



# Absorption Cycle

## an Asset for Industry

### Getting Comfortable with This Technology

#### AT A GLANCE

- Absorption chillers an ideal way to use available industrial thermal resources
- Plastics, food processing, petroleum, paper industries have large potential
- Installation may improve boiler efficiency
- Both single-stage and two-stage chillers available

**A**bsorption cooling can be a valuable asset for the industrial energy user trying to take full advantage of available existing thermal energy resources. One user that has successfully taken advantage of absorption technology is the Ghirardelli Chocolate Company, a California manufacturer of premium chocolate products. The firm had equipped their manufacturing facility in San Leandro with an on-site generation system, using four 350 kW natural-gas fired engines

#### ABSORPTION MAKES A SWEET SOLUTION

Rather than waste the engine cooling water heat, Ghirardelli chose to install an absorption chiller to produce water for spot air cooling for process purposes. The system was engineered and installed by

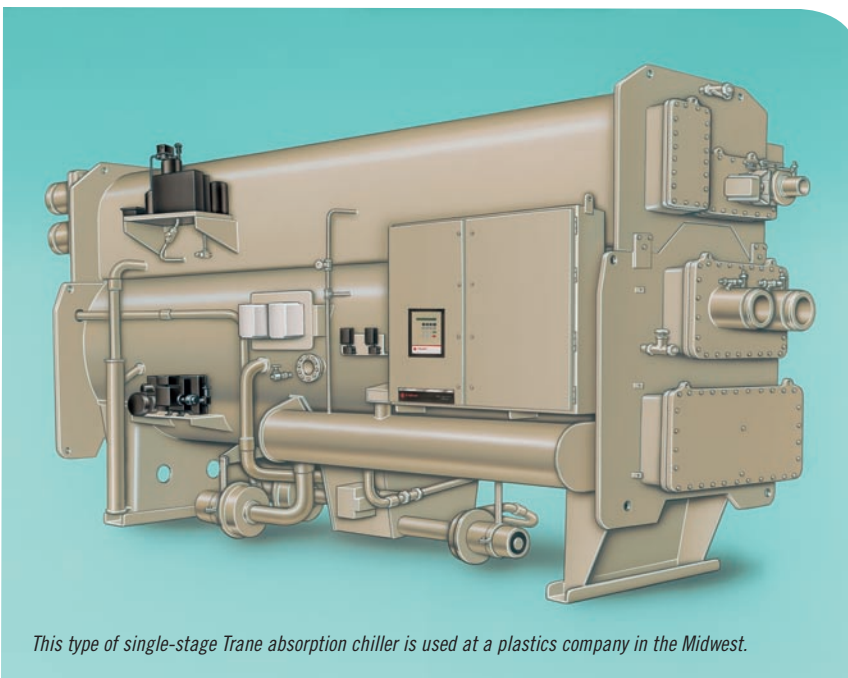
Western Allied Mechanical, a design-build firm in Menlo Park, California.

According to design engineer Loke Van Eveld, Ghirardelli was undergoing an expansion of their manufacturing site and needed additional process cooling capacity. "They wanted to improve energy efficiency and take advantage of this relatively large source of heat from engine cooling water." Ghirardelli achieved this with a York single-stage absorption chiller with a nominal capacity of 170 tons.

#### PROCESS COOLING BONUS

The chiller receives water from the generators at a rate of 330 gpm and a temperature of 200° F. It uses this thermal input to create 300 gpm of chilled water at a temperature of 44° F. This supplies heat exchangers that provide air cooling for critical chocolate processing and packaging areas.

According to Ghirardelli's engineering manager, Ty Tia, the project takes advantage of an on-site byproduct, heat, to improve the overall efficiency of the manufacturing operation. "As we enter some planned manufacturing expansions in the next few years, we will be able to take



*This type of single-stage Trane absorption chiller is used at a plastics company in the Midwest.*

even fuller advantage of this new source of cooling.” Tia notes that the absorption system also eliminates the need to operate cooling towers, which had previously been fully loaded.

Despite a history stretching back nearly 150 years, the absorption refrigeration cycle remains a bit of a mystery to many industrial and commercial facility plant managers. The concept of using a heat source to create cooling capacity seems counter-intuitive. But for those managers who have looked into the well-established potential of absorption, the rewards are sometimes great. This is

ing and then releasing water vapor into and out of a lithium bromide solution. Smaller absorption chillers sometimes use water as the absorbent and ammonia as the refrigerant. The absorption chiller operates at a partial vacuum (about 1/100th of normal atmospheric pressure) to cause the water to vaporize at a cold enough temperature (40°F) to produce chilled water at about 44°F.

