Efficiency Ideas
for
Service Water Systems

Bert Phillips, P.Eng., MBA, FEC
UNIES Ltd.
phillips@unies.mb.ca

Service water system design, installation and operation hasn't changed much in recent decades – the primary emphasis is low installed cost

Improved system designs may cost more, but…

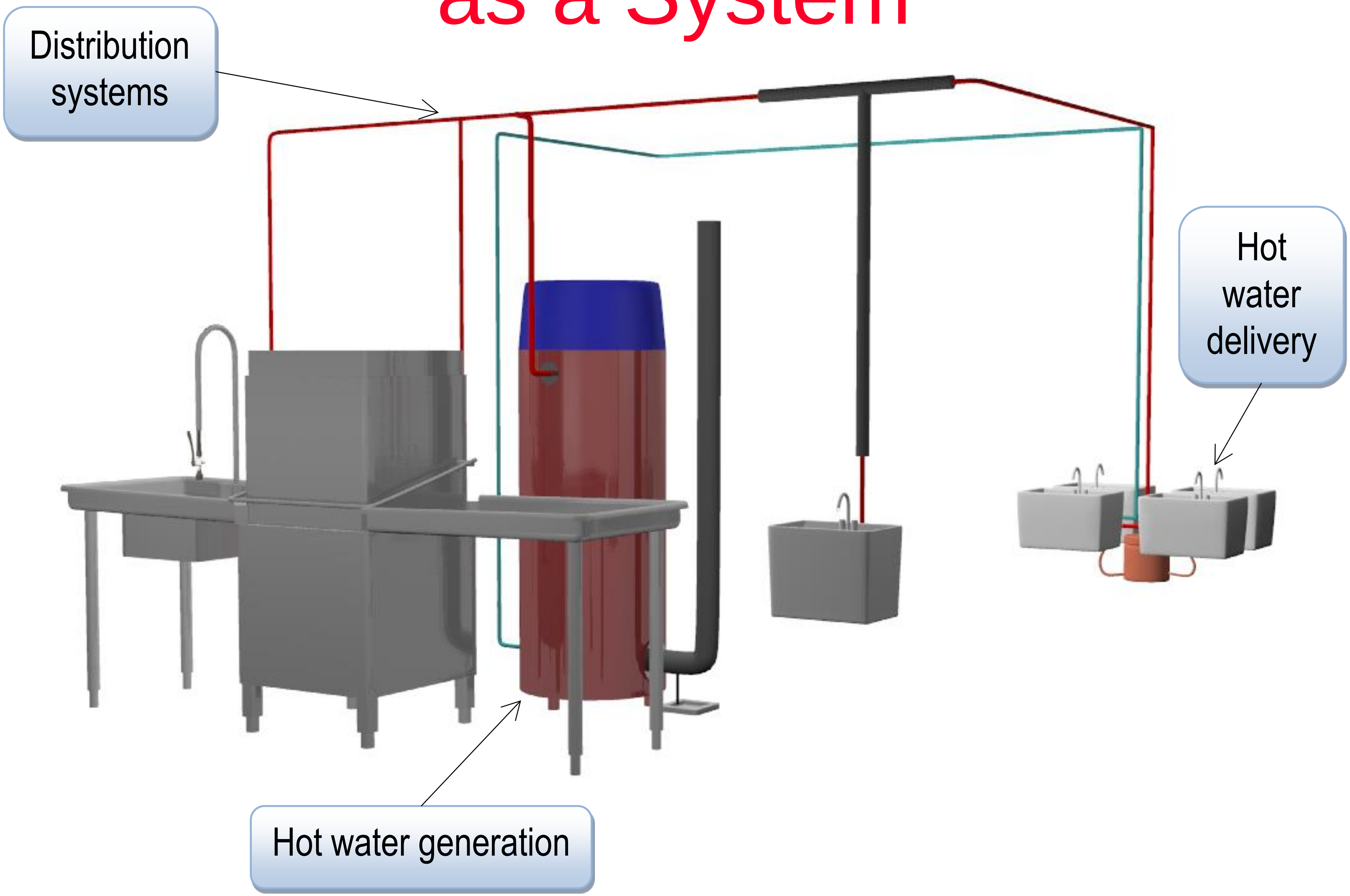
- Lower operating costs help offset the installed cost premium
- Reduced hot-water wait times at hand sinks improve user satisfaction

My Objective

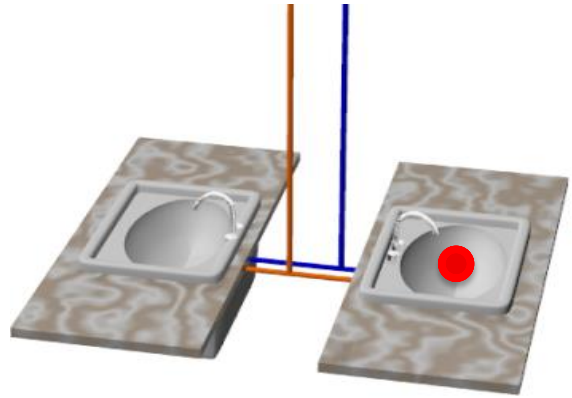
I want you to think differently about service water system design

to think outside the recirc loop and consider technologies and strategies that will improve ***DHW system delivery efficiency*** when you design or maintain service water systems

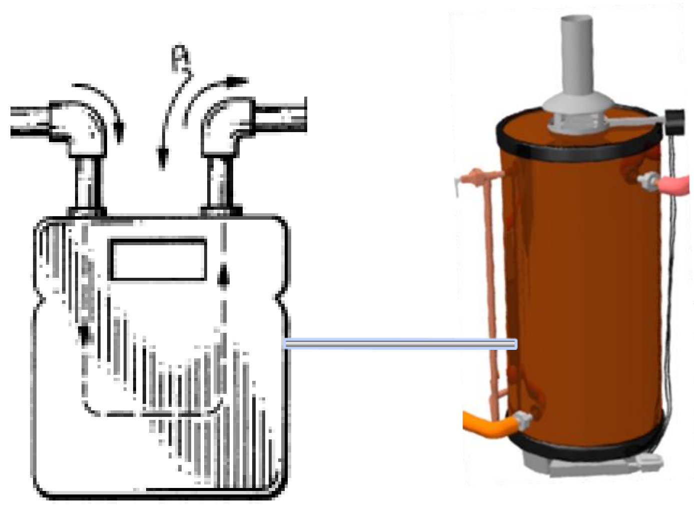
Think of hot water supply as a System



System Delivery Efficiency



$$\frac{\textit{Energy Delivered at End Uses}}{\textit{Input Energy to Heater}}$$



Water – Energy Nexus

- Nexus is a group of connected things
  - Energy is used to deliver water to your pipes and to treat waste water that leaves your premises, and
  - Water is consumed in the production of energy

Billed water consumption in Winnipeg in 2009 was 27% less than in 1990 even though population grew about 10%.

Per Capita Water Consumed	**247.9 L/c/d**

The cost of a cubic meter water in Winnipeg

Cubic metres	Water Charge	Sewer Charge	Total
0 - 272	$1.45	$2.28	$3.73
over 272	$1.38		$3.66

The energy to heat a cubic meter water 40°C = 46.4 kWh

- With electricity (not including demand)
  - $3.59 @ 7.752¢ /kWh (first 11,000 kWh)
  - $2.50 @ 5.381¢ /kWh (next 8,500 kWh)
  - $1.65 @ 3.552¢ /kWh (balance)
- With gas at $0.28 / cu.m.
  - $1.39 @ 90% efficient water heater
  - $1.57 @ 80% efficient water heater
  - $1.79 @ 70% efficient water heater
  - $2.09 @ 60% efficient water heater

So the cost of water may be more than the cost of energy to heat the water

but water heating is not the only energy use in service water systems…

Other energy costs

- tank standby losses
- stranded water losses
- recirc pump energy
- recirc loop heat losses

And leaking fixtures

- 1 drop per second is about a cup of water per hour or 2 cu.m. per year
- One drop per second is a very slow leak

Even small drips add up:

- 20 to 30 drops per second is 35 to 50 cu.m. per year
- water/sewer: $140 to $200/year
- energy: $50 to $175/year

And these guys that don’t shut off waste thousands per year

There can also be water losses in mechanical systems – faulty fill valves serving cooling towers, boilers, humidifiers and ………..

