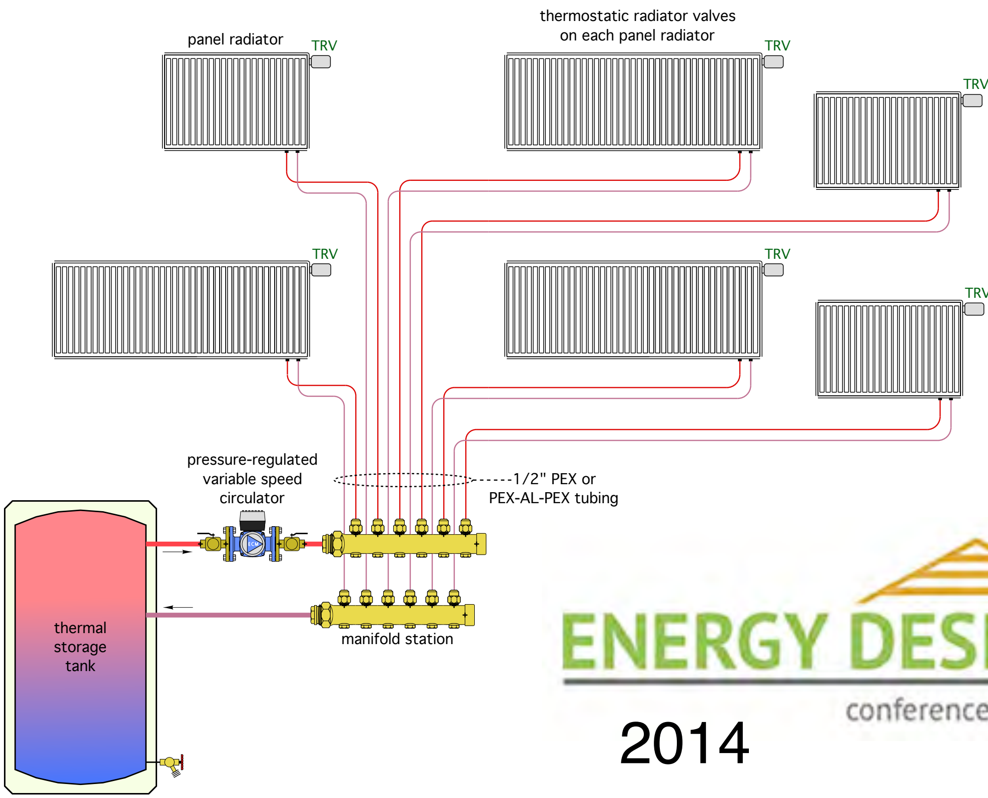
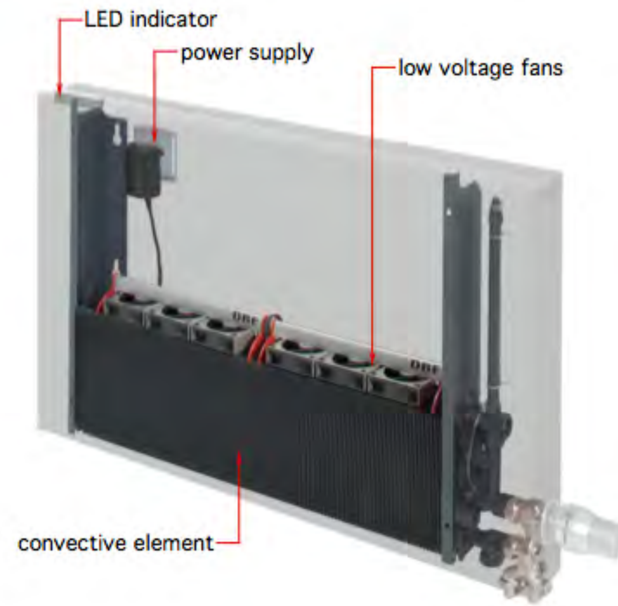
"Best Practices in Modern Hydronic Heating - AN OVERVIEW





conference & expo

2014

presented by:
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Holland Patent, NY
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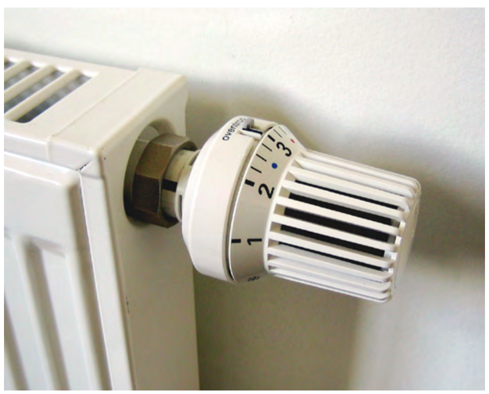
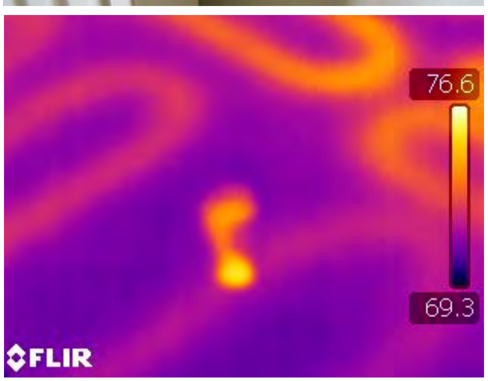
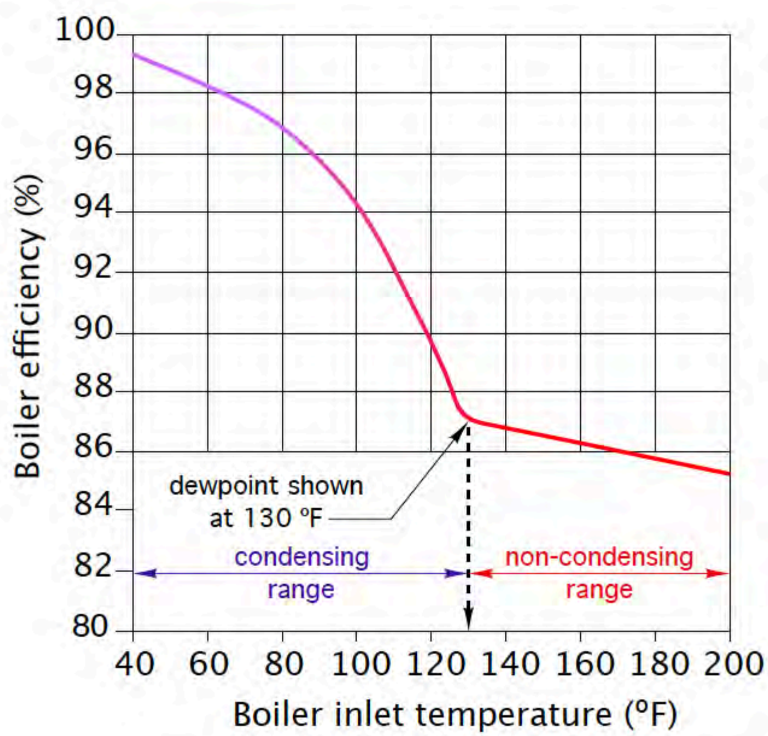
"Best Practices in Modern Hydronic Heating - AN OVERVIEW

This Morning's topics...

- Why hydronics
- High efficiency gas-fired boilers
- Low temperature heat emitter options
- High efficiency circulators
- Homerun distribution systems
- Zoning options





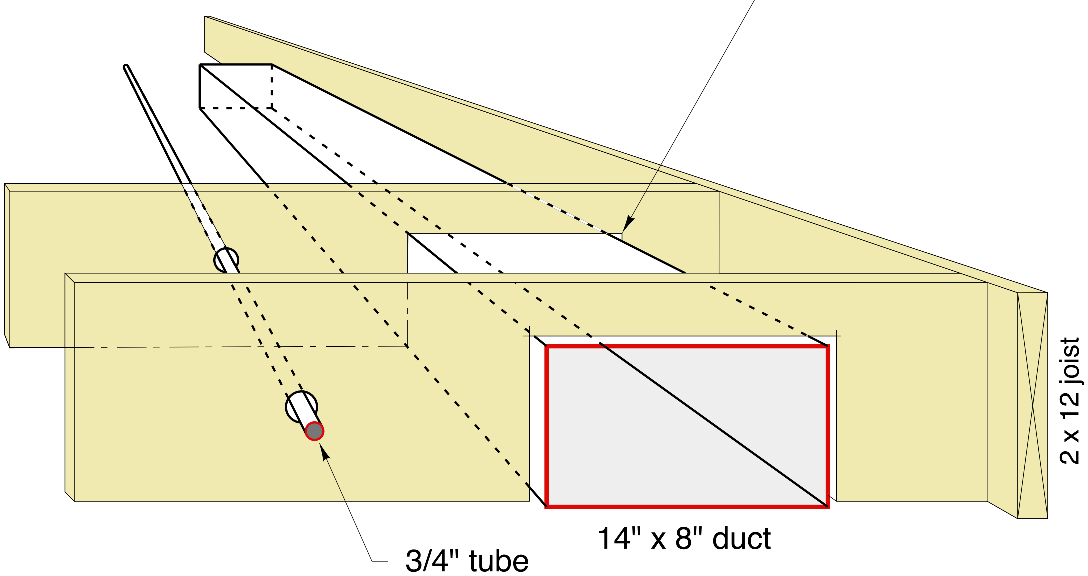


What are the advantages of using hydronic heating in these houses?

Water vs. air: It's hardly fair...

Water is vastly superior to air for conveying heat

Material	Specific heat (Btu/lb/°F)	Density* (lb/ft^3)	Heat capacity ($Btu/ft^3/°F$)
Water	1.00	62.4	62.4
Concrete	0.21	140	29.4
Steel	0.12	489	58.7
Wood (fir)	0.65	27	17.6
Ice	0.49	57.5	28.2
Air	0.24	0.074	0.018
Gypsum	0.26	78	20.3
Sand	0.1	94.6	9.5
Alcohol	0.68	49.3	33.5

