

Adsorption Chillers for Chemical Industry

In the chemical industry, low grade waste heat, through which hot water can be generated at 50o-100oC, is produced in abundance and wasted. This low-grade waste heat can now be used efficiently for process cooling or air conditioning in an eco-friendly way to optimize energy efficiency

It's an advanced green technology using inert 'Silica Gel (Adsorbent) – Water'(Refrigerant) pair.

For the first time in India, Bry-Air has introduced the Adsorption Chiller, an Energy smart green cooling technology that uses low grade waste heat from process waste heat, solar heat and tri-generation (CHP) to produce chilled water for process cooling and air conditioning.

Why Adsorption Chillers?

In the past, the low cost of fuel and feedstock enabled the chemical industry to operate mechanical chillers affordably. But today's fuel prices are creating an opportunity to recover low grade waste heat for Adsorption Chillers. Energy saved add to the bottom line. Process in chemical plant like reflux condensers, condensate streams, product coolers, boiler exhausts, boiler blow down, PRDS cooling, compressor inter stage and after coolers and process furnaces, all produce heat that can be used in adsorption chillers to produce chilled water.

There are other multiple low grade heat sources like evaporator condensate heat that can generate hot water from 60o-80oC in chemical plants. Process will benefit if it can run economically with water supplied at lower temperatures. The process streams can be cooled by Adsorption Chiller using low grade waste heat and replace both product cooler and



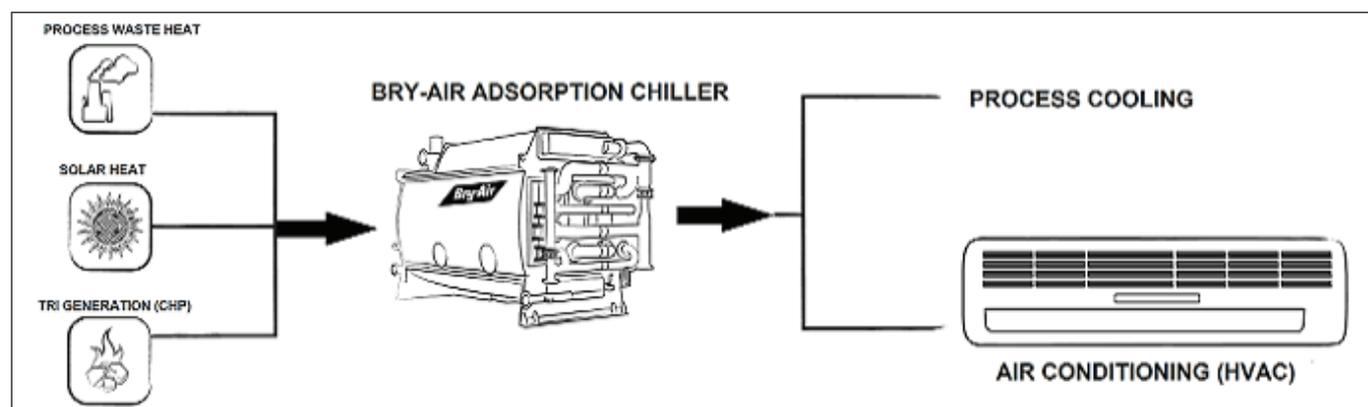
mechanical refrigeration systems and reduces the wear and tear associated with mechanical cooling equipment. Capturing and using waste heat could be one of the largest conservation and green house gas reduction opportunities. Heat recovery is an opportunity to recycle energy that is typically wasted.

The Adsorption Chiller is a unique approach to save energy cost for air conditioning and process cooling. Low grade waste heat is the driver for Adsorption Chillers rather than from large amounts of electricity like conventional air conditioners. The heat extracted from the chilled water and the heat consumed from the hot water is directed into a cooling water system used to dissipate this energy. Very little electric

power is consumed running the chiller. The electric power consumed by the adsorption chiller is mainly by the refrigerant circulation pump, PLC (programmable logic controller) and the intermittent running of a fractional horsepower vacuum pump. Amount of electricity is same as a handful of old-fashioned incandescent light bulbs.

