HVAC Systems

HVAC Objectives

- Health
- Safety
- Comfort
  - Temperature, humidity, air speed, noise, light
- Reliability
  - Long term performance, maintainable
- Efficiency
  - Meet the needs imposed by occupants and enclosure with a minimum of additional energy

12/10/10 2

Functions

- Five Critical functions are needed
- Ventilation
  - "fresh air"
  - Dilute / flush pollutants
- Heating
- Cooling
- Humidity Control
- Air filtration / pollutant Removal
  - Remove particles from inside and outside air
  - Remove pollutants in special systems

12/10/10 3

Physical Systems & Components

- Components
  - Heat production (including cooling)
  - Heat rejection / collection
  - Heat/Cold Distribution
  - Ventilation air supply/exhaust
  - Ventilation Air Distribution Air Filtration
  - Humidification/ Dehumidification
- Confusion arises when functions are combined across different components in different systems

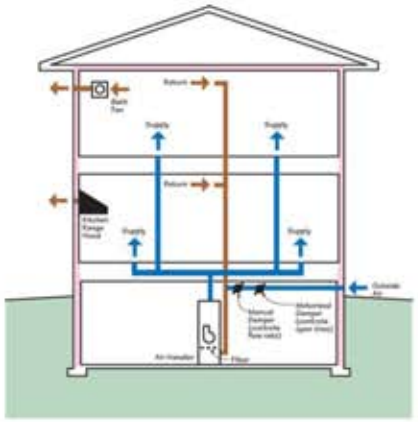
12/10/10 4

Minimum "Good" System

Ducts shared for ventilation, dehumidification, cooling heating

Heat or cold can be by heat pump, furnace, ground water, solar, wood, etc

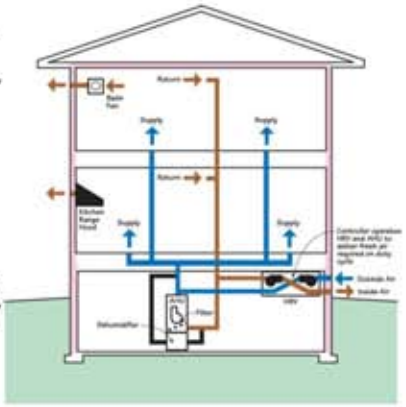
FanCycler ensures fresh air or required amount delivered to each room



Best Affordable

Ducts shared for ventilation, dehumidification, cooling heating

Heat or cold can be by heat pump, furnace, ground water, solar, wood, etc

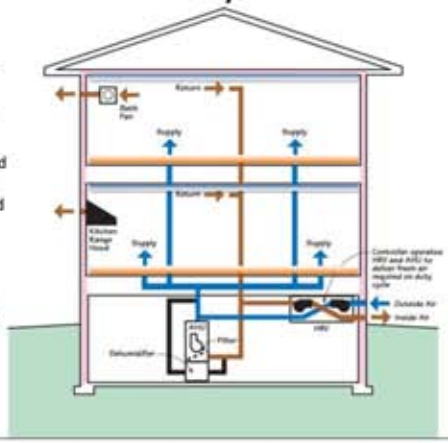


Ultimate System

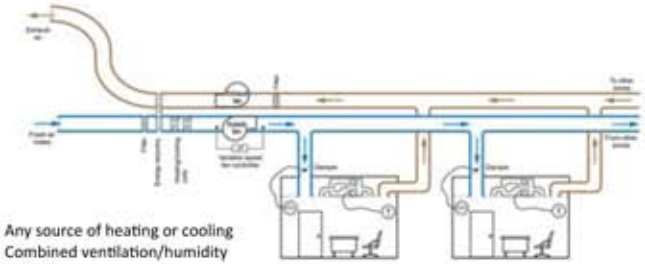
Compromise: Ducts shared for ventilation, dehumidification

Radiantly heated floors
Radiantly cooled ceilings

Heat or cold can be by heat pump, furnace, ground water, solar, wood, etc



BSI-022 Perfect HVAC



Any source of heating or cooling
Combined ventilation/humidity control

Terminal units can be fan coils, PTAC, AHU, radiant panels, etc.

