PULVERIZER PUFFS ARE PREVENTABLE. ARE YOUR PULVERIZERS OPERATING SAFELY? PART II

Last month, we published a technical article that we hope got you thinking about the operation of your pulverizers. Overall, we feel that we receive too many phone calls for support after the plant has experienced a mill puff and come to find out that most of these could have been prevented.

In Part I, we tried to highlight the fact that while primary airflow generally makes up less than 25% of the total airflow supplied to a pulverized coal boiler, it is extremely important that it is accurately measured and controlled. Two case studies were provided where erroneous values were found in the DCS control logic or the operating curves were not optimized. The result was dangerous operating conditions; which, eventually led to a mill puff.

In Part II of this two-part newsletter, we are highlighting two more common concerns that plants often face. The first being the rotating throat geometry. As stated in Part I of this series, Storm's experience has been that 7,000 ft/min velocities must be maintained at the throat to keep raw coal from spilling through the throat. The second point that we will cover in this article is something that over the past ten years seems to have been at the forefront of most pulverized coal plants, and that is changing coal quality. Many plants have been fighting to stay competitive with the addition of natural gas combined cycles and the influx of renewables into the energy market. One of the easiest ways to cut the total operating cost of the plant is to switch to a lower-cost fuel; however, this can come with an array of new challenges; one of them being mill puffs.

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Case Study #1: Rotating Throat Geometry

Many folks in the industry are familiar with the absolute minimum velocity required (3,000 fpm) in the fuel lines to keep pulverized coal suspended in the primary air stream. However, we are not so sure that everyone is familiar with what the free-jet velocity through the throat should be. Storm's experience has proven that 7,000 fpm is that magic number. The reason we question if this velocity is as well known as the fuel line velocity is that during an internal inspection of pulverizers around the world, we almost always find throat geometries, like the one shown in Figure 1, that are too large to maintain 7,000 fpm when operating at minimum airflow.

Figure 1: Oversized Rotating Throat

A facility that Storm was recently involved with had four shallow bowl pulverizers that had similar throat open areas. However, the rotating throat on one pulverizer was replaced but still maintained the same approximate opening as the remaining three mills. Following the throat replacement, the ledge covers that were originally installed beneath the three journals were not replaced leaving a significantly larger portion of the throat open for primary air to pass through; reducing the free jet throat velocity as shown in Table 1.

Mill Geometry vs. Throat Free Jet Velocities					
Mill	Area	Exhauster Position	Airflow	*Density	Throat Velocities
(No.)	(ft^2)	(%)	(lb/hr)	(lb/ft^3)	(ft/min)
A	4.724	53	84,723	0.03650	8,190
B	4.724	25	86,103	0.03650	8,323
C	4.724	45	95,492	0.03650	9,231
D	7.374	25	96,850	0.03650	5,998
*NOTE: Density at throat calculated based on 550°F and -4"wc					

Table 1: Throat Geometry vs. Free Jet Velocities

Mill "D" in this example, experienced severe coal spillage at minimum airflow that caused multiple mill puffs during startup, shut-down and normal operation, and the main contributing factor was the throat velocity being less than required to keep coal suspended within the mill. When raw coal spills beneath the grinding table, the environment can be perfect for combustion to take place. It is an oxygen-rich environment, and the mill inlet primary airflow temperatures can be as high as 650°F - 700°F depending on the coal and air pre-heater performance.

By replacing the ledge covers and installing a temporary throat restriction ring around the outer diameter of the bowl as shown in Figures 2 & 3, the open area was successfully reduced to 4.6 ft^2. By reducing the throat area in conjunction with comprehensive pulverizer testing/tuning, Storm was able to set the throat velocity to approximately 7,000 fpm at the minimum exhauster damper position; improving the performance of the mill during startup and shut-down transitions.

Figure 2:Throat Restriction Ring

Case Study #2: Coal Quality Impact on Throat Velocities

Fuel switches and blending of various coals have been something the industry has been doing for years now due to many different driving factors. No matter what the driving force was behind it was, the impact that fuel changes can have on your pulverizers and boiler can be substantial. Most performance engineers and operators are likely concerned about the heating value, volatile matter, nitrogen and sulfur content, ash constituents (i.e., iron, chlorine, potassium, sodium, etc.), Hardgrove Grindability Index, ash fusion temperatures, and moisture to name a few for a pulverized coal-fired boiler. All these factors can impact pulverizer and boiler performance as seen in Figure 4 which depicts an artistic illustration of a coal particle and the potential impact it has on the plant.