Why Recover Waste Heat?

Industrial operations represent a significant source of greenhouse gas emissions and most of the waste heat is simply rejected via cooling towers to the atmosphere. It can be thought of as "dumped" heat. Waste heat is the by-product of system inefficiencies found in industrial and commercial process and represents a waste of resources,



Attribute	Adsorption Chiller	Absorption Chiller
Continuous operation	Over 8,000 hours per year continuous operation possible	Frequent shut-down maintenance for the dilution of lithium bromide solution
Start-up/Shut-Down Time	No special procedures. Full capacity reached in 8 minutes maximum. No adverse effects from loss of power.	Dilution cycle required. Start-up and Shut-down time varies with manufacturer.
Maintenance	Virtually none	Needs continuous monitoring and maintenance including: 1) Liquid analysis (replacement indication) 2) Pumps 3) Controls 4) Back-up Boiler 5) Air Leakage 6) Li-Br exchange 7) Heat exchanger replacement (corrosion)
Internal Material	Municipal water and silica gel, S ₂	Distilled water and lithium-bromide
Hot water working range	Continuously variable, 50°-96°C (122°-200°F) or higher; simple automatic shutdown at 50°C (122°F)	Variation must be tightly controlled between 180° and 100°C (212°F) or higher; backup heat required if hot water is below 80°C (175°F) to prevent crystallization
Cooling water working range	Preferably <30°C to 10°C (85°F to 50°F). Lower temperatures increase capacity of the system.	Must be between 18°C (65°F) and 30°C (85°F) using a control valve
Chilled water output	5°-10°C (40°-55°F) is normal	9°C (48°F) or warmer
Frequency of desiccant replacement	N/A	Every 4-5 years
End-of-life	No special disposal requirement	Hazardous materials concerns and disposal procedures required

Adsorption versus Absorption Chiller comparison

opportunities and money. Waste heat is commonly generated during:

- Steam generation;
- Power generation;
- Process heating;
- Heating and cooling fluids and gases.

Why Adsorption is a Better Choice than Absorption?

Previous thermally driven chillers have been effective but have been burdened with significant maintenance and upkeep. Absorption chiller systems often depend on a corrosive solution of lithium bromide salt that tends to corrode the internal copper tubing and steel shell of the unit. Additionally, Absorption Chillers produce hydrogen gas as a by-product, requiring an expensive palladium cell inside the chiller

unit to remove the hydrogen.

The lithium bromide solution in absorption chillers also has phase state challenges and has a tendency to solidify within the system while operating. If the regeneration temperature becomes too hot or too cold, or the conditions change too rapidly for the system to adapt, the liquid salt will solidify and crystallize inside the chiller unit. Many installations of absorption units require a dedicated caretaker to maintain.

Conversely, Adsorption Chillers use municipal water as the refrigerant and solid silica gel as the desiccant. There are no CFCs or freons, no Li-Br, and no ammonia. Not using these chemicals equates to no potential for hazardous material leaks, no aggressive corrosion, no chemical testing required and no damage to upper-level atmospheric ozone.

An Adsorption Chiller significantly reduces the maintenance and upkeep costs by substituting the corrosive salt desiccant with a benign silica gel. Reliability and machine availability are significantly improved. Adsorption Chillers have very few moving parts and do not require the maintenance and attention that the absorption chiller systems require.

Why an Adsorption Chiller is a better choice than Mechanical Chiller?

Absorption chillers eliminate noisy compressors, high-pressure refrigerant systems, high amperage electrical connections, refrigerant monitoring and alarm systems, and high maintenance costs. Adsorption Chillers, will provide a 99% reduction in the chiller's electrical usage.

