Title: A Novel Application of High-Carbon Fly-Ash as an Industrial Binder

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Summary

This paper describes the use of high carbon fly-ash as a binder in metallic industries such as metal casting and iron ore pelletization. The sands used in metal casting must be properly bonded to make molds for forming metal parts, and 6.2 million tons of sand were used in this application in 1998. In the same time period, U. S. iron ore producers concentrated over 60 million tons of iron ore. The fine iron ore concentrates must be pelletized with a binder before shipping, and reduced in a blast furnace prior to making iron and steel. Sodium bentonite clay from the Western United States is typically used as a binder for these applications, which together consumed over 1.6 million metric tons of bentonite during 1998.

Shipping bentonite hundreds of miles to the Midwestern foundries and pellet plants triples the cost of the clay. A typical pellet plant spends $3 million to $5 million annually on bentonite. Power plants are located nearby and produce the currently useless and landfilled high-carbon fly-ash by-product that could be used as the binder. Replacing bentonite clay with high-carbon fly-ash based binder (FBB) is one promising application for high-carbon fly-ash.

Iron ore pellets made with either bentonite or FBB exceeded industrial standards, while pellets made with combinations of FBB and bentonite binders had reduced dry magnetite pellet compressive strengths below the industrially acceptable value of 22.2 newtons (5 lbf). Activators and accelerators that activated the fly-ash, deactivated the bentonite. The incompatibility of these two binders is explained as being due to ion-exchange phenomena with the bentonite. Soluble calcium ions replace the exchangeable cations in the sodium bentonite, converting it to the less-effective calcium bentonite.

Similarly, foundry sand test specimens bonded with high-carbon FBB had properties generally similar to specimens made using conventional bentonite binders. While the FBB alone gave good results, mixtures of FBB and bentonite did not perform as well as either binder alone, due to the deactivation phenomenon noted in iron ore pelletization.

Significantly, this work has determined that high-carbon fly-ashes are just as effective for producing FBB as are low-carbon fly-ashes. In fact, carbon content is actually beneficial in both of these applications. The presence of carbon in the binder reduces fuel consumption in iron ore pelletization, and is likely to improve pellet permeability. Finely-divided carbon is routinely added to foundry sands to improve the surface quality of cast metal parts, and so the presence of carbon in the foundry sand binder is a desirable feature.