Water and Energy Savings can come from

- **Heating Water More Efficiently**
- **Delivering Hot Water Quicker**
- **Reducing Fixture Flow Rate**
- **Reducing Heat Loss from the DHW Delivery System**
- **Reducing Stranded Water Energy Losses**
- **Waste Heat Recovery**
- **Other**

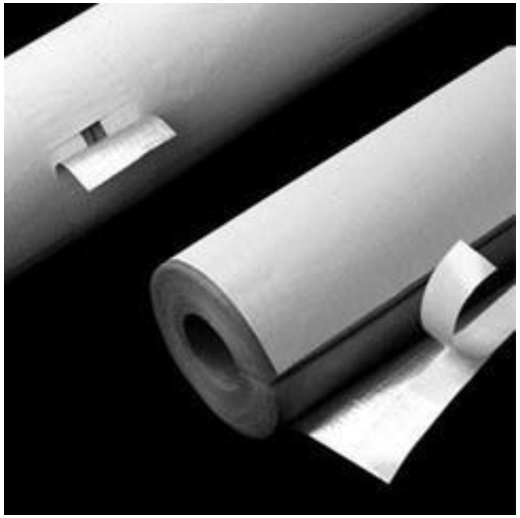
The easy and obvious stuff

- Fix leaky faucets and fixtures
- Select higher efficiency water heaters
- Select low flow/water efficient fixtures
- Ensure flue gas dampers are operating correctly
- Insulate all hot water lines
- Locate water heaters near fixtures/optimize piping layout

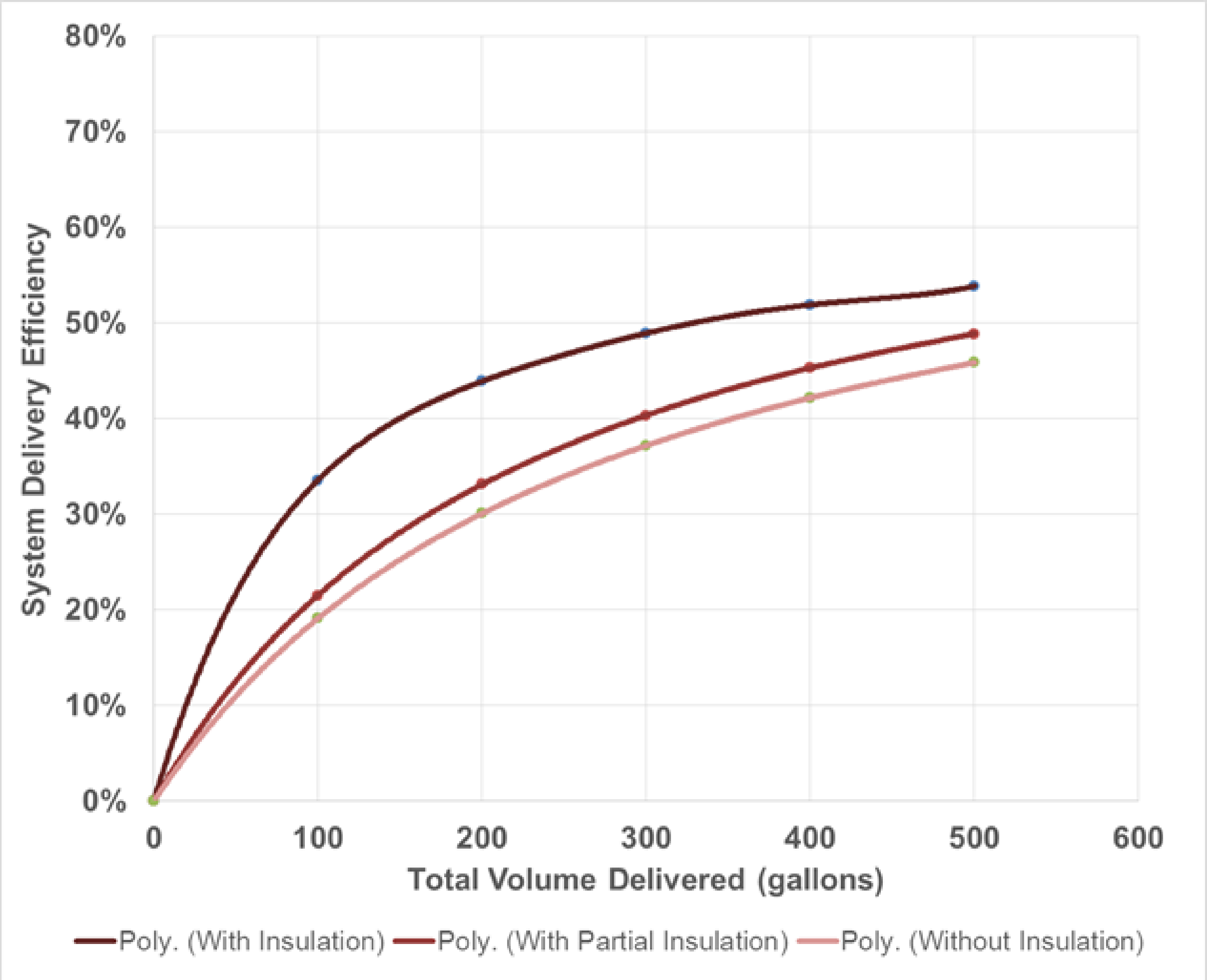
In Food Services
Install Low Flow Pre-Rinse Spray Nozzles
The Real Workhorse in the Dish Room!

Reducing Heat Loss from Piping

- Insulate all hot water lines
  - Extends the cool down time
  - Improves the effectiveness of the distribution system
  - Reduces unwanted heat gain to air-conditioned spaces
- Turn water temperature down
- Control the recirc pump



Pipe Insulation Test Results from ATS Lab



Question #4

What measure is applicable to all hot water systems?

A) Aquastat

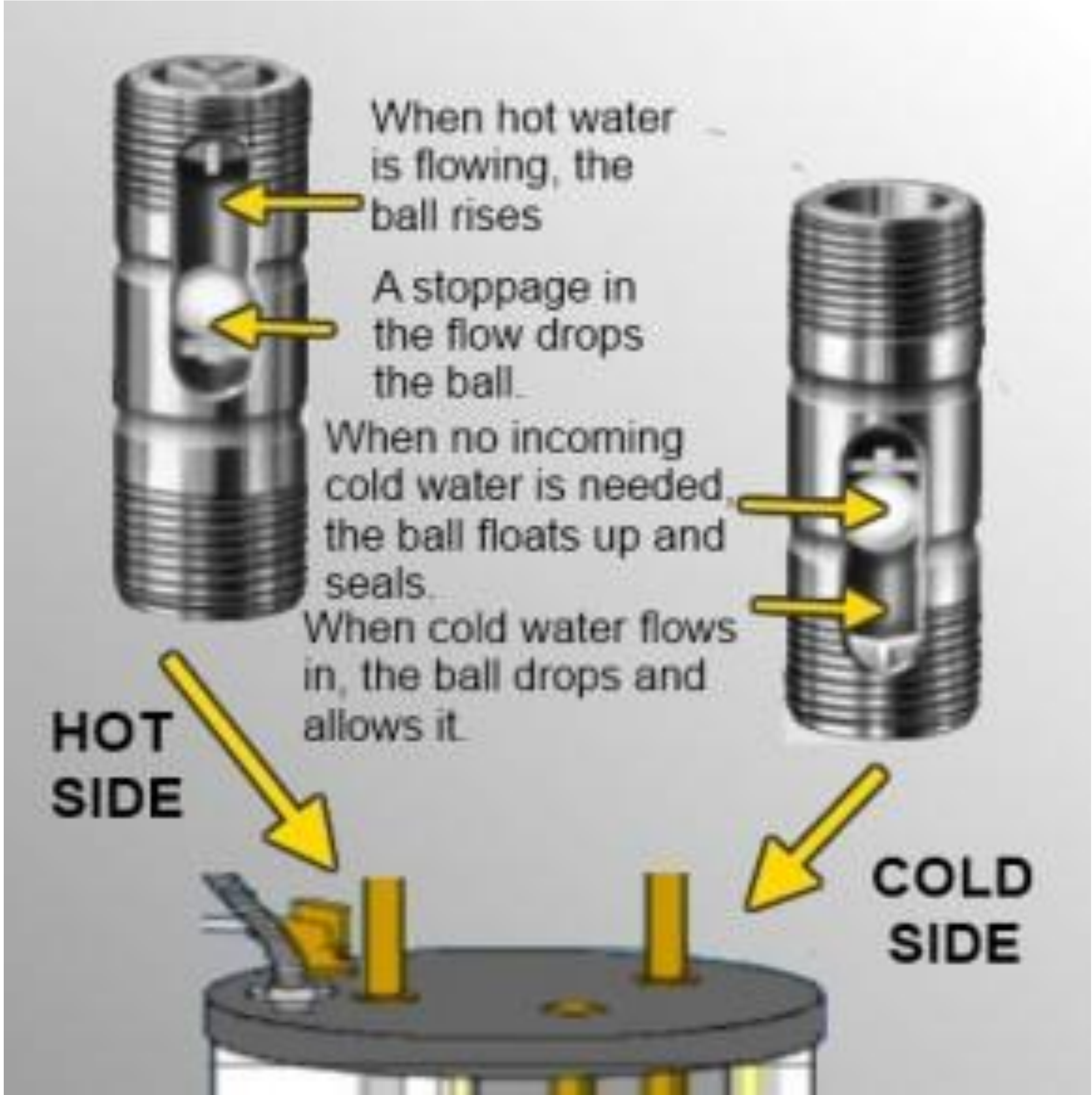
B) Recirculation Pump Timer

C) Flue Damper

D) Pipe insulation


A.O.Smith

Install heat heat traps



Water cooled refrigeration Don't do it!

