Energy Efficiency & Tune Ups for Boilers

CIBO Focus Group- September 14, 2010

Paul Welch Goggins, Cleaver-Brooks

Practical Solutions for Small Boilers

- Practical Solutions for Small Boilers

  - **Boiler and Burner Efficiency**
  - **Using Financial Metrics**
  - **Retrofit or Replace**
  - **Developing a Plan**

- Evaluate Boiler Efficiency in Four Buckets

- Boiler Efficiency
  - Base Boiler
  - Burner Technology
  - Controls
  - Heat Recovery

- Base Boiler efficiency between 80-84% efficient (thermal) “out-of-the-box.”
- Firetubes slightly more efficient from a design standpoint than watertubes.
- A well maintained boiler should remain in this efficiency range throughout its useful life.

- Most of your opportunity is in the later three areas.

- Boiler Efficiency
  - Base Boiler
  - **Burner Technology**
  - **Controls**
  - **Heat Recovery**

- Burner efficiency gains (system efficiency) come from burner modulation with turndown.
- Best-in-class burners operate at:
  - 10-to-1 Turndown for Natural Gas
  - 8-to-1 Turndown on Light Oils
  - Boilers still must maintain expectable efficiencies (thermal) at all turndown levels.
  - CB has developed a boiler which allows 10-to-1 turndown on Natural Gas while maintaining optimal oxygen levels at all turndown levels.
  - Maintains sub 9-ppm NO_x.
  - Amount of efficiency gain depends on load profile of plant.

CleaverBrooks

- Turndown allows you to modulate the boilers load down to the required demand.
- Reduces cycling and “right-sizes” the load.
- If load swing cannot be matched through turndown, evaluate:
  - Multiple or modular boilers
  - Right-sizing your boiler
  - Combination

- Environmental Regulations
  - Out-of-the-box sub 9ppm No_x for natural gas, less than 25 ppm CO.
  - Sub 80ppm No_x on light oil, less than 50ppm CO.
  - Heavy oils are the most challenging.
  - Only using Flue Gas Recirculation (FGR) on small boilers.

- Other environmental options include fuel train conversions to Natural Gas.

- Boiler Efficiency
  - Base Boiler
  - Burner Technology
  - **Controls**
  - **Heat Recovery**

- Advanced controls offer system efficiency gains of 5-7%.

- Control packages should consider:
  - Oxygen Trimming
  - Parallel Positioning
  - Variable Speed Drives for Motors
  - Lead Lag for Multiple Boiler Installations

- Oxygen Trim
  - Keeps excess air at optimum level at all times vs. relying on only tune ups.
- Parallel Positioning
  - Minimizes manual linkage controls for fuel and air. Uses electronic actuators to provide precise electronic control.
- Variable Speed Drives for Motors
  - Matches speed of fans and pumps to that required.
- Lead Lag for Multiple Boiler Installations
  - Matches boiler loads to requirements along with turndown.

- Integrated Control System
  - Provides the upmost control of your system by integrating all control features.
  - One single source of responsibility for integration in the boiler room.
  - Allows for multiple boilers to be integrated easily.
- Reporting & Monitoring
  - Monitors all key performance indicators.
  - Advanced controls will offer the reporting required to meet upcoming regulations.
  - A single integrated control system only requires one data link.
  - Continuous Emission Monitoring available for larger boilers.
- Metering Options
  - Metering of Fuel will be required by many to meet upcoming regulations (even many natural gas)
  - Metering of Fuel, Water, and Steam gives you the real data needed to make energy saving decision.

- Boiler Efficiency
  - Base Boiler
  - Burner Technology
  - Controls
  - **Heat Recovery**

- Stack Economizer
  - Stack economizers recover heat from flue gases that would otherwise be wasted.
  - Acts as a preheat to boiler feed water.
  - Extracts sensible heat only.
- Condensing Economizer
  - Combines a stack economizer with a second stage condensing economizer.
  - Operates at flue gas temperatures below 135 degrees so condensing occurs.
  - Extracts latent in addition to sensible heat.
- Blow Down Heat Recovery
  - Recovers heat lost during blow down.
  - Also preheats feed water.

- What about turbulators?
  - A turbulator is a baffle wedged between bare tubes which increases the turbulence of the gases creating more heat transfer in the tubes.
  - Usually placed in the second or third pass.
  - Cleaver-Brooks has had limited success with tabulators.
- For existing boilers evaluate other options first.
- For new boilers, look into advanced heat transfer tubes.
  - Cleaver-Brooks has develop a line of boilers which uses propriety advanced heat transfer tubes to reap the benefits found with turbulators.

- Boiler Efficiency
  - Base Boiler
  - Burner Technology
  - Controls
  - Heat Recovery

- Now that we know what is available– how do we evaluate the right energy solution?

- Now that we know what is available– how do we evaluate the right energy solution?

- Important Factors to Consider:
  - Retrofit or Replace?
  - Regulatory Impact

- Always evaluate from a financial prospective.

What information is Needed to Speak in Dollars?

- **Cost of the Project**
  - **Cost of Equipment**
  - **Cost of Installation**
  - **Less Any Rebates**
  - **One Time Expenses**
- Dollar Savings Per Year
  - Energy Savings (In Dollars!)
  - What about other savings? Maintenance, salvage value, etc? Maybe…
- Corporate Tax Rate
  - Depreciation of Equipment
- Corporate Cost of Capital or Discount Rate

The Three Most Important Metrics

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback

- Everything should be in after tax dollars.

