Tephra® RFA

CR Minerals offers a unique remediated fly ash, Tephra® RFA, to serve the ready-mix market, DOT infrastructure projects, concrete products manufacturers and the oil & gas industries as a high performance pozzolan that meets or exceeds all of the criteria for ASTM C618 Class F fly ash. Tephra RFA is a blend of fly ash from coal combustion beneficiated with naturally occurring pozzolans from ancient volcanic geological events. The beneficiation process results in a very reactive Class F pozzolan which significantly enhances the strength of concrete, relative to other Class F pozzolans, and outperforms 100% OPC mix designs in long term compressive strength. This newly available Class F fly ash will mitigate the most reactive aggregates (per ASTM C1260/1567) and successfully protect against sulfate attack (per ASTM C1012).

More Environmentally Sound

Tephra RFA pozzolan removes coal combustion fly ash from the waste stream that has been destined for the landfills or settling ponds and beneficiates this waste fly ash with the purest of natural pozzolans to meet ASTM C618 Class F fly ash specifications. In concrete production, Tephra RFA can typically remove and replace cement as a supplementary cementitious material (SCM) at levels of 15-40% by weight in a concrete mix design, resulting in optimized concrete mixes and a reduction in greenhouse gas emissions.

Sustainability and Reliable Sourcing

Due to more stringent environmental regulations to control emissions from coal combustion facilities over the past two decades, along with public mandates and market economics to utilize alternatives to coal for energy production, reliable supplies of Class F fly ash are diminishing. This creates localized, seasonal shortages of supply as well as a long-term issue with supply and costly importing of fly ash from other geographic areas. This market reality has affected concrete

specifiers, concrete producers and contractors in their efforts to protect our concrete infrastructure without a reliable and available Class F pozzolan. Tephra RFA helps fill this critical shortage with our local sourcing of manufactured and blended raw materials to produce a reliable and predictable supply of material that meets the requirements of Class F fly ash.

Quality Control and Consistency

Tephra® RFA is rigorously tested for consistency of particle size, chemistry, and performance. The result is a product that minimizes water demand variability as it effects concrete slump, ensures a stable air void matrix that reduces variability in plastic and hardened air contents of concrete, and maximizes strength gain creating opportunities for mix design optimization over other competitive pozzolans.

Pozzolan Benefits:

Enhances Compressive Strength

The pozzolanic reaction between CRM Tephra® RFA and excess calcium hydroxide in the concrete pore solution begins almost immediately, providing for concrete compressive strengths that are similar to 100% OPC concretes at 7 days and exceed OPC concrete strength at 28 days. At replacement levels of 15~40%, the RFA concrete strength will continue to increase well past 28 days, giving an ultimate long-term strength advantage over an OPC-only concrete of 10% to 35%, depending on mix design.

Comparison Data - Tephra RFA

Sample	Cem TI/II %	Replacement %	w/c	7d	7d-SAI	28d	28d - SAI
Cement T I/II	100	0	0.48	5367	100	7210	100
Tephra RFA	80	20	0.48	5256	98	7698	107
Tephra NP	80	20	0.48	4892	91	7207	100
F Ash #1	80	20	0.48	4677	87	6335	88
F Ash #2	80	20	0.48	4489	84	6434	89
F Ash #3	80	20	0.48	4662	87	6662	92
C Ash	80	20	0.48	5382	100	6885	95

Mitigates Alkali Silica Reaction (ASR)

CR Minerals' Tephra® RFA has a higher surface area than other Class F fly ashes which results in a very reactive pozzolan. The RFA readily reacts with calcium hydroxide as it

becomes available in the cement paste and incorporates the liquid phase alkali into additional calcium silicate hydrate binder (C-S-H). By densifying the cement paste and removing calcium hydroxide as a potentially deleterious agent in the concrete, the prospect of ASR is drastically mitigated.

Resists Sulfate Attack

CRM Tephra® RFA pozzolan will react with the calcium hydroxide to form additional C-S-H, thereby removing or mitigating the opportunity for the naturally occurring sulfates in certain soils to react and damage the concrete. Additionally, the RFA pozzolan will decrease the concrete's permeability, thus restricting the ingress of sulfate infused moisture.