About100 liters water per ton hour of cooling

$0.40 to 0.60 per ton hour for water, sewer and electricity

A poorly performing air cooled refrigeration unit is less than $0.20 per ton hour of cooling

A well operating system will cost less than $0.08 per ton hour

CWWA Water Efficient Toilet Ratings

- Maximum Performance Testing of Popular Toilet Models (updated October 2009)
- Specialty reports: High Efficiency Toilet (HET) Fixtures with MAP scores (updated October 2009)
  - Pressure assist fixtures
  - Single flush, gravity fed fixtures
  - Dual flush fixtures

http://www.cwwa.ca/freepub_e.asp

Lower water heater set-point temperature to reduce standby, recirc loop and stranded water energy losses

Also reduces rate of corrosion, thus extending water heater and tank life

Legionella may be a concern

Install time-clocks and aqua·stats to control recirculation loop pumps

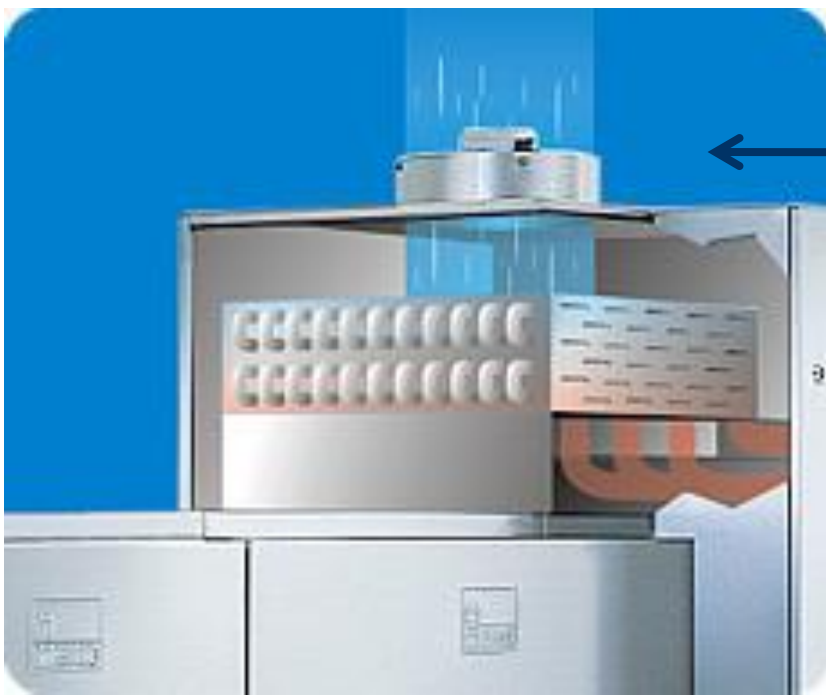
Drain pipe and shower floor heat recovery

Estimated to reduce DHW energy consumption by 5 to 10% in residential applications

May provide larger, or lesser savings in commercial and industrial applications

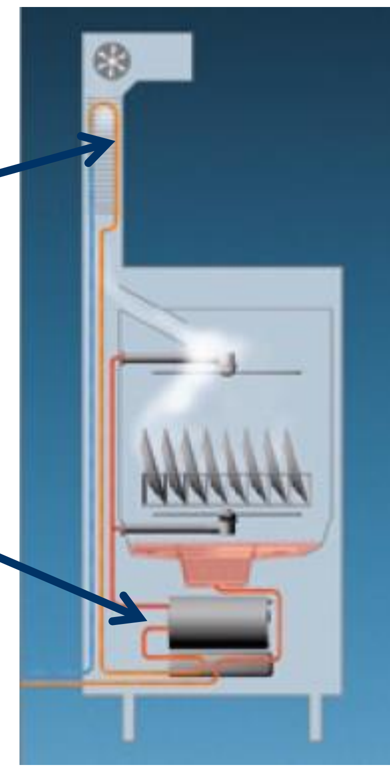
Heat pump heat recovery is problematic

Dish machines with Integrated Heat Recovery



Waste Air
HR

Drain
Water
HR



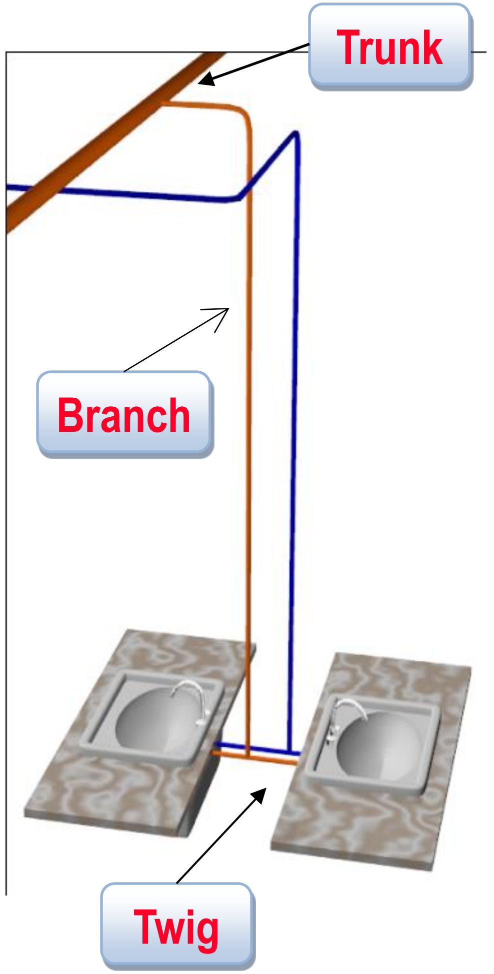
Question

What is the most cost effective way to reduce the operating cost of a hot water system?

A) Adding a timer to the recirculation pump
B) Properly setting the temperature on the heater thermostat
C) Adding insulation on the hot water pipes
D) Adding an aquastat to control the recirculation pump

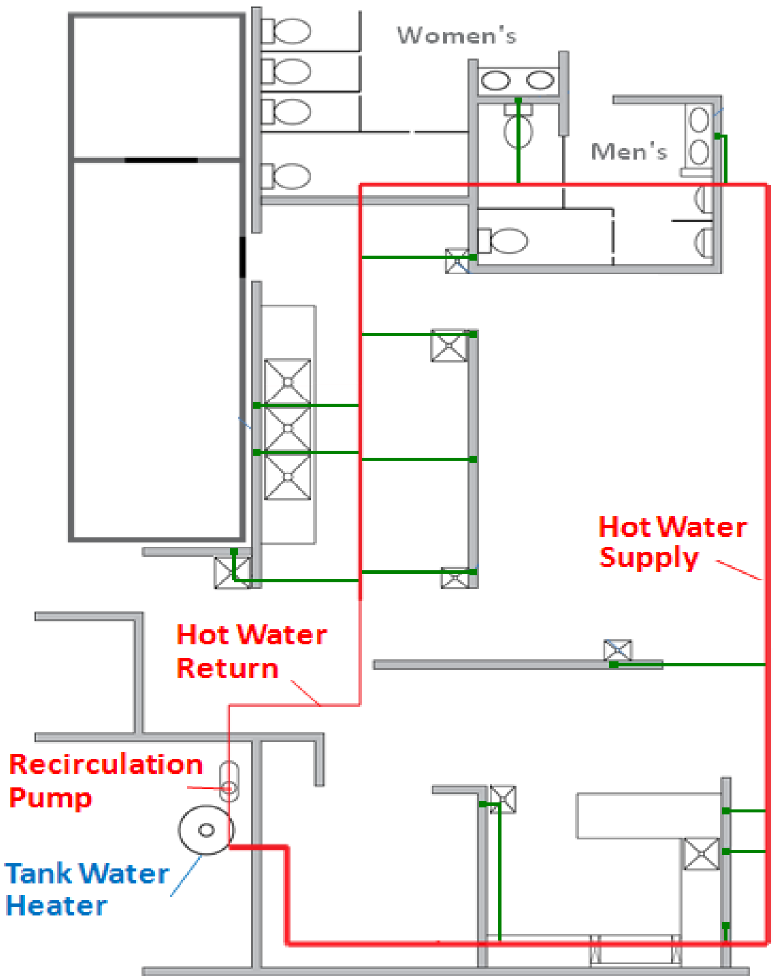
Simple Distribution

- Uses a trunk, branch and twig configuration to deliver water from the heater to the point of use
- Benefit: compatible with all heater types
- Drawbacks: long wait times at hand sinks
- Typically designed for applications where each line is kept to 60 feet or less
- Two common systems: single line and two-line distribution providing hot water to sanitary equipment and warm water to hand sinks



Continuous Recirculation

- Task is to keep the distribution line hot at all times – like moving the heater much closer to the points of use
- Drawbacks: this method does not always ensure that hot water makes it to the faucet
- High operating costs are incurred as hot water circulates long hours, constantly loosing heat to the surroundings

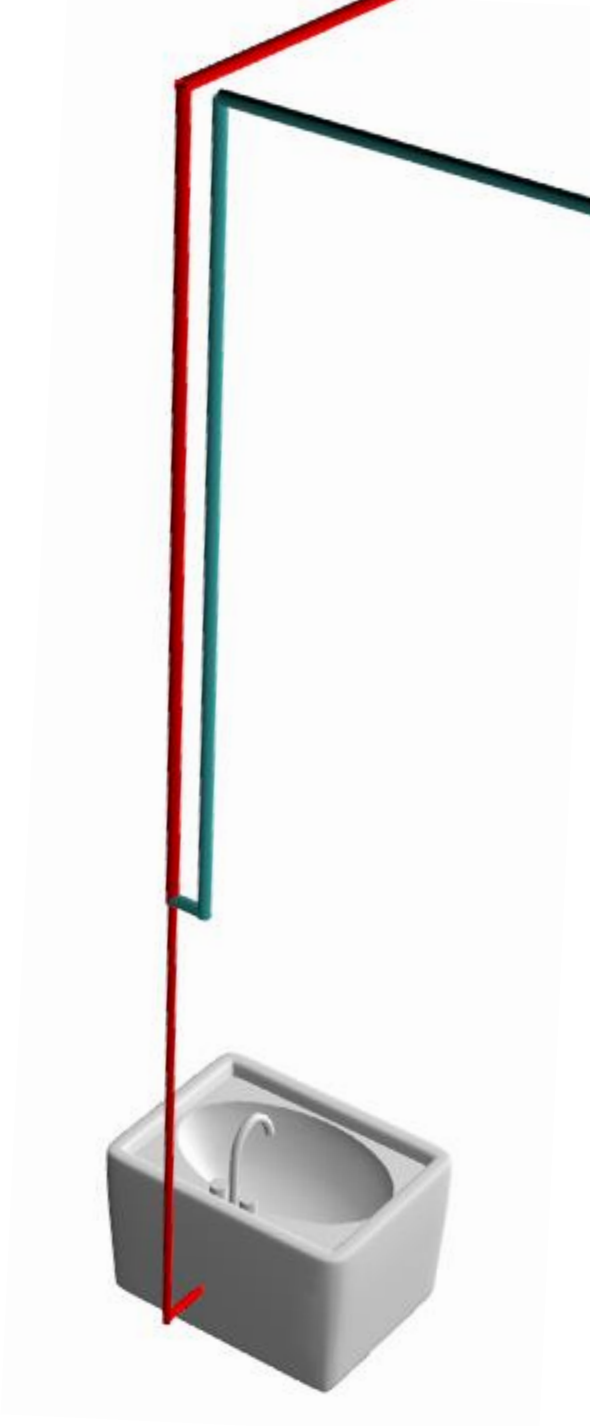


System Operating Efficiency is not just about energy and water

It’s also about wait times

Dropping the recirculation line vertically will reduce the length of branch or twig piping.

