U.S. Department of Energy
Energy Efficiency and Renewable Energy

Mechanical Systems - Enhancing Technologies

High Performance Heating Systems

Presented by:
Peter Rimassa
AERCO International

Rebuild America
U.S. Dept. of Energy

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Question:

- Who likes to save money?
- Who believes "simple" is better?
- Who doesn't like to save money?
- Who believes "complicated" is better?

Chelmsford High School - 33% Saving a Year!

After 25 years the existing cast iron boilers were replaced with a 10 million BTU/hr. high efficiency boiler plant. The boiler plant has a total input in five (5) independent units.

After a complete year of operation, the system reduced fuel consumption 33% based on the owners figures.

Marblehead High School - 30% Saving a Year

This high school was designed around a 40°F temperature differential to take advantage of the condensing operation of high efficiency boilers.

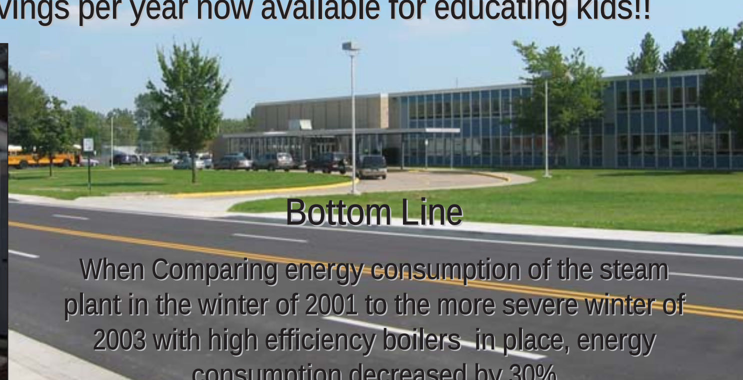
Burning only and exactly the fuel needed, the high efficiency boiler plant is projected to save 30% or more of the energy used with a conventional heating boiler plant.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Geyer Middle School, IN

Geyer Simplifies their heating system by eliminating two (2) 42 year old large steam boilers and converted the system to hot water and installed high efficiency hot water boilers

30% Savings per year now available for educating kids!!



Bottom Line

When Comparing energy consumption of the steam plant in the winter of 2001 to the more severe winter of 2003 with high efficiency boilers in place, energy consumption decreased by 30%

Cuyahago County BMR in Ohio

The Old Flex tube boiler either fired at 100% or it was off.

High efficiency modulating & condensing boilers have a inverse efficiency curve which means the lower the firing rate the more efficient the boiler.

28% Savings

By Just Replacing a Conventional Flex Tube Boiler

Efficiency Definitions

Combustion Efficiency – 100% minus the percent of energy losses at the exhaust (heat, CO2, free air and water vapor lost up the flue) - Flue Loss Method

Thermal Efficiency – Ratio of energy transferred to water compared to the total energy (gas & electric) consumed

Seasonal Efficiency - Overall Effectiveness of the Boiler Over the Entire Heating Season. Takes into account boiler operation at partial heating loads.

Question:

- Which one of these efficiency terms could best be used to compare real operating costs for any given Boiler at the gas meter?
  - *Combustion (Flue Loss)*
  - *Thermal*
  - *Seasonal*

U.S. Department of Energy
Energy Efficiency and Renewable Energy

What is Considered a High Efficiency Boiler?

Conventional Efficiency: 80 - 83%

Mid Efficiency: 84 - 88%

High Efficiency: 89% and up (condensing)

Condensing
Captures *“latent heat”* for +90 + % efficiency by installing product with incoming water temperatures significantly below 140°F
(warranty coverage)

What Defines Condensing Boilers?

Condensing

The 'regain' of energy that occurs when water vapor found in flue gas changes state (condenses), becoming a liquid.

<u>1 pound of condensate = 970 BTUs</u>

When condensing occurs within the heat exchanger, the additional energy (heat) is transferred to the boiler water.

Why Condensing Occurs

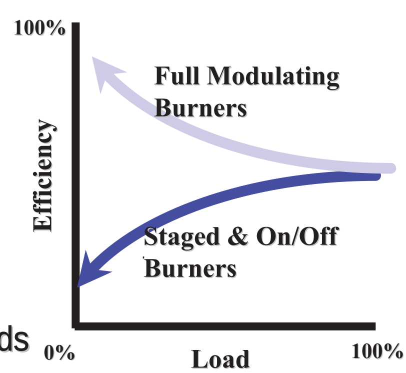
When flue gas drops below its dewpoint ~ 135°F condensing occurs.

Cool water surrounding the heat exchanger "cools" flue gases within.

<u>In general, you cannot achieve thermal efficiencies in excess of 87% without some condensing occurring.</u>

Why Modulate the Fuel/Air Input?

