FCX Oil-Fired Condensing Boiler

Geminox – France's Leading Manufacturer of Steel Boilers
Part of Bosch Thermotechnik
http://www.geminox.com/int/instit/instit.asp

Lucky Distributing – Exclusive importer of the Geminox FCX
Oil-Fired Condensing Boiler

John Jansen – President & CEO
Bill McConaughy – Sales Alaska / Canada

Quintessence Corporation – Fairbanks Master Dealer and
Tech Support

Jim Romersberger – President
Special Technical Representative

Maintaining the
FCX Oil-Fired Condensing Boiler

- **Science of Condensing**
- **How it Works**
- **Cleaning and Anomilies**
- **Tuning**
- **Trouble Shooting**
- **Inspection**

Condensing Technology
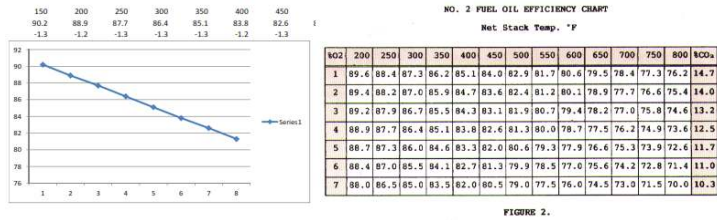## How Heat is Recovered?

There are **Two Processes** by which heat is recovered from the burning of fuel.

Reduction of the burn temperature (sensible heat). Oil burns at about 4000° F, the stack temperature normally is about 350° F. Further reduction leads to the 2nd Process.

Recovering of the latent heat of vaporization (latent from the Greek root word meaning hidden). This is the condensing part.

How does Lowering Stack Temperature Make for Greater Efficiency

https://www.beckettcorp.com/support/tech-bulletins/a-practical-consideration-of-a-f-u-e-ratings-and-burner-adjustment/

	150	200	250	300	350	400	450
	90.2	88.9	87.7	86.4	85.1	83.8	82.6
	-1.3	-1.2	-1.3	-1.3	-1.3	-1.2	-1.3

NO. 2 FUEL OIL EFFICIENCY CHART

Net Stack Temp. °F

%O2	200	250	300	350	400	450	500	550	600	650	700	750	800	%CO2
1	89.6	88.4	87.3	86.2	85.1	84.0	82.9	81.7	80.6	79.5	78.4	77.3	76.2	14.7
2	89.4	88.2	87.0	85.9	84.7	83.6	82.4	81.2	80.1	78.9	77.7	76.6	75.4	14.0
3	89.2	87.9	86.7	85.5	84.3	83.1	81.9	80.7	79.4	78.2	77.0	75.8	74.6	13.2
4	88.9	87.7	86.4	85.1	83.8	82.6	81.3	80.0	78.7	77.5	76.2	74.9	73.6	12.5
5	88.7	87.3	86.0	84.6	83.3	82.0	80.6	79.3	77.9	76.6	75.3	73.9	72.6	11.7
6	88.4	87.0	85.5	84.1	82.7	81.3	79.9	78.5	77.0	75.6	74.2	72.8	71.4	11.0
7	88.0	86.5	85.0	83.5	82.0	80.5	79.0	77.5	76.0	74.5	73.0	71.5	70.0	10.3

FIGURE 2.

So, a Reduction of Stack temperature from 450F to 150F is...

90.2 - 82.6 = 7.6%

Condensing Technology

What is Condensing?