Heating & Cooling 101

- We produce heat to increase temperature
- We remove heat to lower temperature

- Heat/cool Equipment has three stages
  1. Heat production
  2. Distribution (optional)
  3. Heat rejection
- Can mix and match most of different technologies for each stage

12/10/10 9

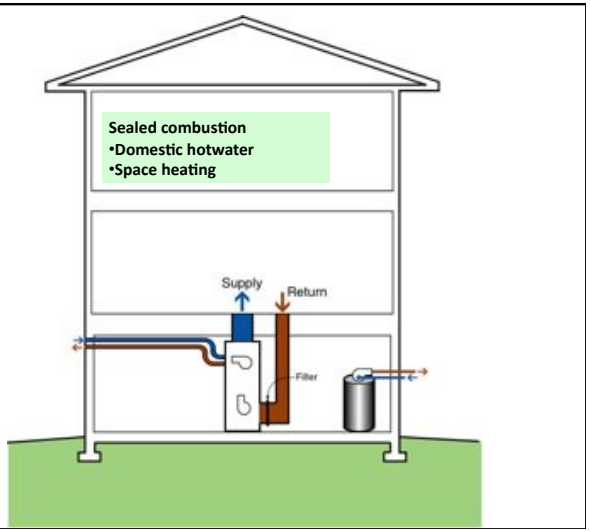
Heat Production

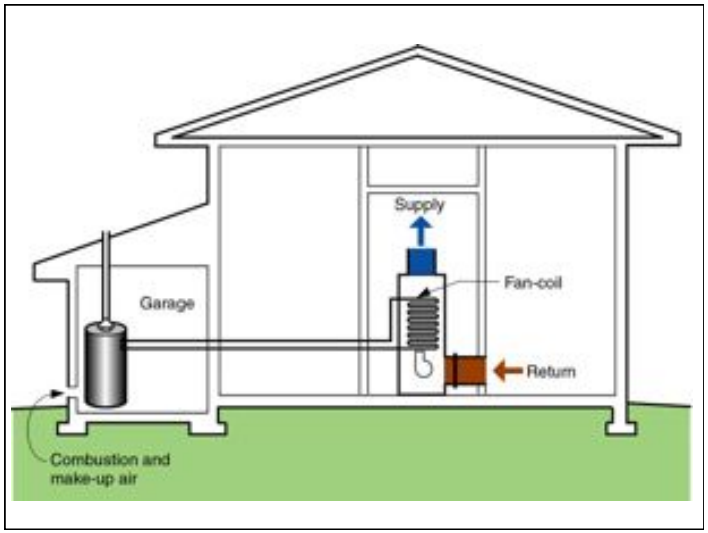
- Boilers : heat to water
  - Old types heated water to steam and distributed
  - Modern heat water to 35C (95F) to 85C (190 F) and pump water using small electric pumps
- Furnace: heat to air
  - Air is heated to min 40 C (110 F) and usually 60+ (150)
  - Electric fan is used to move air
- Both heat exchanger between flame to fluid
- Fuel sources
  - Nat gas, oil, propane, wood, electric, etc.

12/10/10 10

Heating

- Need hot air and hot water
- Can combine one source for two uses
  - Makes sense for small efficient buildings
- This can be a combo fancoil or radiators or radiant slabs
- DHW should be heated to 130 F to kill Legionnaires bacteria