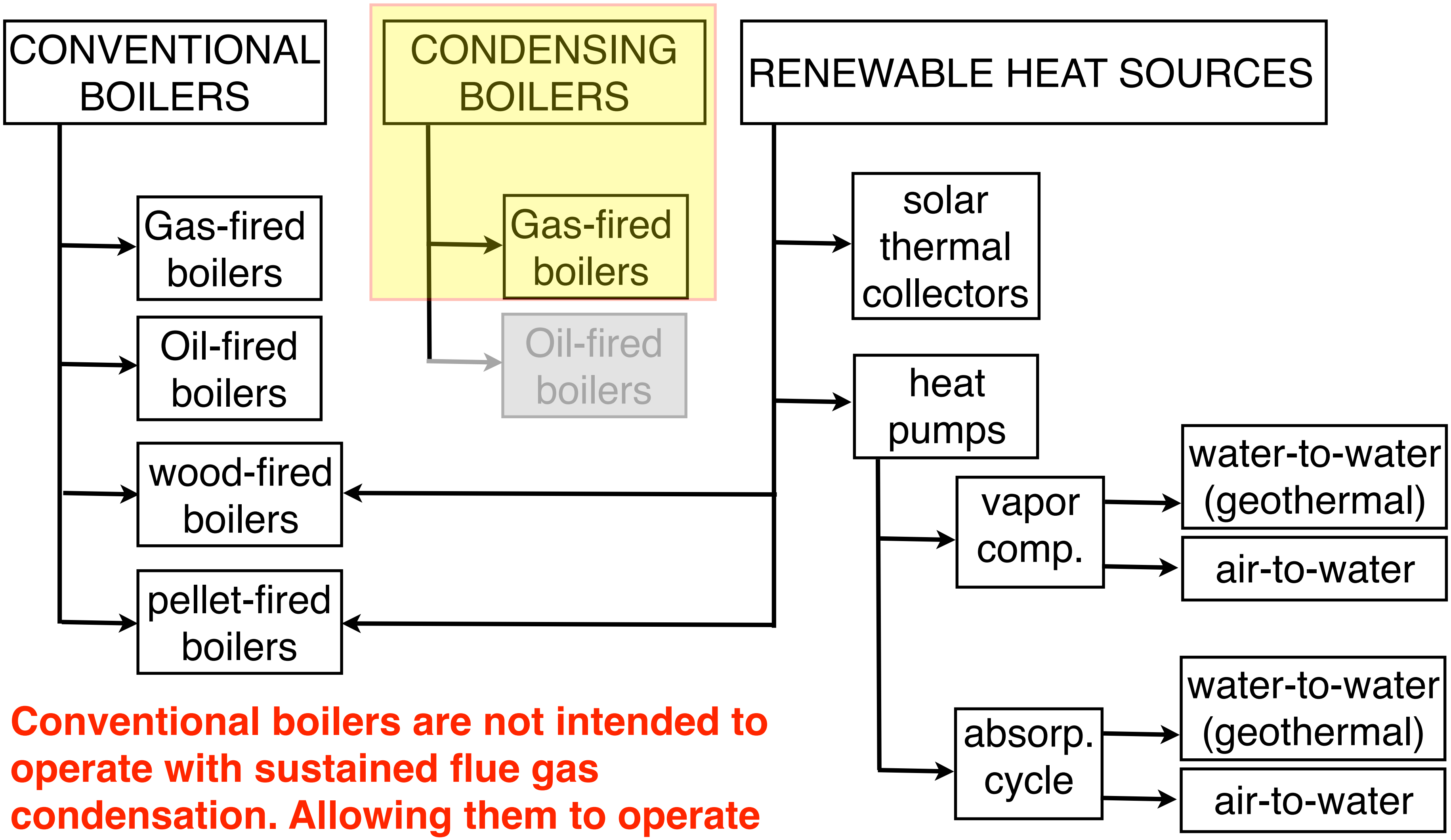


$$\frac{62.4}{0.018} = 3467 \approx 3500$$

A given volume of water can absorb almost 3500 times as much heat as the same volume of air, when both undergo the same temperature change

High efficiency gas-fired boilers

Hydronic heat source options



Conventional boilers are not intended to operate with sustained flue gas condensation. Allowing them to operate with such condensation will damage both the boiler and flue.

Conventional boilers

Conventional boilers are not intended to operate with sustained flue gas condensation

gas-fired
copper water tube
atmospheric draft

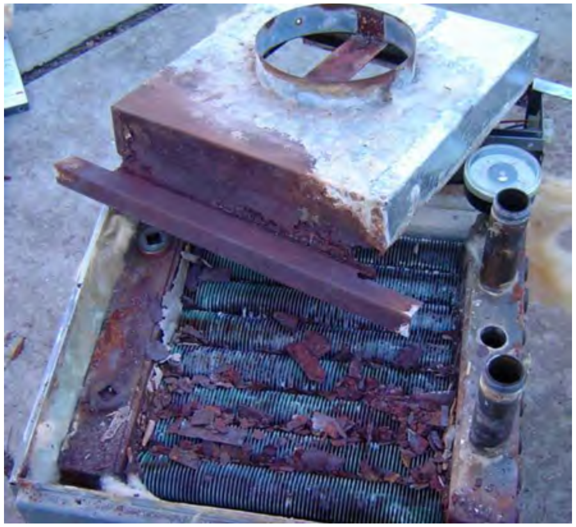
oil-fired
cast-iron sectional
atmospheric draft

oil-fired
steel fire tube
atmospheric draft

gas-fired
cast-iron sectional
atmospheric draft

Conventional boilers

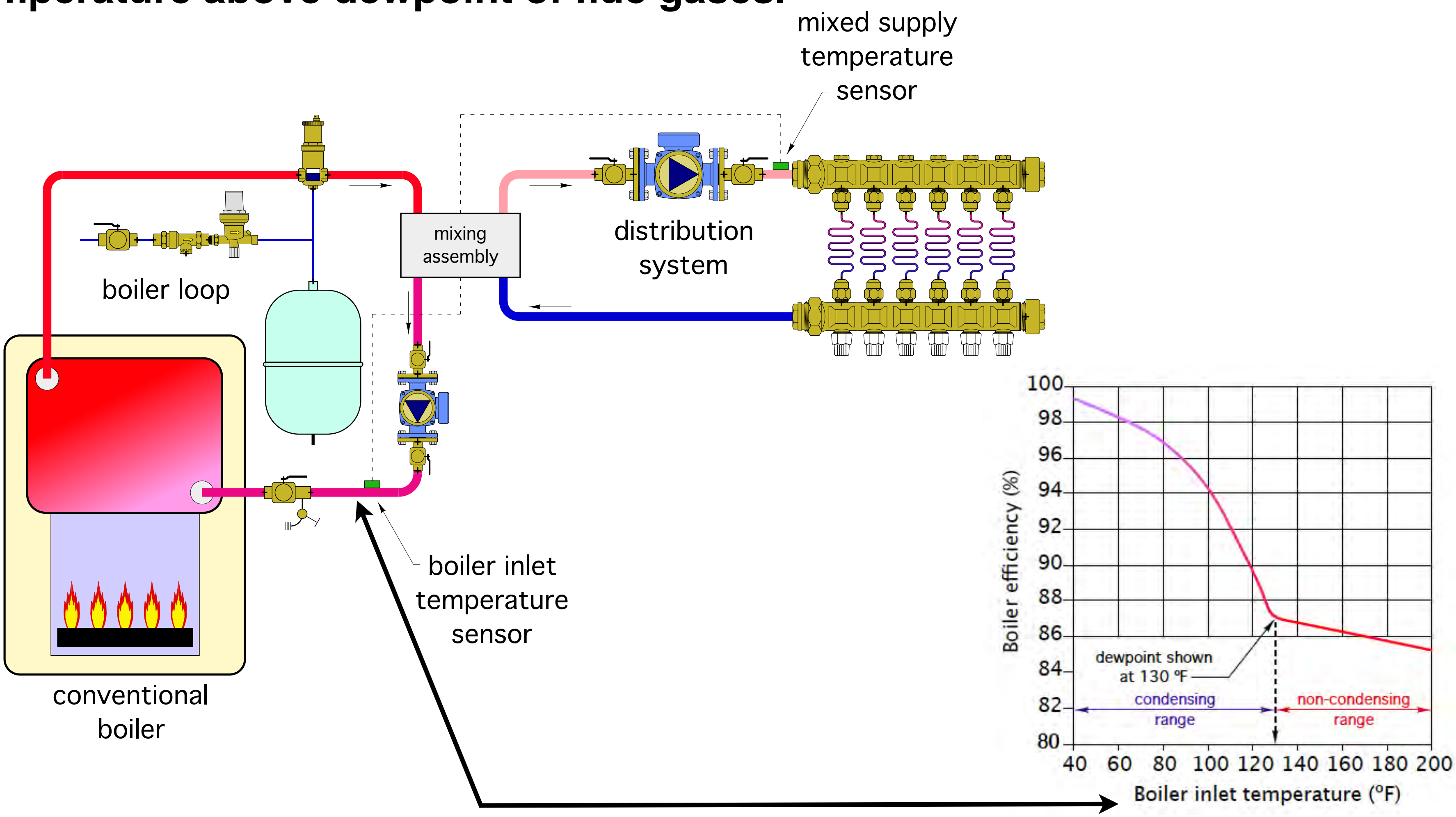
“EVERY BOILER can be a condensing boiler...”



For conventional gas-fired boilers, sustained inlet water temperatures of 130 °F or more are recommended to prevent sustained flue gas condensation.

Conventional boilers

The *system* must be designed to maintain the boiler inlet temperature above dewpoint of flue gases.

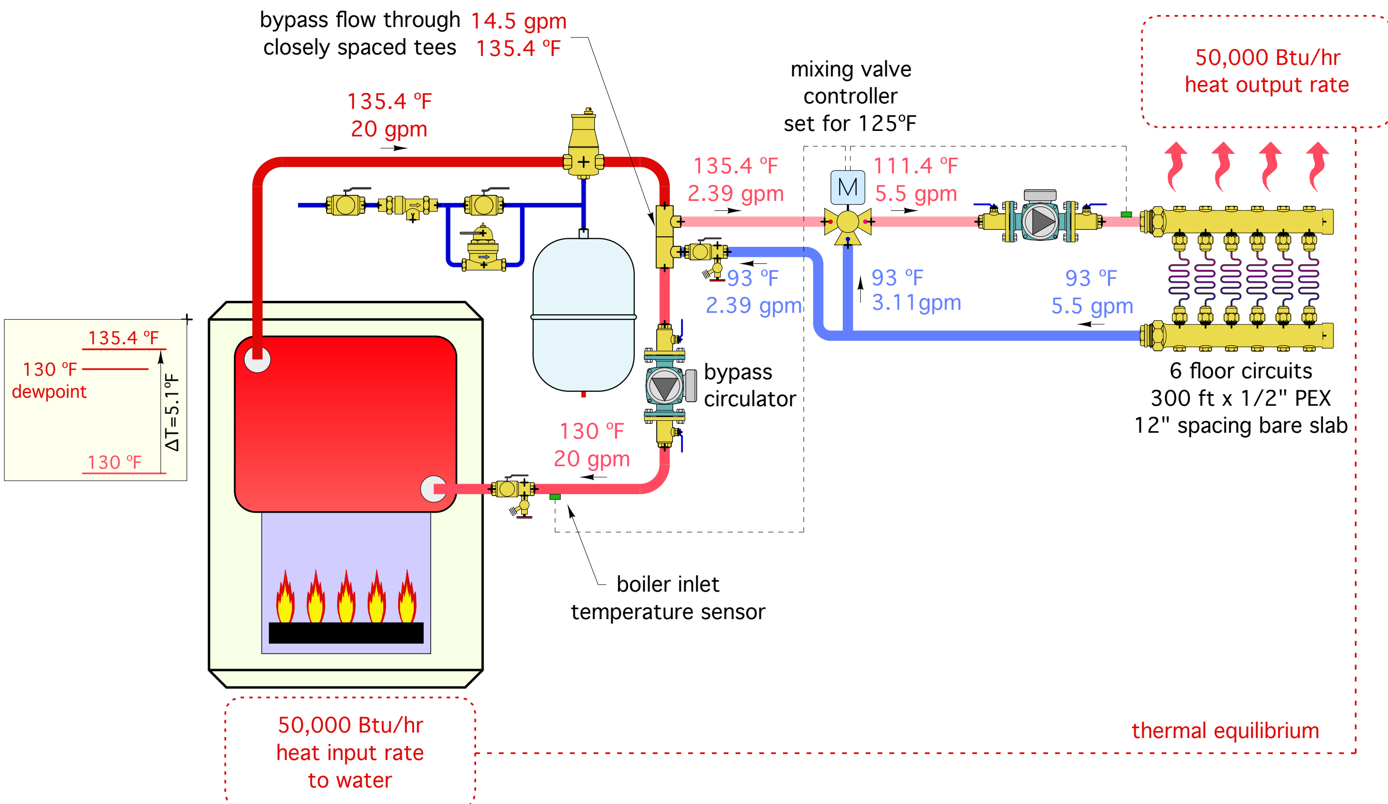


The *only way* to ensure that a conventional boiler is protected against sustained flue gas condensation is to measure boiler inlet temperature and provide a mixing assembly that reacts to this temperature.

Conventional boilers

Protecting conventional boilers from sustained flue gas condensation

An intelligent mixing assembly that can sense boiler inlet water temperature and react to it WILL protect the boiler from sustained flue gas condensation.



