Industrial Heat Pumped Hot Water

Ellen Makar

Energy Concepts Company

Introduction

- Thermally powered absorption cycle provides chilling and heating
- Produces hot water and chilled water simultaneously, sized for hot water load
- EF with direct gas firing = 1.38 (hot water)
- Hot water temperature 120°F to 160°F
- Chill temperature 16°F to 41°F
- Demonstrated at small, large scale; currently installing >800,000 Btu/hr

ThermoSorber

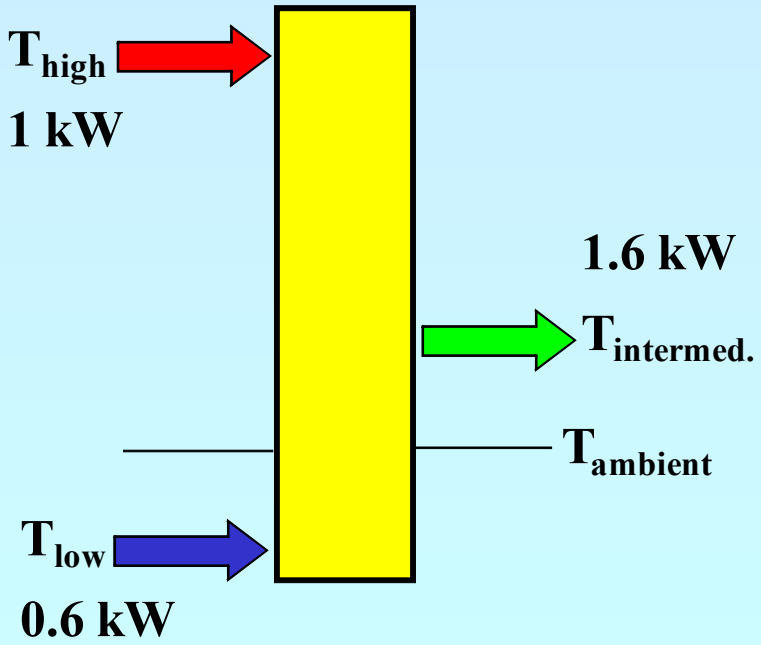
- Drive heat:
  - gas powered via hot water boiler
  - Solar hot water
  - Steam
  - Waste heat such as exhaust
  - Direct gas firing- future development
- $COP_{heating}$ = 1.58; $COP_{cooling}$= 0.58
- Combined COP = 2.16
- No ambient restrictions

Design Strategy

High temperature lift, high COP achieved by:

- **NH_3- H_2O working pair**
- **High efficiency cycle**
- **Extensive internal heat recovery**
- **High efficiency non-adiabatic rectifier**
- **Components with close approaches**
- **Optimized controls**
- **Inventory optimized to adjust to changing ambient conditions / turndown**

Energy Savings



Energy Input / Output of ThermoSorber

Current Markets

- Applications that need hot water and chilled water at the same time:
  - Meat / Poultry / Food Processing
  - Hotels / Hospitality
  - Laundries
  - Hospitals
  - District Heating & Cooling

ThermoSorber Features

- No cooling tower required: Condenser and Absorber heat is captured at useful temperatures
- No cooling tower means additional benefit for the customer: no electric service or need for fans, pumps; reduced maintenance; no makeup water or purge
- ThermoSorber sized to meet hot water demand, and maximize run time and energy savings
- Chilling duty on site is usually larger, so chill load available
- Subcooling site refrigerant can add up to 20% refrigeration capacity

Small Scale Demonstration

- Poultry processor needs hot water to scald (135°F); and chilled water (33°F) to cool product
- 15 RT ThermoSorber runs on 275°F glycol from hot water boiler
- Provides 8.5 gpm of 135°F hot water for 14 hrs/day (507,272 Btu/hr)
- HW storage tanks meet hot water demand all day
- Chilling sub-cools 3 refrigerant streams to 32°F

