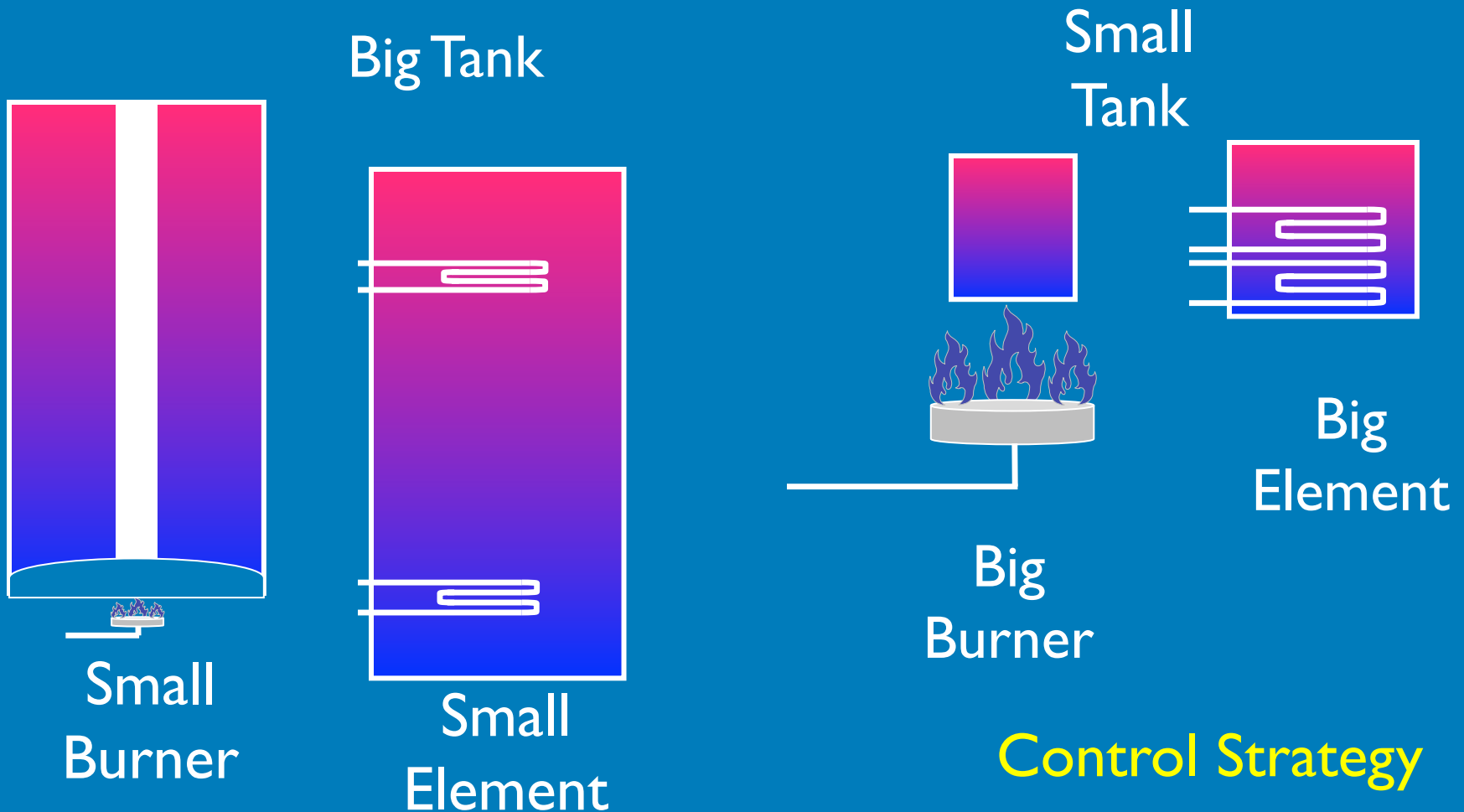


The Essential Differences Between Storage and Tankless Water Heaters?



