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Understanding Condensing Boilers and the Systems Surrounding them

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Mulcahy Company

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Topics Of Discussion During Today's Presentation

Understanding The Different Efficiency Testing Methods
Differences Between Sensible and Latent Heat
Understanding The Combustion Process and What It Means To Your Overall Efficiency.
Materials of Construction and How They Are Applied Into Boiler Design
Condensate Removal
Maintaining Various Types of Condensing Boilers
Outdoor Reset Curves and Their Effects
Piping Strategies To Insure Safe, Reliable and Efficient Operation Of Your Condensing Boiler
Venting Your Condensing Boiler

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What makes a boiler a condensing boiler ?

- Is it the combustion process?
- Is it the water temperature?
- Is it materials of construction?

Yes, it is......

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Condensing boilers make all the sense in the world if they are applied correctly……that is what we are going to talk about today!!

High Temp System		Low(er) Temp System
↑	Initial material cost	↓
↓	Material wear	↑
↓	Control and comfort	↑
↓	Boiler fuel efficiency	↑
↓	Fuel costs	↑
↓	Boiler emissions	↑
↓	Environmental compliance	↑
↓	Service & Maintenance	↑

↓ **Negative** ↑ **Positive**

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Understanding Efficiency Types

- Combustion Efficiency (commonly used for commercial equipment testing)
- Thermal Efficiency (commonly used for commercial equipment testing)

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Combustion Efficiency Defined

- Combustion Efficiency = Calculated measurement of how well the heating equipment is converting a specific fuel into useable heat energy at *a specific period of time in the operation of a heating system.*
- Combustion test instruments evaluate these combustion gases.

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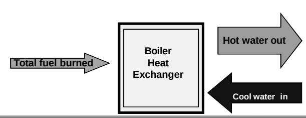
Combustion Efficiency Factors

- Combustion efficiencies assume complete fuel combustion and are based on three factors:
  1. The chemistry of the fuel and how much energy is chemically bound in the fuel.
  2. The net temperature of the stack gases or how much heat is not being used.
  3. The percentage of oxygen (O_2) or carbon dioxide (CO_2) by volume after the combustion process or how much O_2 did the fuel completely burn.

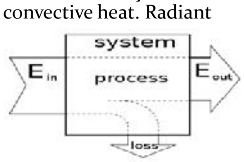
Thermal Efficiency Defined

- Thermal Efficiency = Reflects the rate at which heat exchange surfaces transfer heat to the transfer medium, for the topic of this discussion the medium is water.



Thermal Efficiency Factors

- Types of heat movement that impact thermal efficiency.
  1. Conductive/Convective heating surfaces, also referred to as secondary or indirect heating surfaces.
  2. Radiant heating surfaces, also referred to as direct or primary heating surfaces exposed directly to the radiant heat of the flame. Radiant heat is tremendously more effective than conductive or convective heat. Radiant accounts for 70% of heat transfer



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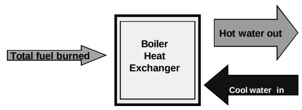
THERMAL EFFICIENCY TESTING



Thermal efficiency:

The ratio of the amount heat absorbed by the water to the higher heating value (HHV) in the fuel burned

Thermal efficiency is sometimes confused with combustion efficiency

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What's the difference?

- Thermal efficiency is measuring the BTU's added to the media, not the actual combustion process creating the BTU's.
- Combustion efficiency is measuring the by products of combustion and comparing those to stack temperatures vs. ambient temperatures.

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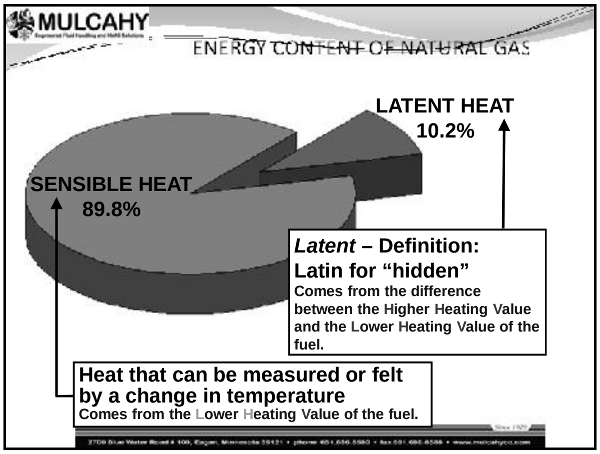
Which one is the most accurate?

