Sometimes It's the Simple Things

Improving Efficiency

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This column is the third in a series exploring refrigeration and heat pump concepts without using jargon.

There are many ways that the efficiency of a refrigeration system might be compromised. Turning this around: it is fair to say that there are many ways in which the efficiency of a refrigeration system might be improved. Funnily enough, sometimes the simplest things are the least likely to be done in practice.

The definition of efficiency I like best is that it is the ratio of "what you want to do" to "what you need to do." Fridge guys think in terms of the cooling effect and the work done on the gas, but this is a bit blinkered and so sometimes misses the point.

For a pie maker what he wants to do is make pies; for a brewer it is beer. In a distribution warehouse, "what you want to do" might be measured in pallet movements and in a data center, it may be uptime or processing speed.

"What you need to do" is a bit more universal; generally it is work input, measured in kWh, which after all is what you pay for, so not an unreasonable thing for an operator to be interested in. A factory that does not measure its output is unthinkable, and yet few of them measure the electrical input to their refrigeration system in a meaningful way; and even fewer correlate that input to their output in order to track their overall efficiency.

Cold stores give a very good example of the way in which fridge guys can be too blinkered. If the cold store doors do not fit very well and the room temperature is regularly a few degrees higher than it is supposed to be, the temperature lift required of the refrigeration plant will be reduced. That's supposed to be a good thing, right? Yes, but if the result of this additional heat load is that the compressor runs all day and all night then the kWh required will ultimately be higher than if the doors were fixed, the store got down to temperature and the compressor switched off.

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Captain Kirk hears that his pies per kWh metric has gone down 10%.

Unless the store operator is measuring what he wants to do (hold pallets at the required temperature) and comparing it with what he needs to do (use electricity), he might be fooled into thinking he has a very efficient system because the temperature lift is reduced and the compressor COP is good.

Efficiency improvement is therefore a very simple three-step process.

Step 1 is to measure what you want to do and divide it by what you need to do (expressed in kWh electrical use for the whole refrigeration system). This will give a rather odd metric, which might be pies per kWh or beers per kWh or pallets per kWh, but it will mean something to the business.

Step 2 is to find things to do that increase that metric, preferably by reducing the number under the line: the "per kWh." The biggest user of kWh is the compressor so that's a good place to start. Clean the suction filter in order to reduce the temperature lift that the compressor sees. If the machine is old and worn, give it a thorough overhaul to reduce internal inefficiencies, perhaps even replacing the rotors of a screw compressor to reduce tip seal losses.

Step 3 is to compare the metric before and after the reduction and then take the difference to the boss and ask for a pay raise. It is essential to build up a record over time of the results of these measurements. This will help to spot when something goes wrong whether it happens quickly or is a gradual decline.

Beyond the compressors, there are many more users of kWh, mainly fans, pumps and heaters. They can all be targets for reducing the kWh figure.

A more subtle way to reduce kWh is to look at the run time of the plant and figure out ways to reduce it without compromising on the number over the line. Systems with hot gas defrost are a favorite of mine for this. All will be revealed in a later article.

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