

TITLE: IN-SITU COAL ASH MODIFICATION TO A CEMENTITIOUS CLINKER

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Summary

AMC is a multifunctional combustion accelerator and emission reduction additive, especially suited for bituminous coal-fired power plants. AMC, added to coal fuel at the coal pulverizer, reduces the following nine emissions simultaneously:

- sulphur dioxide (up to 87%)
- sulphur trioxide
- nitrogen oxides (10 to 27%)
- carbon dioxide
- hydrogen chloride
- ash LOI
- flue gas opacity (particulates and/or coloured sulphur trioxide aerosols) (71% reduction in flue gas particulates)
- mercury (43+%)
- ammonia.

AMC, a lime-rich powder with additives added to coal at the coal pulverizer, increases the calcium oxide content of coal ash while the coal is burning by fusing calcium oxide to the ash. Calcium oxide in coal ash is a catalyst for coal combustion even under low-NO_x boiler modes. Bituminous coals are deficient in the calcium oxide required to achieve the low-unburned carbon contents of sub-bituminous or lignite coals which are richer in calcium oxide. The recyclability and value of coal ash improves dramatically as its unburned carbon content is reduced. AMC can produce CaO-rich cementitious ash or CaO-rich cementitious clinkers.

AMC technology is particularly suited to value enhancement of coals that produce Class F fly ash with high-LOI and low-calcium oxide content under normal combustion mode or low-NO_x burner modes. It is known that coal ash with high-calcium content (e.g. Class C fly ash) has many advantages. However, the calcium content of both anthracite and bituminous coals is very low, less than 10%, typically less than 5%. This low-calcium content limits the bonding characteristics of coal ash. Existing technologies cannot increase calcium content of both anthracite and bituminous coals; therefore increasing their cementitious bonding capacity and solving the coal ash recycle problem. AMC technology reduces carbon residue of fly ash and bottom ash after coal burning, therefore making these materials readily re-usable.

X parts coal ash + Y parts AMC = X + Y parts cementitious clinker

A subsidiary, of an international cement company, reported the following composition by weight for AMC fly ash cementitious clinker produced in a 12 MWe China pulverized coal combustor from coal containing 18.8% ash, 0.6% sulphur, 3.3% CaO and 25.8% LOI (without AMC addition):

LOI	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	SO ₃	K ₂ O	Na ₂ O	Sum
2.42	26.1	12.67	4.09	50.09	1.27	0.96	0.59	0.31	98.5

The AMC fly ash cementitious clinker was ground to 5987 cm²/g fineness and hydrated with the following results:

Compressive strength in MPa (days): 15.8(1), 35.1(3), 45.2(7), 66.2(28)

Tensile strength in MPa (days): 4.2(1), 5.6(3), 6.9(7), 7.8(28)

X-ray diffraction analysis of the AMC cementitious clinker fly ash by CANMET revealed the following chemistry (weight % in brackets): clinker crystals (40.1%) including belite (35.2%), calcium aluminoferrate (4.9%); cementitious crystals (33.2%) including mellilite (5.5%), gypsum (4.9%), calcium carbonate (9.2%), grossular (3.7%), mullite (8.3%), calcium silicate (1.6%); undetectable crystalline or non-crystalline amorphous components (26.7%).

The X-ray data clearly indicate that AMC fly ash product is a cementitious clinker “hybrid” not unlike a blended cement made from clinker-pozzolan or clinker-Class C fly ash.

The following Chinese AMC pulverized coal combustor projects are operating and planned: 12 MWe (Henan Province since October 1998), 50 MWe (Henan Province since May 2000), 50 MWe (Xinjiang Province since September 2000) and 100 MWe (Henan Province for June 2001).