- Depends…….
- Thermal efficiency is calculating energy that is actually transferred into the media, but it doesn't calculate or recognize where the heat source came from our how it was created.
- Combustion efficiency only measures the physics of combustion but doesn't recognize where the heat went other than it didn't go up the stack.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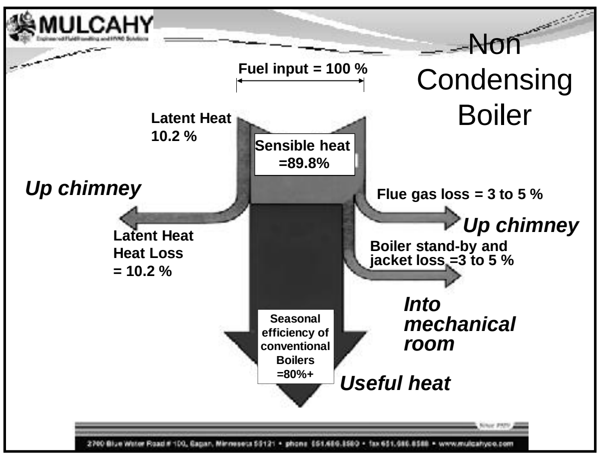
ENERGY CONTENT OF NATURAL GAS
LATENT HEAT
10.2%
SENSIBLE HEAT
89.8%
Latent – Definition:
Latin for "hidden"
Comes from the difference between the Higher Heating Value and the Lower Heating Value of the fuel.
Heat that can be measured or felt by a change in temperature
Comes from the Lower Heating Value of the fuel.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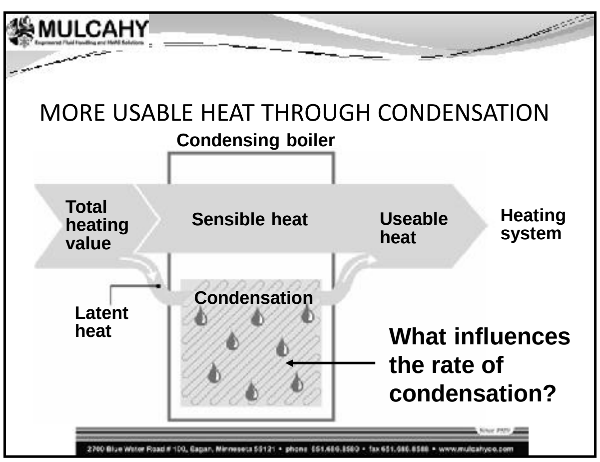
Non Condensing Boiler
Fuel input = 100 %
Latent Heat
10.2 %
Sensible heat
=89.8%
Up chimney
Flue gas loss = 3 to 5 %
Up chimney
Latent Heat
Heat Loss
= 10.2 %
Boiler stand-by and jacket loss =3 to 5 %
Into mechanical room
Seasonal efficiency of conventional Boilers =80%+
Useful heat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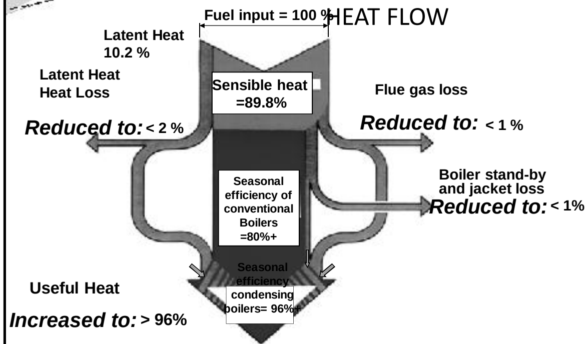
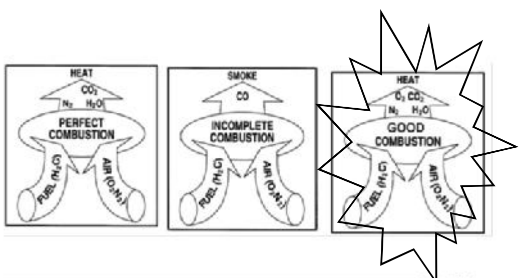
MORE USABLE HEAT THROUGH CONDENSATION
Condensing boiler
Total heating value
Sensible heat
Useable heat
Heating system
Latent heat
Condensation
What influences the rate of condensation?

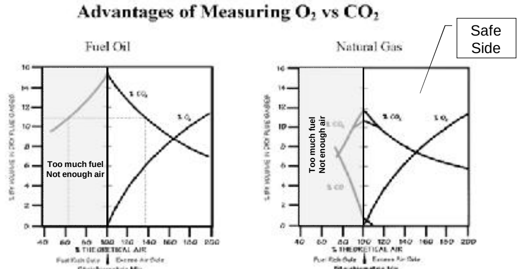
CONDENSING BOILER HEAT FLOW



Note that same constituents coming into the combustion process but depending on the set up and design of equipment you can have a multitude of outcomes!



Advantages of Measuring O_2 vs CO_2



In addition to more accurately being able to precisely monitor burner performance, another advantage to measuring O_2 in a flue gas sample is that a CO_2 measurement does not let us know which side of the stoichiometric curve we are on. The left side of the graph indicates carbon monoxide and/or smoke production as well as inefficient operation. We always want to be on the excess air side of the graph.

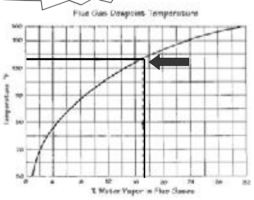
Lower O2 = Higher H2O = Higher Dew Point

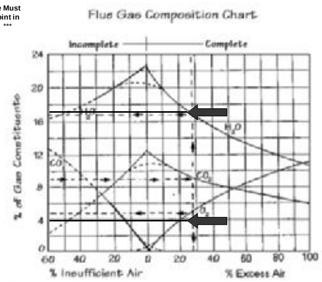
For example:

O_2 = 4.8%
CO_2 = 9%
H_2O = 16.8%

Dew Point = 137°F

** Water Temperature Must be lower than dew point in order to condense ***





Example A

Combustion Oxygen Levels for a 100% Valve Position

Inlet Air Temp	Oxygen % ±0.2	Carbon Monoxide	NOx
≥100°F	4.8 %	<100 ppm	<30 ppm
90°F	[illegible]	<100 ppm	<30 ppm
80°F	5.2 %	<100 ppm	<30 ppm
≤70°F	5.3 %	<100 ppm	<30 ppm

Combustion Oxygen Level at 30% Valve Position

Oxygen % ±0.2	Carbon Monoxide	NOx
6.0 %	<50 ppm	<30 ppm

Combustion Oxygen Level at 18% Valve Position

Oxygen % ±0.2	Carbon Monoxide	NOx
6.0 %	<50 ppm	<30 ppm

Example R

Inlet Air Temperature	CO2 % NG Low Fire	CO2 % NG High Fire	CO2 % LPG Low Fire	CO2 % LPG High Fire	O2 % Low Fire	O2 % High Fire
-40°F	7.2	7.8	8.6	9.2	8.0	7.0
-30°F	7.3	7.9	8.7	9.3	7.8	6.8
-20°F	7.4	8.0	8.8	9.4	7.6	6.6
-10°F	7.5	8.1	8.9	9.5	7.5	6.5
0°F	7.6	8.2	9.0	9.6	7.4	6.4
10°F	7.7	8.3	9.1	9.7	7.2	6.2
20°F	7.8	8.4	9.2	9.8	7.0	6.0
30°F	7.9	8.5	9.3	9.9	6.8	5.8
40°F	8.0	8.6	9.4	10.0	6.6	5.6
50°F	8.1	8.7	9.5	10.2	6.5	5.4
60°F	8.2	8.8	9.6	10.3	6.4	5.2
70°F	8.3	8.9	9.7	10.5	6.2	5.0
80°F	8.4	9.0	9.8	10.6	6.0	4.8
90°F	8.5	9.1	9.9	10.7	5.8	4.6
100°F	8.6	9.2	10.0	10.8	5.6	4.4