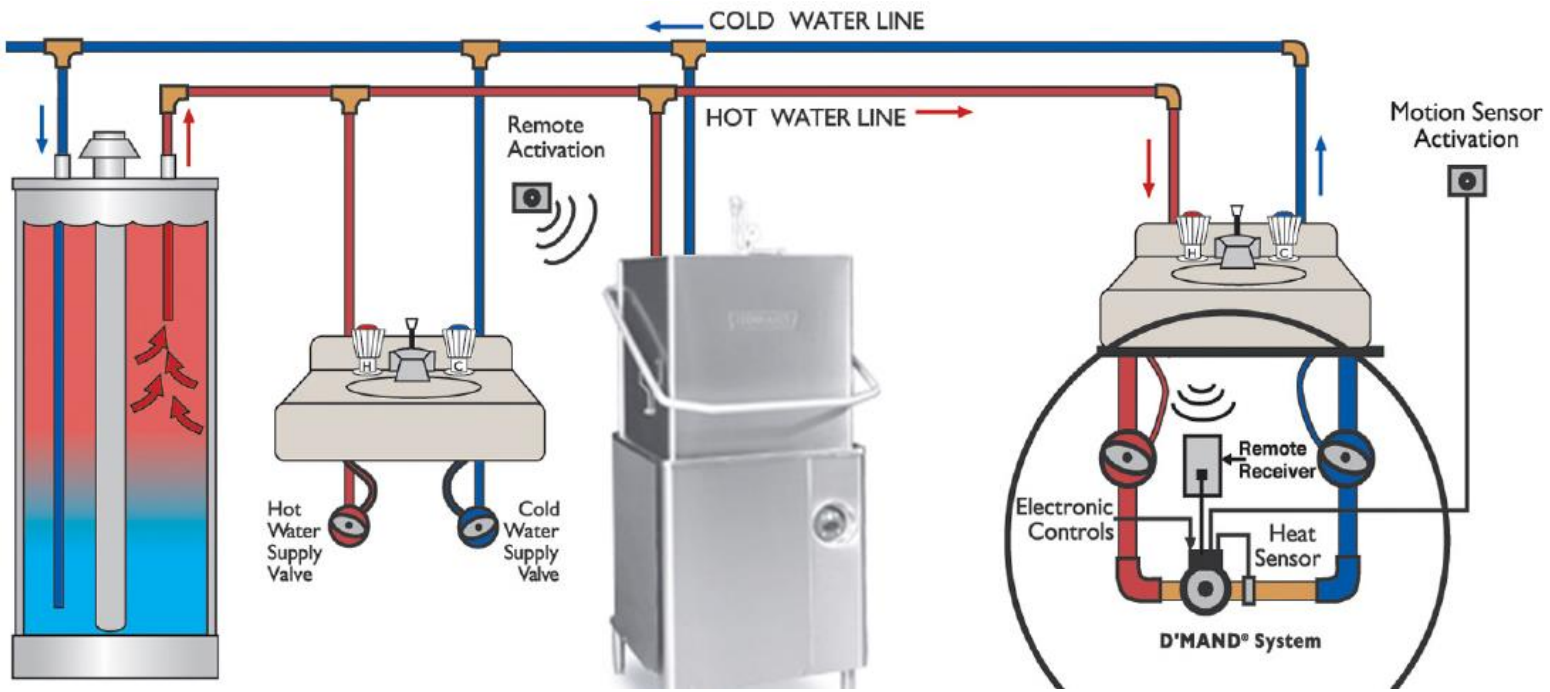
This brings hot water closer to the faucet, reducing wait times and water waste



Demand Circulation

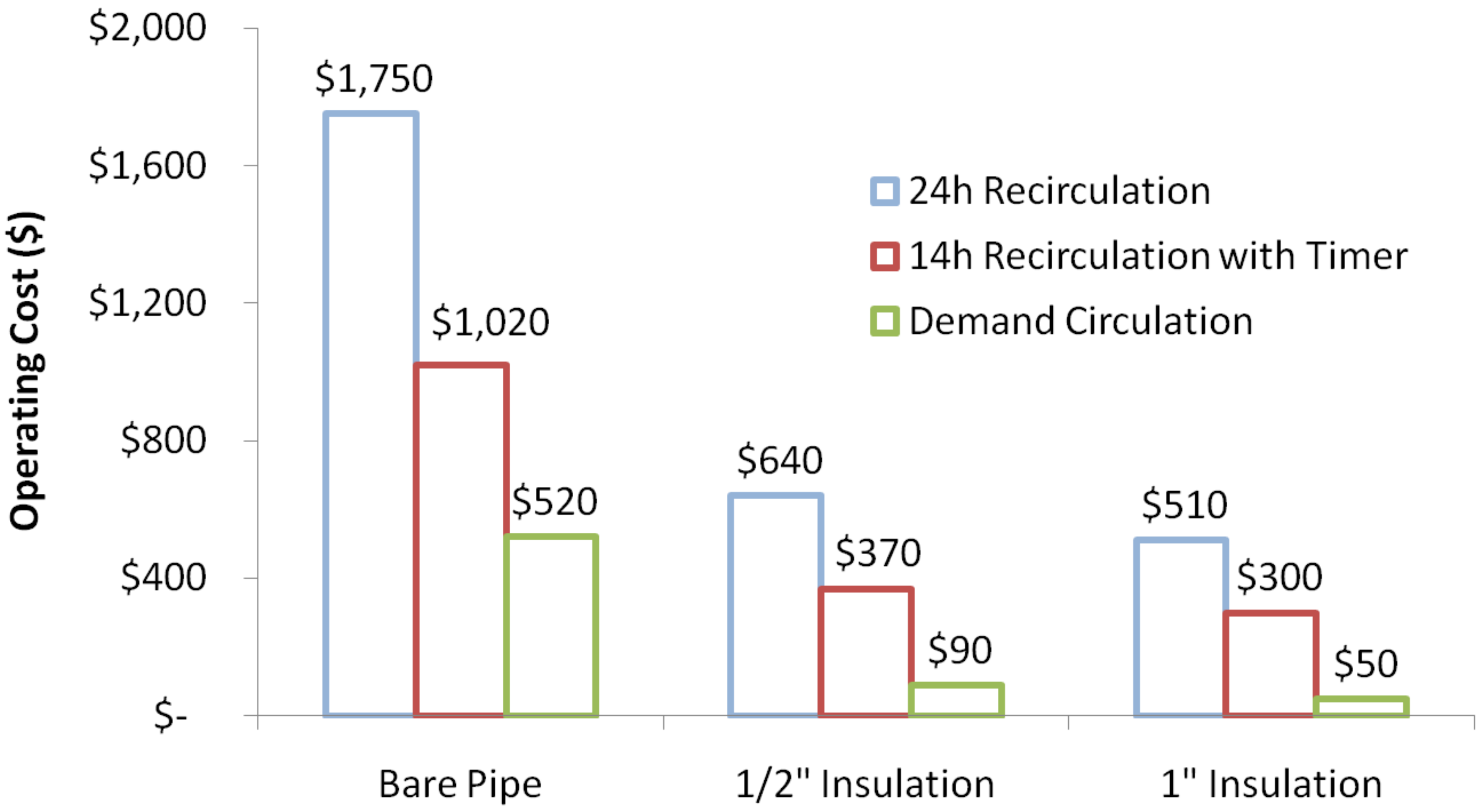
The task of demand circulation is to circulate hot water in the supply line and down to specified fixtures on demand and de-activate automatically when hot water has reached its target.

Demand circulation saves energy and improves hot water delivery.



