

# PRB Coal Slagging Control Product

Benetech has developed a product, patent pending, that controls furnace slagging caused by reflective fly ash for units firing Powder River Basin coals. The fly ash generated by many PRB coals is highly reflective compared to that of bituminous coal fired fly ash. The fly ash reflects the heat to the flame and combustion gases, increasing the flame and gas temperatures. This significantly increases the radiative heat transfer to the fly ash producing a reduction in fly ash viscosity that leads to the formation of a sintered layer or runny slag on the furnace walls. Higher flame and gas temperatures produce higher exit gas temperatures that promote fouling in the convective pass. These phenomena have been widely experienced in industry. Strategies deployed to cope with this problem include unit de-rating or the use of water lances or water canons. The overall result is a significant loss of revenue.

## PRB Coal Slagging Mechanism

Unlike bituminous coal, western coals, especially PRB varieties, contain high level of calcium within the coal structure. The calcium present in bituminous coal is in the form of clay components. The following table shows the significant difference in the calcium levels and their distribution between coal and mineral types.

	Illinois Bituminous		Wyoming Sub-bituminous	
% Ash (Dry)	8.6		6.8	
% CaO	2.7		28.3	
	<b>Coal Bound</b>	<b>Mineral Matter</b>	<b>Coal Bound</b>	<b>Mineral Matter</b>
% CaO	30.0	70.0	97.0	3.0

The coal bound calcium on entry into the furnace is immediately released, forming fine particles of mostly calcium oxide and calcium silicate. These are reflective in nature, reflecting energy back to the flame and flue gas. The gas and flame temperatures rise in accordance with the law of radiative heat transfer:

$$-q_r = AE6 (T_1^4 - T_2^4)$$

Where:

A is surface area

E is Emissivity

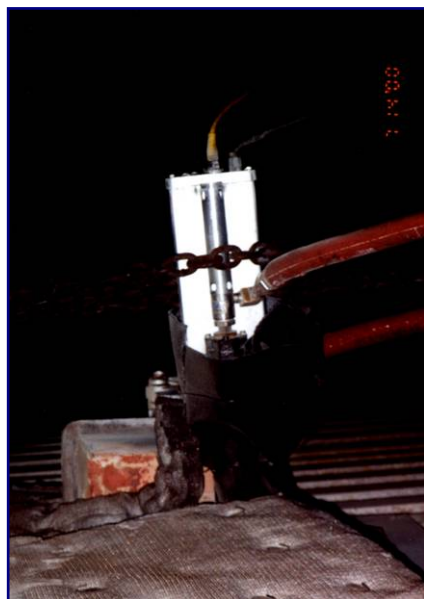
6 is Boltzman constant

T<sub>1</sub> & T<sub>2</sub> are temperatures of heat radiating and receiving bodies.

A small rise in the temperature of the radiating body produces a significant increase in heat flux. As a result, the fly ash temperature increases beyond its melting point giving rise to slag. If the emissivity of fly ash can be reduced, it will reflect less energy. This reduction in emissivity will reduce the gas and flame temperatures, and in turn reduce the slagging propensity, furnace exit gas temperature and fouling propensity.

## Proven Performance

Benetech's GAM-65 product has demonstrated its capability of significantly reducing slagging caused by reflective ash. In a PC furnace firing 100% PRB coal, a small quantity of GAM-65 was added to the coal prior to the pulverizers. The furnace exit gas temperature was monitored by optical pyrometer as shown in the following picture (right).



During the application period, the flame color (left) changed to an orange tint and the color of the bottom ash visibly changed to gray.

Prior to the use of GAM-65 the unit required the use of water lances to maintain load. During the periods when GAM-65 was used, the water lances were not needed and the de-superheat spray flow was reduced to zero. The furnace exit gas temperature showed a decrease ranging from 55 to 110°F. The plant reported a 5% reduction in heat rate, which led to a significant reduction in coal usage.

## Chemical Description

GAM-65 is an environmentally friendly product applied in small quantity either in the pulverizer or on the conveyor belt. During its' use, slagging was eliminated and the plant could operate at lower excess air levels. The reduction in the boiler exit gas temperature led to a reduction in the gas volume, improving ESP performance. The NOx level also showed an improvement as a result of the reduction of the excess air level.