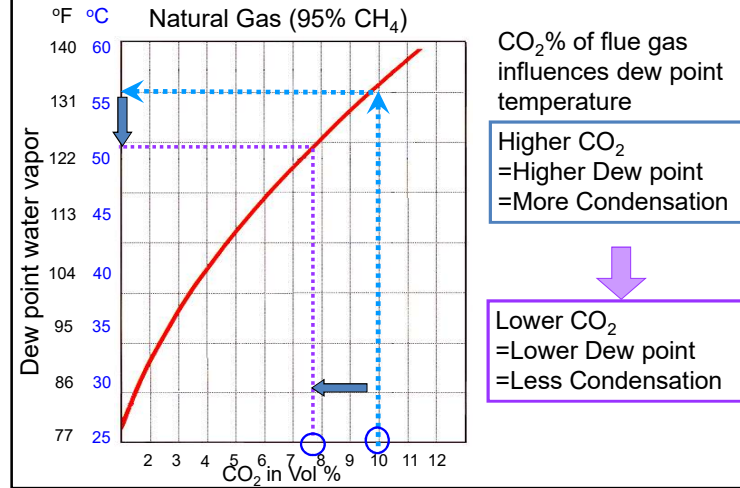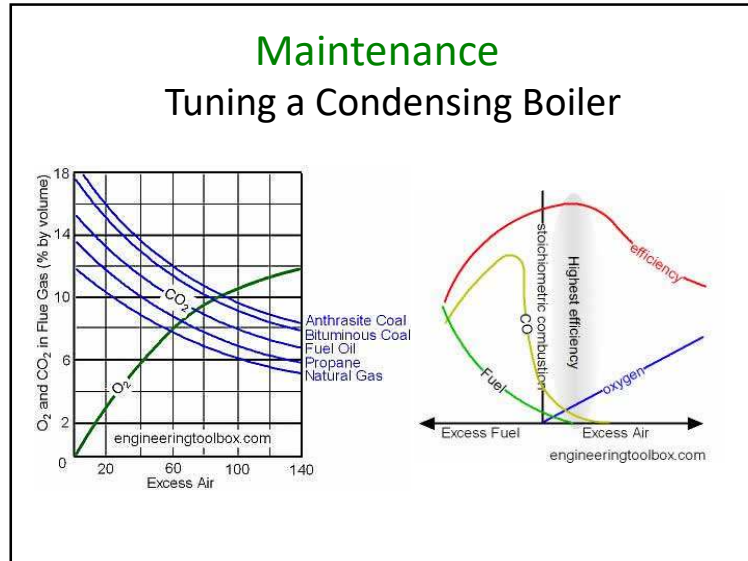**The products of combustion consist primarily of <u>CO2</u> and <u>Water Vapor.</u>**

Condensing refers to the cooling of the stack gasses to the point where the water vapor condenses into liquid. It does <u>not</u> refer to the water circulating in the boiler or the heat emitters. Nor are we talking about steam condensing radiators.

Condensing Technology

How does Condensing Make for Greater Efficiency?

- **When water changes state from a gas to a liquid (goes from a <u>gas at 212°</u> to <u>liquid at 212°</u>), it gives off heat that is absorbed by the water in the boiler. Think of it as just the opposite of adding heat to make water boil.**