Example H

Figure 20B - Hydrotherm KN-6, 10, 20 Series Bekaert Burner (2010) with Orifice Slide Trim*

Inlet Air Temp.	CO_2 % NG Low Fire	CO_2 % NG High Fire	CO_2 % LPG Low Fire	CO_2 % LPG High Fire	O_2 % Low Fire	O_2 % High Fire
-40°F	7.4	8.6	8.7	10.1	7.6	5.6
-30°F	7.5	8.7	8.8	10.2	7.5	5.4
-20°F	7.6	8.8	8.9	10.3	7.4	5.2
-10°F	7.7	8.9	9.0	10.4	7.2	5.0
0°F	7.8	9.0	9.2	10.5	7.0	4.8
10°F	7.9	9.1	9.3	10.6	6.8	4.6
20°F	8.0	9.2	9.4	10.7	6.6	4.4
30°F	8.1	9.3	9.5	10.8	6.5	4.2
40°F	8.2	9.4	9.6	10.9	6.4	4.1
50°F	8.3	9.5	9.7	11.0	6.2	4.0
60°F	8.4	9.6	9.8	11.1	6.0	3.8
70°F	8.5	9.7	9.9	11.2	5.8	3.6
80°F	8.6	9.8	10.1	11.3	5.6	3.4
90°F	8.7	9.9	10.2	11.4	5.4	3.2
100°F	8.8	10.0	10.3	11.5	5.2	3.0

Knowing what we know now…is higher turndown on a boiler really better??

What is turndown?

The amount of times a fuel can be reduced or divided into the full rated input of the burner.

Examples:

2 to 1 – 50% of full firing rate

3 to 1 – 33%

5 to 1 – 20% of full fire

Any higher turndown is a small percentage of firing rate. 20-1 adds 15% on the bottom end (poor combustion)

0%	20%	40%	60%	80%	100%

Higher turndown is not always better

If the boiler is of the high efficiency condensing type, high turndown ratios are feasible and the higher the **turndown ratio**, the more efficient it will be. However there are practical difficulties in designing a gas burner with a **turndown ratio** of greater than six or seven.
The problem is in maintaining the correct stoichiometric ratio (optimum gas air mix) over the entire output range as gas/air velocities change in the burner.

Example A

Combustion Oxygen Levels for a 100% Valve Position

Inlet Air Temp	Oxygen % ± 0.2	Carbon Monoxide	NOx
≥100°F	4.5 %	<100 ppm	<30 ppm
90°F	5.0 %	<100 ppm	<30 ppm
80°F	5.2 %	<100 ppm	<30 ppm
≤70°F	5.3 %	<100 ppm	<30 ppm

Combustion Oxygen Level at 30% Valve Position

Oxygen % ± 0.2	Carbon Monoxide	NOx
6.0 %	<50 ppm	<30 ppm

Combustion Oxygen Level at 18% Valve Position

Oxygen % ± 0.2	Carbon Monoxide	NOx
8.0 %	<50 ppm	<30 ppm

Example R

Inlet Air Temperature	CO2 % NG Low fire	CO2 % NG High fire	CO2 % LPG Low fire	CO2 % LPG High fire	O2 % Low fire	O2 % High fire
-40°F	7.2	7.8	8.6	9.2	8.0	7.0
-30°F	7.3	7.9	8.7	9.3	7.8	6.8
-20°F	7.4	8.0	8.8	9.4	7.6	6.6
-10°F	7.5	8.1	8.9	9.5	7.5	6.5
0°F	7.6	8.2	9.0	9.6	7.4	6.4
10°F	7.7	8.3	9.1	9.7	7.2	6.2
20°F	7.8	8.4	9.2	9.8	7.0	6.0
30°F	7.9	8.5	9.3	9.9	6.8	5.8
40°F	8.0	8.6	9.4	10.0	6.6	5.6
50°F	8.1	8.7	9.5	10.2	6.3	5.4
60°F	8.2	8.8	9.6	10.3	6.4	5.2
70°F	8.3	8.9	9.7	10.5	6.2	5.0
80°F	8.4	9.0	9.8	10.6	6.0	4.8
90°F	8.5	9.1	9.9	10.7	5.8	4.6
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Example H

Figure 20B – Hydrotherm KN-6, 10, 20 Series Dokoert Burner (2010) with Orifice Slide Trim

Inlet Air Temp.	CO_2 % NG Low Fire	CO_2 % NG High Fire	CO_2 % LPG Low Fire	CO_2 % LPG High Fire	O_2 % Low Fire	O_2 % High Fire
-40°F	7.4	8.6	8.7	10.1	7.8	5.6
-30°F	7.5	8.7	8.8	10.2	7.6	5.4
-20°F	7.6	8.8	8.9	10.3	7.4	5.2
-10°F	7.7	8.9	9.0	10.4	7.2	5.0
0°F	7.8	9.0	9.2	10.5	7.0	4.8
10°F	7.9	9.1	9.3	10.6	6.8	4.6
20°F	8.0	9.2	9.4	10.7	6.6	4.4
30°F	8.1	9.3	9.5	10.8	6.5	4.2
40°F	8.2	9.4	9.6	10.9	6.4	4.1
50°F	8.3	9.5	9.7	11.0	6.2	4.0
60°F	8.4	9.6	9.8	11.1	6.0	3.8
70°F	8.5	9.7	9.9	11.2	5.8	3.6
80°F	8.6	9.8	10.1	11.3	5.6	3.4
90°F	8.7	9.9	10.2	11.4	5.4	3.2
100°F	8.8	10.0	10.3	11.5	5.2	3.0

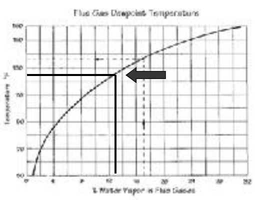
Higher O2 levels yield a lower combustion efficiency.

