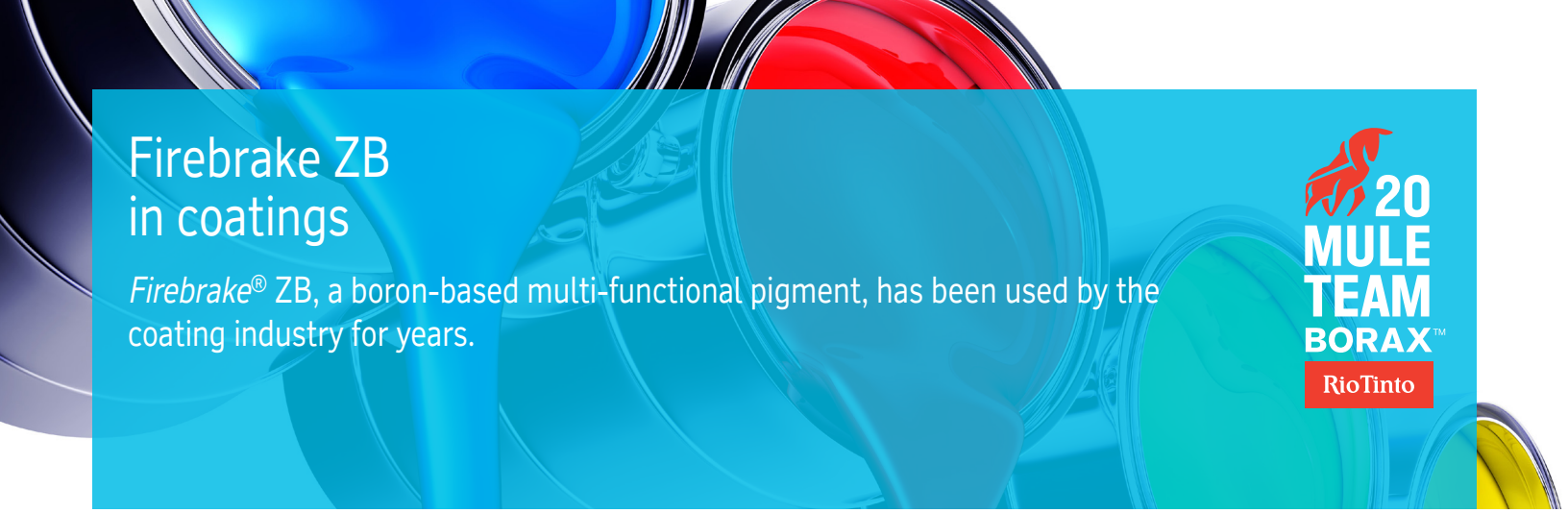

Firebrake ZB in coatings

Firebrake® ZB, a boron-based multi-functional pigment, has been used by the coating industry for years.

Firebrake ZB properties make it suitable for use in coatings:

- Its low solubility and low reactivity prevent cross-linking and interfering with the paint rheological properties
- High dehydration temperature (>290° C): Some other forms of zinc borates have a dehydration temperature in the 100-200° C range which make them potentially unsuitable for use in hot pigment grinds, bake finishes, and powder coatings
- A nearly neutral pH (7.1-7.8) in aqueous slurry: This allows *Firebrake* ZB to be compatible with a wide variety of aqueous and non-aqueous resin systems
- A low reflective index: Aiding in the formulation of a wide range of bright colors and clear coatings

Table 1: Characteristics of *Firebrake* ZB

Formula	$2ZnO{\cdot}3B_2O_3{\cdot}3.5H_2O$
Appearance	Free flowing white powder
Specific gravity	2.8
Typical median particle size *Firebrake* ZB *Firebrake* ZB Fine	 9 µm 2 µm
Refractive index	1.58
Oil absorption	35g oil / 100g
pH of aqueous slurry	7.1 – 7.8
Solubility (wt% at room temperature)	<0.28
Dehydration temperature	>290˚C (>554˚F)

Fire retardancy

Flame retardant coatings are widely used to enhance the flame retardancy of various materials including flammable materials (eg, polymers and wood) and nonflammable materials (eg, steel). Flame retardant coatings may be categorized into two groups: Intumescent fire retardants (IFR) and non-intumescent coatings.

With IFR, the coating decomposes to form a char which is then expanded into foam by the release of gases. The trapped gases within the foam form the char into an insulating layer of carbon which protects the underlying substrate. IFR coatings are applied to surfaces which require improved fire resistance. They are commonly used in the construction industry to give improved fire resistance to building materials by reducing the rate of temperature increase and hence prolonging the time for the building materials to reach critical failure.

Zinc borate is an important component in many fire retardant and intumescent coating formulations. Frequently, other fire retardant additives, such as antimony trioxide or alumina trihydrate, are used in combination with zinc borates to provide synergism leading to a high degree of fire retardancy. *Firebrake* ZB acts as a fire retardant, smoke suppressant, and afterglow inhibitor. It also has anti-arcing properties to insulation used in electrical applications.

It has been employed in a wide variety of solvent-based and aqueous fire retardant coatings, including solvent epoxies, vinyl chlorides, and acrylics.

Anti-corrosion

Soluble borate compounds have been widely used as corrosion inhibitors in recirculating cooling water towers, automotive antifreeze/coolant solutions, cutting fluids, and lubricants.

