



Choosing the Right Type Absorption Chiller

Single-Stage vs. Two-Stage

An example of successful implementation of advanced absorption technology is a recent project at Englewood Hospital and Medical Center in Englewood, New Jersey. After studying alternatives, the Medical Center chose to expand its chilled water capacity by adding an 850-ton Trane two-stage absorption chiller to the facility's two existing electric chillers, to serve over 1 million sq. ft. of space. The Englewood facility is served by Public Service Electric & Gas Co. (PSE&G). PSE&G Major Account Representative Steve McGivney worked with the Medical Center to develop the concept of using an absorption chiller to meet increasing needs for chilled water.

By installing an absorption chiller that uses steam from its existing boiler plant to produce chilled water for a portion of its cooling load, the Medical Center was able to avoid a prohibitively costly electric upgrade that would have been necessary had it installed a third electric chiller. It also allows the Medical Center to produce chilled water economically, by taking advantage of the lowest cost fuel. "It was the best solution," says John DiGirolomo, the hospital's director of facilities, plant operations and construction.

Having an absorption chiller that runs on high-pressure steam created by existing natural gas-fired boilers makes it possible for the hospital to reap additional energy savings, according to DiGirolomo. "It gives us added flexibility — when the cooling load is light in spring and fall,"



A single-stage steam absorption chiller such as this 160-ton Thermax model can use low-grade waste heat for process or comfort cooling.

DiGirolomo says. "If gas or oil costs less than electric, we run the steam chiller because we're making the steam anyway."

Absorption chiller technology is more than 100 years old, and yet is still being discovered by some building owners. These machines use a variety of thermal sources to drive a cycle that reliably delivers chilled water to an industrial process or to a building comfort cooling system. The decision to select absorption over compressor chilling is principally driven by operating economics and resource availability.

Also growing in popularity is the concept of the hybrid chiller plant — a combination of electric compression and absorption chillers. This approach provides the shift between electric and thermal sources, depending on energy price, electric demand charges and possible interruptible rates.

STEAM OR HOT WATER ENERGY SOURCES

Large absorption chillers use water as the refrigerant and heat as the energy input to a thermal generator to create chilled water. Most large commercial absorption

chillers use steam or hot water as thermal sources to vaporize a dilute solution of lithium bromide and water in a hermetic vessel. The water vapor produced is drawn through the condenser, where it gives up heat to the cooling tower water and through the absorption process, cools the system circulating water.

All modern lithium bromide absorption chillers operate with an internal vacuum, and use an automatic purge system to eliminate air or other non-condensable gases.

Regardless of whether you choose absorption as a primary chiller system, or combine absorption with other chiller types for a hybrid application, it is necessary to choose between single-stage and two-stage absorption machine types.

CHOOSING BETWEEN SINGLE-STAGE AND TWO-STAGE

The decision to select a single-stage vs. a two-stage absorption chiller depends on a variety of factors. The machine needs to match the characteristics of the existing building or system steam or hot water supply. Single-stage machines operate effectively on steam pressures between 10 psig and 30 psig. They also operate using hot water at temperatures ranging from 195°F to 270°F as the thermal input.

According to John Szymanski from Trane, most single-stage units actually run with hot water temperatures in the range of 175°F to 190°F, but capacity starts to drop off rapidly below 220°F and the machine provides only a fraction of nameplate capacity. He notes, "For this reason,

AT A GLANCE

- Absorption units use thermal energy from variety of sources
- Single-stage ideal for waste heat utilization
- Two-stage absorption when higher efficiency is important
- Hybrid plants offer fuel flexibility

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these projects sometimes do not move forward because of the cost of the equipment.”

Because of their abilities to use low-grade steam and hot water, single stage machines frequently are chosen when there is an existing source of process or waste heat in this range. According to Rajesh Nabar of Thermax, his company manufactures a chiller that effectively uses hot water at temperatures as low as 158°F.

