ATMOsphere AMERICA
business case
natural refrigerants
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MAYEKAWA
MYCOM

Water Source CO_2 Hot Water Heat Pumps

Lessons Learned from Commercial Installations

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Mayekawa CO_2 Heat Pump Technology

Air Heat Source HW Heat Pump
UNIMO AW

Water Heat Source HW Heat Pump
UNIMO WW

Air & Water Heat Source HW Heat Pump
UNIMO AWW

Achieve Energy Conservation and Reduction of CO_2 Emissions by the use of the Natural Refrigerant CO_2 + Heat Pump Technology !!

Hot Air Supply Heat Pump
ECO SIROCCO

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Commercial Installation Examples
- Water Source CO_2 Hot Water Heat Pump -

Lessons Learned From Actual Project Installations Overview:

- Existing Hot Water System Integration – Design Phase
- New Hot Water System Integration – Design Phase

- Existing Hot Water System Installation
- New Hot Water System Installation

- Existing and New Hot Water System O & M

- Existing and New Hot Water System Project Economic Results

Project installations referenced:

- Winery Facility installed 7/2010 using 25F to 40F prop. glycol as the heat source
- Hotel / Resort installed 6/2013 using 44F to 54F chilled water as the heat source

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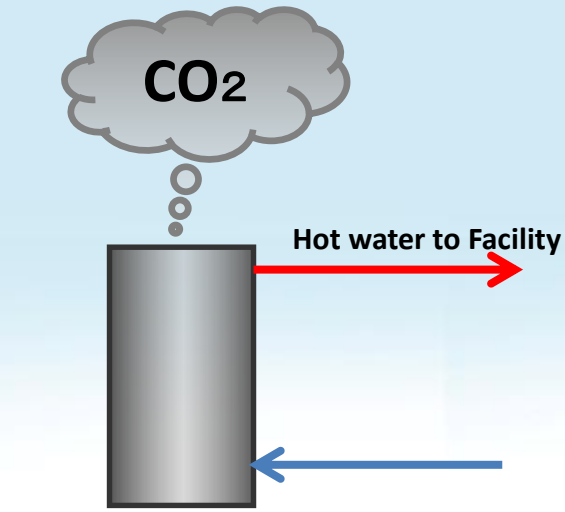
Existing Hot Water System Integration – Design Phase

In many Commercial Applications, a need exists for simultaneous cooling and heating that is traditionally designed with a separate Boiler / Hot Water Heater and Electric Chiller

A & E Firms and Contractors need to reconsider this approach!

Heating Process

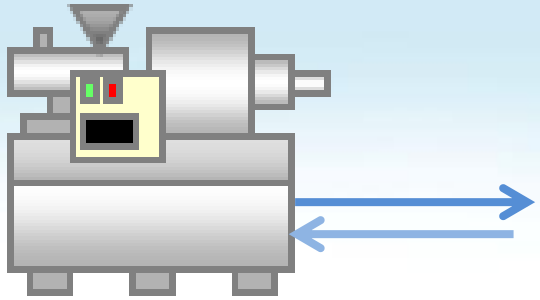
Scope of work typically provided by Plumbing Engineer/Contractor



Boiler / Hot Water Heater

Heat Removal Process

Scope of work typically provided by HVAC Engineer/Contractor



Central Electric Chiller Medium Temp Process or A/C chilled water

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Existing Hot Water System Integration – Design Phase

- A thorough review of existing facility energy use for chilled water and hot water systems including peak hot water demand is very important to calculate accurate ROI/LCCA data for each specific project. These heat pumps are not a “drop in” solution at this time.

- Water quality is very important with these units as they can develop very high refrigerant temperatures in the gas cooler which can lead to fouling/scaling issues. The designer must consider using a secondary heat exchanger if the quality is out of recommended limits, which can lower overall efficiency and increase cost.

- The designer needs to account for varying heat source temperatures and inlet water temperatures to ensure capacity of new heat pump(s) along with any storage system matches the design peak hot water demand. The CO2 hot water heat pump can have widely varying performance at different fluid temperature conditions during a 24 hour cycle and this must be accounted for in the analysis of each project.

New Hot Water System Integration – Design Phase

- The same areas indicated in previous slide for Existing Hot Water System apply for new projects that are integrating CO2 hot water heat pumps.

Opportunities that can be applied with New Hot Water System Integration:

- The designer should consider if a low temperature hydronic heating system could be employed for the Facility to utilize CO2 Hot Water heat pumps for combination Domestic / Hydronic Heating applications. The CO2 transcritical cycle requires a higher "lift" temperature than traditional Hydronic heating systems and there is a maximum 150F inlet temperature allowed, therefore high temperature Hydronic systems are difficult to design with these heat pumps.