- **This process recovers the latent (hidden) heat of vaporization, takes place in the condenser, and is added back into the Boiler water.**
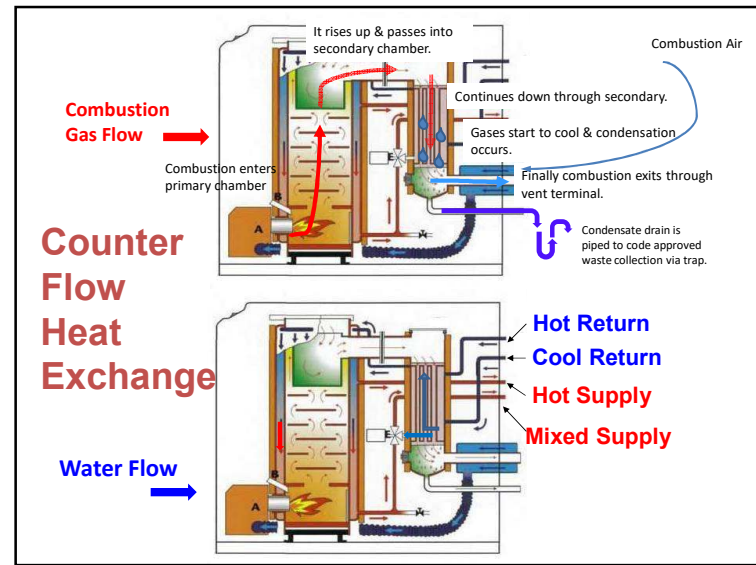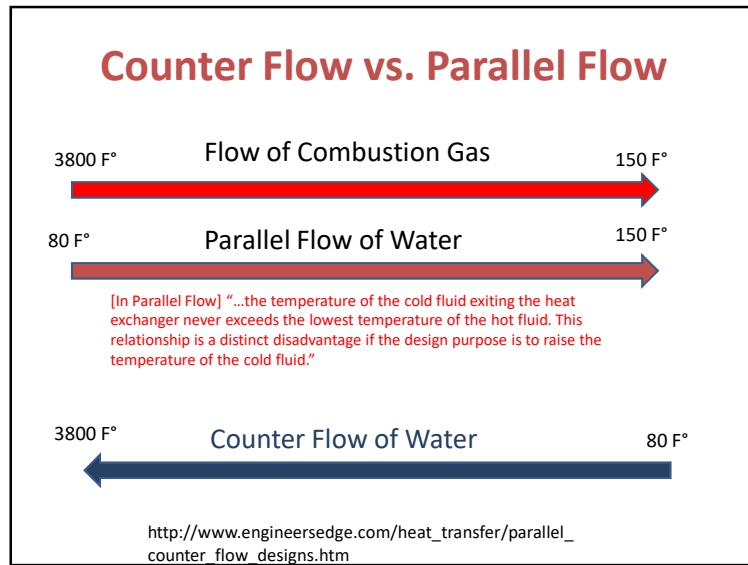
- ***The net result is greater efficiency.***

WATER VAPOR DEW POINT

°F °C   Natural Gas (95% CH_4)

Dew point water vapor

°F	°C
140	60
131	55
122	50
113	45
104	40
95	35
86	30
77	25

CO_2 in Vol %
2 3 4 5 6 7 8 9 10 11 12

CO_2% of flue gas influences dew point temperature

Higher CO_2
=Higher Dew point
=More Condensation

Lower CO_2
=Lower Dew point
=Less Condensation

Maintenance
Tuning a Condensing Boiler

O₂ and CO₂ in Flue Gas (% by volume)

Anthrasite Coal
Bituminous Coal
Fuel Oil
Propane
Natural Gas

CO₂
O₂

engineeringtoolbox.com

Excess Air

stoichiometric combustion
Highest efficiency
efficiency
CO
Fuel
oxygen
Excess Fuel   Excess Air

engineeringtoolbox.com

Heat Transfer and the FCX

How it works

Counter Flow vs. Parallel Flow

3800 F°   Flow of Combustion Gas   150 F°

80 F°   Parallel Flow of Water   150 F°

[In Parallel Flow] "...the temperature of the cold fluid exiting the heat exchanger never exceeds the lowest temperature of the hot fluid. This relationship is a distinct disadvantage if the design purpose is to raise the temperature of the cold fluid."

3800 F°   Counter Flow of Water   80 F°

http://www.engineersedge.com/heat_transfer/parallel_counter_flow_designs.htm

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It rises up & passes into secondary chamber.

Combustion Air

Combustion Gas Flow

Continues down through secondary.

Gases start to cool & condensation occurs.

Combustion enters primary chamber

Finally combustion exits through vent terminal.

Condensate drain is piped to code approved waste collection via trap.

