METAKAOLIN DESCRIPTION

High Reactivity Metakaolin (HRM)
Engineered Mineral Admixture for Use with Portland Cement

Advanced Cement Technologies' PowerPozz™ High Reactivity Metakaolin is a manufactured pozzolanic mineral admixture, which significantly enhances many performance characteristics of cement-based mortars, concretes and related products.

PowerPozz™, derived from purified kaolin clay, is a white, amorphous, alumino-silicate, which reacts aggressively with calcium hydroxide, a normal cement hydration byproduct, to form compounds with cementitious value.

Produced to ISO 9002 certification standards, PowerPozz™ HRM is subjected to strict process quality control to assure product uniformity and consistent performance.

Used at 5 - 15% replacement of cement by weight, PowerPozz™ will contribute to: increased strength; reduced permeability; greater durability; effective control of efflorescence; and control of degradation caused by Alkali-Silica Reaction (ASR).

Raw Materials

The raw material input in the manufacture of metakaolin is kaolin clay.

Kaolin is a fine, white, clay mineral that has been traditionally used in the manufacture of porcelain. It is thought that the term kaolin is derived from the Chinese *Kaoling*, which translates loosely to *white hill* and has been related to the name of a mountain in China that yielded the first kaolins that were sent to Europe.

Kaolinite is the mineralogical term that is applicable to kaolin clays. Kaolinite is defined as a common mineral, hydrated aluminum disilicate, $Al_2Si_2O_5(OH)_4$, the most common constituent of kaolin.

Kaolins are a classification of clay minerals, which like all clays, are phyllosilicates, i.e.: a layer silicate material. The study of the stacked arrangement and the individual layers in the stack are the defining factors of classification.

Kaolin is a mineral typical of continental weathering where solutions percolate and are purified over time. Kaolinite cannot develop in sedimentary basins where solutions accumulate and are enriched.

Kaolin is one of the more highly prized of the industri al mineral clays. Kaolin's traditional markets in ceramics over the past centuries have yielded to the now dominant consumption by the paper industry where it is extensively used as a filler, opacifier, and as an important input to high-end coatings. Additional, smaller markets for kaolin are in the refractory, rubber, paint, plastic, chemical, pharmaceutical and ceramic industries.

Metakaolin

The *meta* prefix in the term is used to denote change. It is a borrowing from Greek meaning *after*, *along with, beyond*. It is used, and is recognizable, in the formation of compound words: *meta*bolic, *meta*morphosis. The scientific use of the prefix is used for a combining form denoting *the least hydrated of a series*.

In the case of metakaolin, the change that is taking place is *dehydroxylization*, brought on by the application of heat over a defined period of time.

At about 100-200 degrees C, clay minerals lose most of their adsorbed water. The temperature at which kaolinite loses water by dehydroxilization is in the range of 500-800 degrees C. This thermal activation of a mineral is also referred to as calcining. Beyond the temperature of dehydroxylization, kaolinite retains two-dimensional order in the crystal structure and the product is termed metakaolin.

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The key in producing metakaolin for use as a supplementary cementing material, or pozzolan is to achieve as near to complete dehydroxilization as possible without over heating. Successful processing results in a disordered, amorphous state, which is highly *pozzolanic*. Thermal exposure beyond a defined point will result in sintering and the formation of mullite, which is dead burnt and not reactive. In other words, kaolinite, to be optimally altered to a metakaolin state, requires that it is thoroughly *roasted* but never *burnt*.

New Age Concrete

The construction industry has taken considerable strides forward over the last two or three decades with regard to many materials, in particular - **High Strength Concrete (HSC)** and generally Higher Performing Concrete Materials.

The development of new technology in the materials sciences is progressing rapidly. Advanced composite construction materials and HSC are gaining wide acceptance in the construction industry of today, and are well positioned for increasing proliferation in use in the future. HSC and High Performance Cement-Based Products will continue to make important contributions to the enhanced quality and efficiency in the construction of infrastructure and our communities in the next century.

PowerPozz™ High Reactivity Metakaolin

The use of pozzolanic materials in the manufacture of concrete has a long, successful history. In fact, their use pre-dates the invention of modern day portland cement by almost 2,000 years.

Today, most concrete producers worldwide recognize the value of pozzolanic enhancements to their products and, where they are available, they are becoming a basic, even a routine, concrete ingredient.

Most pozzolans used in the world today are **byproducts** from other industries, such as coal fly ash, blast furnace slag, rice hull ash, or silica fume. As such, there has been relatively little work done with regard to **manufactured, optimized and engineered pozzolanic materials** which are specifically intended for use in portland cement-based formulations. *PowerPozz™* High Reactivity Metakaolin is a leader among a new generation of such materials.

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The use of **silica fume** and various chemical admixtures have become staple ingredients in the production of concretes with designed strengths in excess of 7500 psi (>50 Mpa) or where service environments, exposure conditions, or life cycle cost considerations dictate the use of High Performance Concrete (HPC).

The introduction of High Reactivity Metakaolin to the HSC market has provided **an alternative to the use of silica fume**. Equivalence in strength development and durability properties along with several additional features of HRM including color and workability have effectively expanded the design boundaries of HPC materials.

The benefits in engineering properties that result from the use of *PowerPozz™* HRM come with few "side effects". Once properly adjusted, the concrete fresh mix texture, **workability and finishability** are generally enhanced by the replacement of 5-15% of cement with HRM.

***PowerPozz™* is white in color** and will not darken pigmented, gray or white cement-based concrete or products. Easy to handle in trucks, silos and plants,

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