- Turndown Increases Efficiency
  Eliminates *Cycling* Losses
  No Energy Waste
- Match Energy Input
  to Actual Heating Load
  No Energy Waste
- Precise Temp Control at All Loads
  Maximize System Efficiency
  & Simplify Building Controls



Thermal Efficiency Rating

BTU/hr = 500 x Delta T x GPM

Thermal Efficiency Measurement: (Energy out/Energy in) x 100

But...

Test Conditions Require: 80°F inlet water temperature
180°F outlet water temperature
100% Firing Rate (full capacity)
30-minute test period after "full soak"

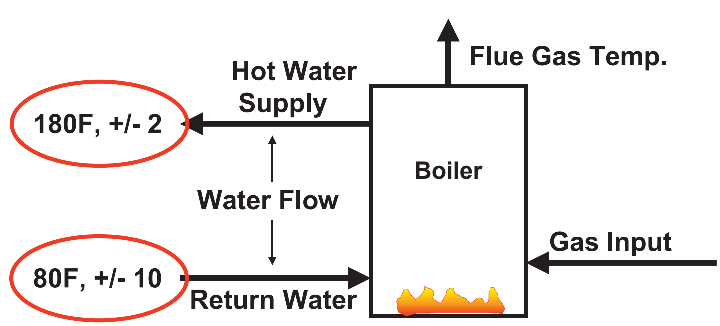
This is NOT representative of typical heating applications!

U.S. Department of Energy
Energy Efficiency and Renewable Energy

ANSI Z21.13-2000: Thermal Efficiency Test

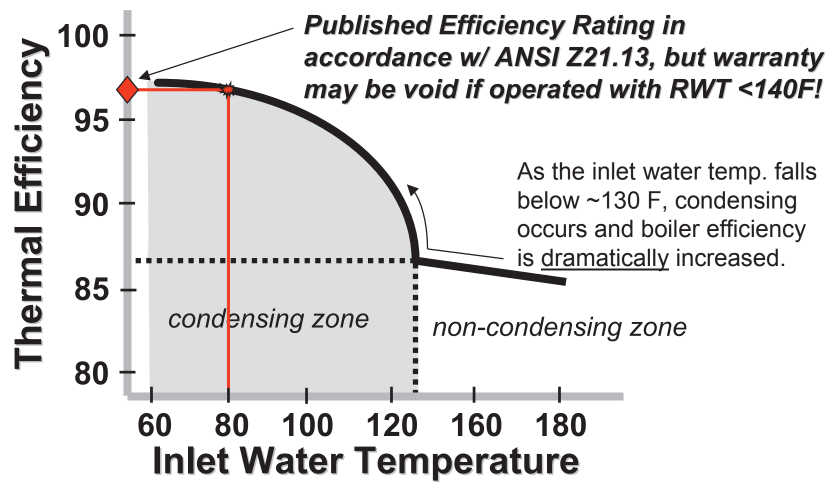
300,000 Btu/h to 12,500,000 Btu/h
Test Boiler at Full Capacity

Thermal Efficiency = (Energy Out / Energy In) x 100



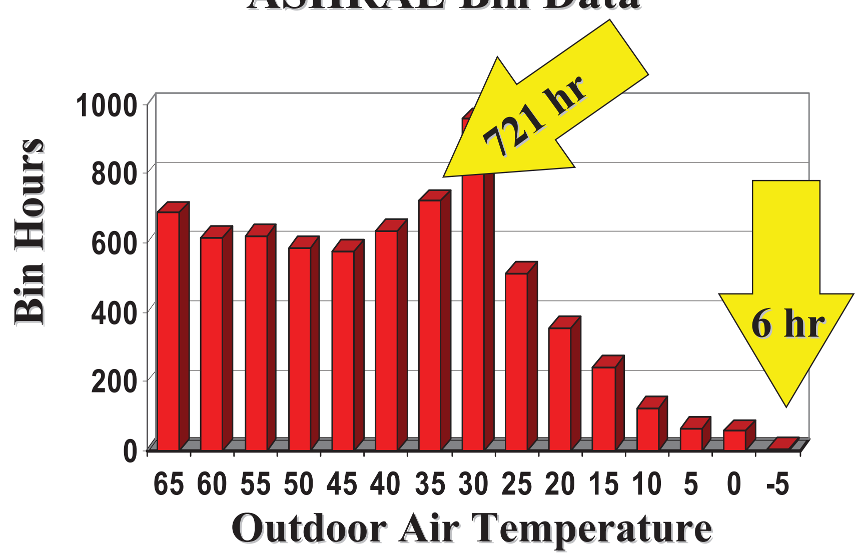
U.S. Department of Energy
Energy Efficiency and Renewable Energy