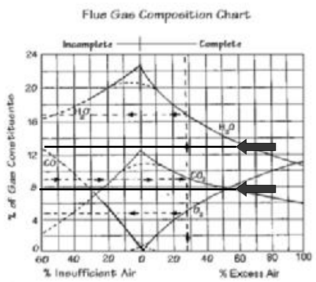
For Example:

O2 = 8%
H2O = 13.8%

Dew Point = 127 deg F
10 deg F lower than 4.8%

Lower O2 = Higher H2O = Higher Dew Point





Not just one thing can make a successful, efficient, long lasting condensing boiler.

A better combustion process yields lower O2 levels which in turn yields a cleaner burn and higher dew points

The higher the dew point the more latent heat that be extracted in turn yielding higher efficiencies.

The better the materials of construction the better the heat extraction resulting in higher thermal efficiencies.

Conductivities of Various

Metal	Temperature - t - (°F)	Thermal Conductivity - k - (Btu/(hr °F ft))
Aluminum, pure	68	118
	200	124
	400	144
Carbon Steel, max 1.5% C	68	21
	752	19
	2192	17
Copper, pure	68	223
	572	213
	1112	204
Iron, pure	68	42
	572	32
	1832	20
Stainless Steel	68	7-26

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Non-Condensing Boiler

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Stainless Steel Boiler
Design Examples

Viessmann
RBI

If There All Made Of Stainless Steel They Must All Be The Same, Right ?

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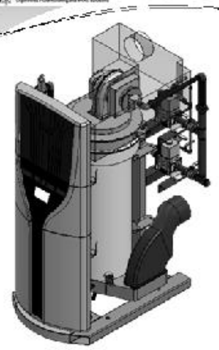
Viessmann utilizes 316Ti heat exchangers

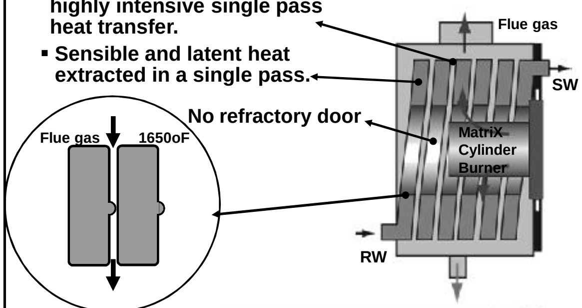


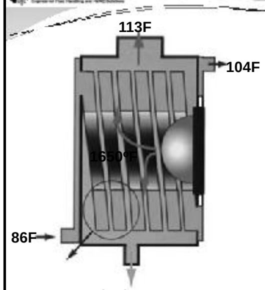
Stainless Steel Designs

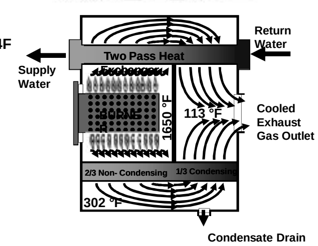
- Corrosion resistant high grade 316Ti stainless steel.
- 1.5 mm wall thickness.
- Compact radial design.

****Designed and manufactured by Viessmann in Germany****

- Precise 0.8mm gaps for highly intensive single pass heat transfer.
- Sensible and latent heat extracted in a single pass.





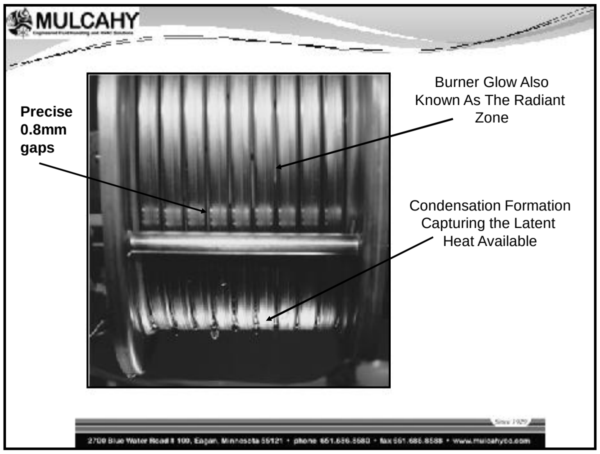


VITODENS 200 **single pass**

- Sensible & latent heat in *single pass*
- SA240 316Ti 1.5 mm thick
- Precise 0.8 mm gaps
- Water cooled front and rear

