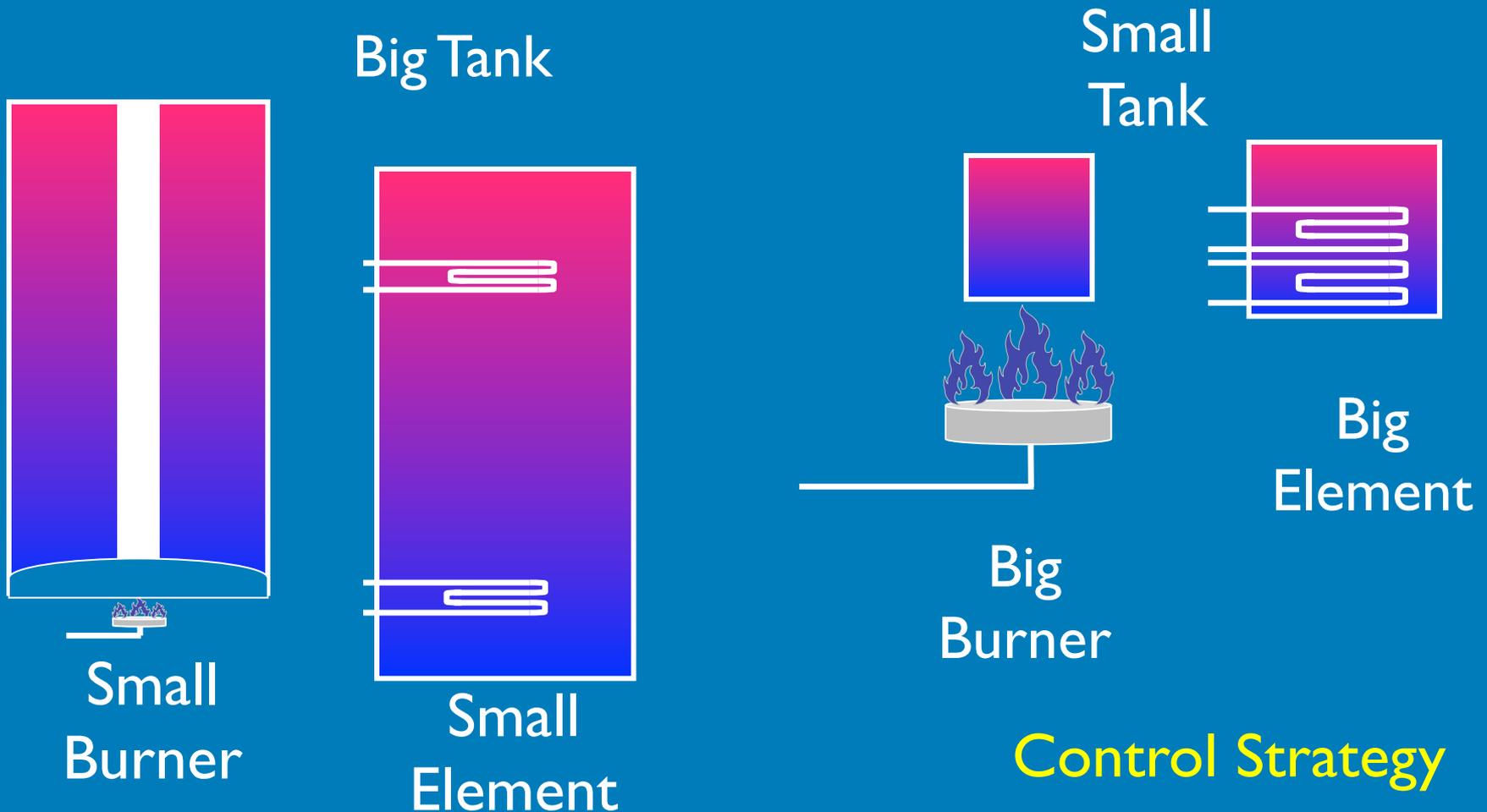


# The Essential Differences Between Storage and Tankless Water Heaters?



# 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

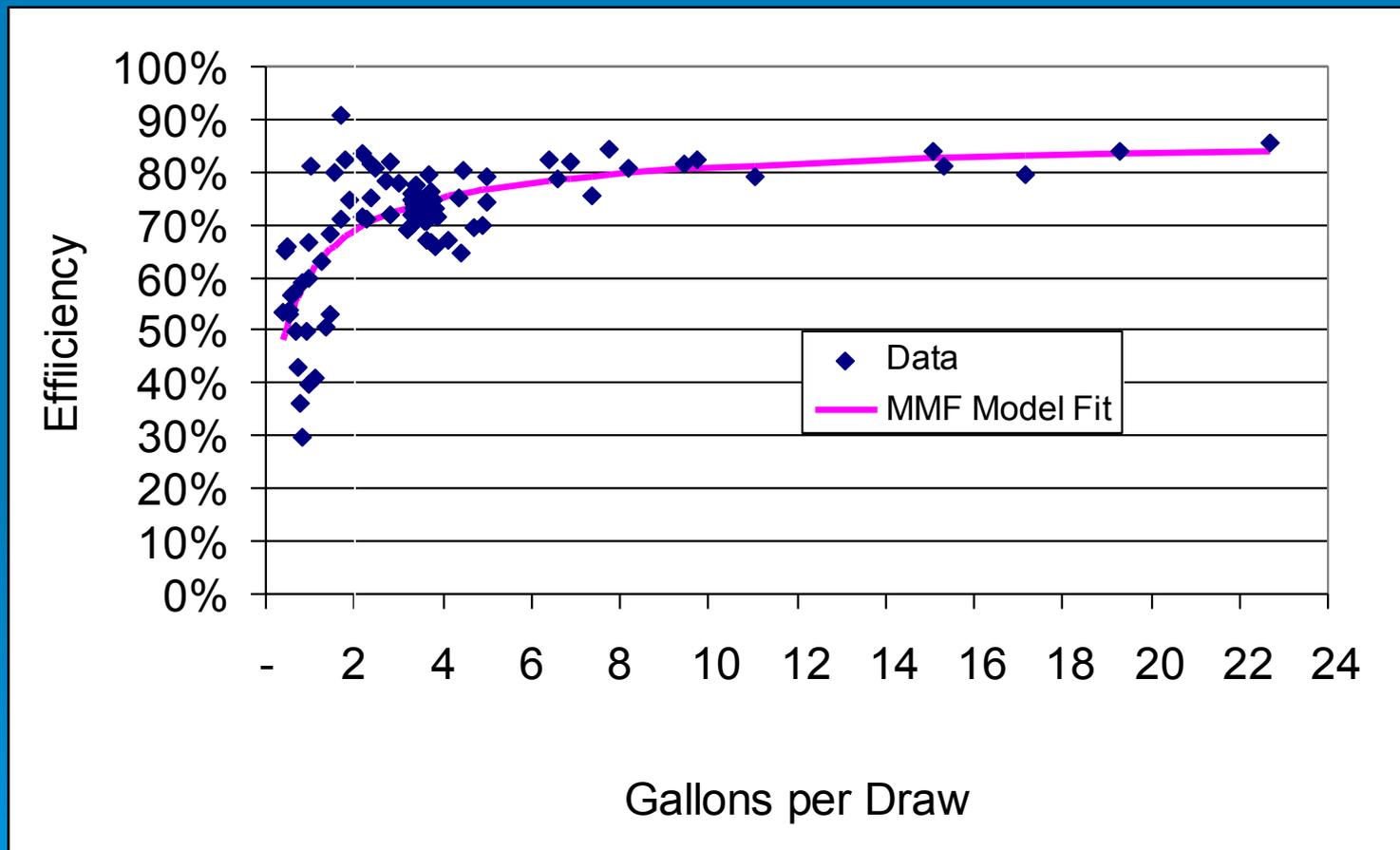
- A gas tankless water heater needs a minimum flow rate to turn the unit. Some current models only require 0.4 gpm to ignite the burner.
- Minimum burner firing rate is limiting factor for the minimum required flow rate
- Maximum flow rate depends burner capacity and temperature rise:
  - Approximately 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

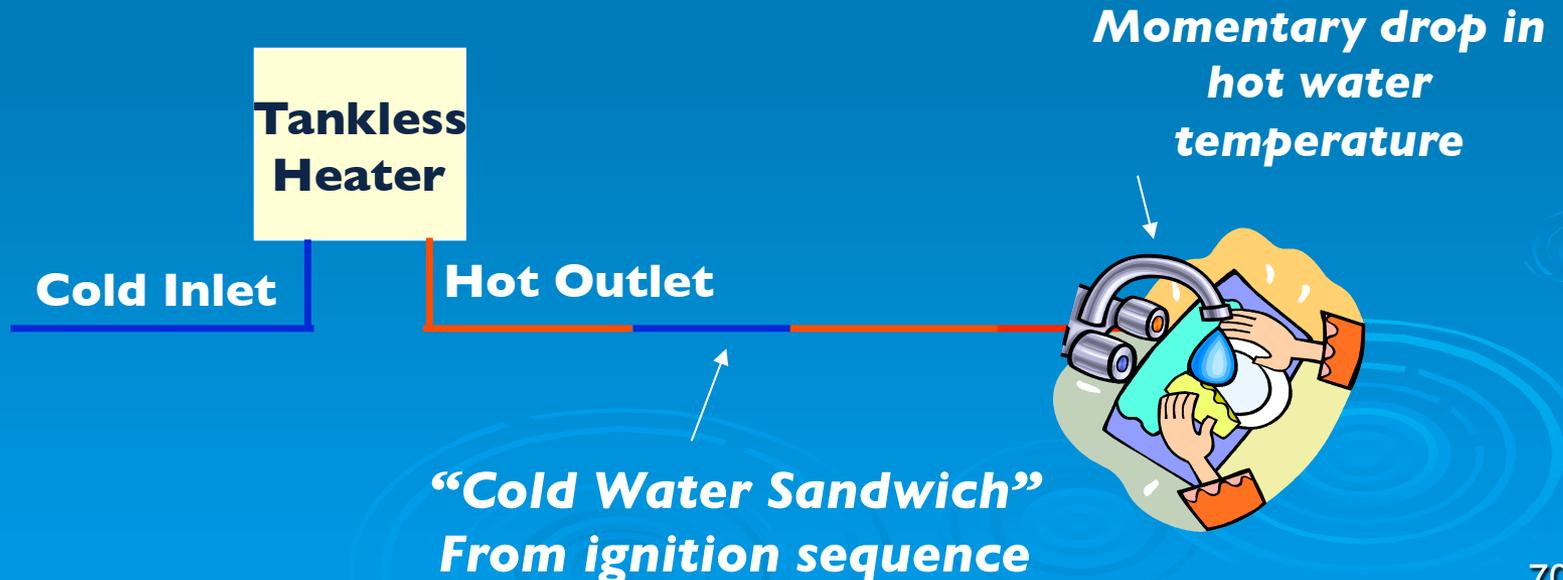
- Depends on flow rate (gpm) and change in water temperature desired.
- If capacity is exceeded, most gas tankless heaters will limit flow and maintain temperature
- If incoming water temperature is very low, even the largest models will have only a modest flow rate capacity.

**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