Modern Boilers: small, quiet efficient

Boilers don't boil


Viessman, gas


Takagi, Oil

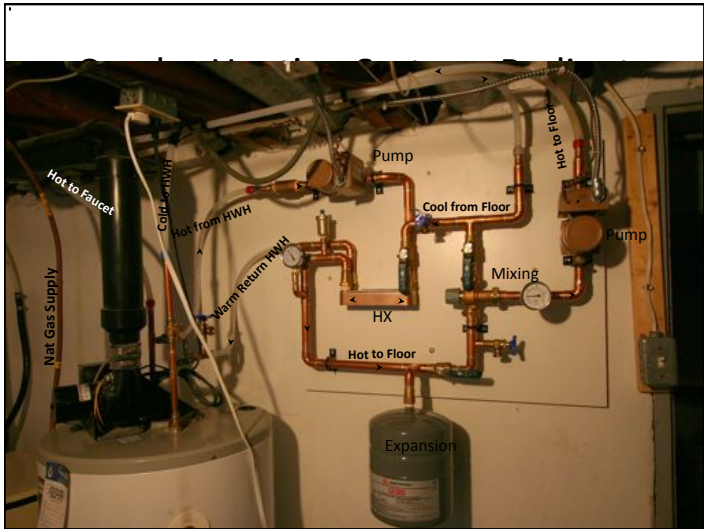
12/10/10


AO Smith, sealed combustion 65%
Now Vertex 90-96%

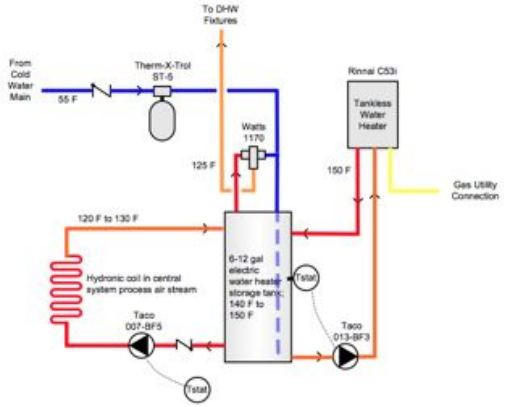

Quietside, combo boiler 90%

- Navien combo 98%+
- Microstorage
- 10:1 turndown
- 4 - 5 GPM
- US$1875 SRP

Item		CR-180, CR-180A, CC-180, CC-180A
Heat Capacity (Input)	Natural Gas	Min: 15,000 Btu/h Max: 150,000 Btu/h
	LP Gas	Min: 15,000 Btu/h Max: 150,000 Btu/h
Thermal Efficiency		98.8 %
Energy Factor (DOE)		0.98
Dimensions		W17" x H28"x D10"
Weight	CR/CC-A	77 lbs
	CR/CC	67 lbs



Tankless heaters need tanks



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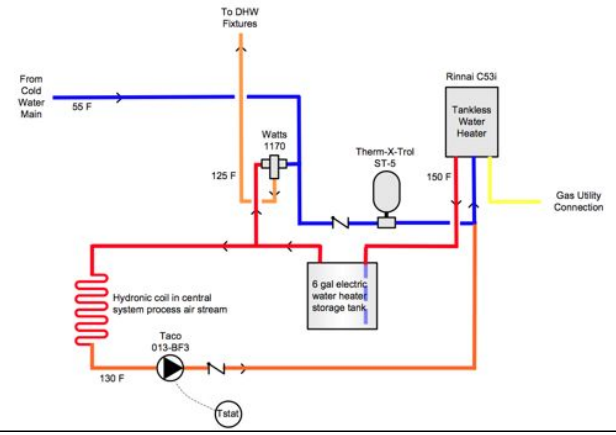
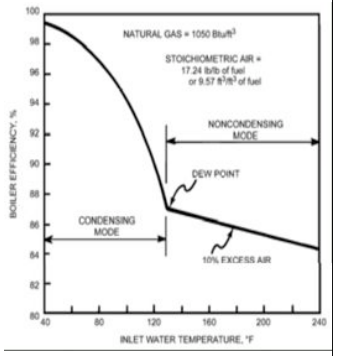


Boiler Combustion Efficiency

- Most combustion is >99.9% efficient
- Equipment varies on ability to extract useful heat from combustion via heat exchanger
- Heat exchanger size is important
- Temperature of entering fluid is also critical
  - Condensing furnace (70 F / 21 C)
  - Condensing boiler >90% (<110 F / 45 C)
  - Normal boiler <85% (>130 F/ 55 C)

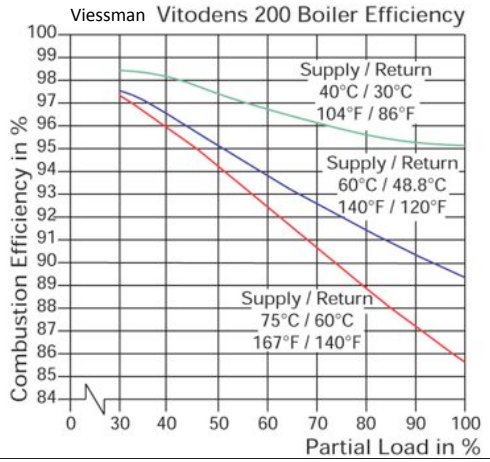
Condensation % Efficiency

- Depends on return temperature
- Terminal equipment that can return low temps aid efficiency
- Target 95-110 F (35-43 C) for condensing
- Target > 130F to ensure non-condensing



ASHRAE Systems Handbook 2000.