Small Scale Demonstration

Large Scale Demonstration Installation

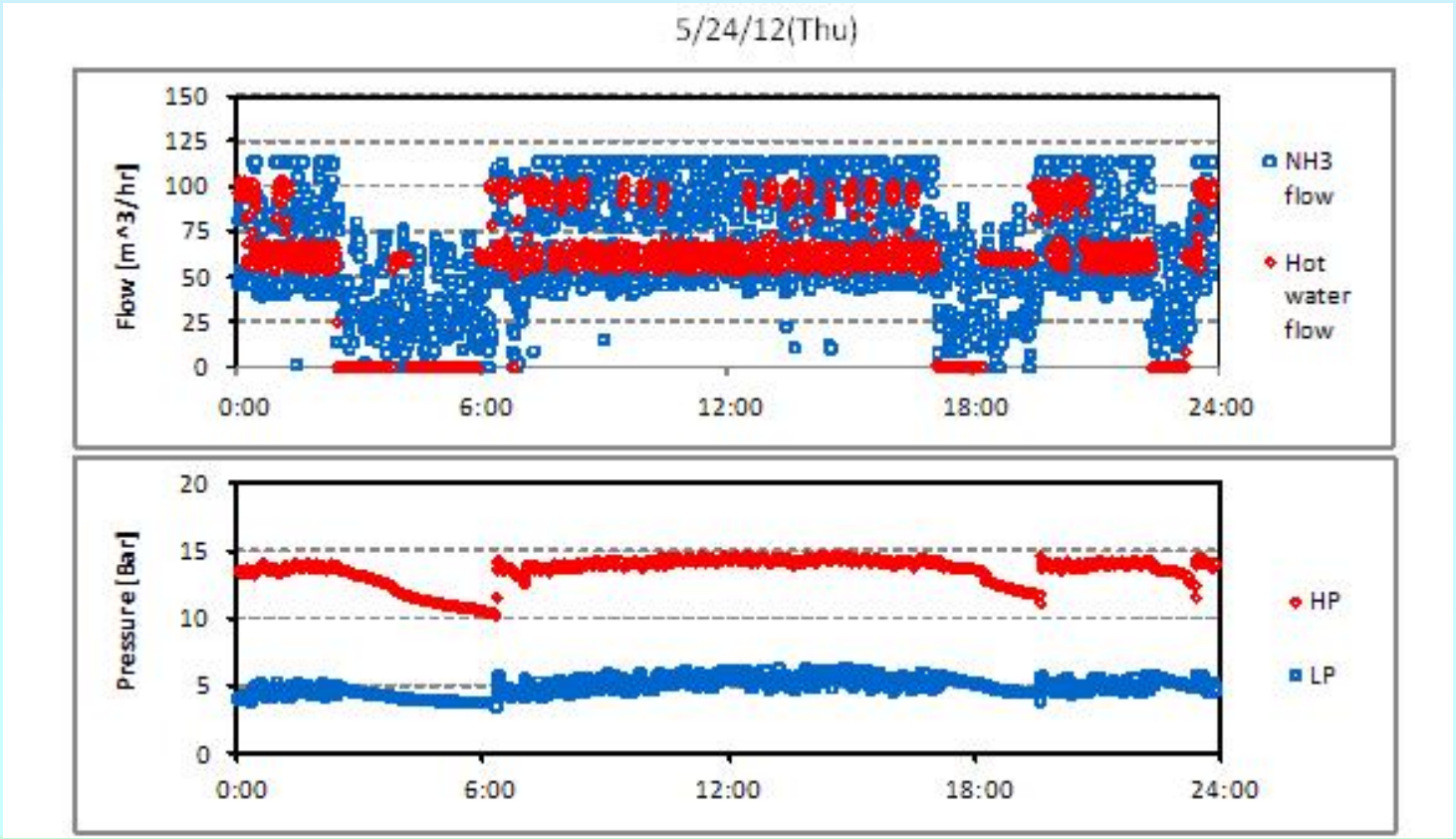
Large Scale Demonstration

- Meat packer needs 145°F hot water and 300RT refrigeration
- ThermoSorber runs on 7,500 lbm/hr of 100 psig steam
- 10.5 MMBTUH of 145°F hot water
- Chilling sub-cools plant refrigerant stream to 35°F ; average 355 RT when running
- Highly variable heating and chilling load