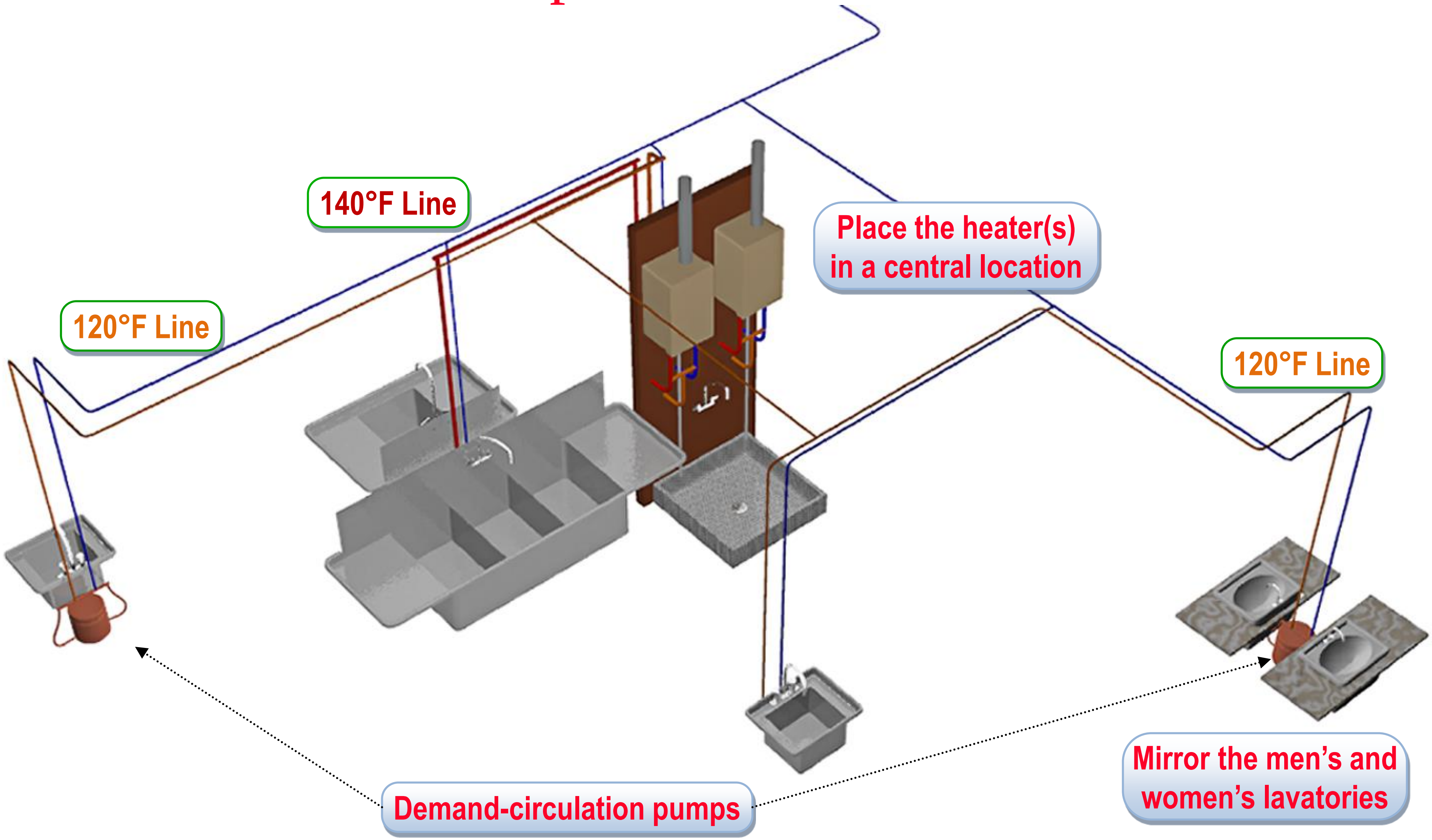
Distribution System Cost Comparison

A FSR with a 80% TE tank is modeled with 220 feet of piping to investigate the operating costs with various distribution system configurations.



Demand Circulation

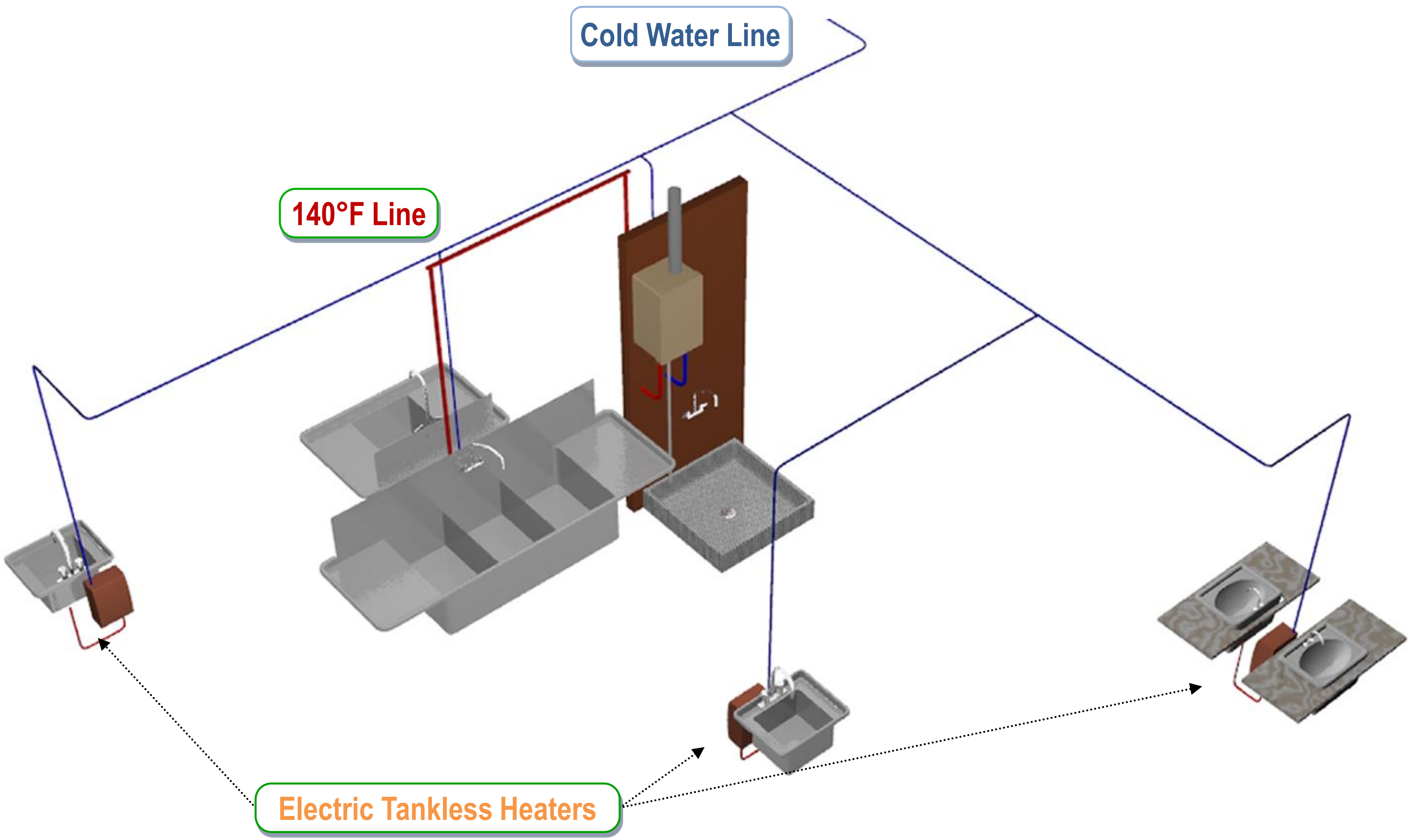
with Optimized Distribution



Distributed Generation or Point of Use Water Heating

- Smaller water heaters, often tankless or low volume electric, installed near clusters of fixtures
- Works well with low flow aerators, saves energy and increases hot water delivery performance

Hybrid System w/ POU Electric Tankless



PoU School example - Carl Hiller of Applied Energy Technologies in Davis California

Original school design - central gas fired DHW tanks and two recirc loops. Annual energy use was 800 therms of gas to heat and 2500 kWh electricity to recirculate

Replacement - three electric water heaters located near end uses

PoU Advantages

- Reduced hot water piping & insulation
- No recirc pump
- Less water and energy waste
- Short wait times

DHW system efficiency is not just about wasting energy and water, it's also about wasting time waiting for hot water

Long wait times waste water and energy

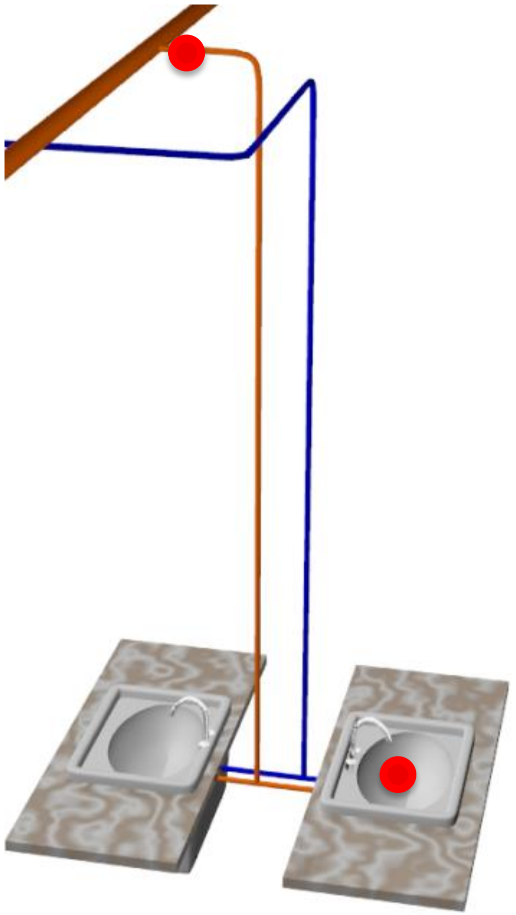
At a given fixture, wait time is a function of

- flow rate
- length of pipe between faucet and hot water
- pipe diameter

Question #5

How many seconds does it take to get hot water from the recirculation line located 25 feet (7.5 m) away to the lavatory sink with a 0.5 gpm (2 L/min) aerator on the faucet?

