

## Use of High-Carbon Fly Ash in the Manufacture of Portland Cement

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The disposal of fly ash in landfills is becoming increasingly costly. A number of uses have been found for fly ash in construction materials. For example, fly ash has been widely used as a supplementary cementing material in concrete. However, carbon contents above about 4% make fly ash unsuitable for direct use in concrete because of interactions between the carbon and the chemical admixtures used in concrete.

CTL has conducted several pilot studies demonstrating that fly ashes having carbon contents up to 20% are suitable for use as raw kiln feed in the manufacture of portland cement. Fly ashes from several power plants were matched with nearby cement plants having compatible raw materials. Raw kiln feed mix designs were formulated using these fly ashes with the raw materials supplied by the cement plants to produce cements comparable to the existing product. The portland cement clinkers produced in a pilot plant were ground with gypsum, and the resulting cement tested according to ASTM C 150, "Standard Specification for Portland Cement".

The use of fly ash as a component of raw kiln feed offers a number of potential benefits for the cement manufacturer:

- The carbon in the fly ash displaces other fuels.
- Fly ash, unlike most other cement raw materials, requires essentially no grinding.
- Fly ash partially displaces other raw materials, thus conserving these resources.
- The use of fly ash usually reduces the alkali content of the cement.

If a particular fly ash contains volatile organic compounds, they could contribute to increases in emissions from the kiln. However, the potential for increased emissions can be eliminated by injecting the fly ash directly into the burning zone or calciner of the kiln, where the temperature is hot enough for complete burning of the hydrocarbons.

The results of this work demonstrate that introducing fly ash as a raw material in the manufacture of cement saves both fuel and electricity, conserves mineral resources, does not increase emissions, and produces a cement at least as good as the existing product.