The *only way* to ensure that a conventional boiler is protected against sustained flue gas condensation is to measure boiler inlet temperature and provide a mixing assembly that reacts to this temperature.

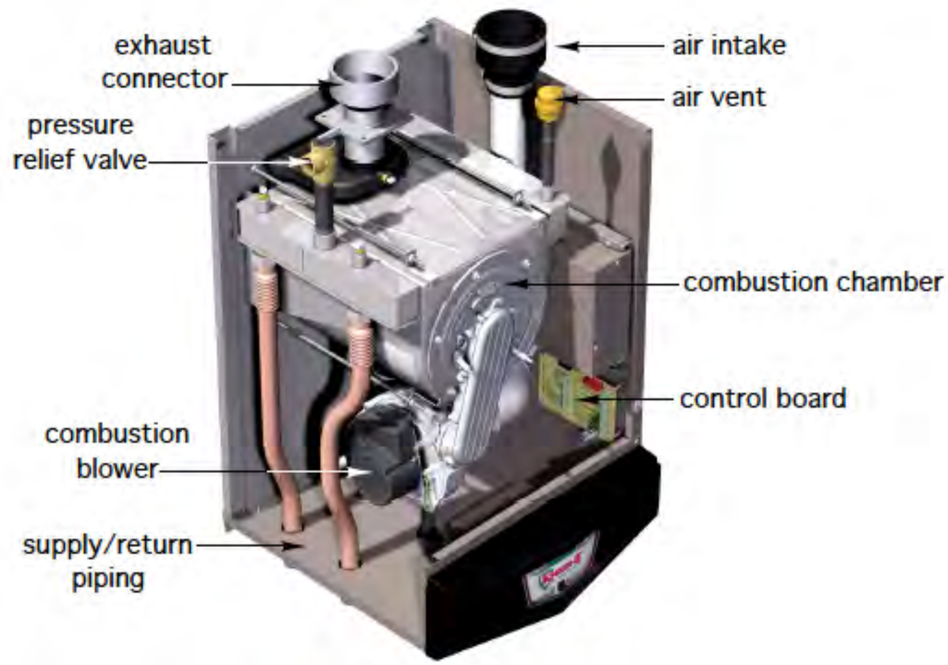
High efficiency gas-fired boilers

Mod/con (e.g., modulating / condensing) boilers are built with the intent that fluid gases will condense within the boiler.

These boilers use **stainless steel** or **aluminum** heat exchangers that can withstand the corrosive nature of condensed flue gases. (pH ≤ 4.0)

Mod/con boilers use a **variable speed combustion air blower** and proportional gas valve to regulate the rate of combustion. **Typical range of modulation (20 - 100%).**

- Wall hung
- Free standing on floor
- Sealed combustion
- Requires condensate drain



High efficiency gas-fired boilers

modulating / condensing boilers, plenty to choose from...





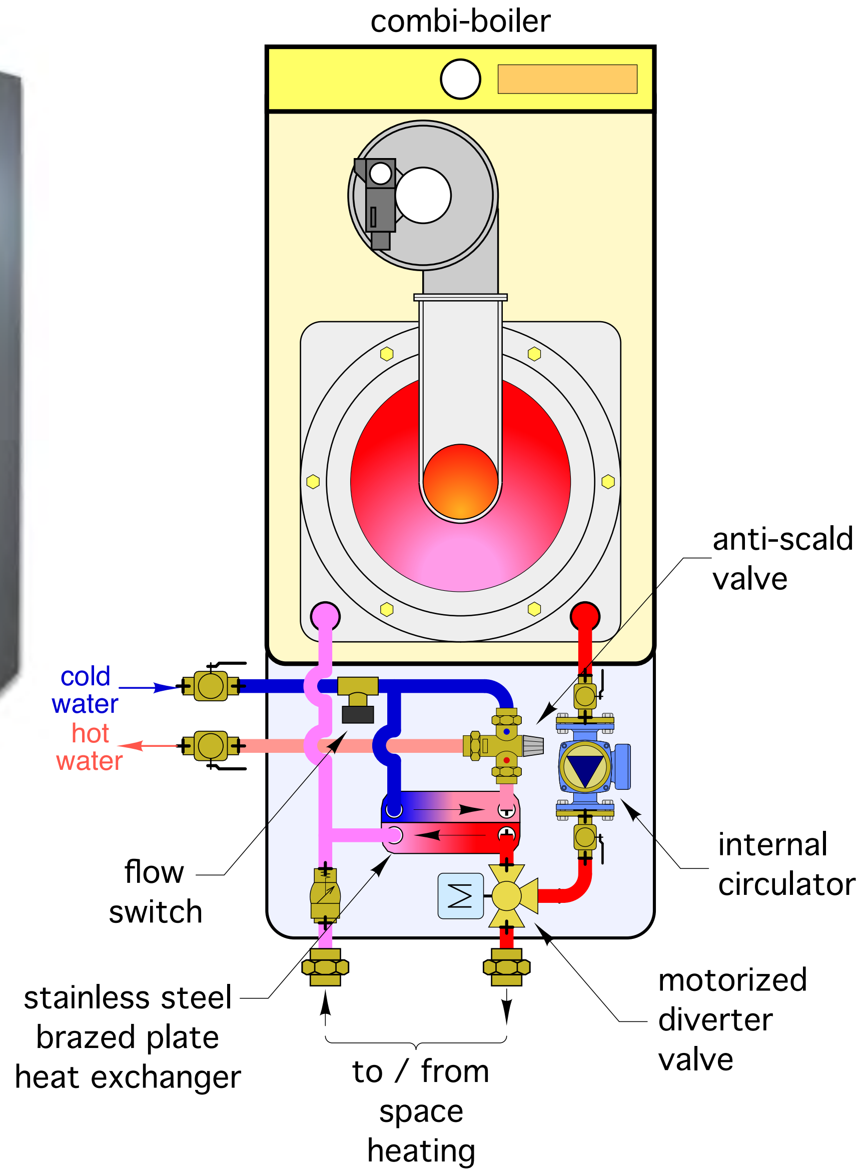

These are all “low mass” mod/con boilers

High efficiency gas-fired boilers

modulating / condensing **combi-units** (space heat + DHW)

Triangle Tube

LAARS

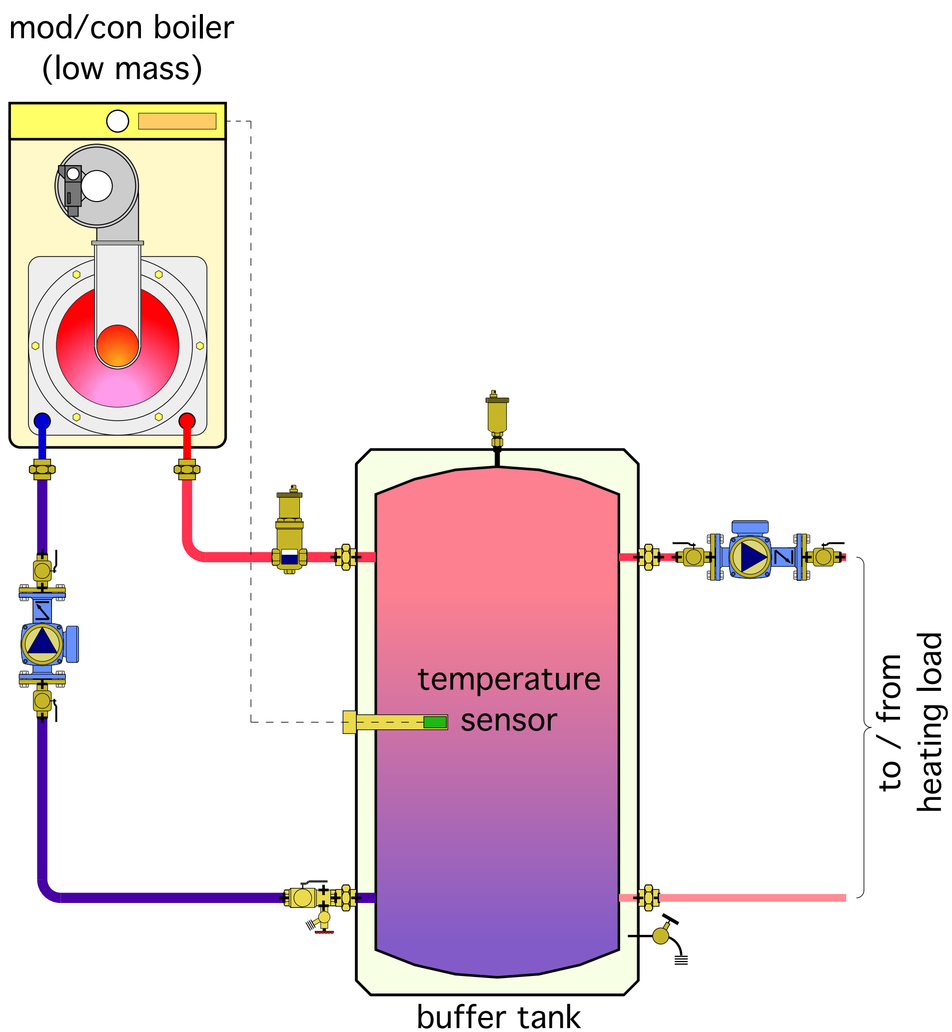


Designed for “on-demand” DHW.

30-45 seconds from cold start to rated DHW delivery temperature.

High efficiency gas-fired boilers

To prevent short cycling - these boilers are often installed with a buffer tank.



High efficiency gas-fired boilers

HIGH THERMAL MASS mod/con heating appliances

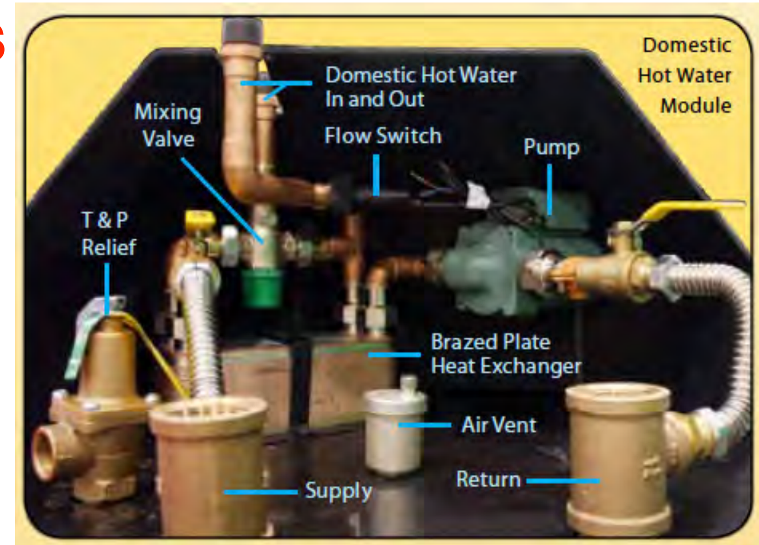
HTP, Inc "Pioneer" heating appliance

- "Self-buffering" heat source. No buffer tank required.