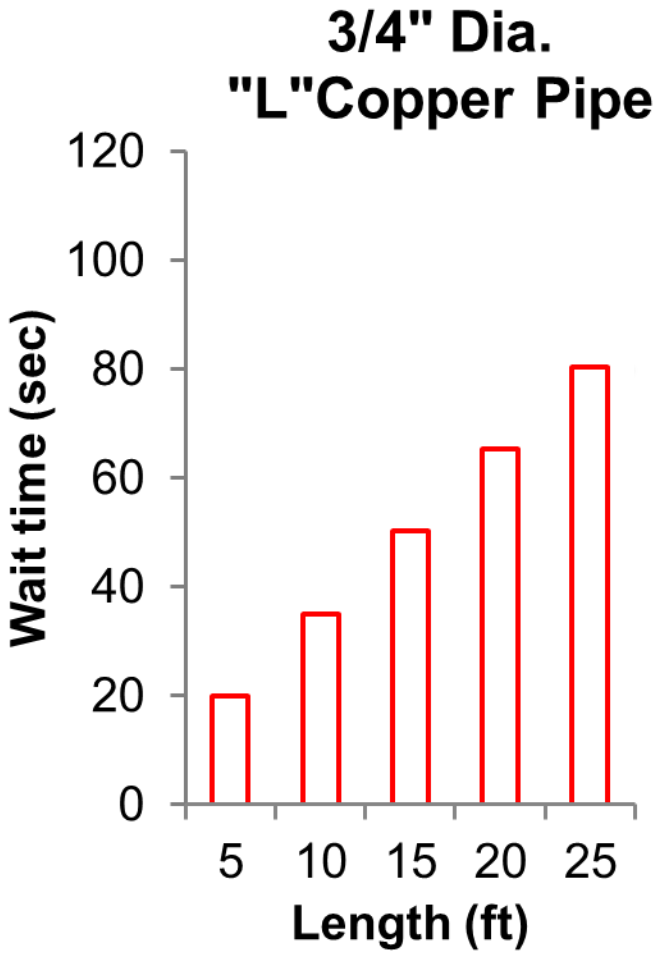
1. 10 seconds (acceptable)
2. 30 seconds (marginal)
3. 50 seconds (unacceptable)
4. 80 seconds (unacceptable)



25 feet in length
¾"-inch dia. pipe

Answer

How many seconds does it take to get hot water from the recirculation line to lavatory sink with a 0.5 gpm aerator on faucet?



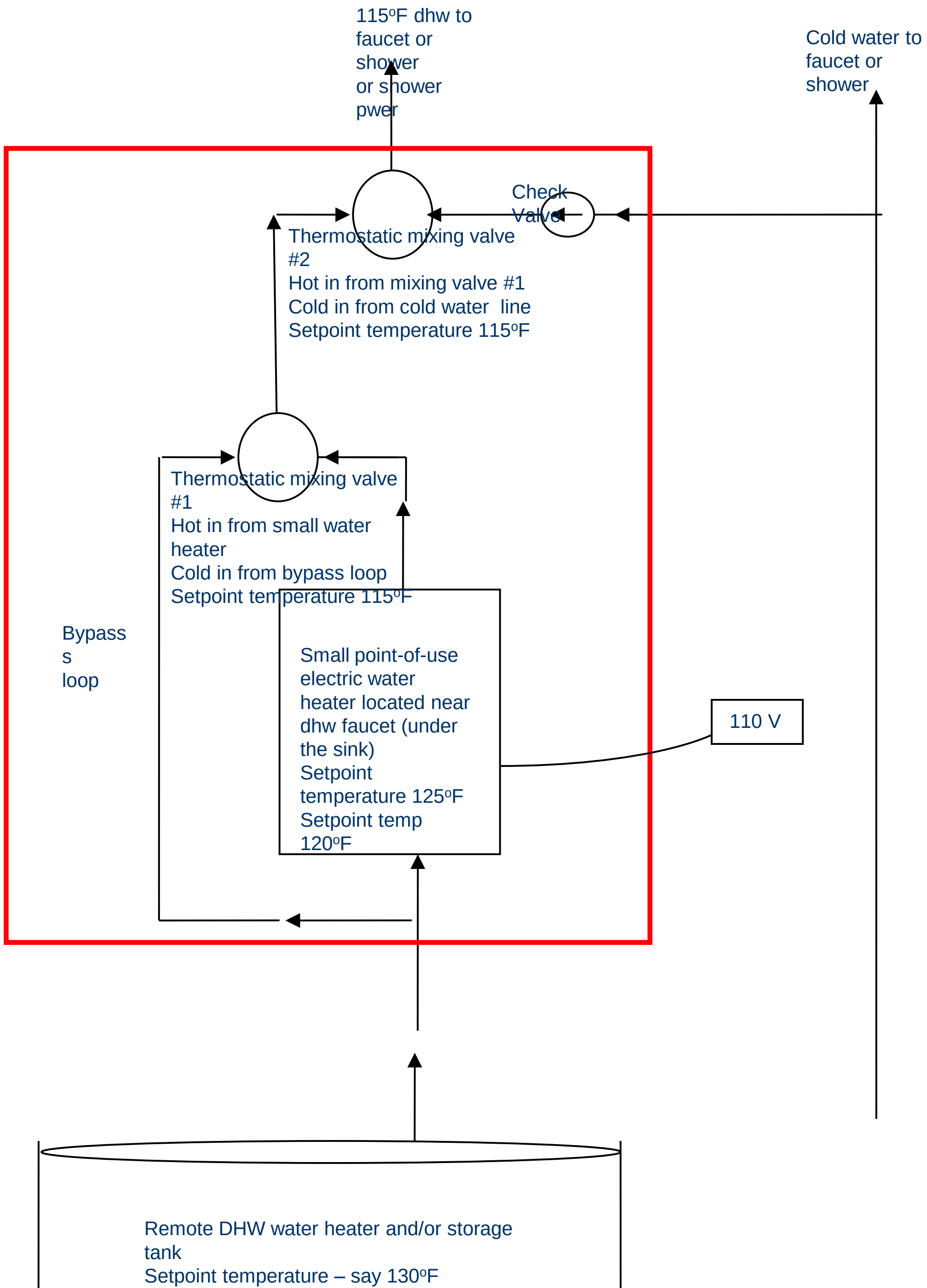
1. 10 seconds (acceptable)
2. 30 seconds (marginal)
3. 50 seconds (unacceptable)
4. 80 seconds (unacceptable)

Pipe ID	Liters of water per meter of pipe	Theoretical minimum time to Hot water – in seconds, per meter of pipe length, at a flow rate of 1 L/min
¼	0.032	1.9
3/8	0.071	4.3
½	0.127	7.6
¾	0.285	17
1	0.507	30
1 ¼	0.792	47
1 ½	1.140	68
2	2.026	122

Simple with POU Supply

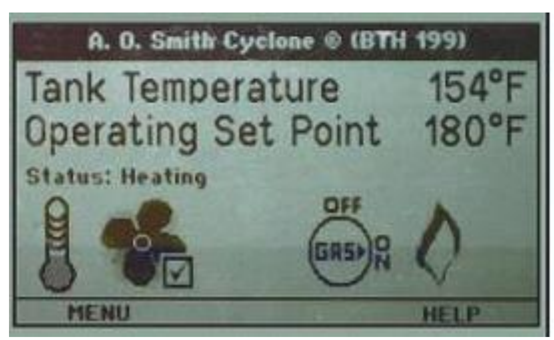
- Install a small POU water heater in hot water line near fixture.
- Immediate hot water while stranded water enters and mixes in POU water heater

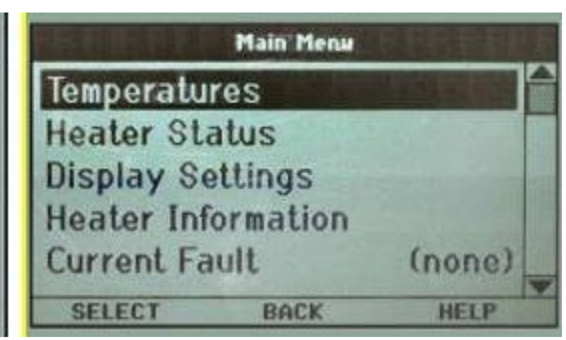
- Water temperature can fluctuate significantly – cold water sandwich


115ºF dhw to faucet or shower
or shower
pwer
Cold water to faucet or shower
Check Valve
Thermostatic mixing valve #2
Hot in from mixing valve #1
Cold in from cold water line
Setpoint temperature 115ºF
Thermostatic mixing valve #1
Hot in from small water heater
Cold in from bypass loop
Setpoint temperature 115ºF
Bypass
s
loop
Small point-of-use electric water heater located near dhw faucet (under the sink)
Setpoint temperature 125ºF
Setpoint temp 120ºF
110 V
Remote DHW water heater and/or storage tank
Setpoint temperature – say 130ºF