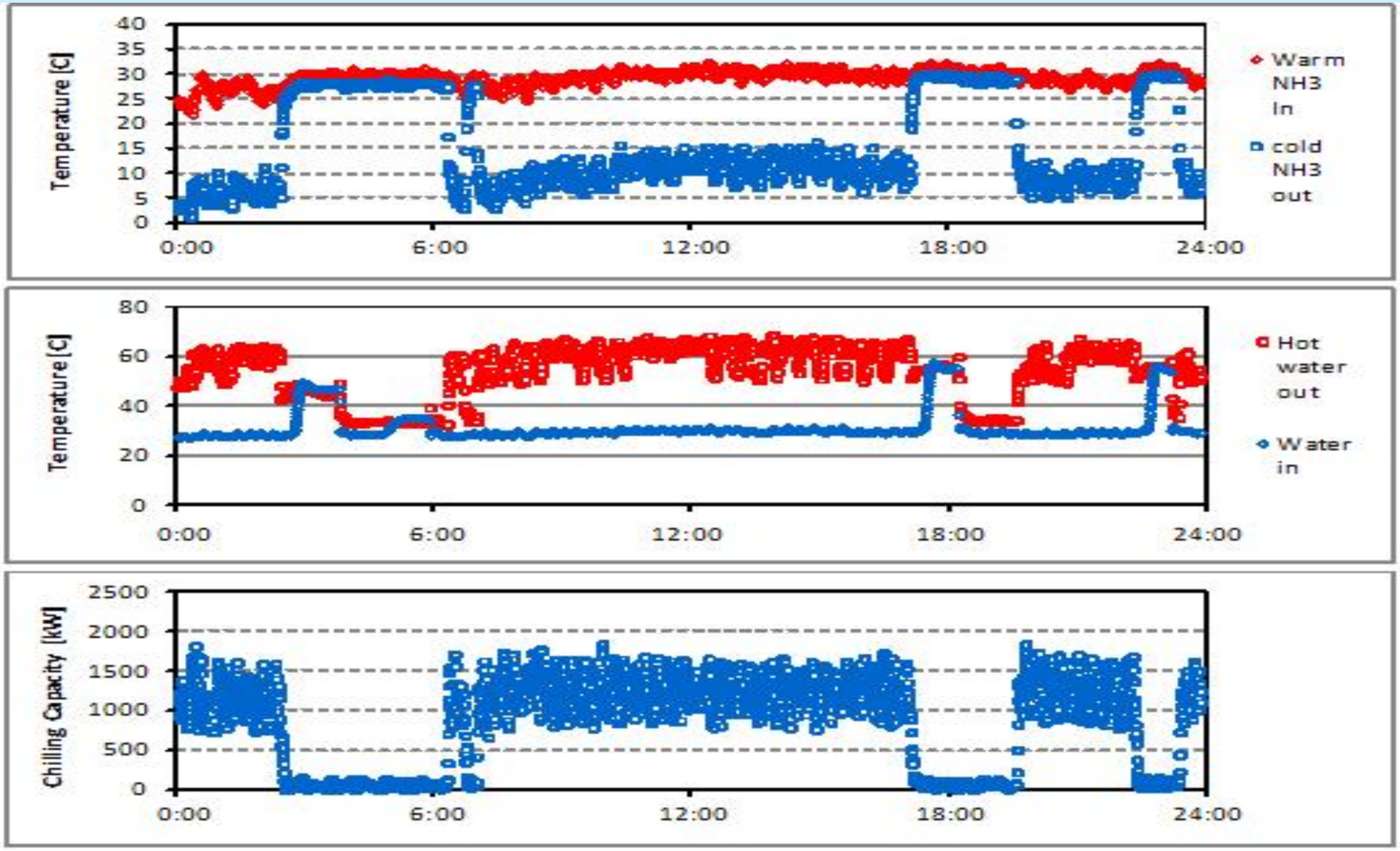
Large Scale Demonstration

Data collected: flows, pressures, temperatures;

Chilling/Heating Duty calculated



Large Scale Demonstration

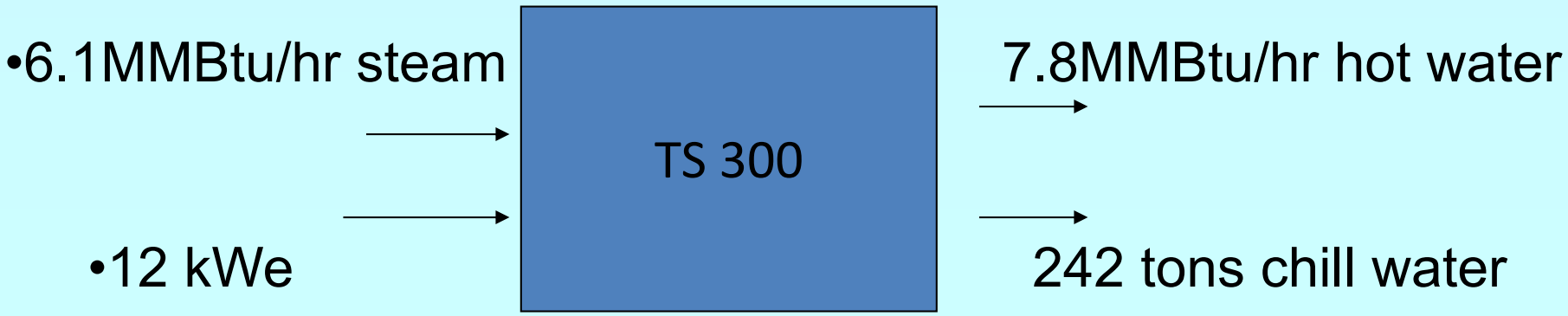


Large Scale Demonstration- Performance

- Continuous Scalder and chiller: 50,000 birds/hour
- Hot water heating requirement: 206gpm from 61°F to 135°F

  = 7.8 MMBtu./hr hot water (**9.7 MMBtu/hr Boiler**)
- Chill water requirement: 206 gpm from 61°F to 35°F

  = 242 tons (compressor 242 kWe)