- Low pressure drop - no separate circulator required

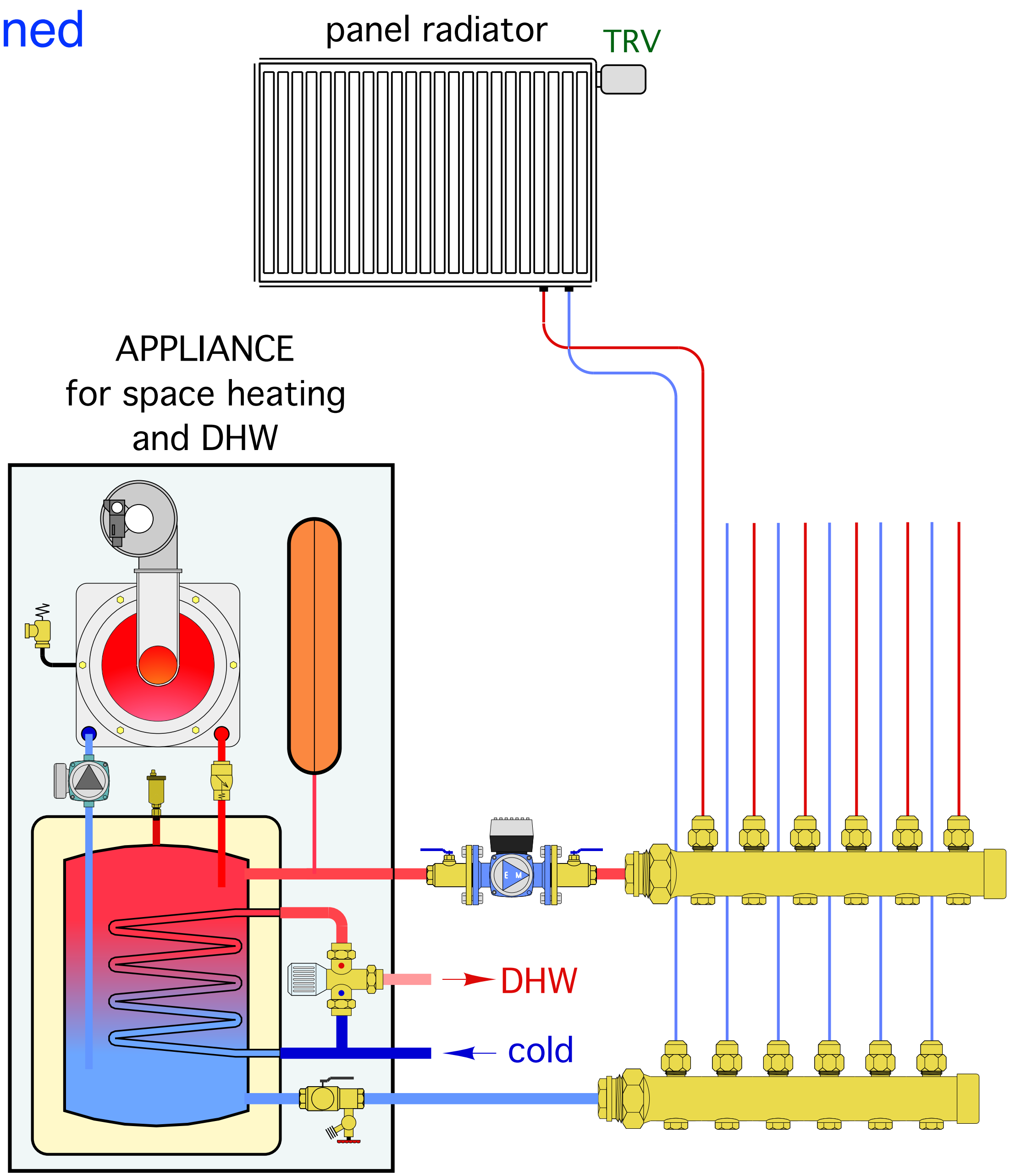
High efficiency gas-fired boilers

add on DHW module to create combi-unit



High efficiency gas-fired boilers

European approach to combined space heating & DHW



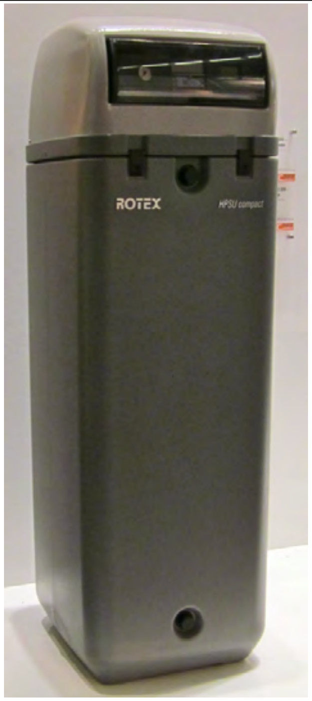
High efficiency gas-fired boilers

European approach to combined space heating & DHW

Do you notice anything in common among these products?

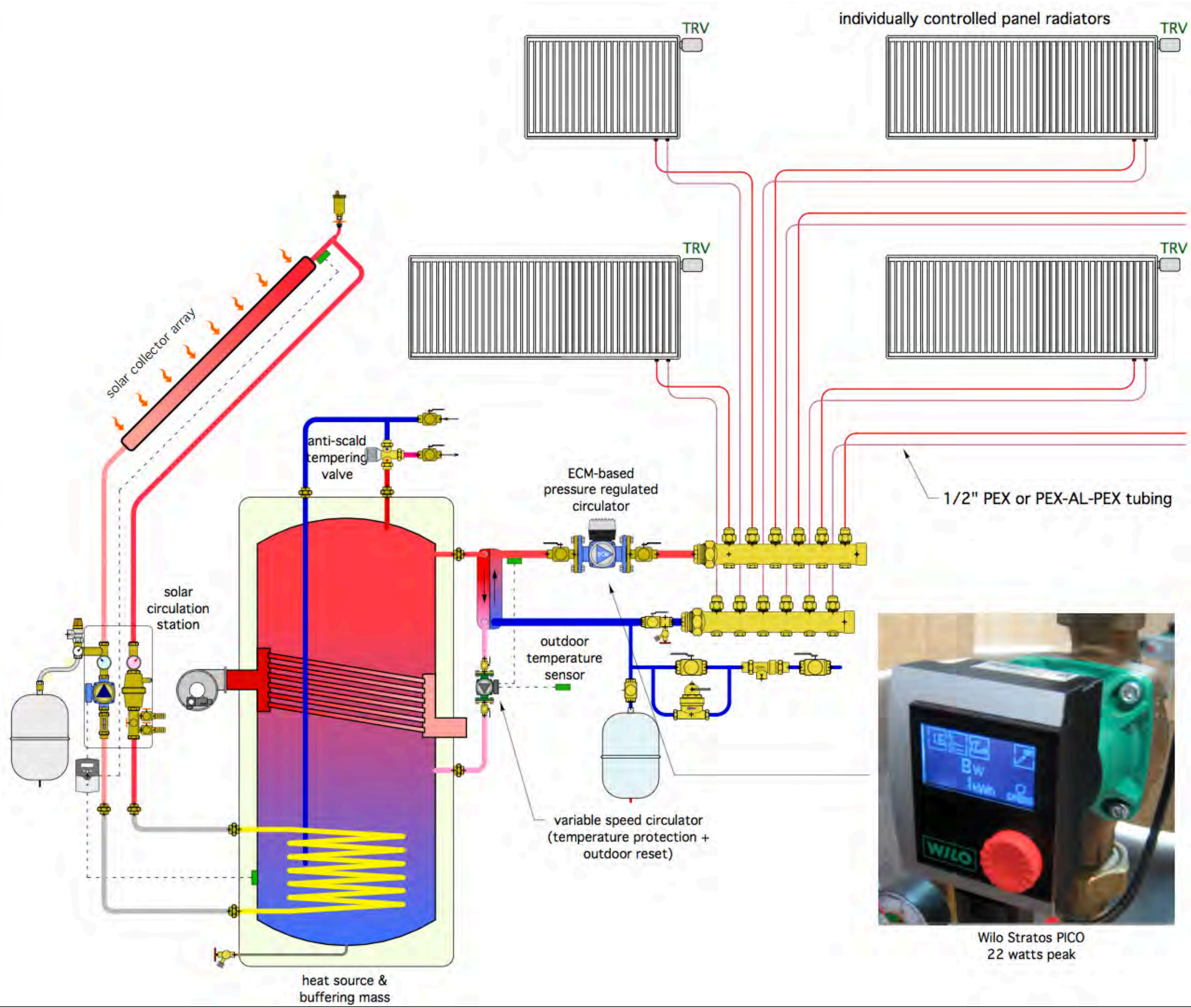
- None of them look like a boiler or water heater...
- They all look like an “appliance.”
- They all have sufficient water volume to stabilize against short cycling the burner under light loading.

This is what some North American systems look like.



High efficiency gas-fired boilers

Solar assisted space heating & DHW, high mass mod/con



High efficiency gas-fired boilers

LOW WATER TEMPERATURE ARE CRUCIAL TO HIGH PERFORMANCE

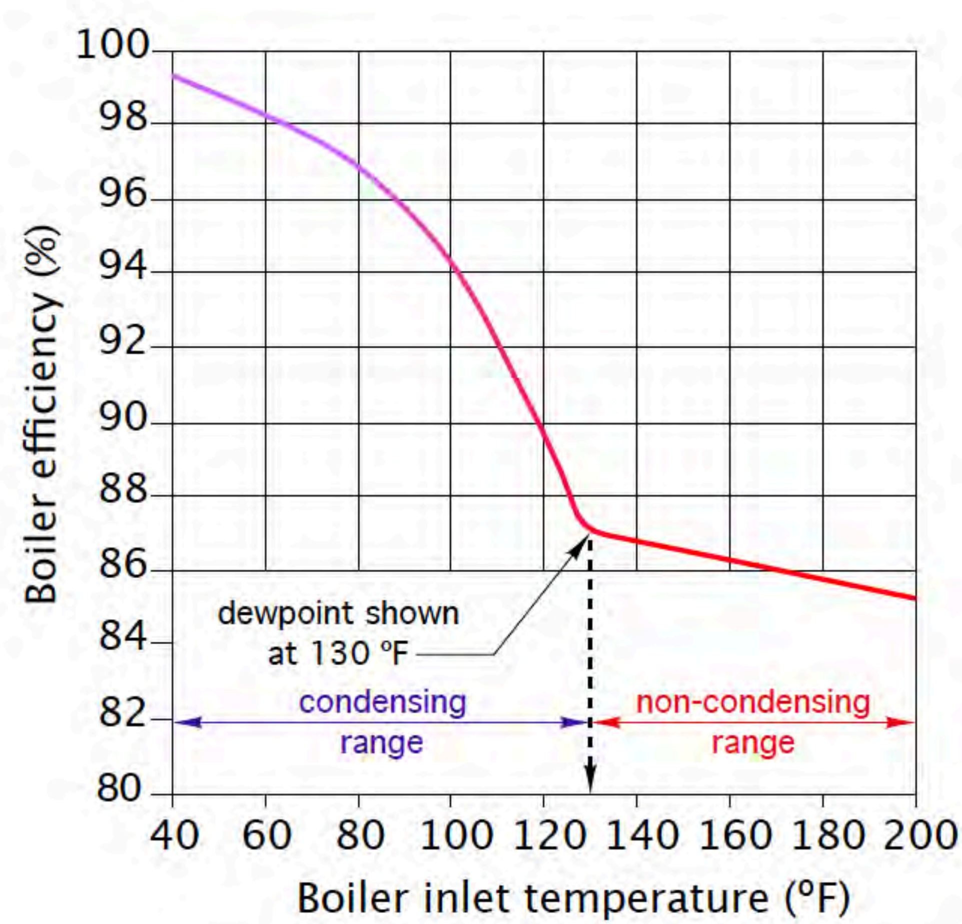
DESIGN ISSUE: To obtain high efficiency (88 to 97%), the water temperature supplied to the mod/con boiler must be lower than the dewpoint of the exhaust gases.

Condensing mode operation **begins** at inlet water temperatures of about 130 °F, and corresponding thermal efficiency of about 87.5%.

Thermal efficiency climbs as inlet water temperature decreases.

Inlet water temperature is a function of system design.

Applying mod/con boilers in higher temperature systems is generally not recommended.