Gas Tankless Water Heaters

Principle of Operation

- Flow is sensed
- Fan purges combustion chamber
- Burner is ignited and modulated to match measured flow rate
- Heat exchanger begins to heat water as it passes through
- When flow stops, burner is extinguished and combustion chamber is purged.



Gas Tankless Start Up

- There is a 10 to 15 second delay before hot water is produced.
- Increased wait at the fitting for hot water
- Additional water wasted down the drain
 - On the order of 10 - 15 gallons per day
 - 10 second delay times 60 draws per day times 1.0 to 1.5 gpm

(If hot water arrives at the fixture for each draw.)

Gas Tankless Water Heaters Shut-Down

They cool down quickly at the end of a hot water event to prevent boiling in the heat exchanger.

- For safety, once a draw is over, the fan continues to operate.
- This removes combustion byproducts from the flue and cools down the thin-walled heat exchanger.
- The “cool down” cycle takes 1-2 minutes.
- This heat is wasted!

Gas Tankless Water Heaters

- Tankless water heaters will be more energy and water efficient with long draws.
- How does the DOE EF test simulate hot water use?
 - Six long draws a day
- How do we use hot water?
 - Many short draws a day
- The DOE EF test favors tankless water heaters over storage water heaters.

Gas Tankless Water Heaters

Flow Rate

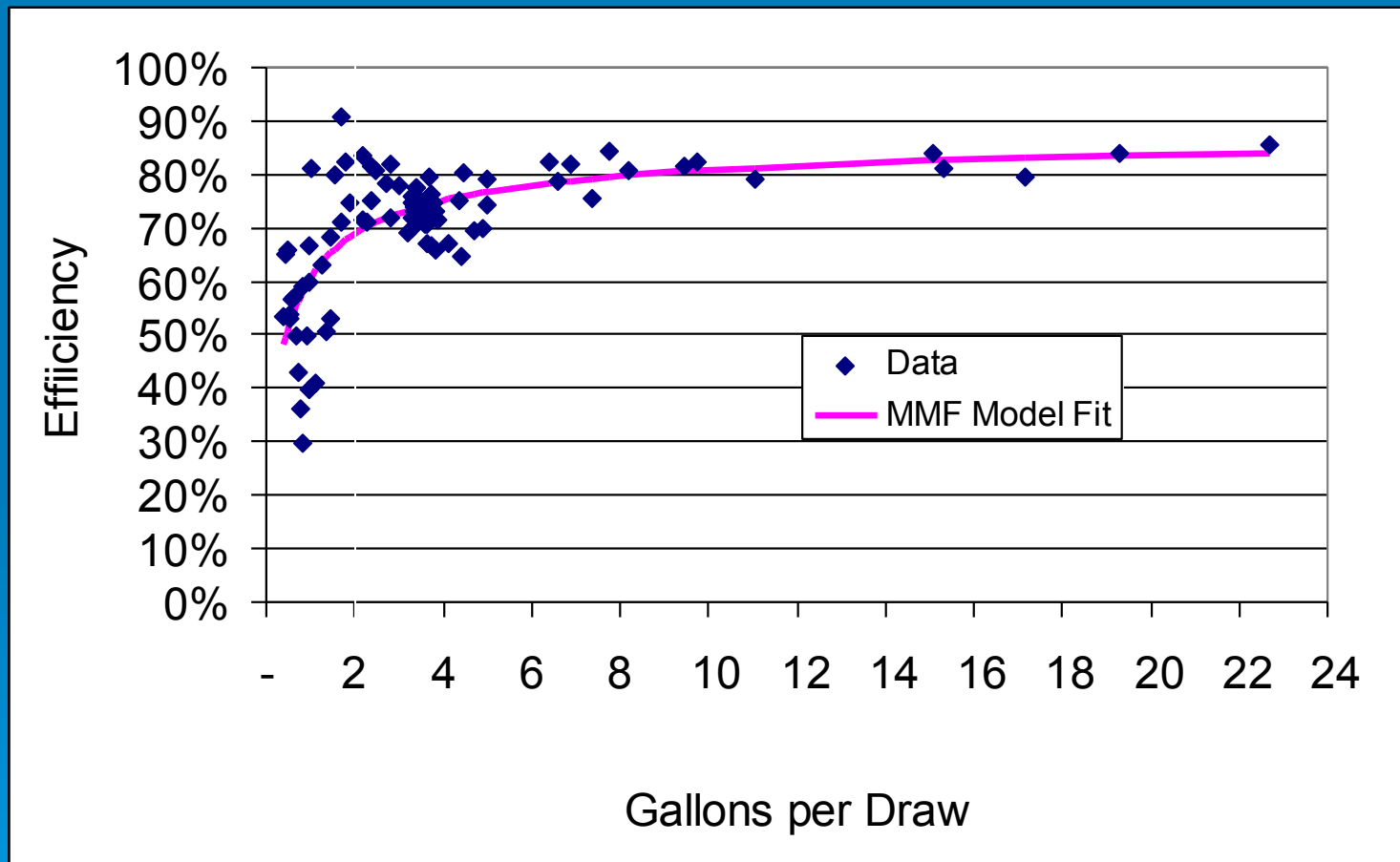
- A gas tankless water heater needs a minimum flow rate to turn the unit. Some current models only require 0.4 gpm to ignite the burner.
- Minimum burner firing rate is limiting factor for the minimum required flow rate
- Maximum flow rate depends burner capacity and temperature rise:
 - Approximately 40,000 Btu per gallon per minute at 70 F temperature rise
- The minimum flow rate **can** it difficult to use:
 - with standard recirculation systems. (Exception is demand controlled recirculation.)
 - as booster for preheated water (such as from solar, geothermal, heat pump)