Counter Flow Heat Exchange

Hot Return
Cool Return
Hot Supply
Mixed Supply

Water Flow

Primary Heat Exchanger

- **Debris**
- **Sooting in Primary**
- **Recycle of Exhaust gases**

**Exhaust Gas Recirculation
and
Back Drafting
typified by
Yellowish Muck
Yellow Ash**

Yellowish Deposits

Secondary Heat Exchanger (Condenser)

- **Debris**
- **Sooting in Condenser**
- **Recycle of Exhaust gases**
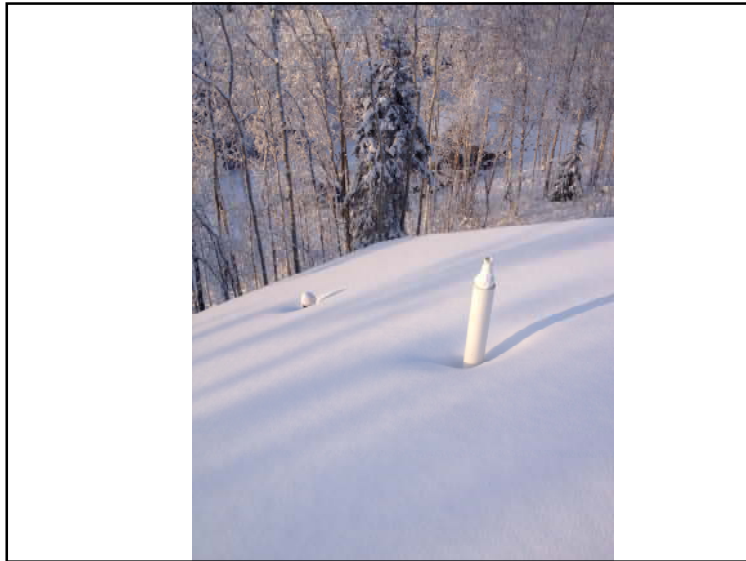- **Backdrafting**

Clean System 550 Gallons
Baseboard House with Tekmar 402

The Danger of Continual Resetting

Blocked Stack

- Partially / Full
- Endless Purge Cycle
- Fixes

Disassembly

- **4 Bolts on Primary**
  - Alignment bolt
  - Anti-sieze on gasket

- **1 Wingnut on condenser**
  - Anti-seize on gasket

- **1 Nut Holding Burner**
  - Serviced from Blast Tube

Disassembly

Cleaning

- **Vacuum Primary**
  - Alignment bolt
  - Anti-seize on bolts

- **Flush Condenser**
  - Plugged condensate trap
  - Cleaning Turbulators
  - Anti-seize on gasket

- **Clean Glass**
  - How to remove stuck glass
  - Anti-seize

Tuning
** This boiler cannot be tuned by eye **

- **CO / O2 / Temp / Pres - Measured**
  - CO higher after cleaning – about 30 ppm
  - O2 +- 4.0
  - Pressure 185 psi

- **CO2 / Excess Air - Calculated**
  - CO2 – 12.5
  - Excess air +- 20

- **Efficiency / Stack Temperature**
  - Also Calculated
  - On system startup – 96-97% / Stack 80F
  - Stabilized (Warm Return) – 92+% / 125-175F

CO2 / Excess Air / Pressure

Set: CO2 = 12.5   Pressure = 185

Trouble Shooting

- **Power Route** – see wiring diagram
  - M/A - Switch (green light)
  - Fuse
  - TSF - Flue Gas Safety
  - TRC - Aquastat
  - TSE – Water Temperature Safety
  - Boiler Plug to Riello Burner

  • Check safeties first
  • Safeties do not stick out when tripped, listen for click when reset
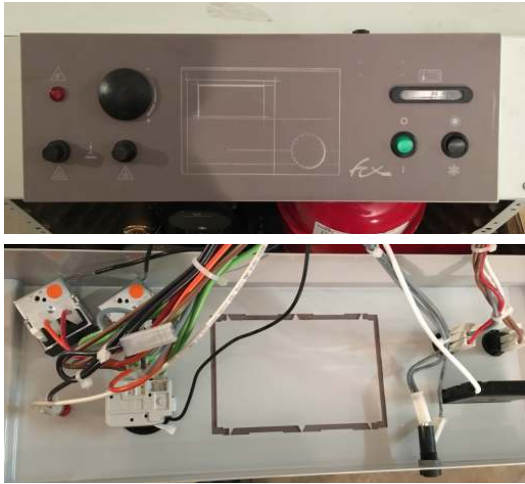 • Check for loose spade connectors