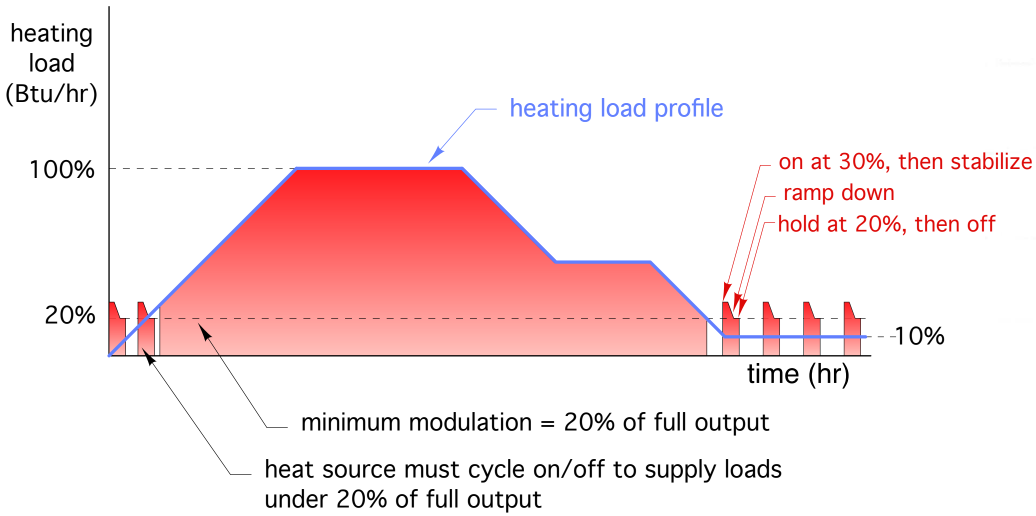
High efficiency gas-fired boilers

Many mod/con boilers have compact heat exchangers:

What's good about this: *Very low metal and water content.*
What's bad about this: *Very low metal and water content.*

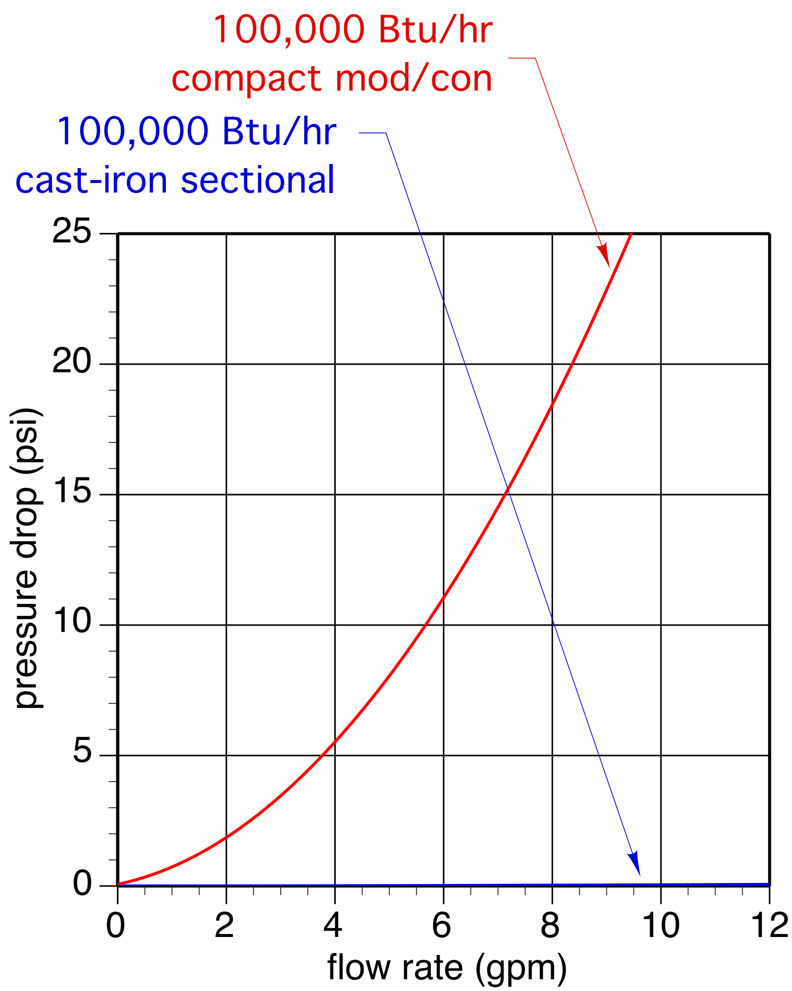
DESIGN ISSUE: Low thermal mass boilers combined with highly zoned distribution systems will cause "short cycling."

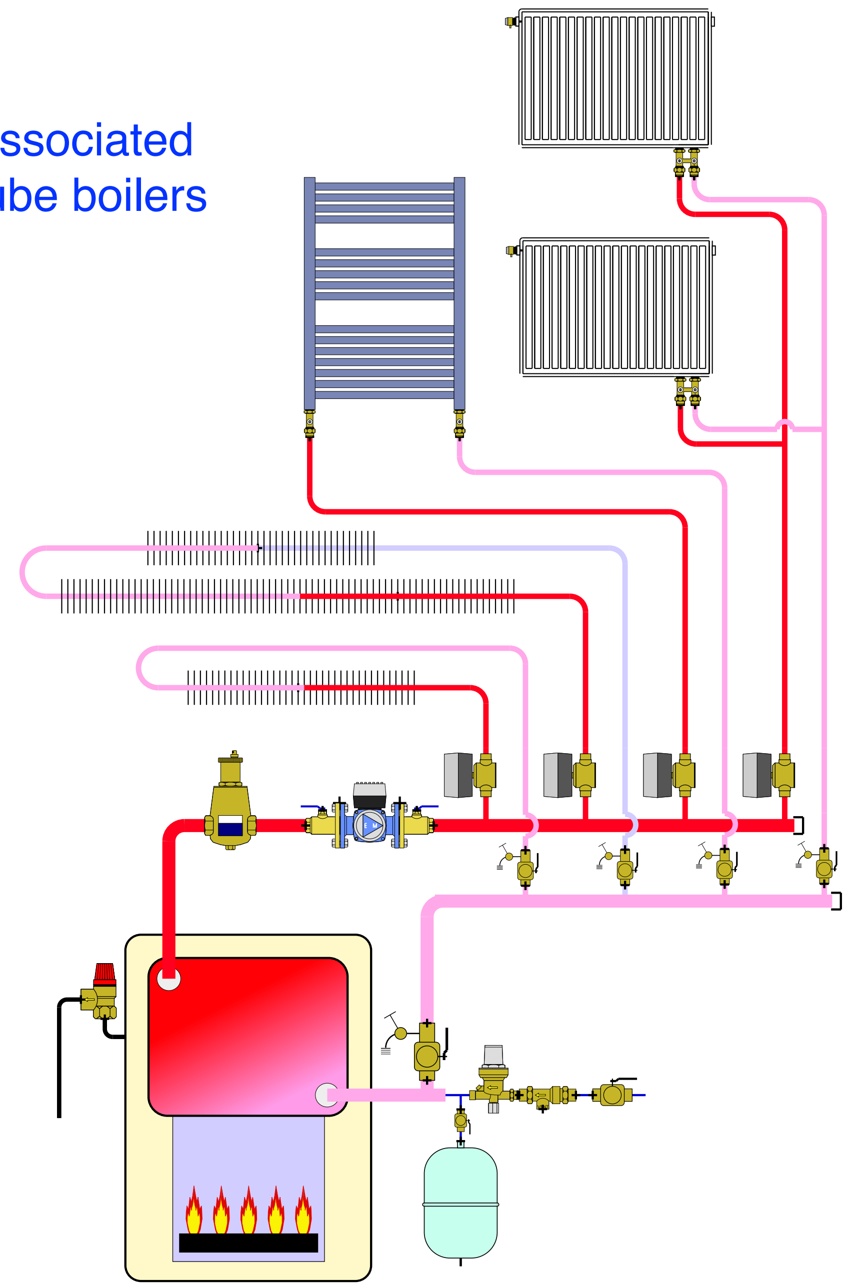
TYPICAL SOLUTION: add thermal mass in the form of a buffer tank.



Conventional boilers

DESIGN ISSUE: The very low pressure drop associated with cast-iron sectional boilers, and most fire tube boilers allows full system flow to pass through boiler.





conventional boiler
with low flow resistance

High efficiency gas-fired boilers

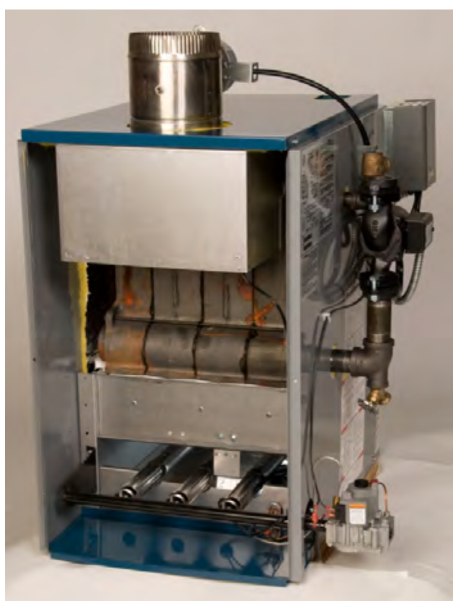
Many compact modulating / condensing boilers create high pressure drop

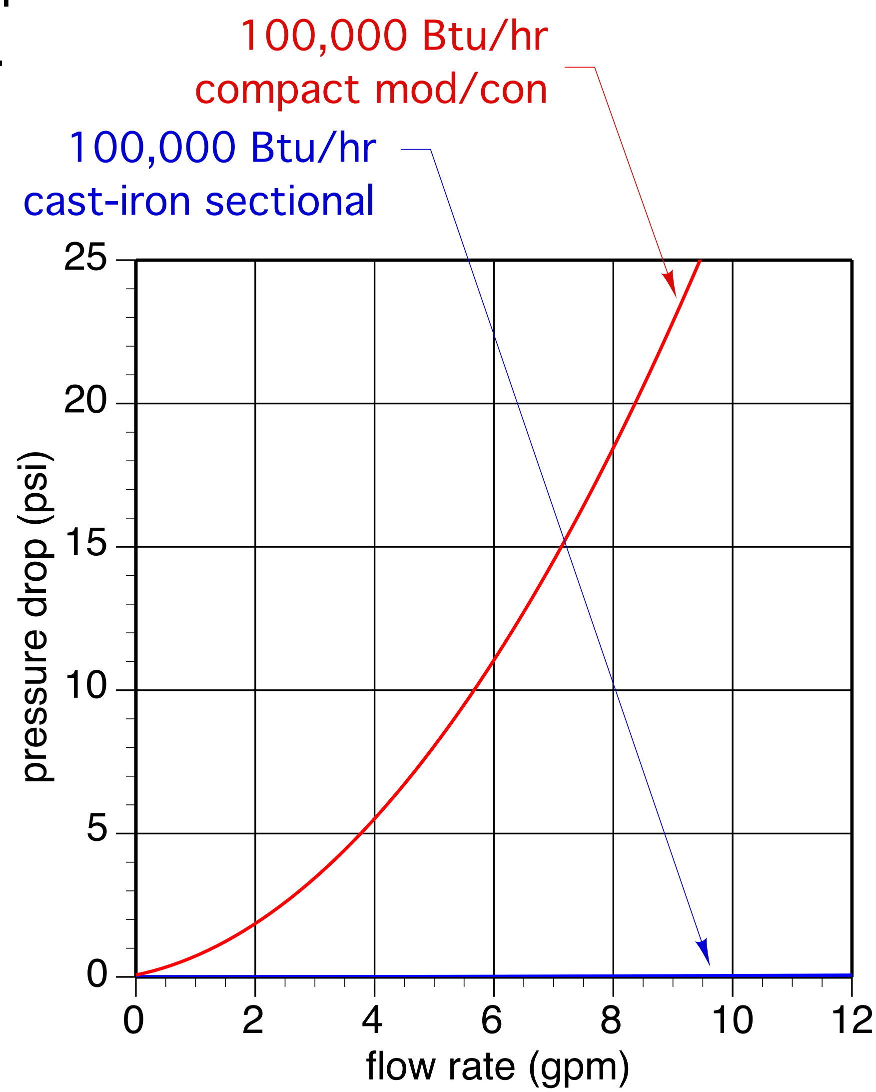
DESIGN ISSUE: Compact boiler heat exchangers also create significantly higher pressure drop as fluid flows through them.