Reduces Permeability and Efflorescence

The leaching of calcium hydroxide produced by the hydration of Portland cement can be a significant contributor to the formation of efflorescence and internal porosity in all Portland cement-based concrete. Tephra® RFA pozzolan can effectively mitigate this by reacting with the calcium hydroxide to form stabilizing and strength enhancing C-S-H before it migrates to the surface of the concrete.

Protects Steel Reinforcement / Resists Chloride Attack

Concrete made with Tephra® RFA pozzolan in the mix design can protect steel reinforcement by creating a more densely packed concrete matrix which then resists the ingress of chloride containing liquids and other chemicals into the concrete. When 15-40% of cement is replaced with Tephra® RFA, it will react with the free calcium hydroxide and form a denser, less permeable paste, providing greater resistance to the ingress of harmful chemicals into the concrete matrix

Reduces Heat of Hydration

Experiments show that replacing 15-40% Portland cement (OPC) with Tephra® RFA pozzolan can reduce the expansion and heat of hydration by as much as 20~40%. Less heat is produced when pozzolan reacts with the available calcium hydroxide. Tephra® RFA pozzolan not only decreases the overall heat generated by cement hydration, it also delays the time of peak temperature. The 'heat of hydration' of a Tephra® RFA pozzolan–OPC cement mixture is extended longer and lower to form a more moderate curve than the 'heat of hydration' curve for OPC itself.

Water Demand

Fly ashes generally provide a lower water demand than cement while natural pozzolans generally provide a water demand that is similar to or slightly higher than Portland cement. The water demand for a concrete mixture incorporating Tephra® RFA typically ranges from 98-102% of the Portland cement control.

Time of Set Characteristics

As with most pozzolans, the initial time of set compared to 100% OPC can be delayed as the percentage replacement increases, special consideration should be given when selecting the usage of water reducing admixtures. Lignosulfonate or blends of lignosulfonate-based admixtures tend to contribute to slower set times in conjunction with use of Tephra® RFA. Polycarboxylate Ether based water reducers (PCE's)typically can reduce undesirable side effects of delayed time of set when used with Tephra® RFA. Most admixture suppliers have a family of PCE-based water reducers that are available for use. Consult with your admixture supplier for assistance on selection and use of an appropriate water reducer for your application.

Cold Weather Concrete Practices

The American Concrete Institute under ACI 306 defines that concrete will be exposed to cold weather when the following conditions exist for a period of 3 consecutive days: The average daily air temperature is less than 40F (5°C) and/or the air temperature is not greater than 50F (10°C) for more than one-half of any 24-hour period. During these periods, be conscious of the use Tephra® RFA in conjunction with a lignosulfonate-based water reducer as mentioned earlier. As normal, monitor concrete production temperatures and concrete temperatures in place during cold weather. Dosage rates or type of water reducing admixture may need to be adjusted for cold weather concrete and concrete accelerating admixtures may be needed. Consult with your admixture supplier. Refer to ACI document 306R-16 "Guide to Cold Weather Concreting" Refer to NRMCA Concrete In Practice (CIP) #27 Cold Weather Concreting.

Technical Information Summary

Bulk Density: 47-50 lbs./c.f.
Specific Gravity: 2.38-2.45
Passing 325 mesh screen: 90%+
Water demand: 98~102% of cement control
Strength Activity Index (SAI): 85~95% @ 7 days; 100~117% @ 28 days, depending on mix design
ASTM C618 Class F: Meets or exceeds all Class F specifications
AASHTO M295 Class F: Meets or exceeds all Class F specifications
ASTM C1012: Meets Class 3 exposure requirements at 6, 12, and 18 months
ASTM C1260/C1567: Acceptable mitigation at 14 days and 28 days of a highly reactive aggregate which is known to cause .6~.7% mortar bar expansion in only 14 days; in the same mix design, using Tephra® RFA at 25% replacement of the cement, the 14 day (.02) and 28 day (.07) expansion results are well below the acceptable limit per C1567.

Additional Information at www.CRMinerals.com

To place an order or obtain additional information, please contact CR Minerals at719-239-7869