- There are ways to reduce the inlet water (hot side) temperature to the heat pump, thereby increasing unit capacity and COP, when using a hot water system with a storage tank or circulated return back to heat pump versus a cold city/well water inlet to heat pump. The designer should consider various piping layouts to optimize the heat pumps' performance.

Existing Hot Water System Installation

Easy installation with all Piping and Electrical connections external of the Heat Pump

Flexible Heat Source Piping Connections to Existing Chilled Water Mains

Possible to integrate Hot water thermal storage to meet peak demand using a secondary coil internal of tank.

Note: Hot Water system piping must use material suitable for the high outlet temperatures that can be achieved with CO2 transcritical heat pumps such as copper or stainless steel. Some locations have used PVC-80 for 120-130F existing HW systems, and this piping material is not suited for the 150-194F HW outlet from CO2 heat pumps.

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New Hot Water System Installation

Flexible unit location with NEMA 3R enclosure for indoor or outdoor use

Possible to incorporate multiple heat sources in the design of a new project to take advantage of maximum heat recovery opportunities

Existing and New Hot Water System O & M

- Due to the simple design and unit's ability to handle a wide variety of heat source temperatures while maintaining maximum performance, a key to Mayekawa's design, these offer the End User a solution that can be maintained by qualified service contractors and trained onsite maintenance personnel.

- Most service related issues on these units for these two projects and many others Mayekawa has done are due to external issues that cause the Heat Pump to stop functioning. These include plugged/dirty fluid strainers on inlet to heat pump and electrical quality issues such as "brown outs".

- The internal unit maintenance required is very minimal including compressor oil check/change at required mfg interval, tightening of electrical terminals and functional check of system via the onboard Control Touchscreen which displays all operational data including alarm events.

Examples of Heat Pump internal component service related issues:
Due to high silica levels in well water supply, the CO2 gas cooler became plugged With silica which was impossible to remove, even with pure acid flush. The entire Gas Cooler had to be replaced.

High side CO2 pressure transducer failed at connection point causing loss of charge. A local contractor was sent to site with mfg. instructions on how to evacuate, recharge CO2 and restart unit, after transducer was replaced, with no problems encountered.

Existing and New Hot Water System
- Project Economic Results -

Project A: Winery Facility

Conditions: 25F to 40F Propylene Glycol/Water Heat Source and 194F Hot Water Outlet

Achieved a 24% reduction in overall energy costs. ($2.65 gal. LPG & $.12 kWh)

- Actual ROI result (including LCCA): 3.4 years - Design ROI: 3.8 years
- Includes main glycol chiller electric capacity offset provided by heat pump

Achieved a 39% reduction in overall carbon emissions.

- Original carbon emissions with LPG boilers: 231,810 lbs./year
- New carbon emissions value with CO2 WS heat pump: 138,640 lbs./year
- Total carbon emissions reduction for installation: **- 93,170 lbs./year !**

Project B: Hotel / Resort

Conditions: 44F to 54F Chilled Water Heat Source and 194F Hot Water Outlet

Achieved a 22% reduction in overall energy costs. ($2.90 gal. LPG & $.14 kWh)

- Projected ROI result (including LCCA): 4.2 years - Design ROI: 2.9 years
- Includes chilled water electric capacity offset provided by heat pump

Achieved a 41% reduction in overall carbon emissions.

- Original carbon emissions with LPG hot water heaters: 252,370 lbs./year
- New carbon emissions value with CO2 WS heat pump: 146,385 lbs./year
- Total carbon emissions reduction for installation: **- 105,985 lbs./year !**

Summary and Benefits of Using Water Source CO_2 Hot Water Heat Pumps in Commercial Applications

- ✓ A significant opportunity exists within the Commercial Market to implement Water Source CO2 Hot Water Heat Pumps to reduce energy consumption and reduce CO2 emissions in a multitude of applications.
- ✓ The CO2 transcritical cycle hot water heat pump is a well proven technology for hot water heating purposes with a large installation base across the Globe.
- ✓ Combining a cooling function and hot water heating function into one small package with simultaneous operation offers application flexibility and increased COP of overall cooling/hot water heating system.
- ✓ Units are simple to operate and service, requiring basic site training after startup to Contractors and End Users.

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Mayekawa USA

Our Mission – 3E's

Ecology
Energy
Environment

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