Attribute	Adsorption Chiller	Mechanical Chiller
Sound Pressure Level	Very low <50 db (A)	Loud >80 db (A)
Operating Cost	Negligible	High
Maintenance	Virtually none	Seasonal maintenance required. Annual oil analysis Replace oil every 5 years Periodic tear down and rebuild required Replacement of bearings every 15 years
Chemistry	Municipal water and special silica gel-S ₂	HFC and HCFC refrigerant with synthetic oils
Energy requirements	Hot water: 50°C to 93°C (122°F to 200°F)	Electricity – 208/230,480 or 4,160 volts
Cooling Water requirement	Preferably <30°C to 10°C (85°F to 50°F) Lower temperatures increase capacity of the system	30°C to 18°C (85°F to 65°F) minimum temperature - unstable at low temperatures
End-of-life	No special disposal requirement	Certified technician required to reclaim all refrigerant for release to the atmosphere

Adsorption versus Mechanical Chiller comparison

How does the Bry-Air Adsorption Chiller work ?

The principle of adsorption works with the interaction of gases and solids. With adsorption chilling, the molecular interaction between the solid and the gas allow the gas to be adsorbed into the solid. The adsorption chamber of the chiller is filled with solid material, silica

gel, eliminating the need for moving parts and eliminating the noise associated with those moving parts. The silica gel creates an extremely low humidity condition that causes the water refrigerant to evaporate at a low temperature.

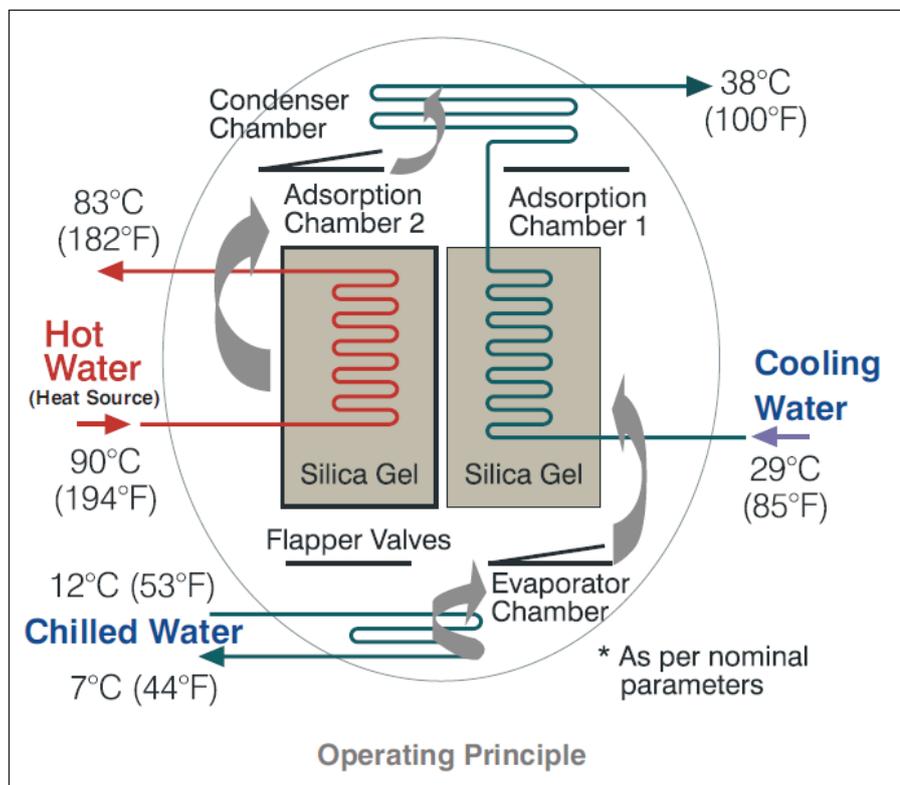
As the water evaporates in the evaporator, it cools the chilled water. The Adsorption Chiller has four chambers; an evaporator,

a condenser and two adsorption chambers. All four chambers are operated at nearly a full vacuum.