Net Present Value (NPV)

- The sum of the present value of all future cash flows less the initial cash outflow (investment).
- The future cash flows are discounted by the Discount Rate or Cost of Capital.
- An investment with a NPV greater than zero is a sound investment.

Net Present Value (NPV)

$$NPV=\sum \frac{R_t}{(1+y)^t}$$

R= Net Cash Flow
t= Period y= Discount Rate

t	R	$(1+y)^t$ y=10%	$R_t/(1+y)^t$
0	-$5000	(1.10)^0=1	-5000/1=-5000
1	$1500	(1.10) ^1=1.10	$1500/1.10=$1363
2	$1500	(1.10) x (1.10) =1.21	$1500/1.21=$1269
3	$1500	1.33	$1126
4	$1500	1.46	$1024
5	$1500	1.61	$931
			NPV=$686

Internal Rate of Return

- The annualized effective compounded return rate which can be earned on an investment

- If the IRR is greater than the Discount Rate or “Hurdle Rate” then the investment is sound.

- Harder to solve algebraically; but easily solved using Spreadsheet Software of Financial Calculator

Internal Rate of Return

t	R
0	-$5000
1	$1500
2	$1500
3	$1500
4	$1500
5	$1500
IRR= 15%	

IRR = 15%

Discount Rate= 10%

IRR is greater than Discount Rate (Hurdle) so investment is sound.

Payback (after-tax!)

- The length of time which is required for an investment to have its initial cost recouped.
- Simplest of all three metrics
- Easy to Understand
- No real rule for a “go” or “no-go” decision.
- More valuable if using after-tax cash flows

Payback (after-tax!)

t	R
0	-$5000
1	$1500
2	$1500
3	$1500
4	$1500
5	$1500
Payback 3.33 Years	

Payback of 3.33 Years

Is that good or bad?

We don't really know, unless we know the hurdle.

More complicated to calculate if using after tax cash flows, but this is a more meaningful number.

What you really need to know.

Net Present Value- If NPV is greater than zero then the investment will make money for the company. If it is less than zero, it will not.

Internal Rate of Return- If the IRR is greater than the discount rate, the investment will create value for the company.

Payback- Some companies will have payback hurdles. This is always a good number to represent.

- BOOST (Boiler Operation Optimization Savings Test)
  - Comprehensive financial analysis.
  - Evaluates boiler, burner, controls, and heat recovery

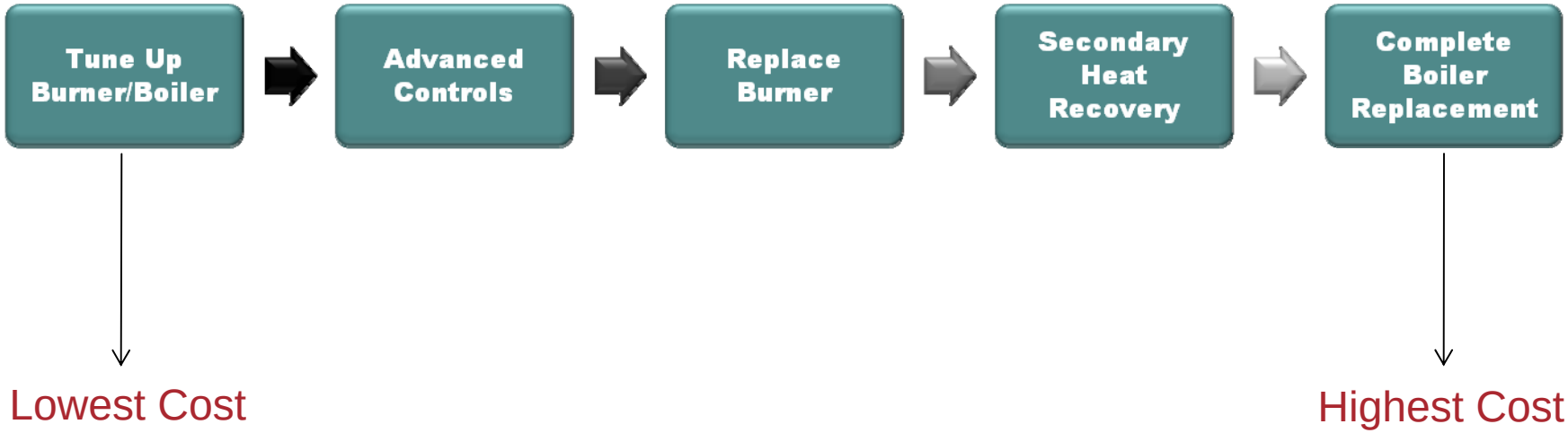
  - Very similar to what we believe will be required by upcoming Regulations.

BOOST Example

- Evaluate both ways: Retrofit or Replace
- Replace has longer paybacks and lower investment metrics...but
- What is the usable life left on the base boiler system?
- Is the boiler sized properly for current applications?
  - Look at both options.

CleaverBrooks

What can I do today?



CleaverBrooks

- Develop a multi-year comprehensive boiler asset management plan.
  - Use Financial Analysis as the guide for developing this plan.
  - Weigh decision between retrofit and replacement.
  - Implement solutions that save energy and meet regulations.

Energy Efficiency & Tune Ups for Boilers

For further questions or comments:
Paul Welch Goggins
pgoggins@cleaverbrooks.com
706-714-7505