- **Riello Control Box**
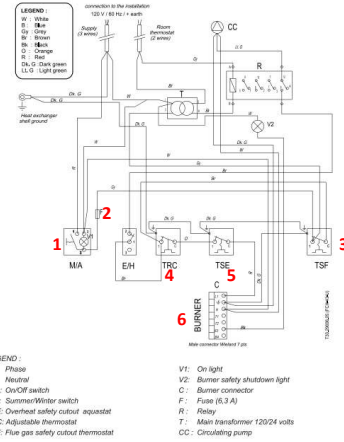 - Jumpering the Thermostat
  - Check for loose connections

- **Fires Erratically – Wont Stay Lit**
  - Fires manually removing cad cell, blocking, and then opening
  - High voltage wire blocking cad cell
  - Blast tube on backwards
  - Bad puffer switch
  - Dirty cad cell

Console

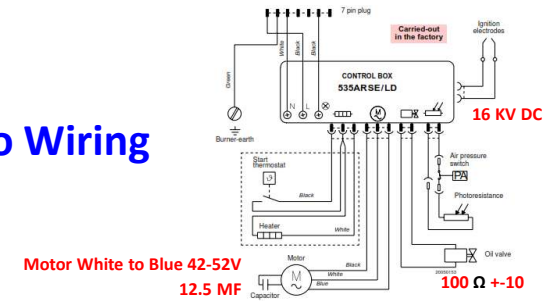## Wiring Diagram

LEGEND :
W : White
B : Blue
Gy : Grey
Br : Brown
Bk : Black
O : Orange
R : Red
Dk. G : Dark green
LL G : Light green

LEGEND :
L : Phase
N : Neutral
M/A : On/Off switch
E/H : Summer/Winter switch
TSE : Overheat safety cutout aquastat
TRC : Adjustable thermostat
TSF : Flue gas safety cutout thermostat

V1 : On light
V2 : Burner safety shutdown light
C : Burner connector
F : Fuse (6.3 A)
R : Relay
T : Main transformer 120/24 volts
CC : Circulating pump

Boiler Side Plug

Power   Ground   Neutral

Riello Wiring

16 KV DC

Motor White to Blue 42-52V

12.5 MF

100 Ω +-10

Riello 535ARSE/LD Readings - FCX 22/30

Motor

	Unpluged V	Running V
Bk - W	0	46
Bk - Bl	120	120
Bl - W	120	70

Cadcell

Disconnected - Prepurge, fires, shutdown, lockout
Jumpered - Continuous prepurge, does not fire
Ohms - 4,000 w/Light, Infinity (open) no Light

Transformer   16 Kv

Inspection

- **Stack**
  - **Check for loose connections**

- **Aquastat**
  - **Check on and off boiler core temperatures**
  - **After firing and coming up to temperatures should be on at 122F, off at 130-135F**

- **2363 Tee**

2363 (MPI Branded FCX's)

- **Failure**
- **Causes**
- **Replacement**

Boiler and Pump Control

Minimum recommended for new construction w/radiant or low temp emitters.

Johnson a421 Digital Temperature Controller

Taco SR502-4 Series

The Johnson provides more accurate temperature control of the boiler core and led read out.

The Taco allows for cold starting the boiler and the control of multiple pumps.

Manual Mix Control

The Cadillac

Tekmar Digital Controller
Boiler / Mixing Valve / Pump / Temperature

This control is a must when retrofitting a Base Board House

Why Digital Controls

Data Logger every 30 sec for about 3 days
Capillary Type Aquastat Gone Wild

Johnson 419 Controller on a Baseboard House