OPPORTUNITY TO USE WASTE HEAT

Good examples might be to use such a single-stage machine with an existing low-pressure building steam or hot water system, or to salvage engine waste heat from cooling water coming from a reciprocating engine CHP application. Alternatively, a single-stage chiller uses steam or hot water from an industrial process. The major manufacturers offer single-stage absorbers with corrosion-resistant tubing and evaporator pans to make them suitable for a wide range of industrial applications with aggressive water conditions either on the energy supply side or the chilled water side.

Single-stage absorbers typically operate with a coefficient of performance (COP) between 0.7 and 0.8. They can deliver chilled water at temperatures down to 40°F, and are available from manufacturers including York International, Carrier, Trane, Thermax, Yazaki and Broad USA in sizes from 10 tons to as high as 2,800 tons. If steam is available at higher pressures, the more attractive option may be the two-stage absorber.

TWO-STAGE OFFERS IMPROVED EFFICIENCY

As the name implies, a two-stage absorption chiller uses two thermal generators in series to add heat to the refrigerant solution, thereby more completely extracting heat from the circulating water. They operate at temperature levels above where hot water can be used as the energy source.

The advantage of two-stage absorbers is that they operate at higher efficiency — typically extracting 10% to 20% more of the heat from the input steam. This is why the medical center cited in the beginning of this article chose a two-stage chiller. These have higher minimum steam temperatures and pressures, typically requiring a steam pressure of 60 psig and ideally between 100 psig and 135 psig.

VFDS ALLOW WIDER OPERATING RANGE

Because two-stage absorbers use a more concentrated thermal source, they offer higher operating efficiency, with COPs of 1.20 and higher. According to Nabar, Thermax offers a two-stage chiller that provides a COP of 1.43. Manufacturers of most two-stage absorbers offer variable speed drives for the absorption solution pumps, allowing higher operating efficiency and allowing the chiller to adapt to changing load conditions rapidly.

Applications where two-stage absorbers are attractive include industrial situations where higher pressure and temperature steam is available, and the annual operating hours are long enough to offset the higher initial cost. Another ideal application is with steam from a waste heat recovery boiler, for example from a gas turbine used for electric generation. Absorption chillers use the most waste heat from the turbine during the months when the demand for steam for heating is low.

HYBRID SYSTEMS OFFER FUEL FLEXIBILITY

Often these are situations where a hybrid system might also make sense. By combining electric and steam absorption cooling — as at Englewood Hospital and Medical Center — system reliability

is increased and owners can choose the source of cooling depending on available rates and avoid high summer electric demand charges.

VARIETY OF FACTORS INFLUENCE CHOICE

Szymanski says a large number of factors go into the decision to select single-stage vs. two-stage absorbers in addition to the steam pressure considerations. He indicates that higher fuel costs, longer operating hours, a need to maximize cooling capacity, and cooling tower capacity limitations favor the two stage option. Single stage systems are favored where there are first cost constraints, cheap or free waste steam or hot water, or limitations on the maintenance staff. Sometimes there is the opportunity to use a backpressure steam turbine, which generates electricity and uses the reduced-pressure steam for absorption.

Szymanski notes, “When we talk with customers about their interests, resources and cooling requirements, it usually becomes quite obvious which type of absorber will work the best.” Nabar adds, “The absorption chiller decision is quite straightforward — if you have waste steam or hot water, you go for the single-effect chiller. When you are spending money for fuel to generate steam, the double-effect is usually the best.”

PAYING A PREMIUM FOR EFFICIENCY

Certainly unit cost also is a factor in choosing between absorption types. Szmanski and Nabar agree that a two-stage absorber is typically 40% to 50% higher in installed cost than a single-stage machine of the same capacity. They note that the first cost differential can be justified if the chillers have enough run-hours and the cost of fuel is high enough to select the two-stage option.

Absorption is obviously not the only method for chilling water. But if you forecast continuing lower costs for natural gas than for electricity, or if you have an economical source of steam or hot water as waste heat, absorption may be the answer. **<GT>**