A COMMERCIAL DEMONSTRATION ON THE USE OF HIGH-CARBON FLY ASH IN CEMENT MANUFACTURE

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Introduction

There more than 60 million tons of fly ash produced in the USA, of which only 33% is reutilized. The remainder is discarded. Approximately half of the fly ash that is utilized is used in concrete as a supplementary cementitious material. This fly ash typically has a carbon content of less than 1%. Increased levels of carbon are detrimental to the freeze-thaw durability of concrete.

CTL recently performed a commercial demonstration where a fly ash that was unsuitable for use in concrete was used to manufacture portland cement. The fly ash had a carbon content in excess of 20%, did <u>not</u> require any preprocessing, and served both as a raw material and fuel.

Background

The objective of the project was to demonstrate the commercial-scale feasibility of using high-carbon fly ash in the manufacture of portland cement. The high carbon fly ash provides two major benefits to the cement manufacturing process.

First, the fly ash can partially replace certain raw materials. Shale, clay, slate, sandstone, and/or mill-scale are typically used to provide necessary silica, alumina, and iron content of the raw feed that is processed into cement. These materials are normally mined or purchased. Since the fly ash is rich in these compounds, it can be conveniently substituted in the formulation.

Second, the carbon content of the fly ash acts as a fuel supplement for the energy intensive manufacturing process. Furthermore, the fly ash can enhance the burnability of the raw feed because of its fine particle size and its favorable reactivity with lime.

Project

Approximately 50 tons of fly ash with an approximate carbon content of 21% was used during this commercial-scale demonstration at a dry process cement plant located in the Midwest. The fly ash was obtained from a power plant that burns Illinois coal. The fly ash from this power plant is normally collected dry and landfilled.

Prior to the demonstration, fly ash samples were analyzed to determine chemical composition, fuel value, and potential for emissions. Analyses indicated that the fly ash was fully compatible with the cement plant operations. The ash had an estimated fuel value in excess of 318 Btu/lb.

Approximately 50 tons of high-carbon fly ash was transported by pneumatic trucks from the power plant to the cement plant. The ash was blended with the other raw materials (limestone and shale) at the cement plant. The target composition of the raw feed, and the chemical composition of the limestone and shale available at the time limited the fly ash content of the raw feed to approximately 6%.

Results

During the demonstration several material, product, energy, and environment benefits were noted. First, the cement plant operated in a more efficient, stable, and predictable manner. Second, the cement plant achieved a 4% savings of purchased fuel and production increased by nearly 10%. Finally, no adverse changes in emissions were noted.

Cements produced during the demonstration were compared with those produced before and after the demonstration in accordance with ASTM specifications. The data confirmed that the cement produced from the demonstration had properties comparable to those of the normally produced cements. Additionally, the use of fly ash helped reduce alkali content of the cement by approximately 20%, compared to that of the normally produced cement. Low alkali cements are often sought by concrete producers for compliance with project specifications.

Summary

Clearly, the interrelated material, operational, fuel, emission, and product benefits realized from the commercial demonstration confirmed the beneficial use of high carbon fly ash in the manufacture of portland cement. Utilizing this technology, cement plants and electric utilities can gain a competitive advantage. It must be emphasized that this technology provides a large-scale consumption of typically unusable fly ash.