PART 2- THE IMPORTANCE OF FUEL FINENESS

This is a follow-up to our June Newsletter which focused on combustion airflow measurement and balance. Fuel Balance and fineness are also important for optimum combustion, best heat rate, fuel flexibility, minimal slagging, best NOx performance and more. If one were to take a look at Storm's 13 Essentials for achieving optimum combustion in pulverized coal boilers, 9 of the 13 essentials are fuel related.

6 Reasons why Fuel Fineness is Important

1. The furnace residence time is fixed, usually about one second. Therefore, large coal particles require more residence time to completely combust.
2. The best fuel balance is achieved with better fineness. Usually coal fineness must be above 75% passing a 200-mesh screen to produce +/- 10% fuel balance.
3. Better fineness provides improved NOx performance of low NOx burners. The internal staging of fuel and air functions better with fineness above 75% passing 200 mesh.
4. Slagging is reduced when fuel fineness is improved both in the lower furnace and in the superheater/reheater zone.
5. Reduced flyash carbon content due to better furnace combustion.
6. Improved Electrostatic Precipitator performance with less carbon in ash

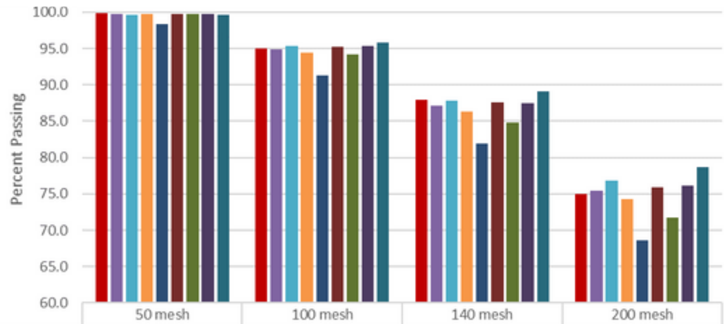
Storm Technologies has been involved in testing and tuning large pulverized coal fueled boilers since 1992. During these past 28 years, we have tested, tuned and solved combustion problems on hundreds of coal fueled boilers. Our take-away from our experiences is that in most cases the root cause of combustion problems have been multiple deviations from the nine pulverizer related essentials of combustion. Problems have included; furnace slagging, secondary combustion, high CO, high carbon in ash content (LOI), higher than desired NOx and Heat-Rate, high de-superheating spray flows to SH and RH, SH and RH metals overheating and more.

STORM's 13 Essentials

1. Furnace exit must be oxidizing, preferably an average of 3.0% with no single point below 2.0%.
2. Individual fuel lines balanced by "Clean Air" test to within ±2% deviation from the mean or better.
3. Fuel lines balanced by "Dirty Air" test, using a Dirty Air Velocity Probe, to ±5% deviation from the mean or better.
4. Fuel line flows balanced to ±10% deviation from the mean or better.
5. Fuel line fineness shall be 75% or more passing a 200 mesh screen. Particles remaining on 50 mesh 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 line velocity.
9. Fuel line minimum velocities shall be 3,300 fpm or higher.(3,300 fpm allows for ± 10% imbalance, 3,000 fpm absolute minimum)
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% deviation from the mean.
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.

The worst part about non-optimum fuel fineness is that in our experience, there has been no successful instrument available to measure and manage fuel fineness in real time. Therefore, most plant personnel only measure fuel fineness periodically and in some cases that has been not very frequent. The major benefit to evaluating fuel fineness on a regular basis is being able to track performance. By tracking performance you can begin to incorporate performance-based maintenance guidelines into your pulverizer overhaul schedules. Secondly, routine testing will allow you to identify degrading performance of the pulverizers and correct it to eliminate its' impact on the heat rate and reliability of the boiler. The following *Figure 1* illustrates this utilizing field gathered test results using Storm's isokinetic sampling method. Between November and May pulverizer performance worsened. Following the testing, an inspection was completed, the root cause was corrected and the performance improved.