Firebrake ZB is a unique form of zinc borate which can be used as a corrosion inhibitor in both organic solvent-based and water-based coatings. It is an efficient and cost effective corrosion inhibitor that allows the formation of high performance coatings. Synergistic enhancement of performance has also been noted with the combination of zinc borate and common corrosion inhibitive pigments, such as zinc phosphate and barium metaborate.

Mechanism of corrosion protection

Borates are generally regarded as anodic passivators. Their hydrolysis products are believed to promote the formation of a passivating

oxide layer of unusual integrity on metal surfaces. They also provide buffering action and possess considerable buffering capacity. Borates may act to neutralize the extreme pH environment associated with corrosion cells, thus interfering with the establishment of functional anodic and cathodic sites that lead to corrosion and loss of adhesion. Research has found that zinc borate provides exceptional protection against pitting and generalized corrosion beneath paint films.

Studies show that zinc borate is effective as an anti-corrosion pigment for solvent-borne coatings based on alkyds, epoxies, epoxy esters, polyurethanes, and phenolics. Good corrosion inhibition has also been noted in coatings based on acrylic and modified acrylic emulsions, water reducible alkyds, and water-borne epoxies.

The anticorrosion resistance of *Firebrake* ZB has been demonstrated by outdoor exposure tests. Solvent based epoxy polyamide, urethane alkyd, and medium oil alkyd primer coatings using various anti-corrosion pigments were tested in a severe marine exposure site. The same dry film thickness of 2 mil was applied and the results were measured after six months of exposure (Table 2). *Firebrake* ZB offers a superior performance in the alkyd and medium oil alkyd primer, and ranks second in epoxy primer after zinc chromate.

UV protector

Zinc borate is synthesized with zinc oxide and boric acid. The zinc oxide, which is present chemically and physically in the zinc borate, is used as antioxidant in many personal care cosmetic formulations and as a light stabilizer for polymer formulations. Zinc oxide in the zinc borate is the main ultraviolet absorber in the polymer material. As the UV is readily absorbed by the inorganic additive, the polymer is less exposed to ultraviolet rays and light. Hence, the polymer composite becomes much more stable and has a longer life with no significant change in mechanical and other properties.

A study by U.S. Borax has shown that the addition of zinc borate in a water-borne coating based on a clear acrylic emulsion reduced about 20% the transmittance throughout the spectral range from 300 nm to 750 nm. A reduction of 10-15% of UV transmittance was observed in a solvent-borne alkyd coating. In all cases, *Firebrake* ZB caused a reduction in light transmittance of the films in both the UV and visible parts of the spectrum.

Tannin stain blocker

Tannin stain is the discoloration of coating on wood caused by the bleeding of water-extractable components from wood. This is especially severe for colored extractable rich wood, such as redwood or cedar, particularly when exposed in moist environments. The incorporation of zinc borate into wood primers and topcoats can significantly reduce or eliminate tannin staining.

Table 3 shows the tannin test results of a vinyl acrylic latex wood primer on various wood species. In this test, *Firebrake* ZB was

Table 2: Performance of anti-corrosion pigments in primer applied to cold rolled steel and exposed to marine weather

Performance	Epoxy polyamide	Urethane alkyd	Medium oil alkyd
Best	Zinc chromate	*Firebrake* ZB	*Firebrake* ZB
↓	*Firebrake* ZB	ZB/ZP*	Zinc phosphate
	Neg. control	Zinc phosphate	ZB/ZP*
	ZB/ZP*	Zinc chromate	Neg. control
Worst	Zinc phosphate	Neg. control	Zinc chromate

The same amount was used for each anti-corrosion pigments (30 phr).
*ZB/ZP = 1:1 mixture by weight of *Firebrake* ZB and zinc phosphate

Tests completed at U.S. Borax laboratories.

compared with two other popular tannin stain blocking additives, a modified barium metaborate and a barium phosphosilicate. *Firebrake* ZB provides the highest tannin stain blocking performance for both cedar and redwood.

Stability

In water-borne systems, pH often has a profound effect on viscosity and general stability. Aqueous paint compositions are often basic in nature and can become unstable below a minimum pH level, usually specified by the resin supplier. Below this critical level, the paints have a propensity to gel or coagulate. In some cases, adding *Firebrake* ZB in aqueous paint may result in a slight drop of pH (usually no more than a few tenths of one pH unit) but in most cases, the pH will remain stable.

Adhesion promoter

Adhesion is the most critical property of a coating durability. Studies have shown that the addition of zinc borate can promote wetting and adhesion between coating films and metal substrates including steel, aluminum, and copper.

Table 3: Tannin stain resistance

	Control	*Firebrake* ZB	Barium Metaborate	Barium Phosphosilicate
Cedar	5+	8	7+	8+
Redwood	3	6	4	5

*Tannin stain resistance (10 = no failure, 1 = complete failure)

**Tannin stain blocker is used at the same loading per weight in each formulation. Filler was added to control to compensate for the tannin stain blocker addition.

Tests completed at U.S. Borax laboratories.

Firebrake® ZB

About U.S. Borax

U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving 500 customers with more than 1,700 delivery locations globally. We supply 30% of the world's need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles. We pioneer the elements of modern living, including:

- Minerals that make a difference: Consistent product quality secured by ISO 9001:2015 registration of its integrated quality management systems
- People who make a difference: Experts in borate chemistry, technical support, and customer service
- Solutions that make a difference: Strategic inventory placement and long-term contracts with shippers to ensure supply reliability

20 MULE TEAM BORAX™

RioTinto borax.com