DHW inlet temperature is usually 55—60 F (10-15C) so great efficiency



Consequence

- Furnaces: return air temperatures = room temperature (70 F/21C)
  - Hence, condensing, 95%+ efficiency practical
- Boilers: depends on system design/operation
  - Radiant panels: 90-120 F / 32-48 C
  - Fan Coils: 100-180 F /40-80 C
    - Will not condense if T > 135F/55C
  - Baseboards: 120-180F+

Building Science 2008

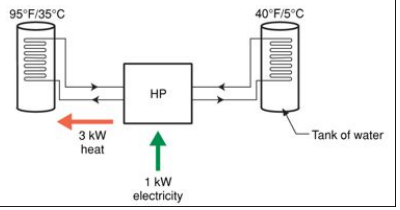
Heat Pumps

- Neither create or destroy heat, but move it around
- Require input energy just like any other pump
- Need
  - **Source** of thermal energy
  - **Sink** of thermal energy
- Sources (inside=cooling, outside=heating)
  - Air ("Air source")
  - Ground ("ground source")
    - Soil, Groundwater, or Surface water (eg lake)
  - Wasteheat in building via exhaust air or drain water

12/10/10 26

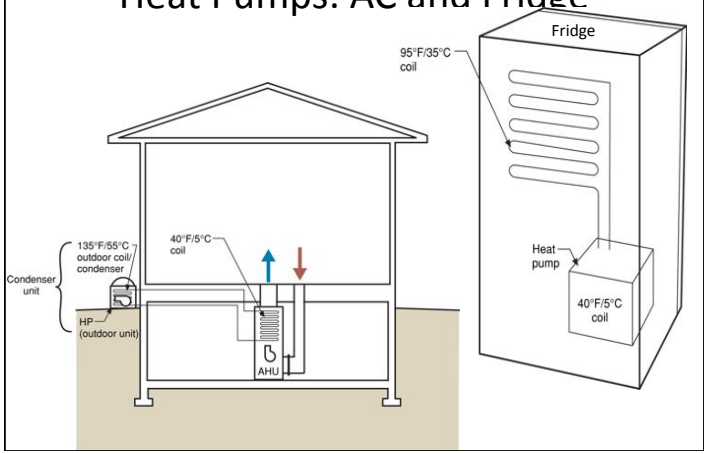
Heat Pumps

- Use compressors, and refrigerant ("Freon")
- All use *internal heat exchangers* to transfer hot or cold refrigerant to water or air
- Terminology
  - "Air to air heat pump" = "air-source"
  - "Water-to-water heat pump"
  - "air conditioning"
  - Water to air
  - Ground source
  - "Geothermal"



12/10/10

Heat Pumps: AC and Fridge



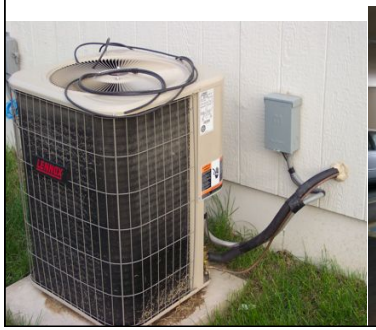
Cooling

- Most cooling equipment is a heat pump
  - uses the interior as a source (collection) and
  - Outside as the sink (rejection)
- Other mechanical cooling systems (all described later)
  - Evaporative cooling
  - "Free cooling"
    - Use a source of cold air or water to absorb (collect) heat and remove to the exterior
    - Air-side economizer
    - Water-side economizer

12/10/10 31

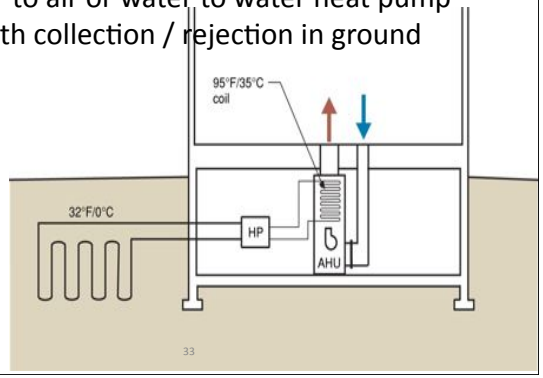
Heat Pump and Reject/Collect in same box

- Compressor, and DX coils in one enclosure



Ground Source Heat Pump

- A water to air or water to water heat pump with with collection / rejection in ground



12/10/10 33