TYPICAL SOLUTION: Use a dedicated boiler circulator to create flow through boiler, in combination with some form of hydraulic separation.

compact
mod/con
heat exchanger

cast-iron
sectional boiler

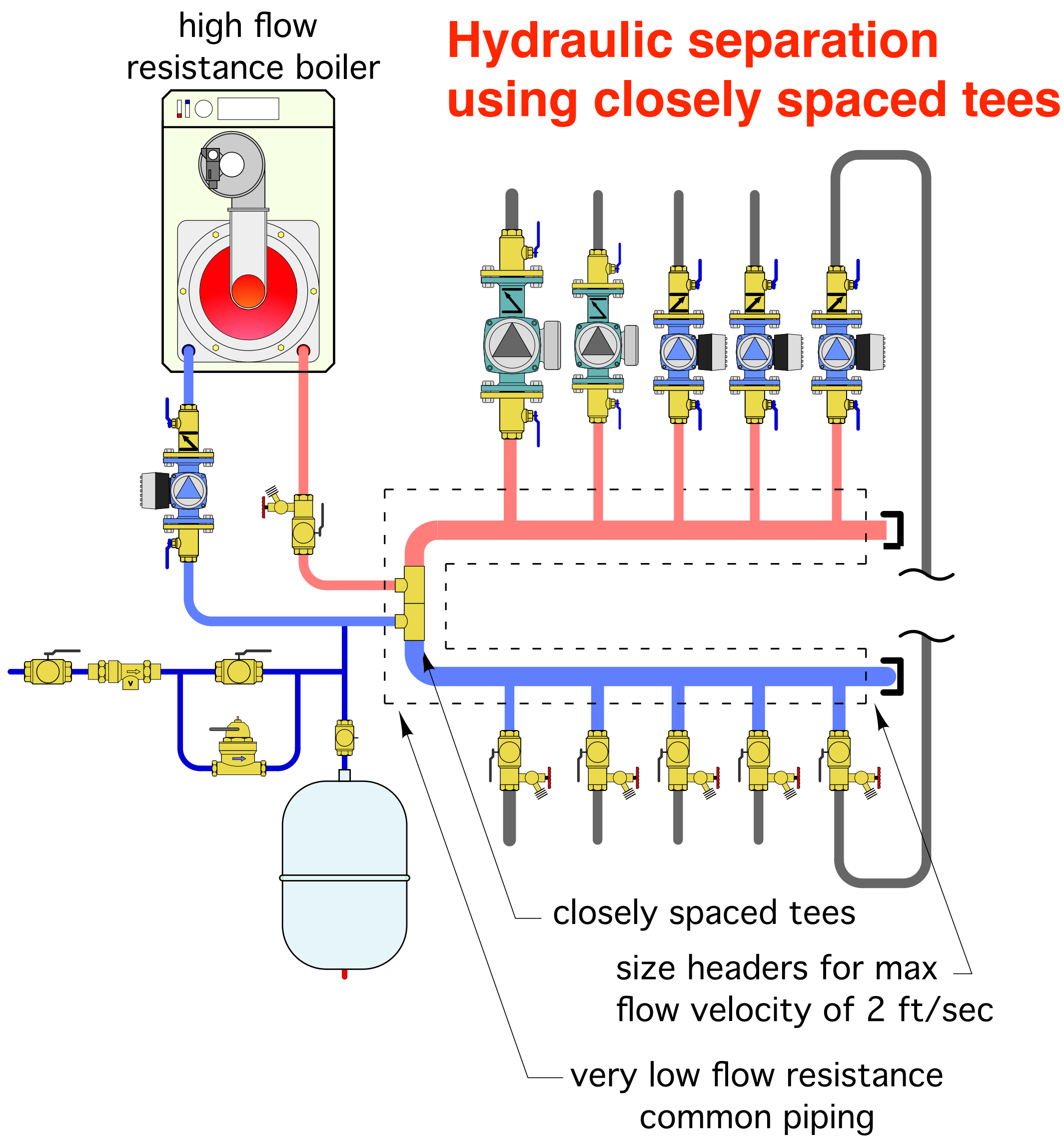




High efficiency gas-fired boilers

DESIGN ISSUE: Compact boiler heat exchangers also create significantly higher pressure drop as fluid flows through them.

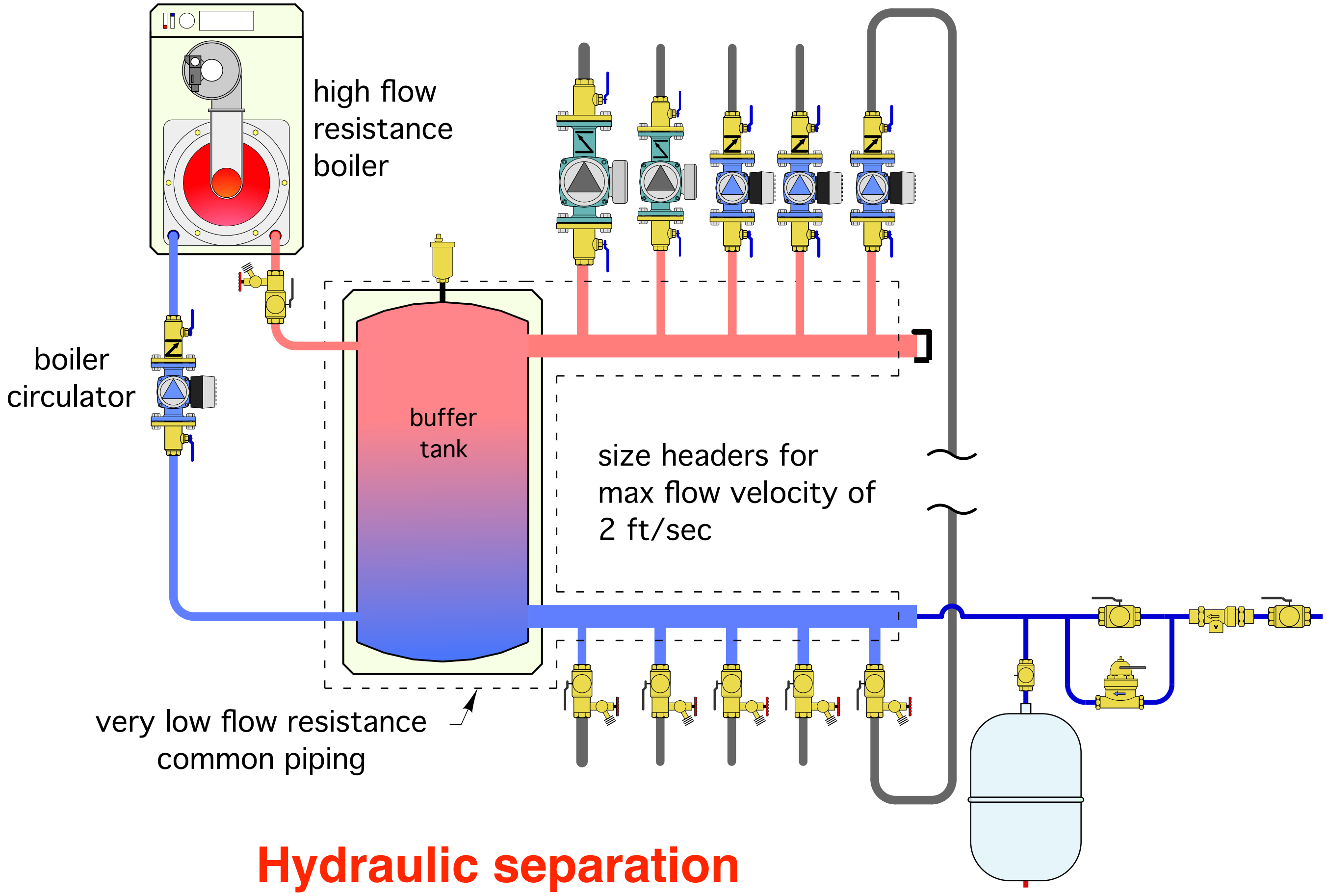
TYPICAL SOLUTION: Use a dedicated boiler circulator to create flow through boiler, in combination with some form of hydraulic separation.



High efficiency gas-fired boilers

DESIGN ISSUE:
Compact boiler heat exchangers also create significantly higher pressure drop as fluid flows through them.

TYPICAL SOLUTION:
Use a dedicated boiler circulator to create flow through boiler, in combination with some form of hydraulic separation.

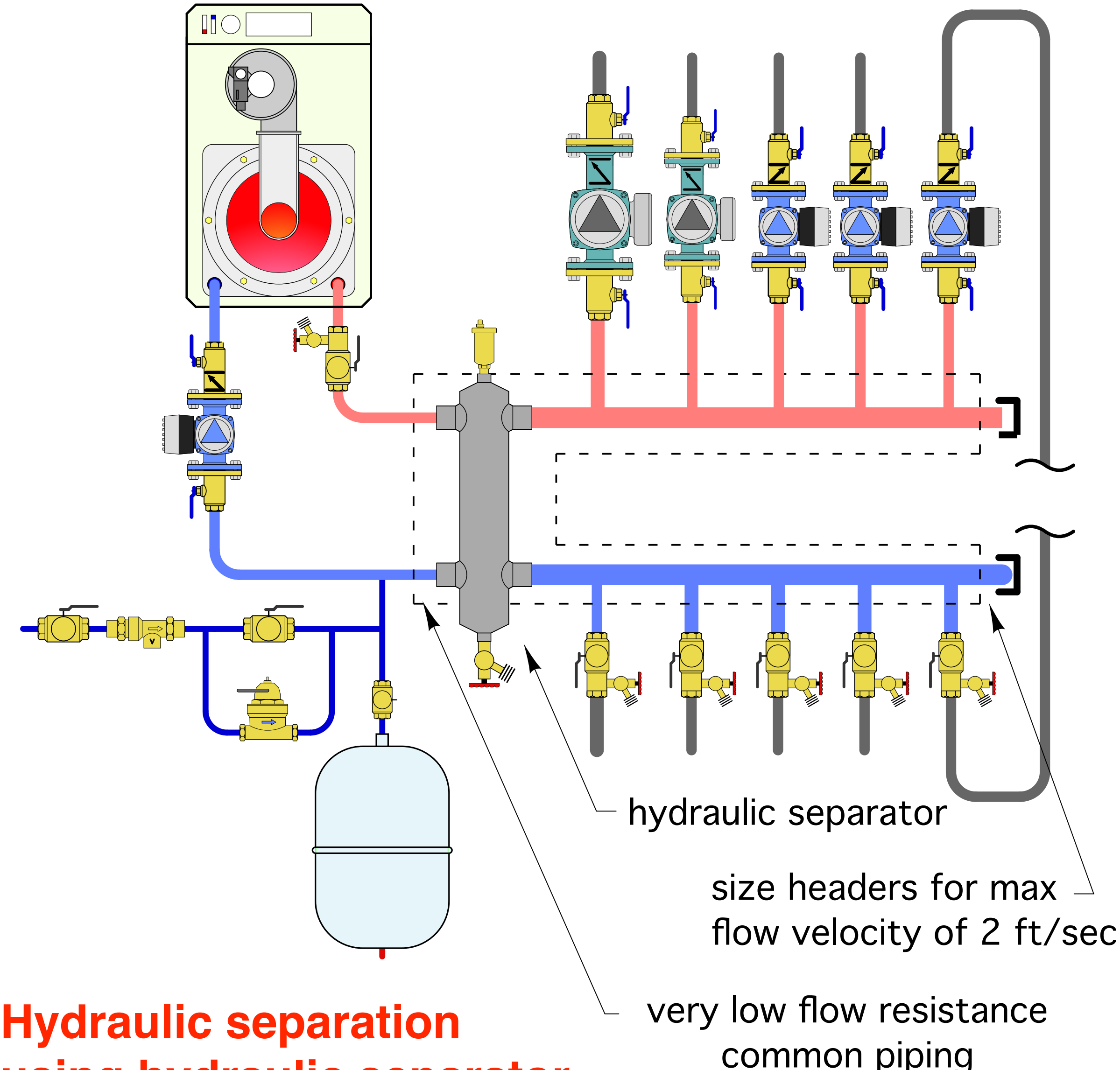


Hydraulic separation using buffer tank.