Example of a two pass Heat Exchanger

- First pass – non-condensing
- Second pass – condensing
- Approx. 1/3 coil in condensing mode.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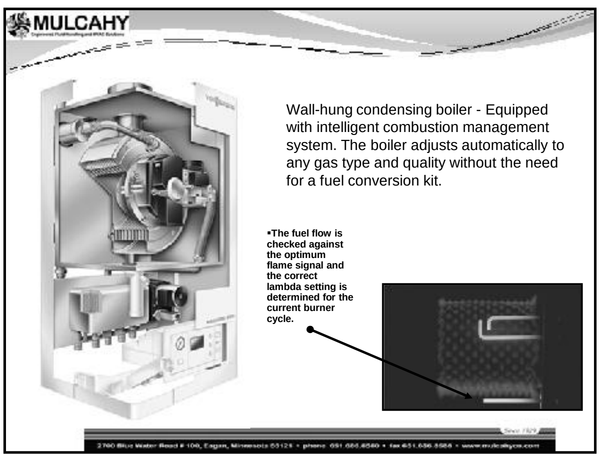
Precise 0.8mm gaps
Burner Glow Also Known As The Radiant Zone
Condensation Formation Capturing the Latent Heat Available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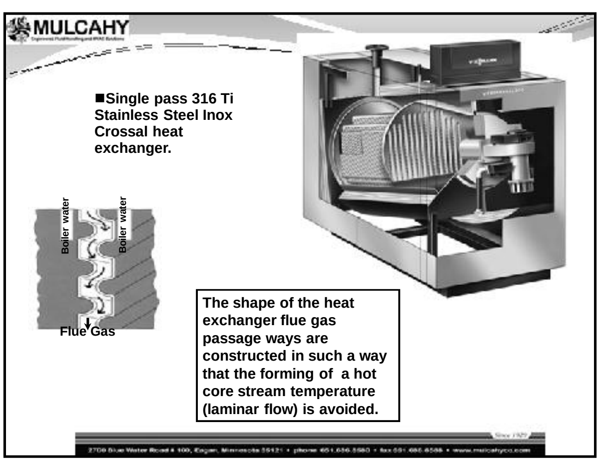
Wall-hung condensing boiler - Equipped with intelligent combustion management system. The boiler adjusts automatically to any gas type and quality without the need for a fuel conversion kit.
▪The fuel flow is checked against the optimum flame signal and the correct lambda setting is determined for the current burner cycle.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■Single pass 316 Ti Stainless Steel Inox Crossal heat exchanger.
Boiler water
Boiler water
Flue Gas
The shape of the heat exchanger flue gas passage ways are constructed in such a way that the forming of a hot core stream temperature (laminar flow) is avoided.

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The ***Giannoni*** 316L stainless steel oval section measures approximately 25 x 7mm with a wall thickness of 0.7mm

Viessmann corrosion resistant high grade 316Ti stainless steel. 1.5 mm wall thickness.

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Condensing Hybrid Boiler
Design Examples

Why Hybrid ?

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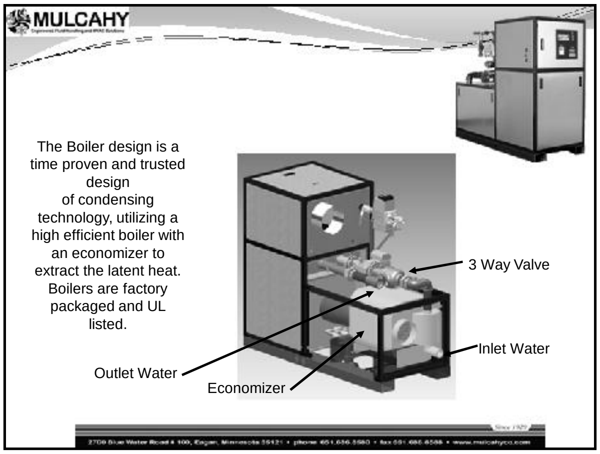
4 pass copper finned primary heat exchanger. Copper heating conductivity is the highest of any metal used in boiler designs available on the market

316L stainless steel secondary heat exchanger. Provides valuable heat transfer of latent heat and resists acidity of flue gas condensate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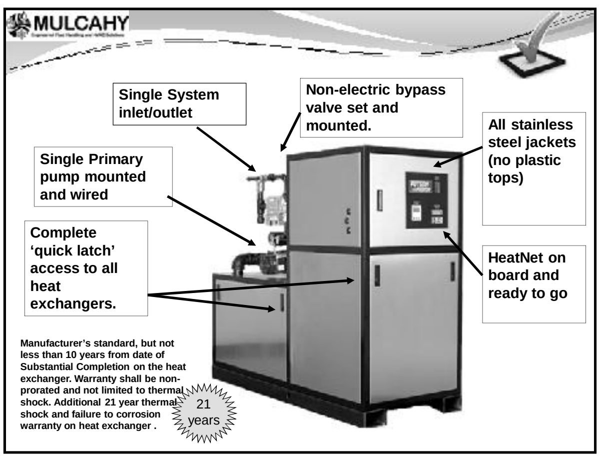
The Boiler design is a time proven and trusted design of condensing technology, utilizing a high efficient boiler with an economizer to extract the latent heat. Boilers are factory packaged and UL listed.
3 Way Valve
Inlet Water
Outlet Water
Economizer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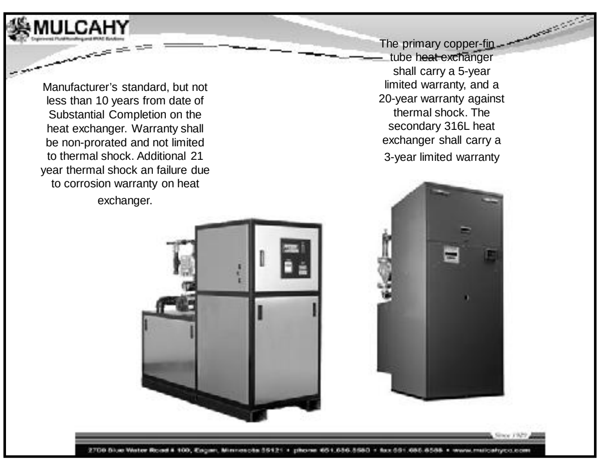
Single System inlet/outlet
Non-electric bypass valve set and mounted.
All stainless steel jackets (no plastic tops)
Single Primary pump mounted and wired
Complete 'quick latch' access to all heat exchangers.
HeatNet on board and ready to go
Manufacturer's standard, but not less than 10 years from date of Substantial Completion on the heat exchanger. Warranty shall be non-prorated and not limited to thermal shock. Additional 21 year thermal shock and failure to corrosion warranty on heat exchanger .
21 years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Manufacturer's standard, but not less than 10 years from date of Substantial Completion on the heat exchanger. Warranty shall be non-prorated and not limited to thermal shock. Additional 21 year thermal shock an failure due to corrosion warranty on heat exchanger.
The primary copper-fin tube heat exchanger shall carry a 5-year limited warranty, and a 20-year warranty against thermal shock. The secondary 316L heat exchanger shall carry a 3-year limited warranty

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Condensing Cast Iron Boiler
Design Examples

Cast Iron...You Can't Do That...Or Can you ?

