The Benefits of Applying the Fundamentals

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The successes of applying the fundamentals are growing. More plants have rediscovered applying the fundamentals of getting the inputs right; that is the furnace inputs of combustion air and fuel. The benefits are INTER-RELATED, COMPOUNDING and HUGE. Let me explain why we say inter-related.

Some Inter-Related Performance Factors:

Primary airflow, when optimized, reduces tempering airflows, which then improves the airheater "X" ratio and reduces dry gas loss. Primary airflow, when reduced to optimum, also lowers $NO_x$by reducing the free oxygen into the fuel rich de-volatilization zone of the flames. The optimum primary airflows also reduce flame lengths on wall fired boilers and thereby reduces desuperheating spray water flows and auxiliary steam consumption by the sootblowers. This reduces the FEGT (Furnace Exit Gas Temperature). These factors (heat rate, reliability, fuels flexibility, load capability and NO_x) are all inter-related.

The STORM Solid Fuel Injection System Approach To Furnace Combustion Efficacy

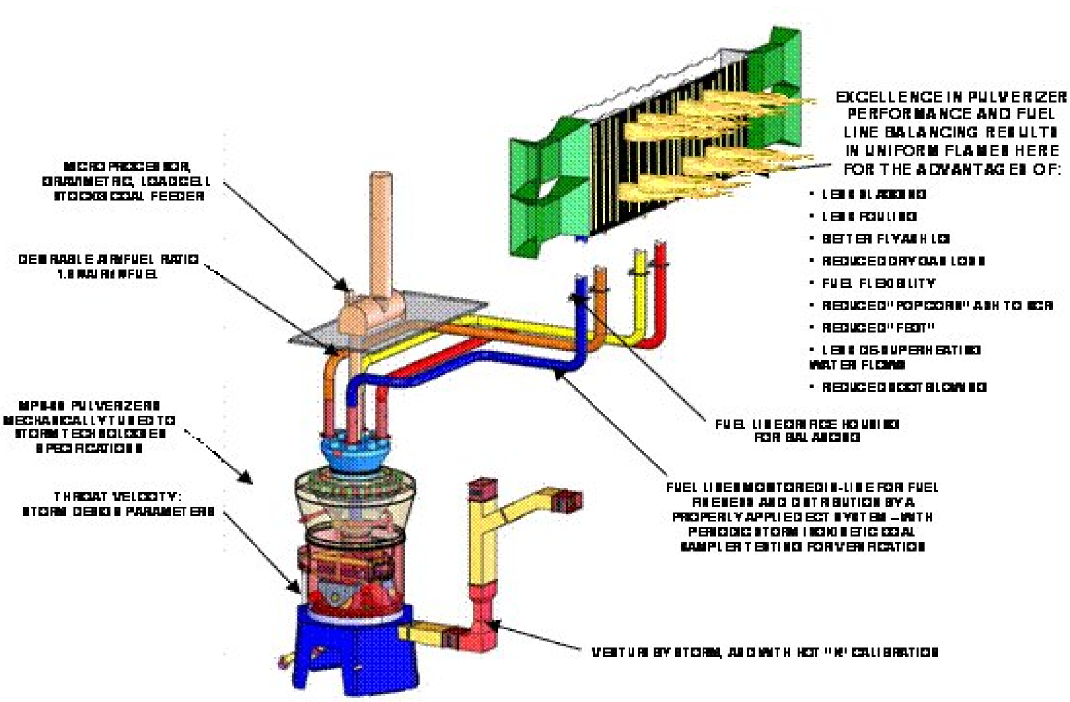

Figure 1

Consider this on the benefits of optimizing combustion. Getting the shortest possible flames for the NO_xlimitation may provide many additional benefits. This means less slagging at the upper furnace. Lowering primary airflows to the true and accurately measured range of 1.6 to 1.8 #air/#fuel provides benefits as follow:

1. Reduced de-superheating sprays at the S.H. and R.H.
2. Less required sootblower operation to remove tenacious “sticky” cinders on the high temperature pendants
3. Less popcorn ash and less consequent fouling of the SCR or airheater
4. Less draft loss as a result of less fouling and therefore less F.D. and I.D. auxiliary power
5. Less airheater leakage due to reduced head between the F.D. discharge, and APH exit gas static
6. With proper sized pulverizer throats, less coal rejects (wasted fuel and fire hazard)
7. Capability to lower excess air with improved fuel balance
8. Less NO_xproduction in the furnace which, in turn, reduces the required SCR reagent requirements

By addressing the fundamentals and the inter-related performance factors, here are some typical benefits/gains that can be expected:

		Controllable Variable Quantities
Reduction of Air In-Leakage	Interrelated	240 Btu/kWh
Reduction of Dry Gas Loss		
Reduction of Coal "Pyrite" Rejects		40 Btu/kWh
Reduction of Air Heater Leakage		60 Btu/kWh
Reduced Carbon in Ash		100 Btu/kWh
Reduction of De-Superheating Spray Water Flows		60 Btu/kWh
Achieve by:		
- Primary Airflow Optimization		
- Pulverizer Optimization and Improvement		
- Fuel Line Balance		
Total		500 Btu/kWh

Figure 2

Financial benefits of getting and keeping the fuel and air inputs at optimum.

Fuel costs are a huge portion of a yearly budget, so improvements in heat rate can provide a substantial financial benefit. Here are a few examples for a typical 400MW coal unit that is based on $2.30/mmBtu fuel cost. Getting the inputs to the furnace right is an economically sound approach. Our example shows a $2.5 million yearly savings by gaining 500 Btu/kwh.

Example Unit Load Capacity:	400 MW
Estimated Heat Rate After Improvement:	9,500 BTU/kWh
Capacity Factor:	70 %
Hours of Operation/year:	8,000 hrs
Fuel Cost/MMBTU:	$2.30
Estimated Fuel Costs/Year:	$48,944,000.00 (70% Capacity Factor)
	$69,920,000.00 (100% Capcity Factor)
Example - Yearly Fuel Cost:	
((9,500 BTU/kWh)*(400,000 kWh)*(0.70)*(8,000 hrs/yr)*($2.30/MMBTU))/1,000,000 =	**$48,944,000.00**
Original Heat Rate Before Improvements:	10,000 BTU/kWh
Estimated Fuel Costs/Year:	$51,520,000.00 (70% Capacity Factor)
	$73,600,000.00 (100% Capcity Factor)
Annual Reduced Fuel Cost for 500 kWh Improvement (see Figure 2):	**$2,576,000.00** at 70% Capacity Factor

Figure 3

Reliability can be just as important to your bottom line. Forced outages cost money too. Here is an example to show the cost of five tube leaks or ten days lost production and production replaced by gas turbines. This results in ~$1M in replacement fuel costs which does not include lost generation sales. This can easily go into the millions depending on the time of the year and power cost per MW.

Heat Rate	10,000 Btu/kWh
Coal Cost $/MMBTU	$2.30 /MMBTU
Fuel Cost for Coal	$23.00 /MW
Gas Fired Heat Rate	7000 Btu/kWh
Gas Cost $/MMBTU	4.75 /MMBTU
Fuel Cost for Gas	33.25 /MW
Lost Hours	240 hrs
Difference in Production Cost	$10.25 /MW
Replacement Production Cost	**$984,000.00**

Figure 4

How to Fix These Opportunities

Engage the services of Storm Technologies, Inc. to work with your team and to monitor early deviations from optimum. For example, let's look at critical and often not routinely measured or/sampled variables. These are examples of tests that should be conducted or measurements that need to be taken at least monthly so that corrections can be made before adverse performance, heat rate or reliability challenges become a reality (below):

Pulverizers:

- Fuel fineness from each fuel pipe
- Fuel distribution from each fuel pipe
- Feeder calibration
- Primary airflow calibration
- A/F ratio (should be optimum)
- Coal rejects (should be NIL)
- Pulverizer drive power (should be at optimum)
- Raw ral size (should be < 3/4")

Boiler:

- Superheater sprays (should be at optimum)
- Reheater sprays (should be at zero for optimum performance).
- Flyash carbon content (western fuels < 0.2% carbon, eastern fuels < 6.0% carbon)
- Bottom ash carbon content (should be < 1.0% carbon)
- Furnace exit excess oxygen – not economizer (should be 2-3% 02)
- Stack CO (should be < 100ppm CO)

Air Heater:

- Leakage (should be < 9%)

The Comprehensive Diagnostic Test

A comprehensive diagnostic test is suggested to be conducted in full, at least twice per year. This is shown in Figure 5.