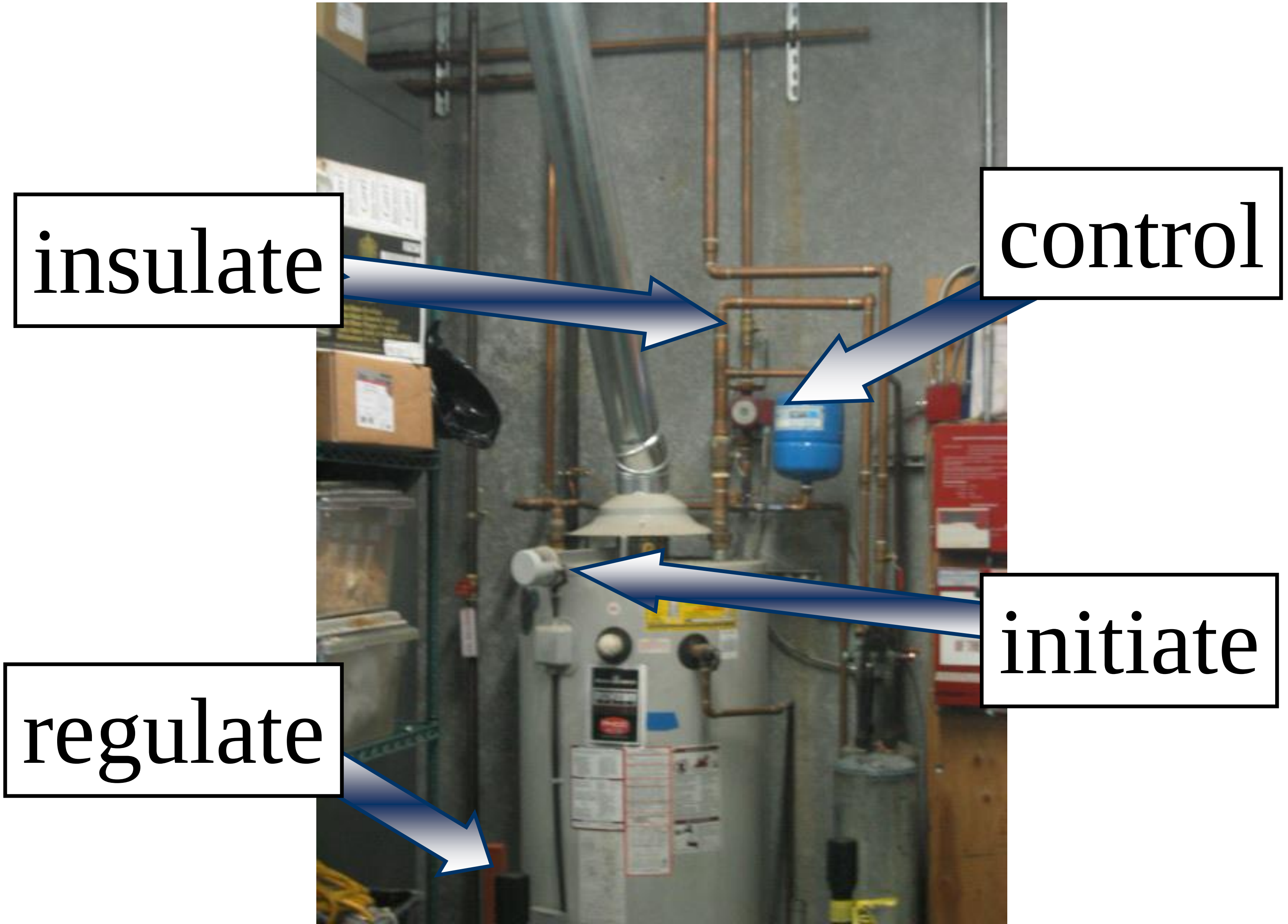
Smart Water Heaters

- Easy to read and accurate thermostats
- Condensing water heaters with central processing units
  - Night setback option
  - Leak detection
  - Remote monitoring



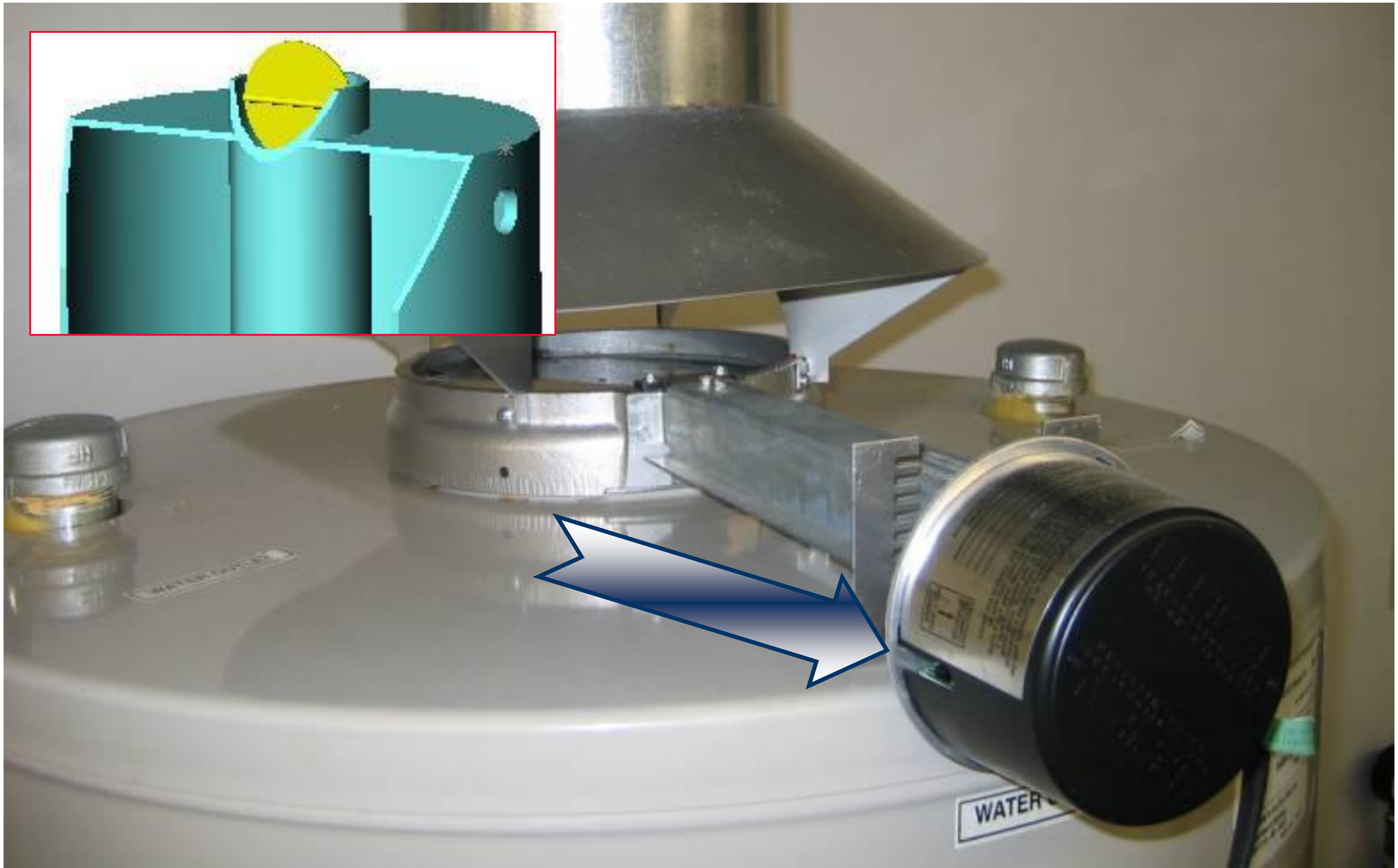


4 Hot Water Heater "Must-Do's"

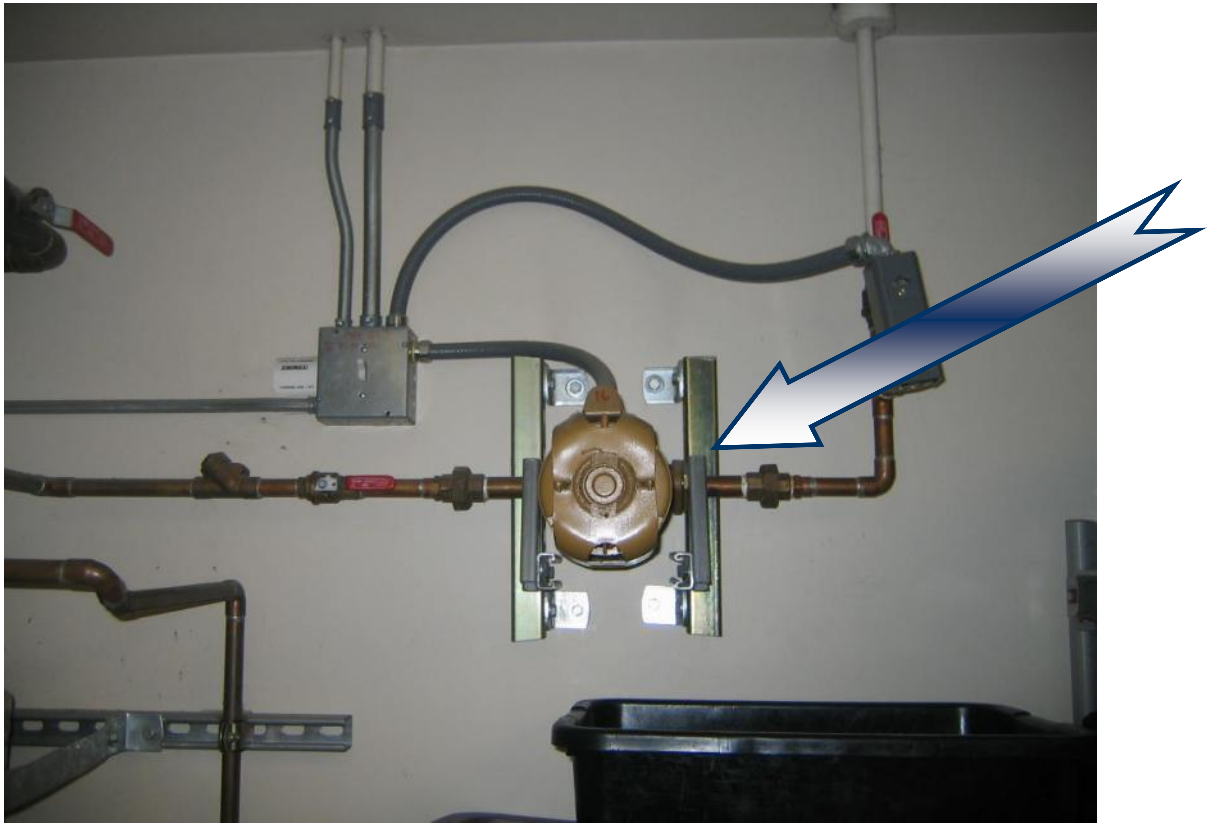


Insulate all accessible hot water lines.