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Cast Iron Condensing Boiler

- American made
- Boyertown Foundry
- 1/4" wall thickness
- Deep-pin design
- Fully machined fit

But I thought we can't condense on ferrous material?

"The condensing portion of these boilers may require special material or operating techniques to resist the corrosive effects of the condensing flue gases. In the past, typical cast iron, carbon steel, and copper were not suitable materials for the condensing section of a boiler. Certain stainless steels and aluminum alloys were suitable. However, advances in design, controls and manufacturing have allowed materials such as cast iron to be used where they previously could not be; as with all products, consult the manufacturer for the proper application. Commercial boiler installations can be adapted to condensing operation by adding a condensing heat exchanger in the flue gas vent."

- 2012 ASHRAE HVAC Systems and Equipment Handbook

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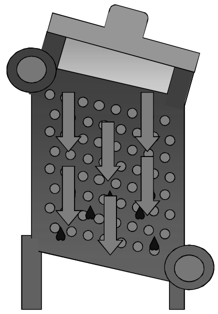
Condensing Design

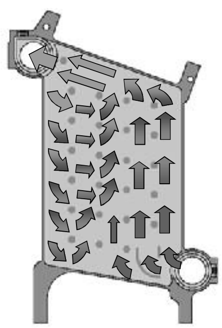
- Down-fired, balanced flow
  - O_2 level controlled
- Wipes condensate away
  - Pushes to base
  - Prevents re-evaporation
  - Water blows off pins
  - Condensate leaves boiler



MULCAHY

Counterflow

- Down-fired counterflow design
- Balanced, orificed flow
- Acts like internal pump
- Only 14 gallon water capacity
- Low pressure drop - Cv=100
- No return water temperature limit
- 21 year thermal shock warranty



MULCAHY

Currently, there is no other boiler manufacturer on the market that uses only cast iron technology in the condensing boiler segment.

MULCAHY

Things to consider outside of just a condensing boiler

- Condensate removal.
- Maintaining the boiler you specified.
- Piping considerations.
- Venting.

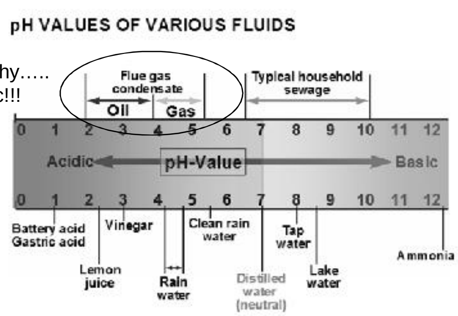
Condensation Removal

Why is it so important?

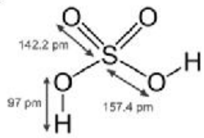
MULCAHY

Condensation from boiler flue

Here's why…..
It's acidic!!!



MULCAHY



Dilute sulfuric acid reacts with metals via a single displacement reaction as with other typical acids, producing hydrogen gas and salts (the metal sulfate). It attacks reactive metals (metals at positions above copper in the reactivity series) such as iron, aluminum, zinc, manganese, magnesium and nickel.

Inexpensive insurance policy!!

Condensate Neutralizers prevents acidic condensate from corroding drains and sewer systems,
Neutralized condensate is more environmentally friendly

MULCAHY

Boiler Maintenance

Why is it so important?

Because it effects everything about the boiler and the owners yearly budget……

Following slides are examples of manufacturers maintenance procedures extrapolated from their I&O manuals

MULCAHY

Maintenance Requirements Examples

The boiler must be inspected at least once a year and before each heating season. Make sure that the burner and ignition components are free from dust, soot, dirt, corrosion or other deposits that would impair the boiler's performance. Visually inspect the burner through the site glass.

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Maintenance Requirements Examples

Combustion Analyzers are $1-3,000.00

Table 7-1 - Maintenance Schedule

PARAGRAPH	ITEM	6 Mos.	12 Mos.	24 Mos.	Labor Time
7.2	Igniter-Injector (58023)	*Inspect	Inspect	Replace	15 mins.
7.3	Flame Detector (66006)	*Inspect	Inspect	Replace	15 mins.
7.4	Combustion Calibration	*Check	Check		1 hr.
7.5	Testing of Safety Devices		See CSD-1 Chart in Appendix I		20 mins.
7.6	Burner			Inspect	2 hrs.
7.7	Condensate Drain Trap	*Inspect	Inspect & Clean		30 mins.

*Only performed after initial 6 month period after initial startup.

Maintenance manual continues for another 5 pages

MULCAHY

Safety requirements for servicing Gianonni style heat exchanger.