High efficiency gas-fired boilers

DESIGN ISSUE:
Compact boiler heat exchangers also create significantly higher pressure drop as fluid flows through them.

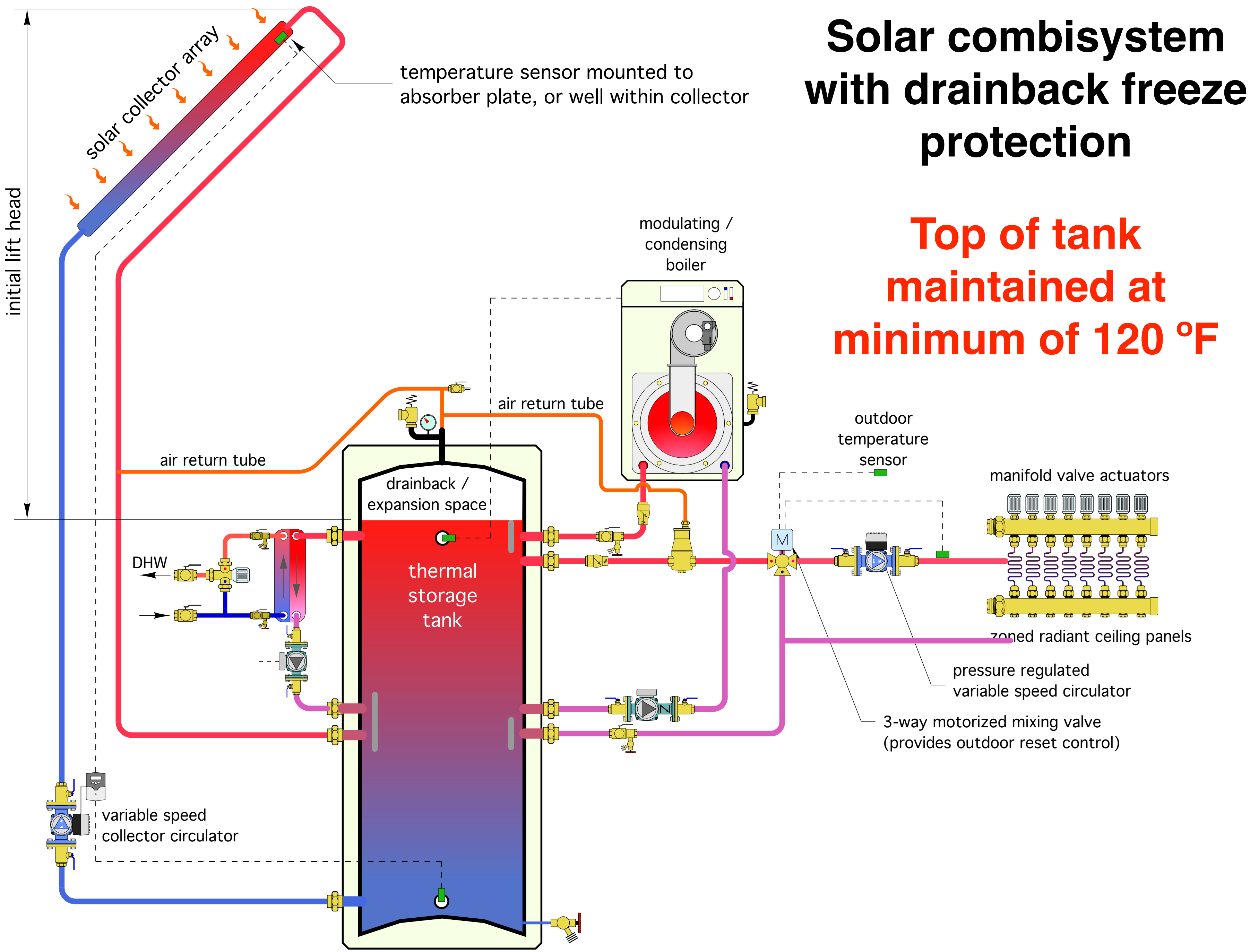
TYPICAL SOLUTION:
Use a dedicated boiler circulator to create flow through boiler, in combination with some form of hydraulic separation.



Hydraulic separation using hydraulic separator.

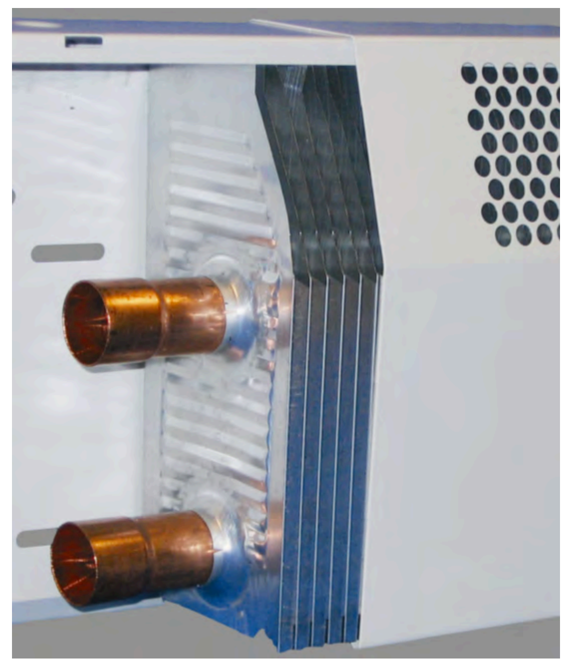
Solar combisystem with drainback freeze protection

Top of tank maintained at minimum of 120 °F

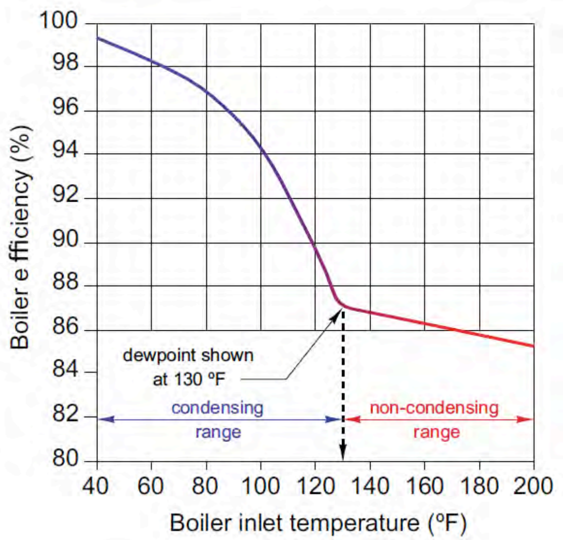


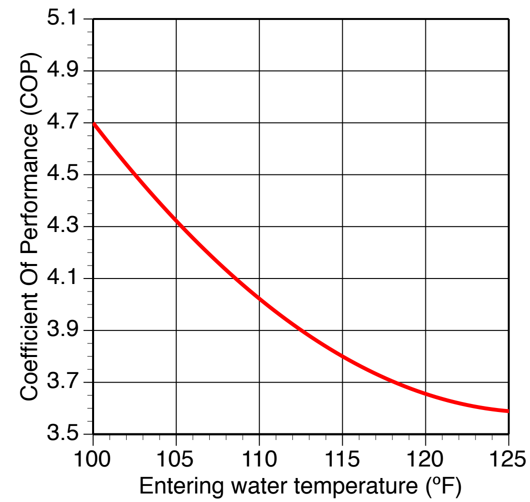
Low temperature / low mass hydronic heat emitters

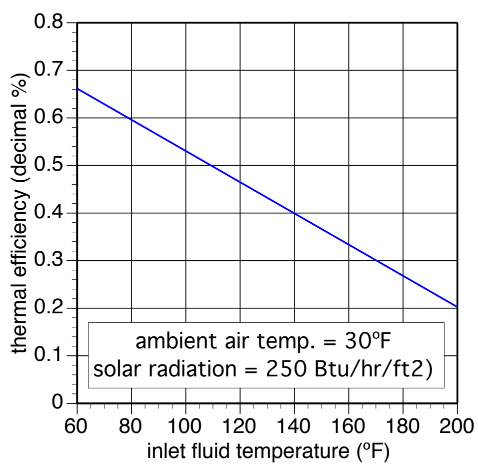
Low temperature / low mass hydronic heat emitters

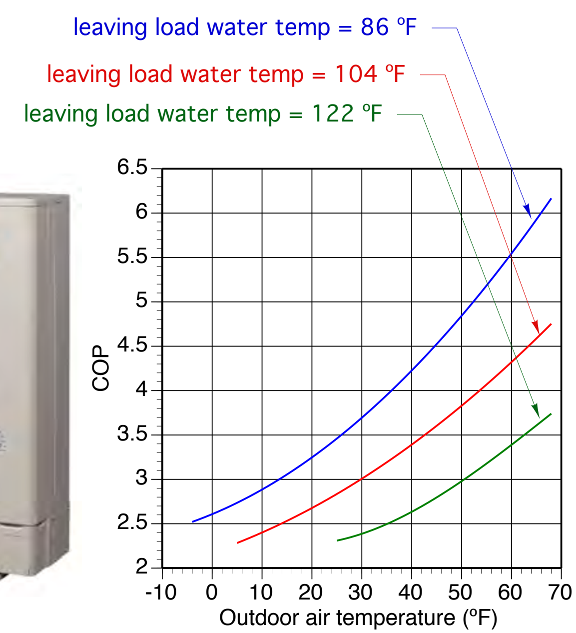


Heat sources such as condensing boilers, geothermal & ATW heat pumps, and solar collectors all benefit from low water temperature operation.









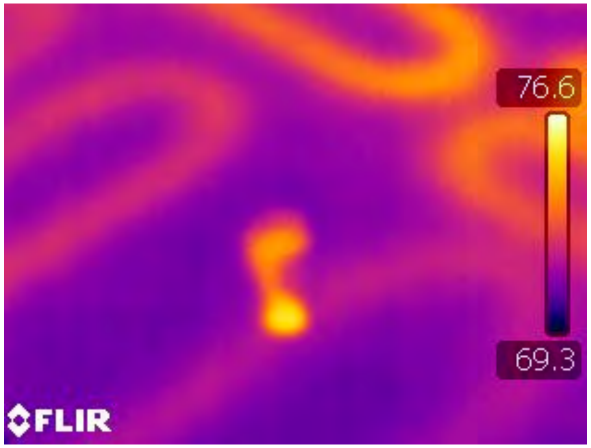
Is radiant floor heating **always** the answer?

"Barefoot friendly" floors...

Is radiant floor heating always the answer?

