FOOD AND BEVERAGE

Power quality and reliability in the food & beverage industry

Market trends and industry economics in the food and beverage sector are putting a spotlight on reliability and power quality, exposing the true cost of sub-par power. What are F&B plants to do?

Milk and cookies, a cautionary tale

What do companies that make vanilla wafers have in common with those that manufacture silicon wafers? When it comes to power systems, the two are more alike than you might think.

In manufacturing environments, a power disruption is never welcome and usually means downtime, if only long enough to bring backup power supplies online. In the case of silicon wafers, even a slight disruption can also ruin work in progress. The same is true for the edible variety of wafers where the cost of lost product is layered on top of lost production time.

Dairy producers face a similar challenge. They must precisely track the temperature of their milk throughout the process, so even a small power system disturbance can mean discarding an entire batch of perfectly good product if it causes temperature sensors to fail.

In late 2016, ABB undertook a survey of F&B companies in partnership with Food Processing magazine that looked at a range of topics including power.

Asked if they had experienced a power disruption in the previous 24 months, 45% of respondents said they had. Of those, 85% said they had suffered lost production time, 64% reported lost work in progress

Rum shot: the cost of downtime

In 2005, a major spirits producer set out to quantify the cost of the almost weekly work stoppages they encountered due to problems on the plant's power distribution system.

The facility operated two 10-hour shifts each day on nine bottling lines producing a variety of bottle sizes. The company had observed losses equivalent to 2,500 cases of product in stoppages as short as 40 minutes, but it would often take more than an hour to restore production to normal line speeds. At $10 per case, this equates to at least $25,000 per event.

In addition, the company had documented $350,000 per year in replacement parts for equipment damaged by unplanned stoppages. In all, the 47 events the company experienced in 2005 added up to nearly $1.5 million in added cost. That figure does not include secondary costs like overtime to recover lost production.

This is an extreme example, but it illustrates the degree to which problems with power quality and reliability can impact the bottom line in F&B operations.

or finished goods, and 22% experienced equipment damage.

Given the cost of downtime—estimated by industry analysts at between $100,000 and $1million per hour—the survey responses indicate a serious problem. Even more troubling is the fact that while two thirds of respondents who had experienced an outage could trace the problem to a disruption from the grid, 25% could not identify the source, thus leaving open the possibility that the failure would recur. In this case, it really is no use crying over "spilled" milk.

In the following sections we outline some of the challenges related to power systems in the F&B industry and explore what plant operators can do to mitigate them.

Market trends put spotlight on power

In an industry with notoriously thin margins and a focus on keeping the line running, investment has tended to flow toward immediate, visible problems like food safety (i.e., avoiding recalls). Investments in preventing infrequent failures are harder to justify, particularly if the given firm hasn't experienced a major power issue recently, but shifting market trends are beginning to change the calculus.

One trend that can influence investment is consolidation. Acquisition is often seen as an opportunity to upgrade aging systems and bring the target company's operations up to par with those of the acquiring firm. Nestle, for example, aims to use a single common user interface on the systems controlling more than 170 facilities around the world. The company is also working to cut costs at its plants by applying capacitor banks to improve power factor and reduce associated penalties assessed by local utilities.

F&B firms, like their counterparts in other industries, are paying closer attention to resource usage, eager to improve their efficiency and reduce waste. Doing so presents a classic win-win, reducing cost and environmental impact at the same time. This is especially visible with regard to energy. For example, some F&B facilities generate their own power on-site with efficient gas generators, reducing reliance on grid power and leveraging low fuel prices. Renewables and energy storage are also on the rise, though more so outside the US where higher electricity rates bolster the business case.

Regulation also plays a role in F&B investment. The Food Safety Modernization Act has driven a renewed focus on compliance, but specifically it has highlighted the connection between a plant's power supply and its ability to ensure food safety. As illustrated in the dairy example above, even a small disruption is enough to throw production out of required parameters. For this reason, power quality is as important as reliability for food and beverage operations.

Minding your PQ

Poor power quality has been shown to lead to reduced efficiencies, increased risk of downtime and higher energy and operating costs. What constitutes a power quality problem? There are several phenomena that fall into this category (e.g., load imbalance, voltage transients, harmonics and reactive power problems), and they can be interrelated.

Voltage swings and harmonics are examples of "dirty power" and they can create a host of problems such as light flicker, excess heating of cables and transformers, malfunction of control equipment, nuisance tripping of breakers and damage to sensitive equipment. Non-linear loads like motors that ramp up and down frequently increase harmonics on the plant's power distribution system. If the problem persists, it can put the plant in a position of non-compliance with regulatory standards.

Reactive power problems also come with a cost. Unlike active power, which is used in electrical equipment to do work, reactive power plays a dual role, maintaining voltage levels but also potentially "displacing" useful power on the distribution system. Too much reactive power means less active power for plant equipment. Too little risks voltage instability.