It may be getting ahead of the topic to offer this method of managing fineness, but realizing the technical personnel shortages these days, perhaps it will be helpful. The relationship of fuel fineness and pulverizer drive power is usually indicative of performance. Of course, this applies best with a constant fuel supply with a constant HGI (Hardgrove Grindability Index), fuel raw coal sizing and blueprinted mills in good mechanical condition. Given these pre-requisites, the pulverizer power and fuel throughput can be monitored to alert management of declining pulverizer performance before boiler slagging or environmental emissions occur. Please note *Figure 2*. This shows the relationship of pulverizer drive power compared to fuel fineness as measured using the Storm Isokinetic Coal Sampler and sampling all eight coal pipes. You will note that of the six pulverizers, only two have acceptable fineness and these clearly are drawing more input power to achieve the better fineness. This is very common for us to find but often overlooked.



	50 mesh	100 mesh	140 mesh	200 mesh
Recommended	99.9	95.0	88.0	75.0
Jan	99.7	94.9	87.1	75.5
April	99.7	95.3	87.8	76.8
Nov	99.8	94.4	86.3	74.3
April	98.4	91.3	82.0	68.6
May	99.8	95.3	87.6	75.8
June	99.8	94.2	84.9	71.7
Feb	99.7	95.3	87.5	76.1
Dec	99.7	95.8	89.1	78.7

Figure 1: Benefit of implementing a routine pulverizer performance testing program

Fineness is not free. It takes applying all of the nine pulverizer related Essentials to achieve acceptable fineness. Perhaps this is a good time to suggest referring to articles in POWER Magazine on this topic. Here are the links to several informative technical articles describing optimizing pulverizer performance.

POWER Magazine, "To Optimize Performance, Begin at the Pulverizers"

POWER Magazine, "Blueprint Your Pulverizer for Improved Performance"

POWER Magazine, "Pulverizers 101: Part 1"

POWER Magazine, "Pulverizers 101: Part 2"

POWER Magazine, "Pulverizers 101: Part 3"

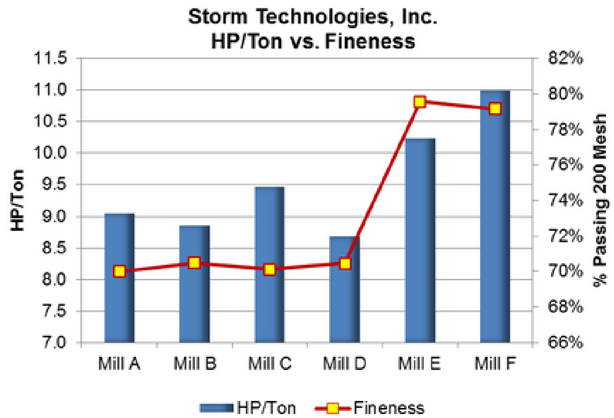


Figure 2: Typical relationship of pulverizer input power and coal fineness

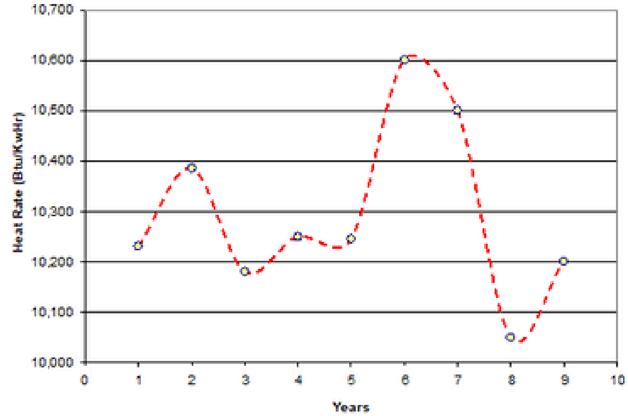


Figure 3: Nine Year Heat-Rate record showing the application of a coordinated Team approach to combustion optimization beginning at year 6. Net Unit Heat-Rate of a 2400psi/1000/1000, 650 MW B&W Boiler with G-E Turbine

What are the potential results of applying the 13 Essentials? Above is a case study of a 650 MW pulverized coal fueled boiler wherein the primary goal was improving the Heat-Rate. *Figure 3* shows the historical heat-rates of this unit over a decade. Note the distinct reduction in Net Heat-Rate after the entire Operations and Maintenance Team, plus Storm Technologies involvement, applied the 13 Essentials. This shows the good results attainable with an outstanding team approach to combustion and overall performance optimization.