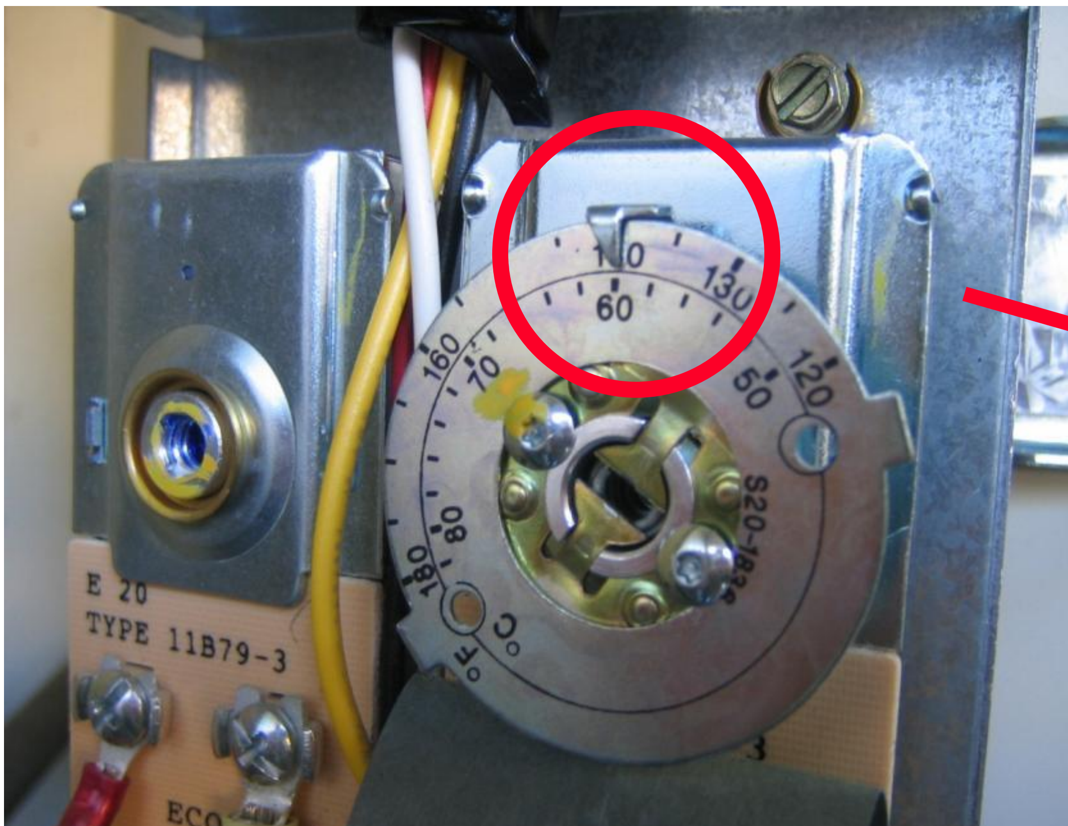
Turn on the automatic damper control.



Control the recirculation pump: use a timer to turn it off when not needed.



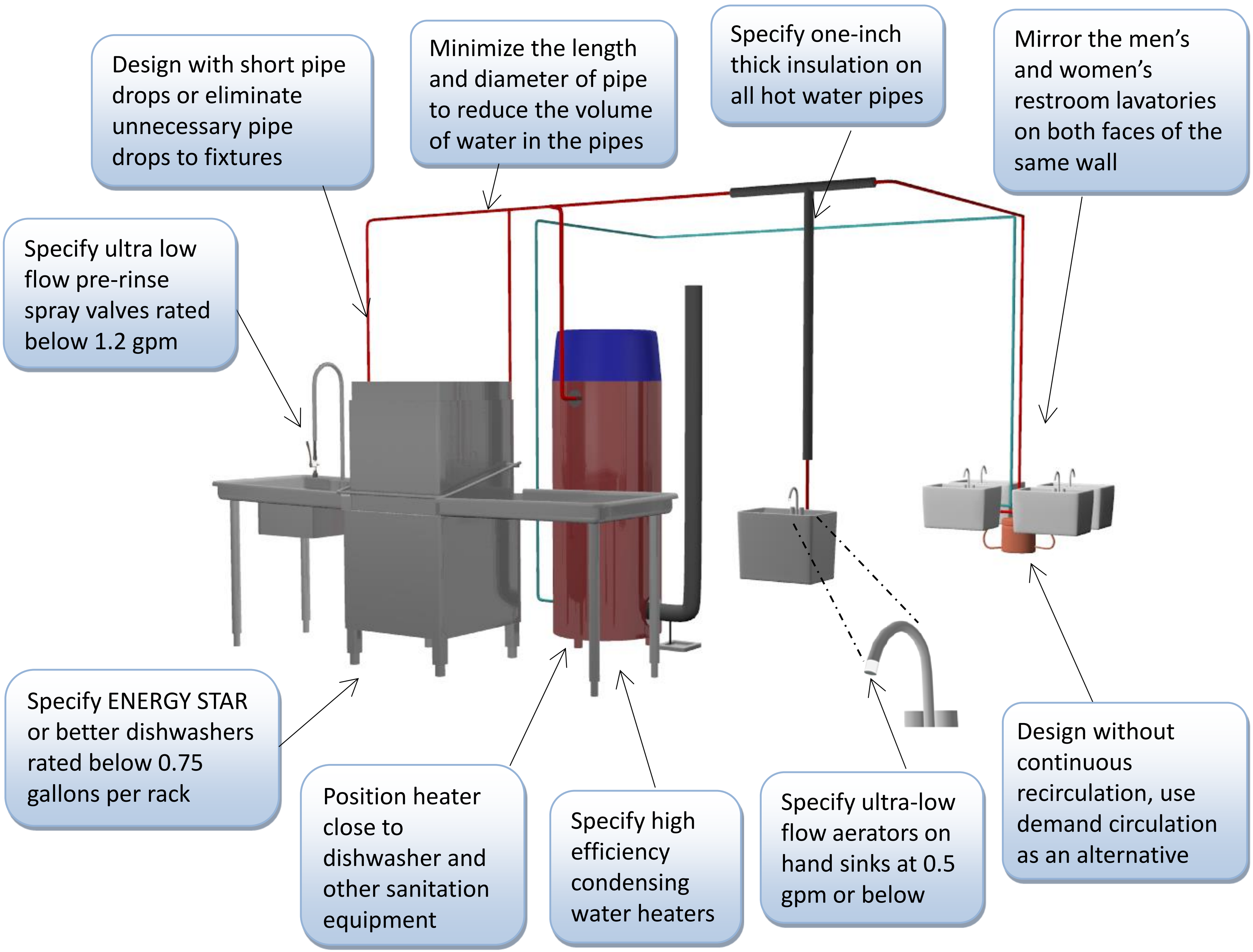
Regulate the tank temperature by properly setting the thermostat.



Optimizing a hot water system

see handout

- Reduce the energy used to heat water
- Reduce the amount of hot water used
- Deliver hot water to the faucet faster
- Reduce heat loss from the hot water distribution and delivery system
- Reduce stranded hot water
- Reduce wasted water



Design with short pipe drops or eliminate unnecessary pipe drops to fixtures
Minimize the length and diameter of pipe to reduce the volume of water in the pipes
Specify one-inch thick insulation on all hot water pipes
Mirror the men's and women's restroom lavatories on both faces of the same wall
Specify ultra low flow pre-rinse spray valves rated below 1.2 gpm
Specify ENERGY STAR or better dishwashers rated below 0.75 gallons per rack
Position heater close to dishwasher and other sanitation equipment
Specify high efficiency condensing water heaters
Specify ultra-low flow aerators on hand sinks at 0.5 gpm or below
Design without continuous recirculation, use demand circulation as an alternative

FOOD SERVICE
TECHNOLOGY CENTER
PROMOTING ENERGY EFFICIENCY IN FOODSERVICE

Design Guides

Saving hot water through innovative design strategies!

Design Guide

Improving Commercial Kitchen Hot Water System Performance

Energy Efficient Heating, Delivery and Use

This design guide provides information that will help achieve superior performance and energy efficiency in commercial water heating systems. The information presented is applicable to new construction and, in many instances, retrofit construction. The target audience consists of kitchen designers, mechanical engineers and contractors, code officials, food service operators, property managers, plumbing professionals and maintenance personnel.

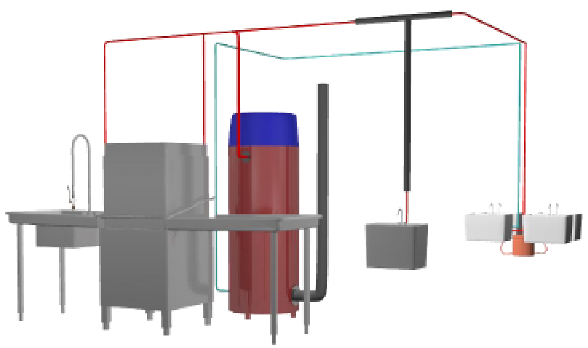
This guide reviews the fundamentals of commercial water heating and describes the design process from the perspective of application. It concludes with real-world design examples, illustrating the potential for high performance, energy and water efficient systems. It is a supplemental guideline that complements current design practices (ASHRAE Handbook 2007) and codes.

Introduction

This document guides the restaurant designer or engineer to use innovative design strategies that will deliver the service of hot water as efficiently as possible while meeting the increasingly challenging regulatory codes and user expectations. This is fundamentally a four-step process: (1) reducing hot water use of equipment and faucets while maintaining performance; (2) increasing the efficiency of water heaters and distribution systems; (3) improving hot water delivery performance to hand sinks; and (4) incorporating "free-heating" technologies like waste heat recovery and solar pre-heating. Through high-efficiency system design and equipment specifications, the potential exists to reduce energy use for water heating by half.

Background

Hot water is the life-blood of restaurants and other food service operations. The hot water system provides the service of hot water to clean hands, wash dishes and equipment, and for cooking purposes. For food safety reasons, restaurants are not allowed to operate without an adequate supply of hot water for sanitation. It is essential to design the water heating system to meet the needs of all the hot water using appliances under peak operation.



http://www.fishnick.com/publications/waterheating/

www.fishnick.com

?