The Adsorption Chiller uses a simple refrigeration process. The chiller cycles the adsorption chambers 1 and 2 between the processes of adsorbing and desorbing. In the figure above, the water vapour flashes off the surface of the tubes in the evaporator, creating the chilling effect captured in the output of chilled water. The water vapour enters Chamber 1 through the open ports in the bottom of the chamber and is adsorbed into the silica gel in Chamber 1. Cool water is circulated in this chamber to remove the heat deposited in Chamber 1 by the adsorption process.

Hot water enters Chamber 2 to regenerate or desorb the silica gel while Chamber 1 is in the adsorption process. The water vapour is driven from the silica gel by the hot water. The refrigerant water vapour rises to the condenser portion of the machine where it is then condensed to a liquid state. The condenser water is recycled in a closed-loop to the bottom of the machine where it is immediately available for re-use.

As the machine cycles, the pressure in Chamber 1 is slightly lower than in the evaporator chamber. A portion of the water refrigerant evaporates and moves to Chamber 1. Simultaneously, the pressure





in Chamber 2 elevates slightly as the water vapour is driven from the silica gel. The water vapour is then pushed to the condenser chamber where it is condensed back to the liquid state and returns to the evaporator chamber.

When the silica gel in Chamber 1 is saturated with water and the silica gel in Chamber 2 is dry, the machine's process reverses. The first step is the opening of a valve between the two chambers, allowing the pressure to equalize. Then, cool water is sent through Chamber 2 to transfer any residual heat to Chamber 1, which begins the heating process. The reversal is

completed and the adsorption in Chamber 2 commences while Chamber 1 is dried by the desorption heating.

The Adsorption Chiller is capable of operating within a wide range of temperatures. The machine self-regulates and balances the performance of the system by the control programs, shifting to the program best suited for the system conditions. For optimal performance of the Adsorption Chillers the hot water should be 90°C (194°F), the cool water about 24°C to 35°C (75°F to 95°F) and the output cold water 7°C to 12°C (45°F to 55°F).

The Bry-Air Adsorption Chiller

Bry-Air, as a global leader in Adsorption technology, has developed a special grade high performance Silica Gel with very high Kinetics.

The Bry-Air Adsorption Chiller is based on advanced green technology using inert, very special Silica Gel S2 (adsorbent) and Water (refrigerant) pair. Both Silica gel and water are inert, making them an ideal combination for green technology.

Bry-Air Adsorption Chillers are effective as a stand-alone system either as an enhancement to a current HVAC system or a replacement technology to a current chiller system.

Industries/applications that generate a steady stream of waste heat as well as have the demand for either chilled air or

water include:

- Chemical Industry
- Power Plants
- Food and Beverage Industry
- Petrochemicals and Refineries
- CHP

The new Bry-Air Adsorption Chiller can convert this waste heat into usable cooling. The current range is 35 kW to 1180 kW (20 to 335 tonnes) and is manufactured in India by Bry-Air under license from Power Partners, Inc, USA (PPI). PPI markets energy-efficient, environment-friendly ECO-MAX Adsorption Chillers that are manufactured in Athens, GA, USA.

The smaller range starting of 10 kW to 35 kW is currently under phased release by Bry-Air and can be stacked as modules.

In most cases, the Bry-Air Adsorption Chillers pays back in less than 3-4 years. With a life more than 25 years and a lower life cycle cost, the cost of ownership effectively is above half to a one third of the Absorption Chiller.

With rising power costs every day, here's your best chance to reduce them permanently. Opt for Bry-Air Adsorption Chillers and use waste heat to cool you.

You would love to see savings in your energy bills! And also leave a cleaner and healthier environment for your children.

Contact us to learn the Bry-Air MAGIC. bryairmarketing@pahwa.com or visit us at www.bryair.com ▣

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