Figure 3: Ledge Cover

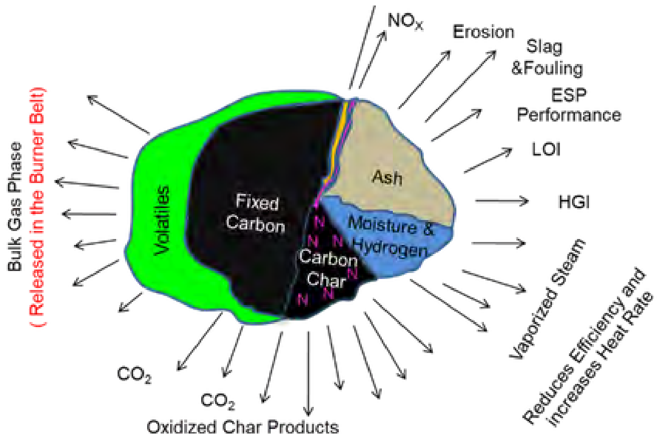

Figure 4: Coal Quality Challenges

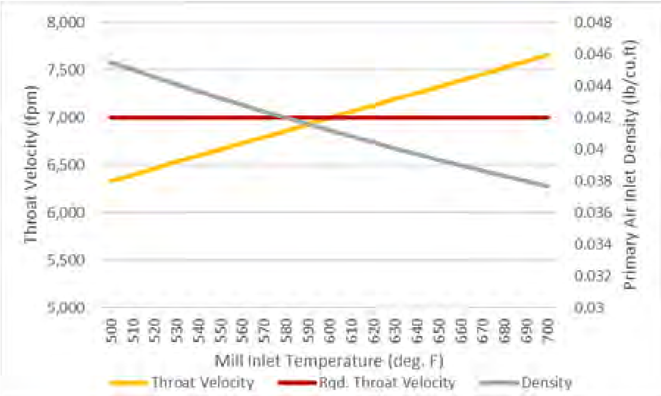

Figure 5: Mill Inlet Temperature vs. Throat Velocity

Out of all the various coal constituents that affect mill performance, the moisture content will have the largest impact on coal spillage. This is primarily a concern when a plant switches from high moisture coal to low moisture coal. If you remember, in Part I of this technical newsletter series, we discussed the heat balance surrounding the pulverizer. A graph was provided that illustrated how varying the coal moisture affects the required inlet temperature for a given outlet temperature setpoint and primary air/fuel ratio. If the mill outlet temperature and primary air/fuel ratio remain the same, as the moisture increases or decreases in the coal, the required inlet temperature will also vary. This will impact the density of the primary air entering the pulverizer and in turn, the volume of air supplied to the pulverizer. As the volume of air changes, the velocity through the throat will be impacted as seen in Figure 5.

Throat velocities are usually not on anyone's radar when switching coals but depending on the coal constituents they will impact the primary air density entering the pulverizer and as a result the throat velocities.

Storm's Pulverizer Engineered Solutions

If coal spillage is a challenge that your plant is facing hopefully Parts I and II of this technical newsletter series have shed some light on what may be the potential root cause. Determining the root cause of the coal spillage requires the plant to evaluate the primary airflow rate at the mill inlet and throat areas to establish if the velocity of the primary air through the throat is adequate. If the variables discussed here check out, then there may be another mechanical variable that is causing excess coal spillage on your pulverizer.

For years, Storm has helped eliminate coal spillage by focusing on the fundamentals discussed in these two articles. In doing so, we have developed our own engineered rotating throat and deflector design. This design has been installed in many vertical spindle mills to achieve the correct throat velocities. In addition to setting the open area to achieve the desired 7,000 fpm velocity at minimum airflow, Storm's design also redirects the primary air towards the center of the pulverizer as shown in Figure 6. By doing this, you effectively sweep the fine particles from the grinding zone and entrain them in the primary air stream exiting the pulverizer. This can help reduce mill rumble when operating with desirable fuel fineness levels. Many plants experience mill rumble at low load when the coal bed has not yet been established. However, you can also experience rumble as the coal gets finer. When this happens the journals and roll wheels lose traction and begin to skid across the top of the coal bed. By vectoring the primary air towards the coal bed with Storm's engineered throat and deflector you can effectively sweep those fines out, allowing for the coarse particles to take their place and in turn reducing the rumble associated with fine coal.