Poor maintenance practices: a partial list

Following are just a few of the more common bad habits that can cause problems for the plant's power system.

- Missing conduit body covers
- Missing while-in-use covers
- Temporary fixes that turn into permanent ones
- Components being used in the wrong environmental-rated area
- Mating two dissimilar metals, causing corrosion due to galvanic differences
- Bypassing overcurrent protection and/or having inadequate overcurrent protection when updating a motor control center (MCC) bucket
- Increasing capacity with a new transformer and front-end equipment without upgrading downstream equipment

Deviations in either direction can create problems for the larger power grid and force the grid operator to take steps to bring the system into balance. That typically triggers surcharges for poor power factor, a measure of the ratio of active to reactive power. Such

penalties can be substantial, but some utilities also offer incentives for exceeding requirements.

Relying on reliability

The reliability of a plant's power distribution system is essential, but threats to it can be hard to spot and can fester for years. Some of the more obvious culprits include placing power equipment in production areas where dust, high humidity and the use of caustic chemicals in wash down procedures can shorten equipment life and increase the risk of a failure. Poor maintenance practices will do the same (see sidebar), but other problems can manifest over a longer period of time.

As plant operations grow, loads accumulate incrementally and will strain the distribution system if it is not upgraded. Power quality comes into play here as well as the addition of new processes that use sensitive microprocessor control can expose the limitations of legacy power systems. Older plants also frequently lack proper documentation or accurate drawings for the equipment in service. This can happen when "temporary" repairs undertaken for a specific problem may become permanent fixes. F&B facilities also face regulatory challenges with regard to electrical systems and equipment. Older facilities designed and built under outdated codes are usually grandfathered in under current rules, but the addition of new equipment can trigger a reassessment of the entire facility. At that point, the older equipment must be brought into compliance with current code, a potentially costly prospect.

Solutions and best practices

Addressing reliability and power quality challenges in food and beverage facilities, whether on a remedial or preventative basis, starts with understanding the causes (or potential causes) of failure. So, it makes sense to begin with monitoring the incoming power supply, vital equipment like transformers, and key assets within the plant.

Beyond monitoring, there are several straightforward fixes and equipment installs that can boost reliability. These include:

- Replacing mechanical protective relays on medium-voltage systems with electronic ones
- Replacing fuse protection on step-down transformers with circuit breakers for faster action
- Retrofitting older low-voltage breaker trip units with modern ones that provide zone-select interlocking and reduced energy let-through
- Installing dual-mode overcurrent devices that provide a normal operating mode and a maintenance mode (also important for worker safety)
- Programming devices properly to take advantage of ride-through capability
- Isolating specific electrical loads by using redundant power sources.

Transformers: a key asset gets smart

Transformers are the lynchpin of any power system. Installing the right one for a particular application can be the difference between decades of reliable service and a costly unplanned outage.

Dry-type units, for example, have no bushings (the #1 point of failure in transformers) and no insulating oil. They require very little maintenance and can be located almost anywhere.

Today's transformers are increasingly available with onboard sensors to monitor internal temperature as well as voltage, current and load measurements. This data feeds into analytic tools to facilitate maintenance planning, real-time monitoring and condition-based maintenance, further improving reliability and asset life.

When it comes to power quality issues, the easiest and most effective solution to avoid unplanned shutdowns is the correction of voltage anomalies coming from the grid. This can be accomplished using harmonic filters, capacitors and other protective equipment. Additional PQ best practices include:

- Using variable frequency drives or soft starters to reduce peak and overall energy demands and minimize harmonics
- Applying medium- and low-voltage capacitors and filters to improve the efficiency and reliability of the network
- Installing an industrial uninterruptable power supply for 100% availability of critical control systems, security of product data records and to ensure safety compliance for critical processes

Looking ahead, the rapid advances being made in data analytics are likely to produce applications specifically designed to address power quality and reliability issues in F&B environments. Currently, the sector lags other industries in the adoption of IoT and supporting technology, but as costs continue to fall this is likely to change.

Asset health, for example, is more commonly understood in the utility, mining and other asset-intensive industries. Ditto for remote monitoring, but both of these have a clear value proposition for F&B, for example by allowing experts from the equipment manufacturer to support plant personnel remotely and address problems more quickly. Condition-based maintenance is already a well-proven strategy for extending asset life and reducing failure rates. As the

data collection and communication systems needed to support it become easier and less expensive to implement, it is likely to become a staple in the F&B sector, too.

The changes food and beverage producers face today in terms of changing consumer demands, increasing regulatory requirements and industry consolidation are unlike any the industry has faced before. Plant power systems underpin not just the production process itself, but also the means by which producers will meet these challenges. Investments in power quality and reliability are typically long-term, and in this case they carry even more importance.

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