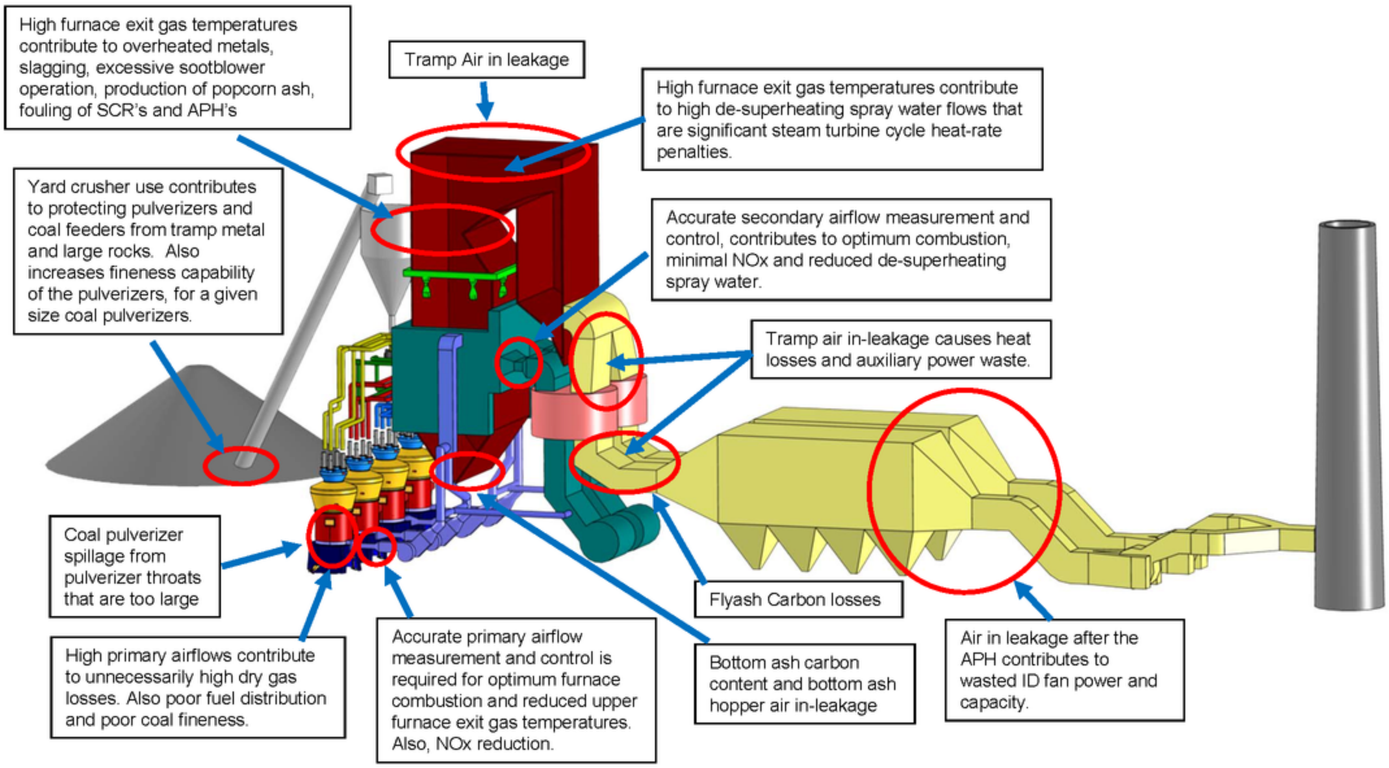


Figure 4: The Results shown on Figure 2 were obtained by actively measuring, testing, tuning and correcting all of the 13 Essentials plus, correcting some balance of plant issues. Bottom line was, outstanding performance close to the design best possible.

Applying the fundamentals has worked for us for all of our 28 years. Sure, we have some patents and new equipment that we have developed as a result of our experiences, but we have always stressed the importance of the "First - Apply the Fundamentals" approach. Let us know if you would like to discuss the specifics of your plant. We love helping our customers get to the very best performance for their coal fueled boilers!

For achieving the best performance,

Richard F. Storm

Richard F. "Dick" Storm, P.E.