Electrification of Heating

Powered by Trane
Sustained by Nature
Heat pumps are classified by heat source and heat distribution system

- Air to Air

- Air to Water

- Water to Air

- Water to Water

Heat pumps transfer (move) energy very effectively. They typically have an average coefficient of performance (COP) in the order of 2-5 depending on operating conditions. In other words, they move multiple units of heat energy per one unit of electrical input.
Working Principle – reversible heat pump

Heat sink

Compression

Condensation

Evaporation

Expansion

Cold distribution

Heat source

Compression

Evaporation

Condensation

Expansion

Heat distribution

Summer

Winter
Air-to-water application overview

Trane’s portfolio

- CGAF
- RTAF
- GVAF

Chiller + Heat Recovery

- CGAF or RTAF
- PHR
- THR

Heat Pump

- CXAF

Heat Recovery Heat Pump

- RTXC
- CXAF
- PHR

Multi-pipe

- CMAF

Cooling only

Heating while Cooling

Heating or Cooling

Heating while Cooling
Or
Heating/Cooling

Any combination

The most versatile and flexible portfolio of Air-to-Water Heat Pumps
What is a Multi-pipe unit?

Operating modes:

- **Chiller**
  - 0% HEATING
  - 100% COOLING
  - Condenser only disposes of heat

- **Heat Pump**
  - 100% HEATING
  - 0% COOLING
  - Evaporator not utilized
  - Separate HX for hot water

- **Chiller + Heat Recovery**
  - 100% HEATING
  - 100% COOLING
  - Condenser & evaporator fully utilized for cooling/heating needs

- **Heating**, **Cooling**, plus **simultaneous** heating and cooling
- Different to traditional heat pumps as there are separate heat exchangers for CHW and HW production
- Combines an A-W H/P with a W-W H/P within the same unit
Preferential loading is desirable when applying heat recovery where heat energy can be recovered from the cooling demand. Side-stream location also permits application in a VPF system.
Boilers vs heat pumps / defrosting

• When ambient air temperature is low (below 6ºC) and the relative humidity is high, the heat pump coils will condense moisture and freeze up

• **Defrost cycle is:**
  • Reversing the refrigerant cycle of the circuit (with 4-way reversing valve)
  • Once back in cooling mode the hot gas will flow through the condenser coils and ensure the coil defrosting

• **Defrost time and defrost cycles depending:**
  • Ambient air temperature and relative humidity
  • Heat pump load
  • Air flow over the coils.
  • Maintenance condition of unit

• **Heat pump refrigerant circuit in defrosting cycle is NOT providing heat to the hot water loop**
  • .... there is no magic. Valid for all manufacturers
Hydraulic System

Hot water circuit

Chilled water circuit

Rule of thumb: Minimum water content in hot water circuit = 3x chilled water circuit

Based on $\Delta T$ of 5°C on the heat exchanger. IOM provides very good info on this

Heat pump system designs need to consider defrost cycles
Innovative technologies exist to improve defrost performance

Dynamic Receiver
Varying refrigerant level in TARS
Traditional building cool/heat system

Chiller for cooling
Gas Boiler for heating

4-6 row

80 C
60 C
6 C
14 C
1 row

14 C
What is boosting?

Boosting installs a high temperature water to water heat pump in cascade with an air to water heat pump to produce “boiler grade” 70-80°C heating temperatures from a lower grade energy source.
Water to Water heat pumps (R1234ze) provide up to 70-80 deg C

Flexibility for a wide range of flow rates and delta T’s
2050 mm max.

920 mm

Easy for retrofit application
Buffer tank provides loop volume for defrost and/or mode changes

A-W Heat Pump
OR
Multi-pipe

Boosting

Full HFO solution
Boosting to equivalent boiler temperatures

Design ambient 7 deg C

Air to water heat pump
4.28 COP

Water to water heat pump
3.71 COP

System COP = 2.22
Air to Water heat pump efficiency depends on ambient temperature and heating water temperatures.

Water to Water heat pump efficiency depends on cooling water and heating water temperatures.
Boosting with heating water reset (match supply temperature to part load / off design demand)

Off- Design ambient 16 deg C

Air to water heat pump 5.32 COP

Water to water heat pump 7.3 COP

System COP = 3.35
What impacts CO2 reduction when moving away from Gas Heating?

- Carbon intensity of the source energy
- Water temperatures used for heating
- Equipment / System efficiencies