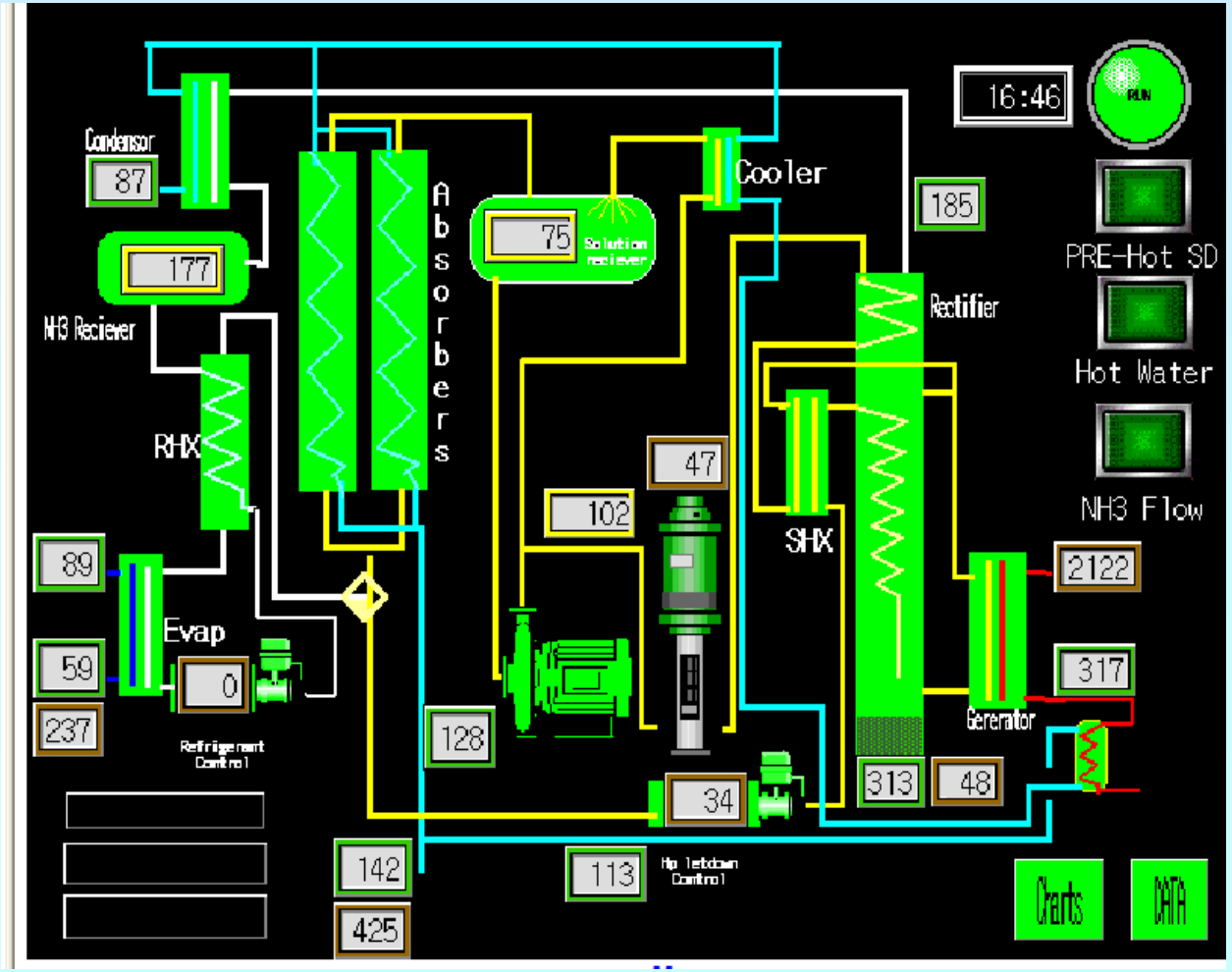


Large Scale Demonstration- Savings

•HOURLY SAVINGS	
- 1,055 kWht @ $0.031/kWht	$32.40
- 230 kWhe @ $0.09/kWhe	$20.70
	$53.10/hour
•ANNUAL SAVINGS (for 20/5 operation)	
- 5200 HOURS @ $53.10	**$276,120/yr**
•INSTALLED COST	$500,000
•PAYBACK	**1.8 years**
•AVOIDED CO2 EMISSIONS	**1984 tons / yr**

Remote Monitoring

- Accessible via internet
- Shows operational status
- All data
- faults / alarms



Remote Monitoring

Data collected every 30 seconds,

Stored for 30 days,

Can be remotely downloaded

Conclusions

- Novel absorption heat pump cycle developed and demonstrated
- Doubles the energy efficiency of producing hot water
- More energy efficient than compression heat pumps
- Major energy savings available to users with coincident hot water and chilling demand
- Looking for development partners for small capacity implementation