Table 17-1 Handling Instructions for Refractory Ceramic Fibers (RCF)

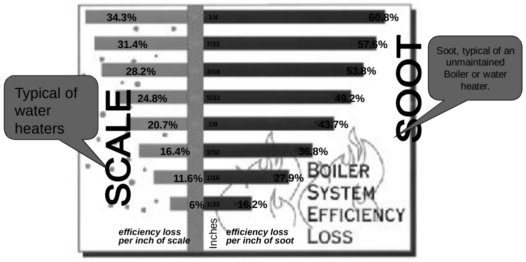
Reduce the Risk of Exposure	Precautions and Recommended Personal Protective Equipment
Avoid contact with skin and eyes	• Wear long-sleeved clothing, gloves, and safety goggles or glasses.
Avoid breathing in silica dust	• Wear a respirator with a N95-rated filter efficiency or better.[1] • Use water to reduce airborne dust levels when cleaning the combustion chamber. • Do not dry sweep silica dust. Pre-wet or use a vacuum with a high efficiency filter.
Avoid transferring contamination	• When installing or removing RFCs, place the material in a sealable plastic bag. • Remove contaminated clothing after use. Store in sealable container until cleaned. • Wash contaminated clothing separately from other laundry.
First Aid Measures	If irritation persists after implementing first aid measures consult a physician. • **Skin** - Wash with soap and water. • **Eyes** - Do not rub eyes; flush with water immediately. • **Inhalation** – Breathe in fresh air; drink water, sneeze or cough to clear irritated passage ways.

Notes:

[1] Respirator recommendations based on CCOHS and OSHA requirements at the time this document was written. Consult your local regulatory authority regarding current requirements for respirators, personal protective equipment, handling, and disposal of RCFs.

⚠ WARNING **Potential Carcinogen** - Use of *Refractory Ceramic Fibers* in high temperature applications (above 1000°C) can result in the formation of Crystalline Silica (cristobalite), a respirable silica dust. Repeated airborne exposure to crystalline silica dust may result in chronic lung infections, acute respiratory illness, or death. Crystalline silica is listed as a (potential) occupational carcinogen by the following regulatory organizations: International Agency for Research on Cancer (IARC), Canadian Centre for Occupational Health and Safety (CCOHS), Occupational Safety and Health Administration (OSHA), and National Institute for Occupational Safety and Health (NIOSH). Failure to comply with handling instructions in Table 16-1 may result in serious injury or death.

Effects of a poorly maintained boiler

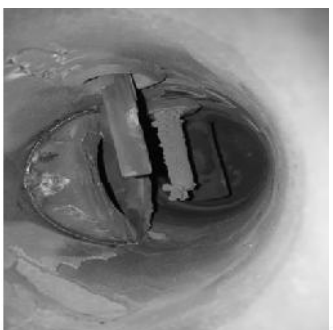


Source: Department of Building Inspection, Milwaukee, Wisconsin
Calculated with formulas from Mark's Standard for Mechanical Engineers, ninth edition

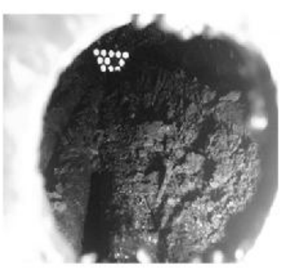
Water Quality

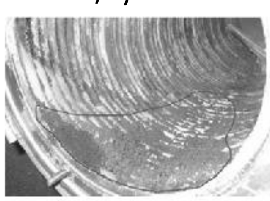
LWCO Switch
- Scale

Heat Exchanger ???



Not maintaining a boiler/system





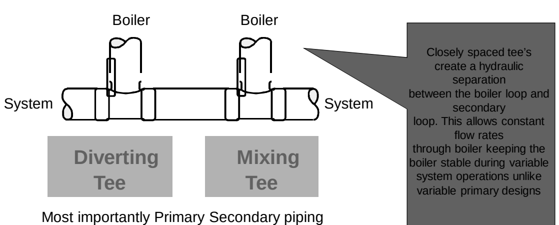
MULCAHY

Basic Boiler Piping and the difference's between popular designs…

MULCAHY

Primary Secondary Boiler Piping

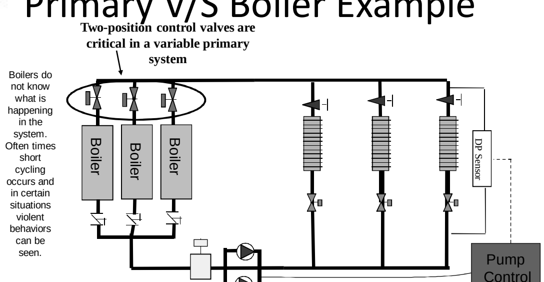
Why you should consider primary secondary over variable primary systems?



Most importantly Primary Secondary piping eliminates the potential for laminar flow.

MULCAHY

Primary V/S Boiler Example



As system flow varies, it is likely that the system flow could go below boiler minimum flows. System can be made "better" by installing 2 way valves, but even then controls have to be monitored closely to insure that a second boiler is not fired until a minimum flow rate has been made.

MULCAHY

Variable Primary System with erratic behavior. The slower the system went the worse the behavior became.

MULCAHY

With all the ways to heat a building why water?

1,000,000 Btu/hr --------- 67 gpm @ 30 Degree ΔT = 2.5" Pipe

Roughly a 2 hp pump

1,000,000 Btu/hr --------- 100 gpm @ 20 Degree ΔT = 3" Pipe

Roughly a 3 hp pump

1,000,000 Btu/hr ----- 30,860 cfm @ 30 Degree ΔT = BIG DUCT!

Roughly a 10 hp fan

Condensing boilers allow for an even bigger ▲T reducing energy even more.

MULCAHY

- Media of a furnace is relatively constant…66 to 70 deg. F return air. Those temperatures are far below the dew point of the combustion gas making it much easier to condense and extract latent heat from the exhaust.

- Boilers on the other hand, have media temperatures which are constantly changing and are often times far above the dew points of the combustions gases due to traditional building systems having 180 deg water for design conditions.

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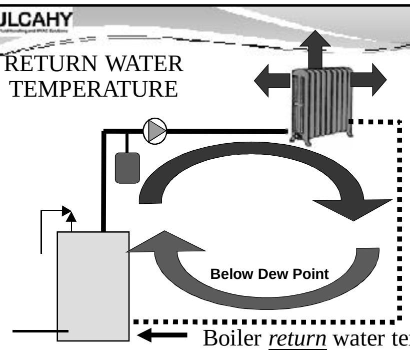
So how do we get boilers to condense if the design water temperatures are over the dew points???

