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Cost Savings and Environmental Stewardship Through Improved Coal Combustion

Betterment Engineering and Results Engineering are two terms used in the 60's to describe Testing and Improvements in power plant performance, reliability, fuels flexibility and capacity. Environmental Betterments have overshadowed and out budgeted betterments for heat rate for about 30 years now. Those environmental benefits were outlined in the December 2005 issue of this newsletter. Reductions in NO_x and SO_2 are substantial and our industry is to be commended for a job well done. Now, enter the issue of greenhouse gases (GHG) and reduction of CO_2. Coal combustion for power generation may produce 3% or less of the man made total greenhouse gases emitted into the atmosphere. However, minimal or not, and whether or not GHG's are a significant factor in global warming and climate change, coal combustion is receiving substantial attention by energy ignorant politicians.

Reducing Greenhouse Gases is reason enough to improve heat rates. Good old fashioned fuel cost savings potential are also a compelling case for concentrating on combustion and heat rate improvement. Note, the magnitude of cost savings that are possible for a typical 500MW coal fired unit.

Changes & Optimization for Excellence in Operations and Maintenance	Typical Cost Savings Benefit
Reduction of air in-leakage on Balanced draft boilers	$1,500,000/year
Optimize and more accurately measure And control combustion airflows	$500,000/year
Reduce airheater exit gas temperature 35°F on a no-leakage basis	$640,000/year
Reduce de-superheating spray water To the reheater	$450,000/year
Optimize superheater and reheater Steam temperatures	$300,000/year

*The approximate listed savings above are based on a 500MW Coal unit, operating at 10,000Btu's/kWh, designed for 9600 Btu's/kWh. Fuel cost $2.00/mmBtu 8000 hrs/yr operation, 80% capacity factor.

The fact remains; Coal Combustion for electric power production in America performs the heavy lifting for electric power production. Coal remains the fuel for over 50% of the total generation in the USA and along with Nuclear is likely to remain the dominant base load fuel for over 70% of our nation's power production. I know, the people this newsletter is addressed to, already know that. But, as a reminder, your neighbors and state and federal political representatives probably do not. So what should we do? In my opinion, resurrecting "Results Engineering" and "Betterment Engineering" is a good start. Combining these to yield "Performance Driven

Maintenance" can lead to improved heat rates, which is the most practical means to reduce GHG emissions from coal combustion.

Here is the Storm recommended approach to Coal Plant Heat Rate Improvement. Yes, this applies to pulverized coal and fluid bed combustion. I have been convinced for years that the "opportunities for heat rate improvement" are in Boiler Combustion Optimization. The more experience that we gain the more this is becoming apparent to others that are in our business. Just as a reminder, here is a list of past newsletters/published articles on the subject of optimizing combustion for heat rate improvement:

- "How Stealth Combustion losses lower plant efficiency", Power Magazine, March 2005
- "The Growing Importance of Accurate and Reliable Combustion Airflow Measurement", Storm Newsletter, November 2005
- "Fire Side and Steam Side Incompatibility", Storm Newsletter, October 2005
- "Condition Based Maintenance and Performance Preservation", Storm Newsletter, September 2005
- "Heat Rate and Combustion Performance Improvement by Applying the Storm Performance Preservation Program", Storm Newsletter, August 2005
- "Balancing Pulverized Coal Fired Burner Lines by the Storm Method", Storm Newsletter, July 2005
- "Good Stewardship in Coal Plant Combustion and Performance Improvement", Storm Newsletter, June 2005
- "Pulverized Coal Furnaces or Circulating Fluidized Beds, The Fundamentals Still Apply", Storm Newsletter, November-December 2004
- "Applying The Fundamentals for Improving Heat Rates", Storm Newsletter, July 2004

There are more. These newsletters and technical papers presented by our talented staff are available on our web page at www.stormeng.com.