#### ADOPTION OF ABSORPTION TECHNOLOGY VARIABLE

The conventional wisdom has been that absorption makes the most sense when

Absorption cooling may be the best method any time there is byproduct steam or hot water from a manufacturing process, or available surplus boiler capacity.

#### MANY INDUSTRIES HAVE LARGE POTENTIAL

In many industries — including food processing, pulp and paper, plastics manufacturing and petrochemicals — there are already large quantities of hot water or low-to-medium pressure steam available at no cost or very little additional cost. In fact, some facilities are operating cooling towers year-round to discharge this heat.

For example, at plastics manufacturing plant in the Midwest, a single-stage absorption chiller uses steam at 12-16 psig to make chilled water for process cooling. The chiller used is a Trane Horizon(tm) absorption chiller with a capacity of 750 tons. It produces chilled water at 40°F for process cooling, process safety control and to a minor extent for summer building cooling. A central facility boiler produces the steam. This unit replaced a smaller capacity older unit and the facility engineer expresses satisfaction with its reliability.

Here, as in many industrial and institutional settings, significant boiler capacity is available at the same time there is a need for chilled water. In this situation, the incremental cost of additional steam is usually low, and boiler efficiency may even be improved by operating at higher levels.

There are many major manufacturers of lithium bromide based absorption chillers, with units available in sizes from 10 tons to as large as 6600 tons. These can be matched to a wide range of steam or hot water supply conditions. Manufacturers offer both single-stage and two-stage machines. Single-stage machines can use either hot water, or steam at pressures as low as 12 psi. This is the chiller normally used with a byproduct or low-cost heat supply, as is often the case in industry. Some chillers can effectively use hot water with temperatures as low as 180°F.



*Absorption cooling provides process efficiencies, heat utilization for Ghirardelli Chocolate Company.*

especially true in industrial settings where there is abundant byproduct steam, hot water, or underutilized boiler capacity.

#### CYCLE OF ABSORPTION AND VAPORIZATION

Absorption chillers transfer thermal energy from the heat source to the heat sink through an absorbent fluid and a refrigerant. The typical absorption chiller accomplishes cooling by absorb-

ing natural gas fuel or municipal steam is inexpensive and electric rates are high, especially in the building cooling months. Today, engineers have found that even when these conditions don't prevail, absorption may be a good choice. According to a recent U.S. Department of Energy article, "Absorption chillers generally become economically attractive when there is a source of inexpensive thermal energy at temperatures between 212°F and 392°F"

**Broad USA**<http://www.broad.com.cn/index-eng.htm>**Carrier**<http://www.global.carrier.com>**Thermax**<http://www.thermax-usa.com>**Trane**<http://www.trane.com>**York**<http://www.york.com>**TWO-STAGE ABSORBERS  
FOR HIGHER EFFICIENCY**

Two-stage machines can handle steam at much higher pressures and offer coefficients of performance (COP) up to 40% greater than single-stage, at the price of a higher first cost and a somewhat more complex design. These are normally suitable if the steam pressure exceeds about 100 psi. Two-stage machines make

more sense when the owner has to pay the full cost of creating the steam, or the available medium-pressure process steam is a higher temperature than can be effectively used directly by a single-stage machine.

A third category is direct-fired absorption machines. These have on-board steam generators and may be an attractive option where natural gas is available at an attractive rate. An example might be industrial users that have an annual gas contract with take-or-pay provisions during summer low process usage times, when facility absorption cooling may be useful.

Absorption chillers are mechanically simple machines, with the only moving parts being the pumps and the throttling valves. For this reason, if they are well-built and maintained and used in the right application, they have very long

operating lives. This durability is an often-forgotten virtue of absorption. Maintenance consists of regular inspection, refrigerant testing and prompt correction of any problems such as air or refrigerant leaks. Today's digital controls help assure that the operating fluids stay within necessary guidelines, thus virtually eliminating the former risks of solution crystallization or freezing.

Absorption cooling is finding new fans in commercial and industrial applications, especially where there is an existing source of heat, either as steam or hot water, and a need for process or comfort cooling. If you feel your installation may have potential, the next step is to have an engineer who understands absorption cooling evaluate the site and make a recommendation. This not-so-mysterious technology may be the solution you have needed. **<GT>**