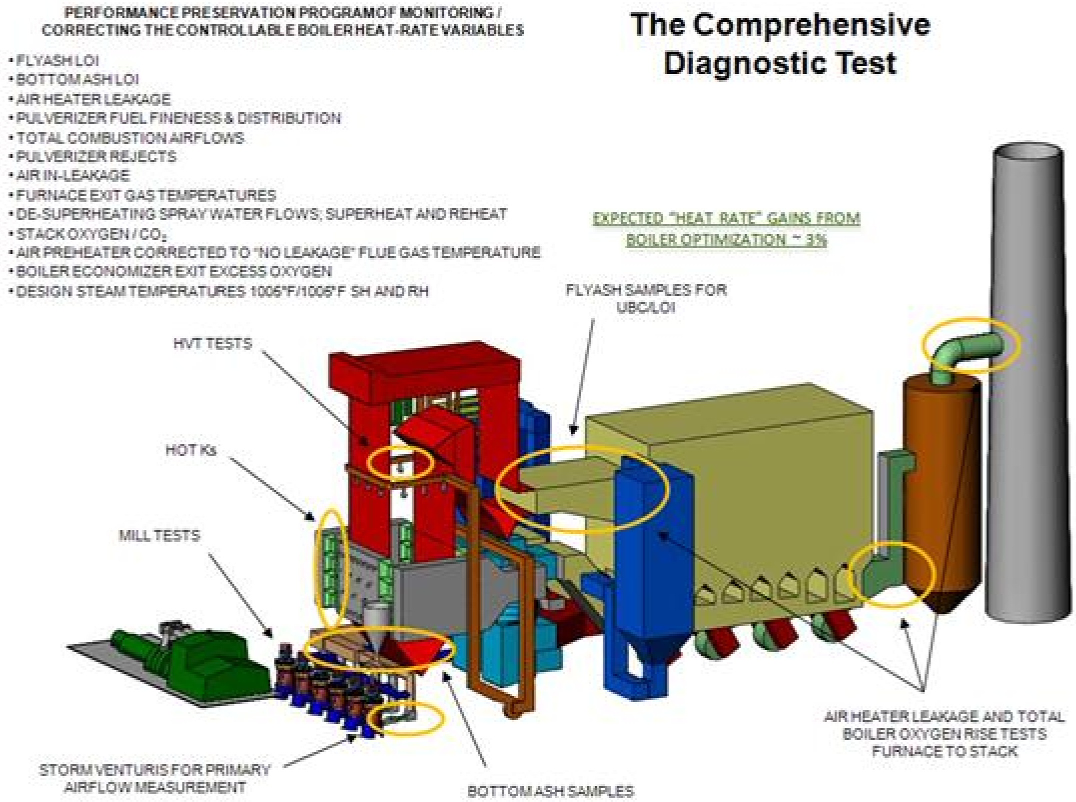

Figure 5

I and our staff have published a number of technical papers and articles in magazines detailing examples of our success. We know that this approach works, and it works well. The two keys to continued success are perseverance and commitment!

Also, stick to the TEST, TUNE, CORRECT, TEST, ADJUST, CORRECT and TEST again approach. We never said it was fun or easy. After all of these years, we have a new suggestion: commit to the program with your performance testing/maintenance and/or operations and maintenance team and then send us the data.

We can contract to do these services at our current rates for office time and therefore provide the benefits of our experience without the travel and mobilization costs. If the test data shows a need for closer attention, we can dispatch the appropriately experienced field service engineers or technicians to your plant.

At Storm we strive to earn, re-earn and live up to our reputation for<u>RESULTS</u>on every field assignment. Thank you for your interest in our techniques, our products and our services.

Yours very truly,

Richard F. Storm