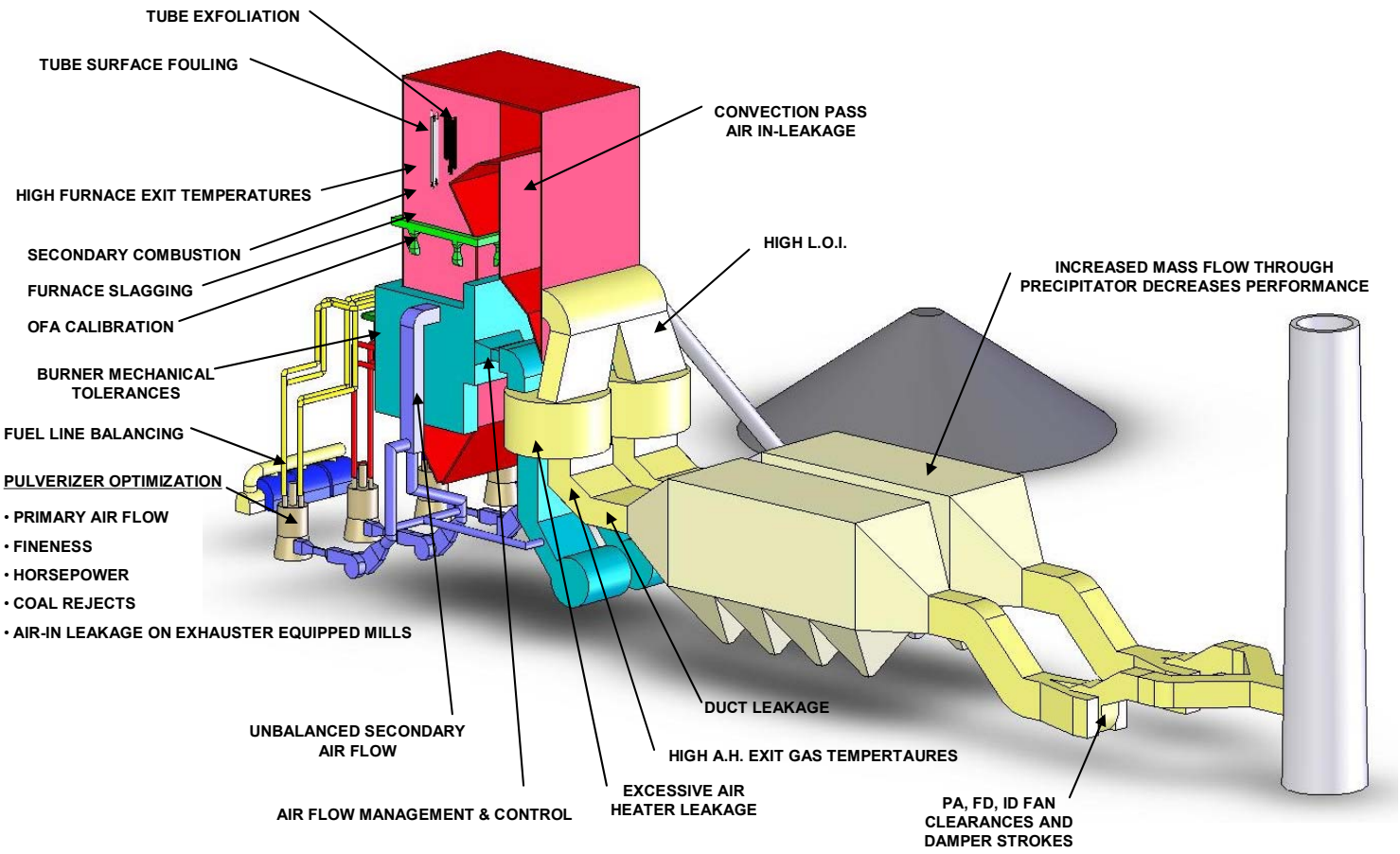
As a Summary: Here are the 22 Heat Rate Variables that are related to Excellence in Boiler Operation and Maintenance:

1. Flyash LOI.
2. Bottom ash carbon content.
3. Boiler and ductwork air in-leakage.
4. More precise primary airflow measurement and control, by reducing tempering air.
5. Reducing pulverizer air in-leakage on suction fired mills.
6. Pulverizer throat size and geometry optimization to reduce coal rejects and compliment operation at lower primary airflows.
7. Secondary airflow measurement and control for more precise control of furnace stoichiometry, especially important for low NO_x operation.
8. Reduction of extremely high upper furnace exit (FEGT) peak temperatures, which contribute to "Popcorn Ash" carryover to the SCR's and ApH's, High spray water flows, Boiler slagging and fouling, and high draft losses due to fouling. The high draft losses cause increased in-leakage, increased fan auxiliary power wastage and increased associated losses with the high spray water flows.
9. High de-superheating spray water flow to the superheater.
10. High de-superheating spray water flow to the reheater.
11. High air heater leakage (note: Ljungstrom regenerative airheaters should and can be less than 9% leakage).
12. Airheater Outlet Temperature.

13. Superheater outlet temperature.
14. Reheater outlet temperature.
15. Airheater exit gas temperature, corrected to a “no leakage” basis, and brought to the optimum level.
16. Burner “inputs” tuning for lowest possible excess oxygen at the boiler outlet and satisfactory NOx and LOI. Applying the “Thirteen Essentials”.
17. Boiler exit (economizer exit) gas temperatures ideally between 650°F to 750°F, with zero air in-leakage (no dilution!).
18. Cycle losses due to valve leak through – i.e. spray water valves, reheater drains to the condenser, superheater and re-heater drains and vents, and especially any low point drains to the condenser or to the hot well.
19. “Soot blowing” Optimization – or smart soot blowing based on excellence in power plant operation. (Remember, soot blowing medium is a heat rate cost, whether compressed air or steam).
20. Feed water heater level controls and steam cycle attention to detail.
21. Steam purity and the costly impact of turbine deposits on heat rate and capacity.
22. Auxiliary power consumption/optimization i.e., fan clearances, duct leakage, fuel system, primary air system optimization, etc.

OPPORTUNITIES FOR IMPROVEMENT

AT LEAST SOME OF THESE ARE TYPICAL OF MOST P.C. UTILITY BOILERS

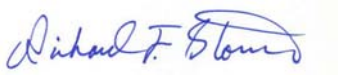


Also, the 13 Essentials of Optimum Combustion are, as we see it a pre-requisite for excellence in Pulverized Coal Firing:

1. Furnace exit must be oxidizing preferably, 3%.
2. Fuel lines balanced to each burner by "Clean Air" test ±2% or better.
3. Fuel lines balanced by "Dirty Air" test, using a Dirty Air Velocity Probe, to ±5% or better.
4. Fuel lines balanced in fuel flow to ±10% or better.
5. Fuel line fineness shall be 75% or more passing a 200-mesh screen. 50 mesh particles shall be less than 0.1%.
6. Primary airflow shall be accurately measured & controlled to ±3% accuracy.
7. Overfire air shall be accurately measured & controlled to ±3% accuracy.
8. Primary air/fuel ratio shall be accurately controlled when above minimum.
9. Fuel line minimum velocities shall be 3,300 fpm.
10. Mechanical tolerances of burners and dampers shall be ±1/4" or better.
11. Secondary air distribution to burners should be within ±5% to ±10%.
12. Fuel feed to the pulverizers should be smooth during load changes and measured and controlled as accurately as possible. Load cell equipped gravimetric feeders are preferred.
13. Fuel feed quality and size should be consistent. Consistent raw coal sizing of feed to pulverizers is a good start.

Some may yawn and say, "What does this have to do with Heat Rate?" Our answer is, quite a lot. Try applying the fundamentals by the Storm Approach. It works and it is "Betterment and Results" oriented. It is also the Right Thing to do, as good stewards of our environment and using natural resources wisely and carefully. Think about it.

All the Best,



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