How do tankless water heaters perform in actual installations?



Measured Efficiency vs. Draw Volume

Gas Tankless Water Heater Performance vs. Draw Size (15 second monitoring interval)



Efficiency also varies by flow rate and draw schedule.

Gas Tankless Water Heaters

“Endless hot water” if sized correctly

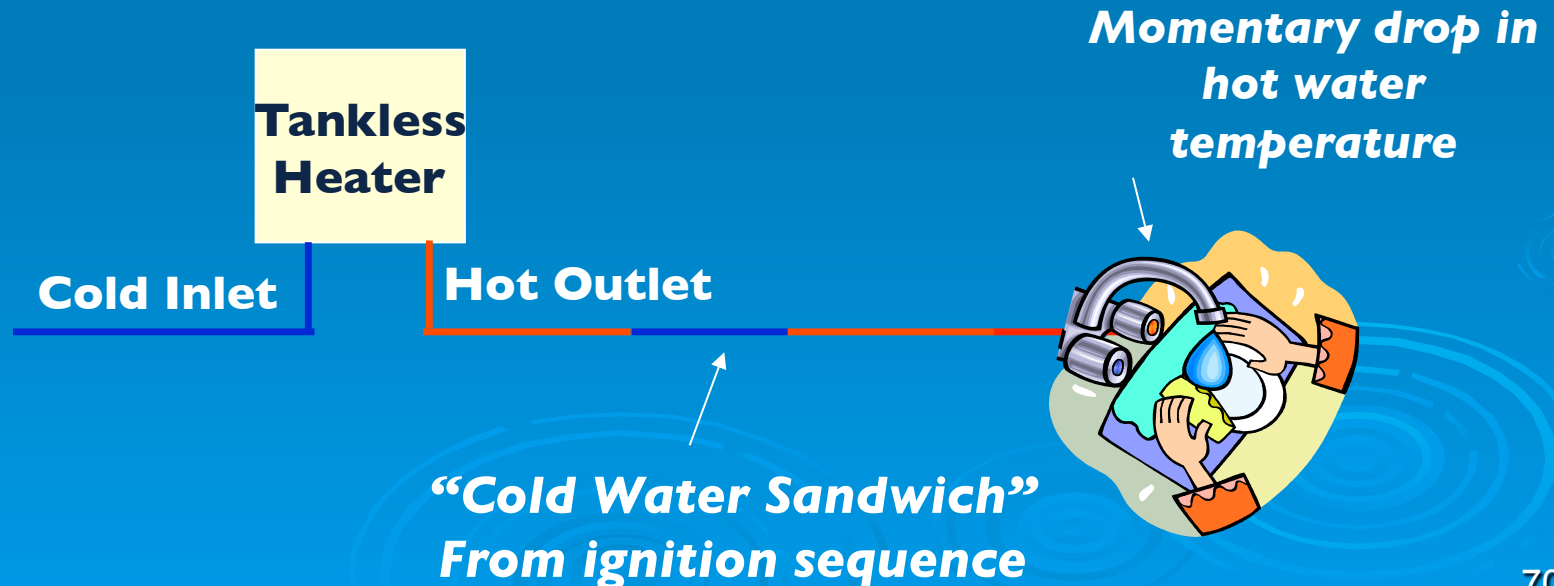
- Depends on flow rate (gpm) and change in water temperature desired.
- If capacity is exceeded, most gas tankless heaters will limit flow and maintain temperature
- If incoming water temperature is very low, even the largest models will have only a modest flow rate capacity.