- When designing new construction, select radiation that is designed to emit the BTU's you need at a lower temperature.
- ****In a retrofit application specify a steeper reset curve allowing for longer periods of time with water temperatures below the dew points of the combustion gases.
- Simply increase the delta T of your system

MULCAHY

RETURN WATER TEMPERATURE

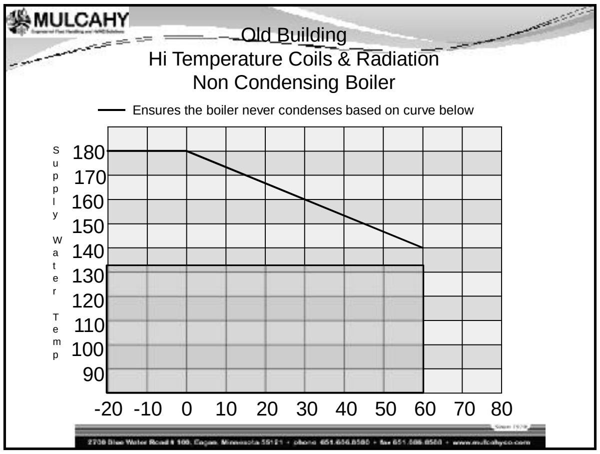


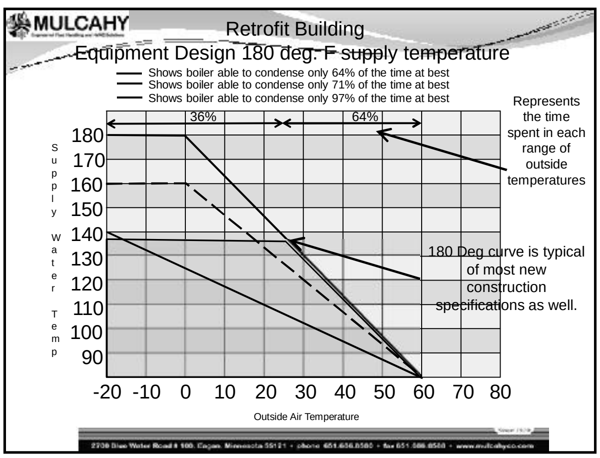
Boiler *return* water temperature determines condensing operation, no matter what the Delta T across the boiler.

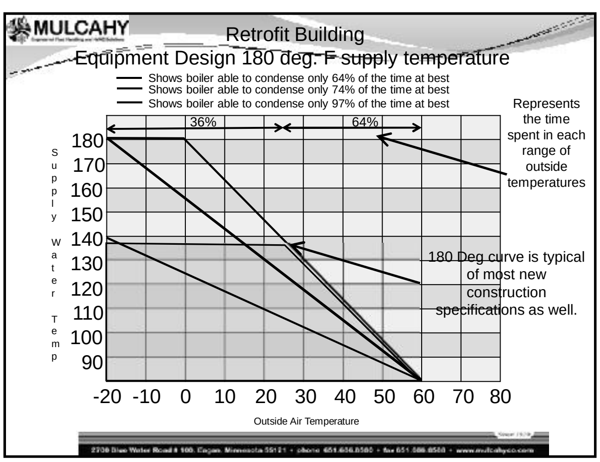
MULCAHY

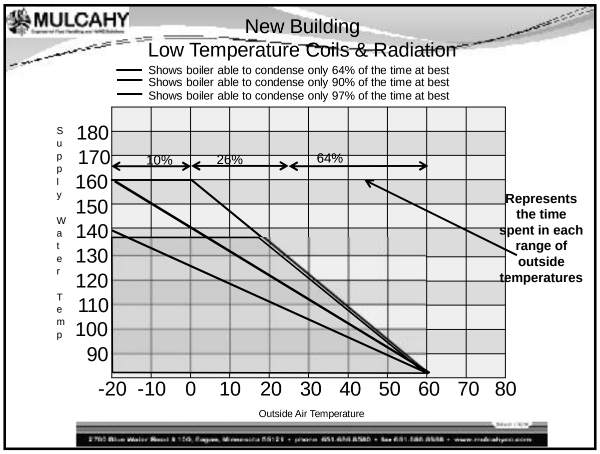
The following slides are examples of various reset curves

Please note how water temperatures relate to the point at which the boiler can actually condense (making it the high efficient boiler you purchased)


MULCAHY
Old Building
Hi Temperature Coils & Radiation
Non Condensing Boiler
Ensures the boiler never condenses based on curve below
Supply Water Temp
180
170
160
150
140
130
120
110
100
90
-20 -10 0 10 20 30 40 50 60 70 80


MULCAHY
Retrofit Building
Equipment Design 180 deg. F supply temperature
Shows boiler able to condense only 64% of the time at best
Shows boiler able to condense only 71% of the time at best
Shows boiler able to condense only 97% of the time at best
36%
64%
Represents the time spent in each range of outside temperatures
180 Deg curve is typical of most new construction specifications as well.
Supply Water Temp
180
170
160
150
140
130
120
110
100
90
-20 -10 0 10 20 30 40 50 60 70 80
Outside Air Temperature


MULCAHY
Retrofit Building
Equipment Design 180 deg. F supply temperature
Shows boiler able to condense only 64% of the time at best
Shows boiler able to condense only 74% of the time at best
Shows boiler able to condense only 97% of the time at best
36%
64%
Represents the time spent in each range of outside temperatures
180 Deg curve is typical of most new construction specifications as well.
Supply Water Temp
180
170
160
150
140
130
120
110
100
90
-20 -10 0 10 20 30 40 50 60 70 80
Outside Air Temperature



MULCAHY

Making your boiler operate in condensing mode

- Learn your system. How does it really work?
- Balance your system.
- Lower the water temperature as much as possible. Physics states that we must be below the dew point of the combustion to condense (approx. 137 deg F)