Refrigeration – surreptitious profit eater

COLIN KINSEY discusses the extensive energy costs that can be incurred by refrigeration systems and the ways to curb them.

A three-metre reach-in refrigerator will set you back about $5000 and chew up about $22,500 of electrical energy over its lifetime. Smart compressor electricity monitoring systems can have a short pay back, and save buckets of electrical energy use, as well as maintenance expenses.

To focus the mind: the cost of a kilo of refrigerant can equal the profits on 1000 litres of milk. Chasing down leaks can therefore pay off. Conserving energy usage for refrigerated cabinets and coolrooms is also smart.

Typical profit margins for supermarkets are around three percent, and energy, much of it electrical, is of the order of one percent of sales. Electricity usage for refrigeration is between 40 and 50 percent of the total bill. And those refrigerant leaks? They can cause the compressors for the refrigeration systems to work harder – and use up more than the needed kilowatt-hours.

Because of the great range of refrigerated displays and freezers in supermarkets, we pick on a modest size cabinet – the three-metre, reach-in display refrigerator – to illustrate energy and efficiency considerations.

The energy apportions for the refrigerator are the following: compressor 55 percent, lighting 18 percent, anti-sweat heaters 13 percent, fans nine percent, defrost three percent and miscellaneous two percent.

ENERGY AND MAINTENANCE CAN A MOUNT UP – UNNECESSARILY

A ballpark for the annual electrical energy consumption is around 3500 kilowatt-hours per metre, of which the compressor accounts for at least half. Each metre runs out at an annual cost of $500 or thereabouts. So running things efficiently pays off and we'll flesh that out in a practicable way.

Let's move on to maintenance. There are emergency repairs, regular maintenance, preventive maintenance, predictive maintenance and there's a wait for things to break. The cost stats for the supermarket sector are hard to come by – in part because people don't necessarily break down costs in ways that suit the points we make here. But that doesn't make them any less valuable.

Maintenance labour hours are expensive. A lot are wasted because, and it often happens, equipment problems crop up anyway – unexpectedly. Breakdowns during trading hours are the worst. Regular maintenance is better than acting after equipment failure and preventive maintenance sounds like 'motherhood', but it is oversold because the factual basis for 'prevention of problems' is just not there.

So, a lot of money is actually being wasted either on service that's not needed or, worse, service that causes problems. Remember that old adage: 'If it ain't broke, don't touch it.'

PREDICTIVE MAINTENANCE REQUIRES A SOLID DATABASE

What about predictive maintenance – are we just playing with words? The short answer often enough is 'yes'. However, it's 'no' if monitoring equipment on your refrigeration machinery is part of the picture. Then there's a solid basis for predictive maintenance. And it's efficient – the troops are only sent in when there's a really good chance of finding problems.

Back to the reach-in display... unless remodelling in the store takes place, and a smarter looking one is needed, it will stick around for 15 years. Its compressor will be sharing a rack with other like compressors.

In large stores there are often two replacements per year, and many are needlessly replaced. Here's the rub, management is unlikely to disagree with its maintenance engineering department on technical issues, but if they don't like the expenses all that happens is that budgets are cut, solving the 'financial problem' for a short time.

However, coming back to the opening bars of the profitability tune, the discords are still there – unnecessary dollars continue to be spent on both maintenance and electrical energy use for the long term.

We are not saying here that cleaning evaporator coils, drains, intake screens, condenser coils etc should not be done, but when it comes to the labour intensive stuff (checking compressor bearings, starter panels and controls) and testing the refrigeration charge, the right answer is a monitoring system and, furthermore, one that is an integral part of a big data system.

MONITOR ELECTRICAL 'PAIN'

The monitoring system is very simply a collection of intelligent electricity panel meters, housed in the compressor stack rooms or nearby switchboards. Where appropriate, these smart meters can be used in conjunction with other stack controllers, which, among other things, control the compressor drive speed, adjust the condenser capacity in accordance with refrigerants requirement of the refrigeration points and increase energy efficiency, for example, by lowering the condenser temperature.

The intelligent meter outputs go to a data collector, and a program basically puts the various measurements (more about this later) into bins, or silos, where each silo is provided with low- and high-level warning levels.

The overall silo monitoring program uses logical combinations to provide

maintenance management with exception reports, which clamour for attention. The sort of developing conditions that will be flagged are uninsulated or poorly insulated coolant pipework, heat gain through poor seals, insufficiently loaded compressors, condenser fouling and condenser fan malfunctions etc.

In short, what we're saying is that the features of the electrical power intake by compressors are like your central nervous system. Persistent pain has you going to your doctor who then figures out what's wrong with you – it's no different with your refrigerated displays or freezers.

The monitoring system provides detailed energy use information, which forms part of the watching brief such as 'spike' problems (loss of a stator winding, bearings packing up etc), but also indicates longer-term problems, including increased energy usage as a result of refrigerant leakage.

The seemingly unavoidable refrigerant leaks from supermarket refrigeration systems – at an average annual rate of 25 percent of total refrigerant charge (these are US figures) – have cost the US supermarket industry dearly for decades, while prompting its Environment Protection Agency to impose regulatory limits on leak rates to curtail their environmental impact.

AND NOT TO FORGET POWER QUALITY

In addition to energy usage, other monitored parameters form a part of 'power quality'. This is very much an electrical engineering term, but it includes things like over- and under-voltage, and voltage imbalance.

Supermarkets use three-phase power, so there are three voltages to contend with. When these are not equal, bad things happen to compressors; they run hotter than they ought to and, if the condition persists, lifetime is cut very short. Fixing this may require you to call in the distribution network provider. However, the problem can also be at the store side, in which case you could have an expensive cure on your hands.

Quite apart from energy usage – i.e. kilowatt-hours – supermarkets are charged for kVA (kilovolt-amp) demand. The additional charge, which can quite easily add 30 percent or more to electricity bills, covers the additional electric current the distribution network provider has to carry in order to deliver the usable energy.

Oversized compressors and fan motors require additional demand and add to your power bill needlessly. The monitoring system described above is an essential part in flagging this problem.

SO, WHERE TO FROM HERE?

Use up some accounting department labour to pore over past maintenance accounts, breaking out the identifiable refrigeration and freezer classifications.

It won't necessarily provide details of what specific technical services were performed. Based on a three-metre reach-in display, we will assume a 1.5-kilowatt minimum rating compressor at $600 replaced three times over the display life; i.e. $1800. Energy usage over the display lifetime is $1500 by 15 years, or $22,500. Let's assume conservatively a 10 percent saving as a result of monitoring-based, predictive service and add that to two avoided compressor replacements, or $3450 in total. Now we have a base for comparing the capital investment per monitoring point at $500 per compressor.

Although a very approximate method, in the absence of specific details for a particular supermarket, the payback per monitoring point is two years. However, combining two reach-ins reduces the payback to one year.

In conclusion, go and talk to energy and maintenance experts – you have nothing to lose save for unnecessary costs. ●

Colin Kinsey is a system engineer at Intelligent Energy Management Services, Power Parameters Pty Ltd.