Consider a 2,000 square foot well insulated home with a design heat loss of 18,000 Btu/hr. Assume that 90 percent of the floor area in this house is heated (1800 square feet). The required upward heat flux from the floor at design load conditions is:

$$\text{heat flux} = \frac{\text{design load}}{\text{floor area}} = \frac{18{,}000\ \text{Btu/hr}}{1{,}800\ \text{square feet}} = 10\,\frac{\text{Btu}}{\text{hr}\bullet\text{ft}^2}$$



$$T_f = \frac{q}{2} + T_r$$

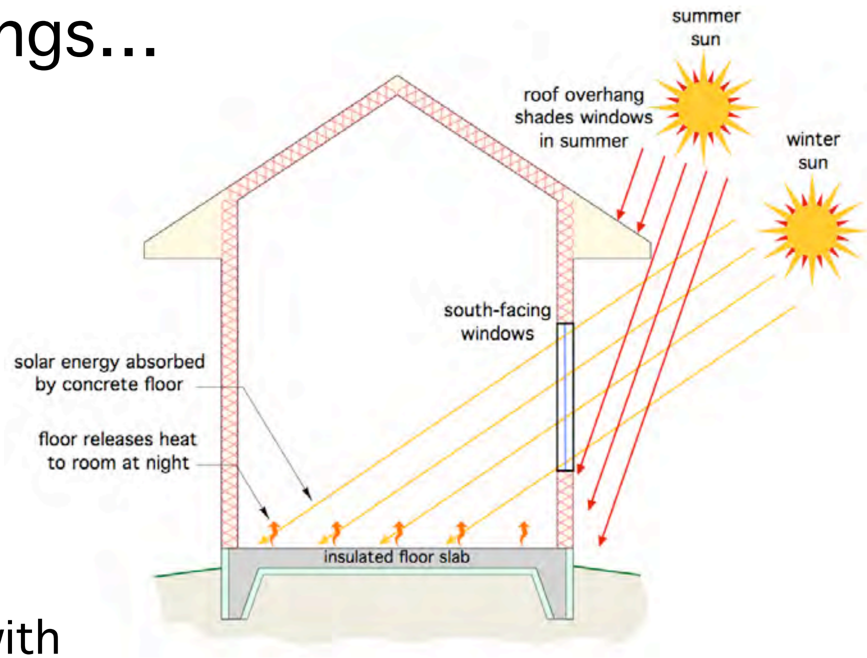
Tf = average floor surface temperature (°F)
Tr= room air temperature (°F)
q=heat flux (Btu/hr/ft^2)

To deliver 10 Btu/hr/ft^2 the floor only has to exceed the room temperature by 5 degrees F. Thus, for a room at 68 degrees F the average floor surface temperature is only about 73 degrees F.

*This is not going to deliver "**barefoot friendly floors**" - as so many ads for floor heating promote.*

Why radiant floor heating ISN'T always the best choice...

Direct gain passive solar buildings...



Initial concept: Since the insulated floor slab is already there- why not add tubing to keep it warm on cloudy days?

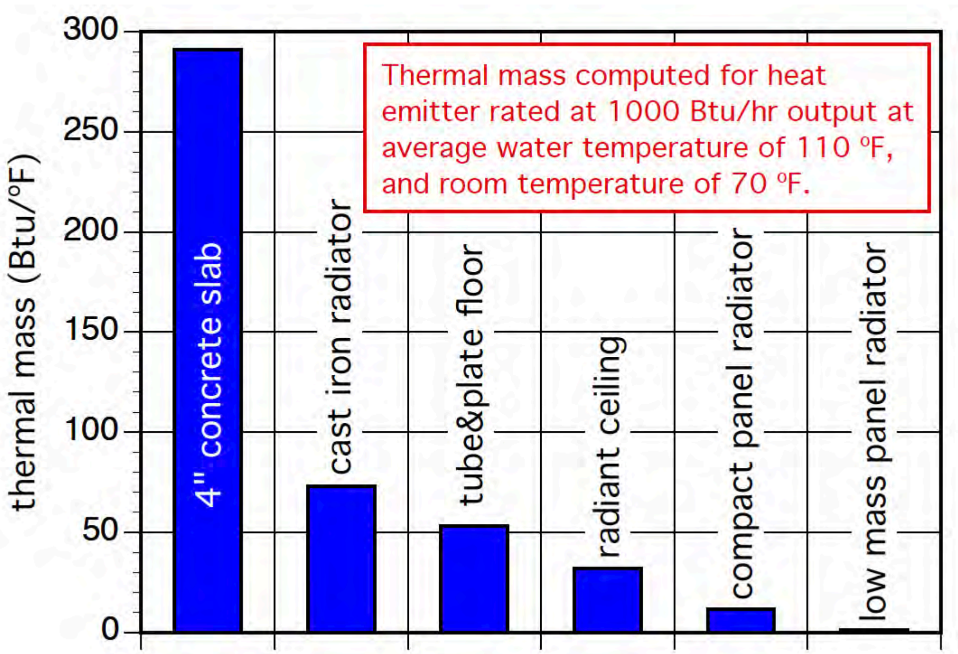
The passive solar concept relies on the floor mass giving up it's heat at night.

If maintained at an elevated temperature with auxiliary heat ensuing solar gains cannot be absorbed.

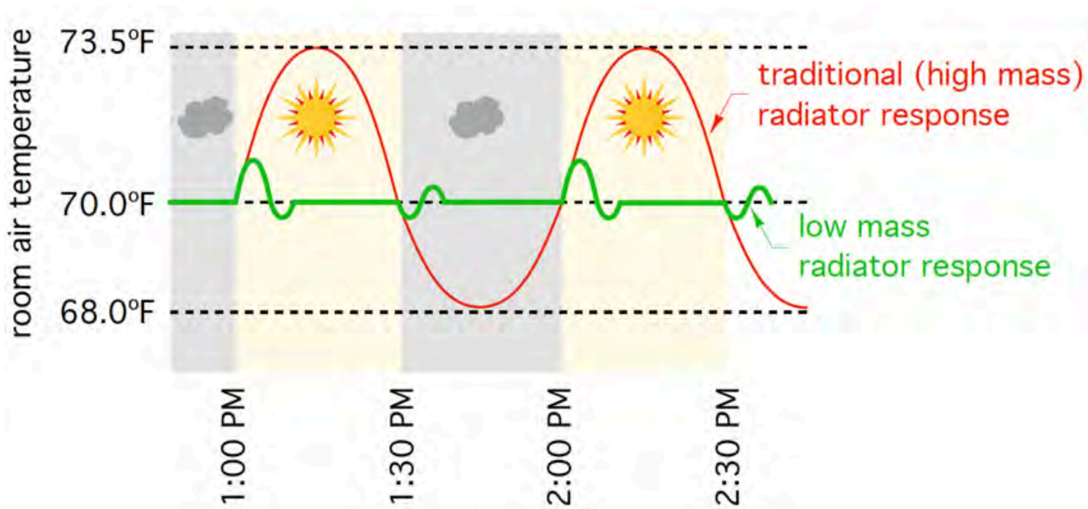
The space quickly overheats.

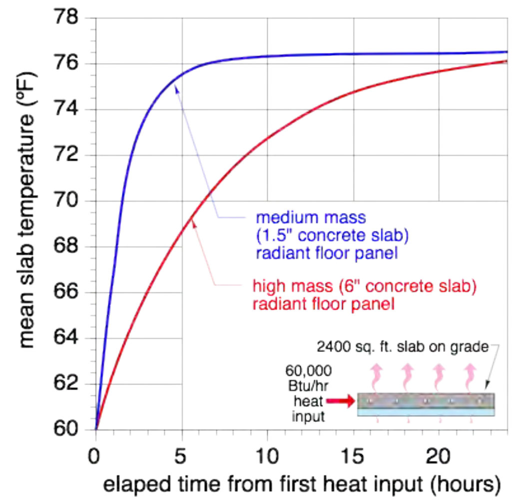
A comparison of THERMAL MASS for several heat emitters:

All heat emitters sized to provide 1000 Btu/hr at 110 ºF average water temperature, and 70 ºF room temperature:



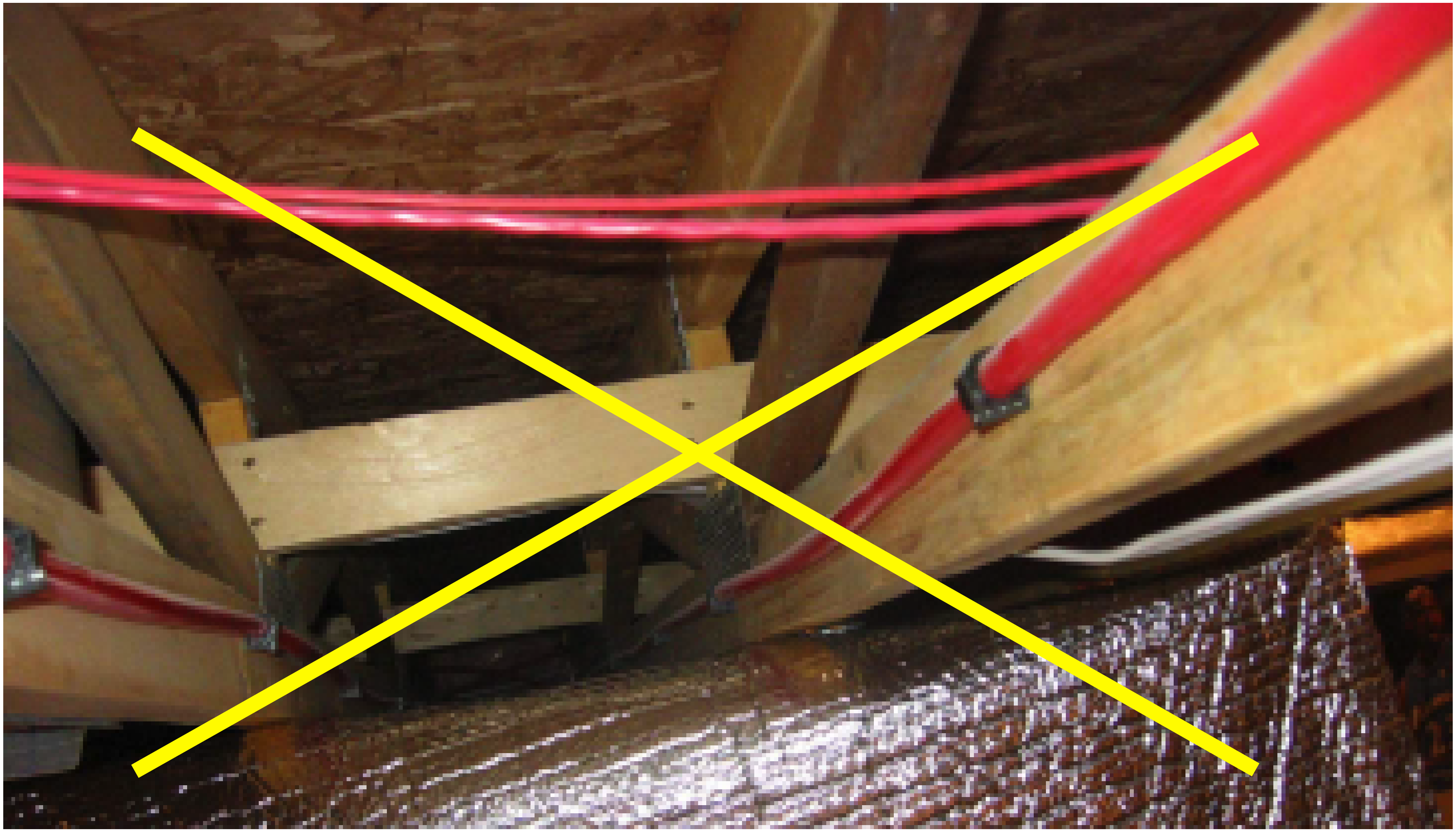
Low thermal mass allows the heat emitters to quickly respond to changing internal loads





Notice where the tubing is in this 6” heated concrete slab

Don't do this with ANY hydronic heat source!



Heat transfer between the water and the upper floor surface is severely restricted!