expressed in Kilowatts (KW) and fixed administrative and transmission charges. Some jurisdiction charge at 100% power factor while other base charges on a lower power factor. Both consumption and peak demand can be reduced through conservation measures.

Power Conservation Opportunities

There are many ways for manufacturers to conserve electrical power. Some of these measures are easy to implement and inexpensive, others are quite far more expensive and disruptive. Many manufacturers have already harvested the "low hanging fruit" of energy conservation such as by retrofitting incandescent or lower efficiency florescent lighting systems. Plants can sometimes conserve power by reducing building envelope heat losses with upgrades to insulation, air leakage management and by fine tuning of the plant's HVAC system. When selecting new manufacturing equipment or retooling existing production lines or equipment, power efficiency should be considered, and variable speed drives can often help reduce consumption. It should be recognized that the cost of a wholesale retooling of a plant with newer more energy efficient equipment can be prohibitively expensive with very long payback periods. In some cases, this type of re-tooling may not be even technically feasible or may result in production interruptions which may be inconvenient or even unacceptable.

Power Factor Correction & Power Quality Improvement Technology

Another approach to energy conservation, as alluded to above, is the extraction of the maximum latent power supplied by the utility through power factor correction and power quality improvement technology. Using this technology can restore a

building's power utilization ratio to almost 100%. One of the hottest areas of research in the field of power engineering is the field of power quality. Power quality improvement is a highly sophisticated technique which filters out a variety of power wave anomalies to reinforce the main primary power wave used by manufacturing equipment. Power quality improvement can correct numerous power problems by restoring the supply to ensure that all three phases have equal amplitude and phasing. The system also filters out and deals with surges, transients, sags and other problems. Any building that has reactive or inductive loads, will experience most of these problems. In addition, most off the energy contained in these wave imperfections cannot be effectively used by motors, compressors and other inductive devices and constitute wasted energy factor which cause production equipment to operate sub-optimally, and contribute to the overheating of motors leading to equipment malfunctioning and ultimately to pre-mature equipment failure. In addition, because so much of production equipment is microprocessor controlled, and these control chips or devices are often far more sensitive to electrical fluctuations, power quality problems can often trip out circuits and shut off of vital piece of production equipment which then has to be reset or re-started. The installation of a power quality improvement system will correct these extraordinarily costly and disruptive power anomalies which can be, so that production can continue without unnecessary interruption.

These systems are installed in a building's electrical room where the main transformer is located, and are installed in parallel to the power supply so that no power interruption is required during installation and operation. A computer controlled power factor correction system like PowerCon's PowerKure system then dynamically and continually adjusts the power supply to the building to increase the building's power factor to almost 100% and recycles power anomalies which in combination reduce both KW peak demand and KWh power consumption.

Conservation Incentives

Currently, many LDCs are offering very generous financial incentives to customers to reduce either Peak Demand (KW) or Power Consumption. Toronto Hydro, Hydro One Networks, Waterloo-Wilmot Hydro and are just some of the utilities currently offering direct financial incentives based on demand reduction. Most of these jurisdictions offer $150 for every KW of peak reduction, although the rules applied by each utility vary somewhat. Brampton Hydro One has a specific program to specifically encourage Power Factor Correction. The Ontario Power Authority's Conservation Bureau, which provides leadership to the utility sector in association with the Ontario Ministry of Energy, is exploring ways of encouraging further conservation in the industrial sector as they have already done in the residential and other targeted sectors. Recent changes to capital cost allowances in the last Ontario budget also make conservation projects more attractive than before. It is anticipated that the federal government will be presenting new legislation and programs which will provide further incentives to conservation measures to replace the one which had previously been offered by Natural Resources Canada's Office of Energy Efficiency.

Conclution

It is time for manufacturers to turn their attention far more seriously to energy conservation since these measures can often constitute the difference between profitability and losses in a fiercely competitive global market. The benefits of conservation are permenant so these projects are always worthwhile, and as an added bonus, constitute good corporate citizenship.

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