Will “Endless hot water” result in increased hot water use?

Gas Tankless Water Heaters

“Cold Water Sandwich Effect”

- The introduction of cold water into the hot water line during frequent on/off operation
- Cold water flows through the water heater during the ignition sequence delay (~ 10 sec),
- Two causes:
 - Drop in flow rate below minimum firing rate
 - Intermittent use



Gas Tankless Water Heaters

Manufacturer Recommended Solution to the “Cold Water Sandwich”

Add a small electric buffer tank after the tankless water heater

- Costs more to purchase and install
- Increases energy use
- This improves performance, but how cost effective and energy efficient is it?

Gas Tankless Water Heaters

Manufacturer Recommended Solution to get “Instantaneous” Hot Water

Add a circulation pump to the small electric buffer tank

- Costs still more to purchase and install
- Effectively the recirculation loop is kept hot with electric resistance heating
- Increases energy use
- This improves performance, but how cost effective and energy efficient is it?

Note: Many manufacturers have models which are “recirculation compatible” which should minimize these issues

Gas Tankless Water Heaters

Installation in New Construction

- Installation is modestly more expensive than gas storage type
 - Larger diameter gas pipe ($> \frac{1}{2}$ inch)
 - Larger diameter vent pipe
 - More make up air
 - (Bigger burner = more make up air and bigger flue)
 - Stainless steel vent pipe
 - Need a 110 VAC outlet near the heater
 - Can select location for heater to minimize costs
- Labor is similar to tank type
- Tankless units are more expensive than storage units.
- Total tankless costs are somewhat higher than for storage water heaters.

Gas Tankless Water Heaters

Life Expectancy

➤ 10-15 years are claimed...with regular maintenance

- No data available to support this claim in North America

➤ Potential Issues

- Thin-walled heat exchangers
- Lots of structural stress during normal operations (expansion and contraction)
- Small passageways for the water are likely to scale up in areas with hard water
 - Where does the scale go?

➤ Service

- Simple cleaning of filters required annually unless water is hard. With hard water, acid cleaning of the heat exchanger is often recommended.
 - What will repeated acid cleaning do to the copper heat exchangers?

Gas Tankless Water Heaters

Expected **energy** savings

- According to the DOE, the average household will save 41 Therms/year by using an Energy Star gas tankless rather than an Energy Star conventional water heater.
 - If water usage is much lower than average (64 gals/day), a tankless is more advantageous.
 - If water usage is high, a condensing storage water heater will cost less to install and less to operate.

Gas Tankless Water Heaters

Expected **cost** savings

- The projected cost savings of 41 Therms/year must be compared to:
 - An increased installed cost (according to Energy Star) of between \$605 and \$1635
 - The manufacturer's recommendation of regular maintenance.

Condensing Gas Tankless Water Heaters

- Condensing tankless units have recently been introduced by most manufacturers
- Condensing increases the EF to the 0.91 to 0.97 range and allows use of PVC venting.
- Condensing tankless models are more expensive but their installation should be more economical due to the venting.
- By in large, these are newly introduced models with little track-record.

