Use Low-Grade Waste Steam to Power Absorption Chillers

Reduce Demand Charges

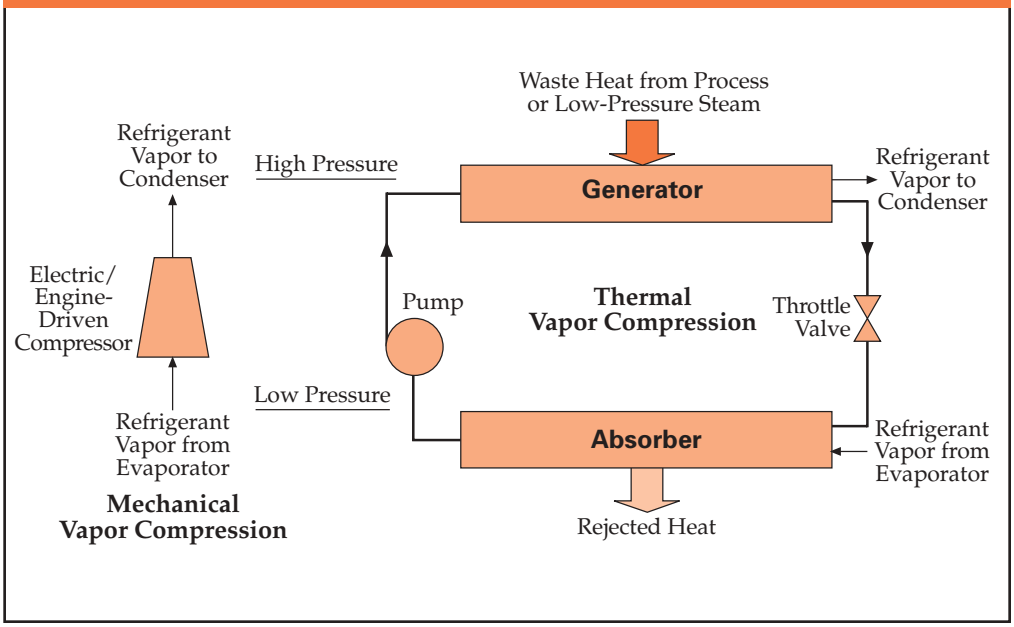
Absorption chillers can reshape facility thermal and electric load profiles by shifting cooling from an electric to a thermal load. If you are served by an electric utility with a ratcheted demand charge, you may be able to reduce demand charges throughout the year by reducing your summer peak loads.

Utility Incentives

Some gas utilities offer reduced rates during the summer. In some areas, electric utilities provide rebates or incentives to replace mechanical chillers with steam absorption units.

Absorption chillers use heat, instead of mechanical energy, to provide cooling. The mechanical vapor compressor is replaced by a thermal compressor (see figure) that consists of an absorber, a generator, a pump, and a throttling device. The refrigerant vapor from the evaporator is absorbed by a solution mixture in the absorber. This solution is then pumped to the generator where the refrigerant is revaporized using a waste steam heat source. The refrigerant-depleted solution is then returned to the absorber via a throttling device. The two most common refrigerant/absorbent mixtures used in absorption chillers are water/lithium bromide and ammonia/water.

Comparison of Mechanical and Thermal Vapor Compression Systems*



* The evaporator and the condenser, required for both systems, are not shown in the figure.

Compared to mechanical chillers, absorption chillers have a low coefficient of performance (COP = chiller load/heat input). Nonetheless, they can substantially reduce operating costs because they are energized by low-grade waste heat, while vapor compression chillers must be motor- or engine-driven.

Low-pressure, steam-driven absorption chillers are available in capacities ranging from 100 to 1,500 tons. Absorption chillers come in two commercially available designs: single-effect and double-effect. Single-effect machines provide a thermal COP of 0.7 and require about 18 pounds of 15-psig steam per ton-hour of cooling. Double-effect machines are about 40 percent more efficient, but require a higher grade of thermal input, using about 10 pounds of 100- to 150-psig steam per ton-hour.

Adapted from an Energy TIPS fact sheet that was originally published by the Industrial Energy Extension Service of Georgia Tech. For additional information on steam system efficiency measures, contact the OIT Clearinghouse at (800) 862-2086.

Example

In a plant where low-pressure steam is currently being exhausted to the atmosphere, a mechanical chiller with a COP of 4.0 is used 4,000 hours per year to produce an average of 300 tons of refrigeration. The cost of electricity at the plant is $0.05 per kilowatt-hour.

An absorption unit requiring 5,400 lbs/hr of 15-psig steam could replace the mechanical chiller, providing annual electrical cost savings of:

Annual Savings = $52,740 = 300 tons x (12,000 Btu/ton / 4.0) x 4,000 hrs/year x $0.05/kWh x kWh/3,413 Btu

Suggested Actions

Determine the cost-effectiveness of displacing a portion of your cooling load with a waste steam absorption chiller by taking the following steps:

- Conduct a plant survey to identify sources and availability of waste steam.
- Determine cooling load requirements and the cost of meeting those requirements with existing mechanical chillers or new installations.
- Obtain installed cost quotes for a waste steam absorption chiller.
- Conduct a life cycle cost analysis to determine if the waste steam absorption chiller meets your company's cost-effectiveness criteria.

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