Storm's standard rotating throat and deflector (illustrated in Figure 6) have provided performance improvements at many plants. One common drawback to adjusting the throat to a smaller area is the increased differential that is experienced across the pulverizer. Most of the time, plants can operate effectively with this increased pressure drop and it sure does save them on repair costs if mill puffs are a problem due to low velocities. With higher pressure drops in mind, Storm has engineered and patented a new "adjustable" rotating throat design. We all know that any adjustable mechanical device that is installed in a coal or ash-laden environment is likely not going to stay adjustable for very long. This is why our design adjusts the proportion of primary air through the main rotating throat and a second primary air inlet to the mill. This allows Storm to always maintain 7,000 fpm through the throat and provide a secondary primary airflow path that enters immediately above the rotating throat to provide the remaining portion of primary air as shown in Figure 7.

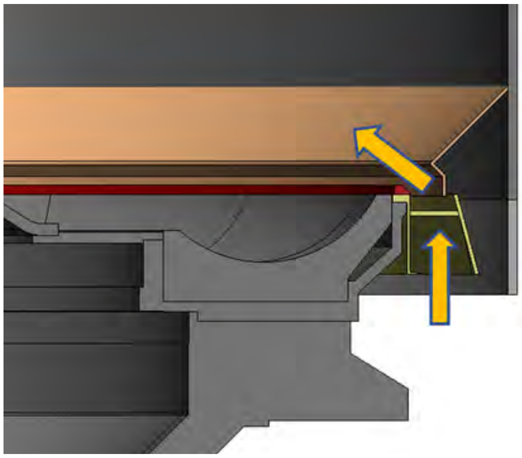

Figure 6: Storm Standard Rotating Throat and Deflector

The two separate air paths create a larger overall open area than your standard rotating throat does to achieve the desired velocities. This has multiple positive impacts on pulverizer performance such as:

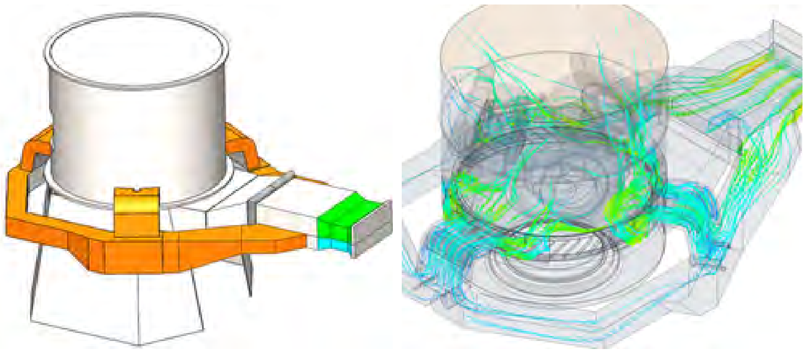

Figure 7: Storm Adjustable Throat Concept

- Reduced mill differential at high loads.
- Eliminates coal rejects across the load range.
- Effectively sweeps the fine coal from the grinding zone (reducing skidding).
- Accurate control of the primary air to both under the table and the throat bypass zone.
- Capable of reducing air/fuel ratios.
- Reduced wear on housing and mill internals due to reducing velocities.
- Improved initial classification of coal particles.

Thank you for taking the time to read this article and we hope that these two technical articles have helped you get a better understanding of some of the controllable factors you have for eliminating mill puffs. If you have been fighting with excessive coal rejects, mill puffs, or are just generally reviewing the performance of your pulverizers, then please reach out to us at 704-983-2040. Furthermore, if you have any type of fabrication need at your facility, please do not hesitate to contact us as we can provide you with "in-kind" replacement parts as well as engineered solutions with turnaround times on orders that we feel can beat anyone in the country. We look forward to hearing from you.

Respectfully,

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