Electric Tankless Water Heaters

Principle of Operation

- When flow is sensed, heating elements are activated.
- Current to the heating elements is determined by flow demand and outlet temperature
- When flow is terminated, current to heating elements is stopped.



Electric Tankless Water Heaters

Older Technology

- Flow switch controls operation
 - Minimum and maximum flow rates
- Restricted flow - $\frac{3}{4}$ inch down to $\frac{3}{8}$ inch tubing
- Downward plumbing connections
- Elements:
 - Multiple, welded-in, non standard elements with different wattages.
 - Turn on combinations of elements to get the desired output temperature.
- Canisters contain relatively small volume of water
 - More difficult to absorb residual heat at the end of a draw
 - Cool down relatively quickly



Electric Tankless Water Heaters

Recent Innovations

- Temperature difference controls operation
 - No minimum or maximum flow rates
 - Soft start power ramp-up
- Unrestricted Flow
 - Minimum $\frac{3}{4}$ inch tubing
- Normal plumbing connections
- Elements:
 - Standard, easily removed elements
 - Activated in on-off pattern so that the power requirement is averaged over the total number of available heating elements
- Tubes contain relatively large volume of water
 - Able to absorb residual heat at the end of a draw
 - Cool down relatively slowly



Electric Tankless Water Heaters

“Endless hot water” if sized correctly.

- Depends on flow rate (gpm) and change in water temperature desired.
- If the capacity of the heater has been exceeded, either:
 - Temperature drops to maintain a given flow rate (recent innovations) or
 - Flow rate is limited to maintain a given temperature (older technology)

For use with recirculation systems or to boost the temperature of preheated water, such as solar thermal, geothermal, off-peak electric tank

- Units with flow switches are not recommended
- Units with temperature based activation will work well

Which will prevail?

- Tankless will have a market share:
 - First adopters
 - Perceived “green” impact
 - Infrequent or low hot water usage
 - Where space is an issue
- Condensing storage water heaters are significant competition
 - More efficient
 - Less expensive
 - Less water usage

Remember What People Want

Hot Water Now = “Instantaneousness”

- Need hot water available before the start of each draw.
 - A tank with hot water
 - Heated pipes
- Need the source of hot water close to each fixture or appliance

Never Run Out in My Shower = “Continuousness”

- Need a large enough tank or a large enough burner or element
- Or, a reasonable amount of both

Which will prevail?

Neither Tank or Tankless is the Answer

- A combination of the two might be better:
- Burner
 - Sized for some amount of continuous use
 - Approximately 1.5-3 GPM
 - 60-120,000 Btu Natural Gas
- Modest tank
 - Some volume for peak conditions
 - Hot water available at the beginning of every draw
 - Enables a simpler burner control strategy
- Pick the right combination of burner or element and storage?

Should a builder/homeowner install a gas tankless water heater?

- Inexpensive way to claim you have a “green” house.
- BUT,
 - Homeowner must pay for regular maintenance
 - Homeowner may pay for more water usage
 - Homeowner will have to live with minimum flow restrictions and cold water sandwiches

What water heater should be installed in a new home?

➤ For gas,

- At the very minimum, provide for electrical power and a condensate drain at the water heater location.
- Install an Energy Star water heater
- Preferably install a condensing storage water heater
 - More efficient and more cost effective than the tankless options

What water heater should be installed in a new home?

➤ For electric:

- At a minimum provide a water heater location which is suitable for a HPWH...condensate drain and adequate ventilation.
- Provide a HPWH:
 - By far the most efficient option

What water heater should be installed in an existing home?

➤ For gas:

- Install an Energy Star water heater
- Preferably install a condensing storage water heater
 - More efficient and more cost effective than the tankless options

What water heater should be installed in a new home?

➤ For electric:

- Consider a HPWH water heater if there is a suitable location...condensate drain and adequate ventilation.
- Buy the most efficient water heater available.

The Hot Water Distribution Systems

