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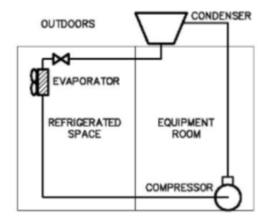
Michaels Engineering Energy Brief

INHERENTLY EFFICIENT INDUSTRIAL REFRIGERATION



SUGGESTIONS...

Do you have certain Energy Efficiency topics you'd like to know more about? Send an email with your suggestion to the author listed below and your topic might become a future Energy Brief!

DID YOU KNOW...

...Low first cost and old habits can be expensive.

...25% savings can be achieved through optimal plant design using standard compressors.

MEET THE AUTHOR

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THERE IS NO REPLACEMENT FOR THE RIGHT COMPRESSORS IN THE RIGHT LINE-UP

A wisely designed refrigeration plant can operate 25% more efficiently simply by selecting the right size compressors and staging the compression process.

With this kind of energy-saving potential why doesn't everyone do it? Typical answers include: (1) "this" is the way the contractor has always designed their compressor plants (2) preferred manufacturer "x" doesn't make a compressor of that size or characteristic or (3) it is cost prohibitive. Most of the time, none of these are legitimate reasons when energy costs are factored into the equation.

REFRIGERATION BASICS

In the simplest terms, there are four stages to a refrigeration cycle. The compressor takes low-pressure, low-temperature refrigerant gas and compresses it to high pressure and temperature. The condenser cools the high temperature gas until it condenses to liquid form. The liquid is transported to an expansion device upstream of an evaporator. The expansion device monitors refrigerant flow and reduces pressure, which causes the refrigerant to boil at low temperatures. The low temperature boiling absorbs heat from the space and this provides the cooling.

The pressure on the inlet side of the compressor is known as the suction pressure and the pressure on the discharge side of the compressor is known as the condensing pressure.

COMPRESSOR WORK

Compressor work in any refrigeration cycle is proportional to the temperature difference between the cooled space and the heat sink, usually the outdoors. Greater temperature/pressure differences (i.e., colder space) require more compressor power.

As the pressure difference rises, compressors become less efficient. The cylinders (or screws for screw compressors) get hotter. As gaseous refrigerant enters for compression it expands as it picks up heat from the compressor. This allows less refrigerant to be drawn in during the intake stroke. Also, the required clearance between piston and cylinder head results in residual refrigerant after each compression stroke. As the pressure rises, the mass of residual refrigerant increases, and this decreases efficiency. These losses increase sharply as the compression ratio increases.

SOLUTION

Break the compression process into smaller steps and use an intercooler to improve "volumetric efficiency". This mitigates the losses described above. Typically, two-stage compression using a low stage compressor and a high stage compressor is most cost effective. Savings potential is demonstrated below.

CONSIDERATIONS

Two-stage compression is suitable for systems serving freezer spaces.

A two-stage system may be more expensive depending on the level of backup that is desired. A multi-stage system inherently has some backup capability and may be enough to cover repair time for equipment problems depending on temperature requirements, even if one compressor isn't capable of carrying the entire load for a long period of time.

Compressor selection is everything. Consider the various suction temperatures and loads the system requires. Be sure the compressors operate in their "sweet spot" nearly all of the time. This will be the topic of a future brief.