Inlet Water Temp Effect on Boiler Efficiency



U.S. Department of Energy
Energy Efficiency and Renewable Energy

ASHRAE Bin Data



Assume Full Plant Capacity on Coldest Day

2000 MBH load at -5° F

2000MBH x 6 hrs. = 12,000,000 BTUs

That's 120 therms @ $0.50/therm = ***$60***

Assume Partial Loads on Other Days

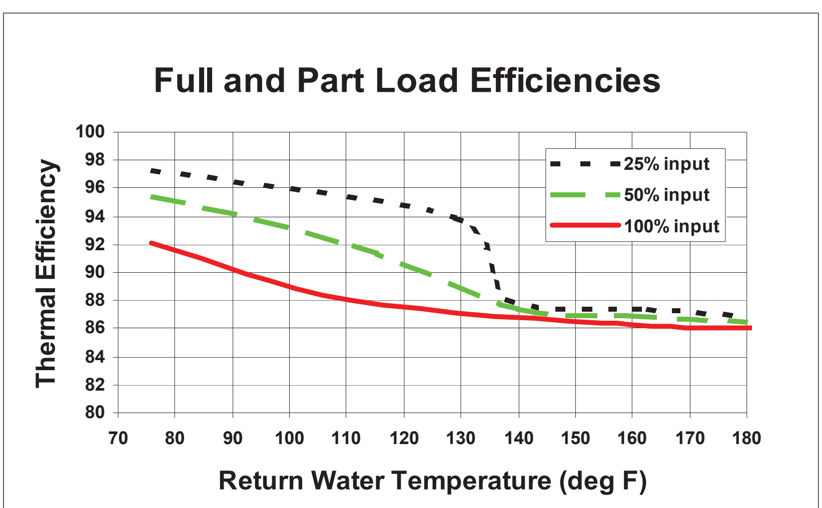
800 MBH load at 30° F

800MBH x 721 hrs. = 576,800,000 BTUs

That's 5768 therms @ $0.50/therm = ***$2884***

When should the boiler operate most efficiently?

U.S. Department of Energy
Energy Efficiency and Renewable Energy



How The Industry Modulates Its Firing Rate

Examples:

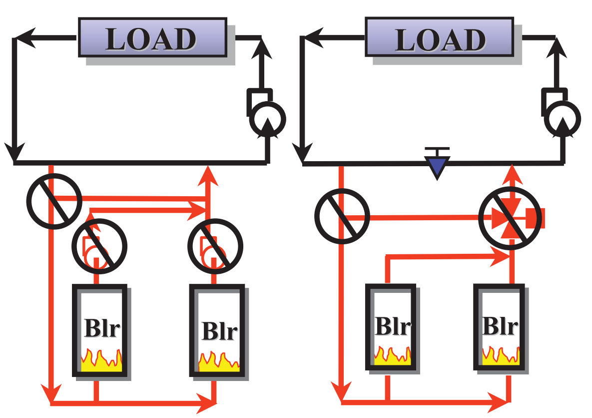
Linkages from a Motorized gas Valve to a Damper on the Exhaust

or

Single Shafted Motorized Air/Fuel Valve

Conventional Boiler Piping

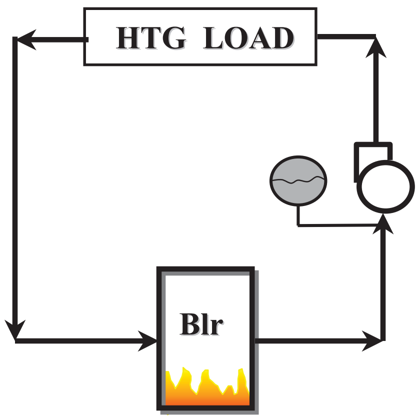
Primary/Secondary Pumping or Control Valve



Protect boiler:
- condensing
- thermal shock
- reduce standby losses

U.S. Department of Energy
Energy Efficiency and Renewable Energy

High Performance Heating System



Eliminates Auxiliary Components:
- ❖Primary/Secondary Pumping & Controls
- ❖2, 3 or 4 - Way Valves

and

Maximize System Efficiency

Maximize Boiler Efficiency

Reduced Installation Cost

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Maximizing Heating System Efficiencies

•Increase Temperature Differential from 20°F to 40°F (or more)

Result: Smaller pipe size

Lower pump horse power (cost and consumption)

Improved /operation of valves & terminal units means better control over room temperatures

Lower return water temps to condensing boiler means higher boiler efficiency

•Variable Speed Pumps

Result: Energy Efficient, Better room temperature control

How Can I Achieve 90%+ Average Seasonal Efficiency?

- Boiler must condense water vapor in flue gas under operating conditions
- Must reduce cycling losses by modulating boiler input at partial load conditions
- Must design the system to take advantage of boiler and controls technology

U.S. Department of Energy
Energy Efficiency and Renewable Energy

More Questions for the Industry?

- Does the boiler modulate? How much? How?
- Is the boiler a condensing boiler?
- What is the boiler constructed of?
- How diverse is the boiler's venting capabilities?
- Can I take advantage of the boiler capabilities in my overall heating system?

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Thank You For Attending This

Rebuild America
U.S. Dept. of Energy

Program